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Peak management for the Dutch Railways: can students be banned from the rush hour?

A Case Study for the Rotterdam area

Abstract:

This thesis discusses the different possible policies in order to review the suggested policy from the NS to ban students from the rush hours (Bouwens, 2016)*. The passengers from the NS are facing overcrowded trains in the urban areas. The first part of the text is looking at theoretical support for peak management, strategic pricing and it looks at other countries. The second part is a case study about Rotterdam which shows the local process of decision making. The NS is trying to change the behavior of passengers and focuses on raising the awareness to use different modes of transport. Pricing policies combined with loyalty programmes could be an easier solution than banning certain groups of customers.*

Masterthesis Business Economics
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Contents

Preface:

This thesis was written to complete the Master programme in Business Economics with specialization in Urban, Port and Transport Economics. I was engaged in writing from April 2016 till May 2017.

The research was performed independently from any business named in this research. The urgent problem of overcrowded trains in The Netherlands needed a helicopter view. All companies involved in this research have their own ideas and interests. Bundling them together might help the NS in making policies. The case study of Rotterdam shows the cooperation between the local Governments, the educational institutions and the public transport companies.

There are two people who deserve special attention. First and foremost, I want to thank my supervisor dr. Giuliano Mingardo. Due to personal issues I had a 7-month break in the writing process. I never had the feeling that I needed to hurry. Every meeting I felt sincere interest in my topic and I liked the discussions about a variety of problems. Furthermore, valuable contacts with local companies helped me a lot finishing the case study.

On of those valuable contacts was Adem Cankaya from De Verkeersonderneming. He showed very much interest in the topic and even helped with additional papers, reports and connected me to the most essential link in this thesis: the NS.

I take full responsibility for both the opinions I express and for the factual accuracy from the interviews I did.

Enjoy reading

Frank Seip

Rotterdam, May 2017

1. Introduction

1.1. Problem Statement

The Dutch Railways are being blamed for overcrowded trains. Especially in the rush hours, when most people go to their work or get back home, trains are crowded. When we look at data from the Dutch bureau of statistics (CBS), we can conclude that the Dutch Railways is the most frequent used railroad and that they transport the most people per kilometer railway in Europe. With 2.5 million passenger kilometers for each kilometer railroad in one year, the Netherlands is on top. EU-27 countries that come close are Italy, France, Belgium, United Kingdom, Denmark and Germany (CBS, 2009). With the upgoing trend of customers and the introduction of free[1] public transport for an additional 90.000 students under 18 years, the Dutch Railways, NS[2] from now on, came with an interesting idea.

On March 2nd, 2016 the NS pronounced big changes in the public transport sector for students. The NS is suggesting a shift in the timetables for students to prevent them from travelling at peak hours. Research showed that this would not cause any trouble in the average student's life (Bouwens, 2016). However, considering myself attending lectures which have been shifted to avoid the rush hours, forces me to quit my 20 hours-a-week job. Lots of students revolt against this plan. They organized a ludic caveat with 27.000 students travelling during the peak hours by train. It was not a great success, but their point was made: Students does not like lectures in the afternoon or evening (Verlaan, 2016). My interest is therefore to find the real arguments behind this idea. Lots of newspapers and magazines have been writing about this case, but with the NS as center of this research, getting answers will not be easy (Maartens, 2015). The NS conceals most of the data in order to protect their knowledge and experience. As said, the Dutch rail network is used intensively, which is interesting for competitors. This might give crucial information to foreign, much larger, train companies who have in turn more international power and could force the NS to change business.

The NS, represented by Chief executive officer Roger van Boxtel, focuses on the Randstad where most universities are close together which causes extreme crowded trains at peak hours with both commuters and students. Van Boxtel acknowledges the material problem, but counterattacks this argument by saying that students are the best traceable group, as they are with thousands at the same time at the same place, and that they can be easily transported by train at different hours (Tsao, 2016). Also, next year will be a peak in the number of student-cardholders for public transport

[1] Students receive this as a gift after getting a degree within the selected timeframe. More detailed information on http://www.studentenreisproduct.nl/detail/over-het-studentenreisproduct/

[2] Nederlandse Spoorwegen, Dutch Railways.

use. The 90.000 extra Dutch students under 18 years will get this card as well. This will make a total amount of students that potentially use the train on a daily basis of more than 700.000 (de Vos, 2011). With new trains coming, part of this problem is tackled, but with a better spread of people over the day, the NS tries to improve the satisfaction among the travelers and increase the quality.

Students, who might be involved in this suggested shift, counterargue this with the miss of income from part-time jobs. A lot of students work in the field of hospitality and catering next to the lectures. If the universities agree with the suggested plans of the NS, students miss possibilities to work in the evening. Combined with the fact that students recently lost their financial study-support provided by the Government, 'being student will be for the elite once again', is the most common reaction (Tsao, 2016).

The last party directly involved is the university that changes the schedules. Shifting lectures to off-peak hours means that there is also need for personnel at the end of the day. Instead of the classic 9-17 working hours, both the university and the employees need to adapt. This does not seem to give much trouble, but thousands of employees need to be paid until late. Others will have children at home and are not happy with a working day from 12:00-20:00.

1.2. Aim and Research Questions

This thesis is focusing on the different parties and reviews the suggested policies by the local Governments, the educational institutions, the students and the public transport companies. The main research question for this thesis is:

What policies could the NS use to reduce the number of students during the rush hours?

This thesis wants to research first and foremost whether the NS has suggested a feasible plan to ban students from the peak hours. Since the problem is two-sided, both parties will be reviewed. The NS on one side as the policymaker and the students and universities as parties who need to react. In the next section the theory behind this idea is explained in three subsections. All three subsections have their own research question as to make it clear for the reader. One of the theoretical approaches used in this thesis is peak management. The problem of having large demand peaks at the rush hours is the exact problem. Improved peak management has the goal to flatten peaks and get a predictable and constant demand. However, the problem of peaks is the seasonality. Every working day the NS suffers from the same peak demand. The paper of (Ronen, Coman, & Schragenheim, 2001) looks at the capacity during peaks. The NS might be able to use more trains during peaks and on more crowded routes. On the other hand, having the knowledge that The Netherlands has already the most frequently used railroad of Europe, we certainly have to look for other solutions as well. In the

last part of their paper they argue about implementing a pricing policy on the passengers. With different prices at different hours of the day, the NS might be able to get rid of the peaks. A pricing policy is not an innovative tool, since the whole market is functioning in this way. In case there is more demand, the prices will go up.

Subsection 1: Peak management and price incentives: what public transport companies can do.

''How can the NS make use of peak management and smarter pricing in order to remove the rush hour peaks?''

There surely are more theoretical measures to overcome the problem of overcrowded trains. With peak management and the pricing strategy full trains can become history. For example, the NS is currently offering 6 different monthly or yearly subscriptions. One of them offers off-peak rides for a strongly reduced price (NS-producten, 2017). The paper of (Ronen, Coman, & Schragenheim, 2001) about peak management will provide the theoretical basis needed to answer this question whereas the field study of Spitsmijden will focus on the application and the feasibility of this idea (Knockaert, Peer, & Verhoef, 2013). The next question this thesis focuses on is copy-pasted from the statement of Roger van Boxtel, CEO of the NS, who addresses all students. In his opinion, shifting the timetables of universities such that every class starts after the morning rush hour and finishes after the evening rush hour would be a proper solution.

Subsection 2: Effects of shifting timetables: what students and schools can do.

''Assuming that the NS can force universities to change the timetables in NS's favor, would this, in theory, be a solution to the given problem?''

The assumption made in the question might be exaggerated, because in the current ownership status, where the NS is partly state-owned, this is not going to happen. Still, the assumption might be valuable to get further insights in the topic. The whole network between the NS and its customers becomes visible. Students are one of the major sources of revenue. In the annual report of 2015 the NS estimates that particular revenue at €459 mln. When we take the average of the profits after taxes for the last 10 years, the NS gains €182.1 mln annually (NS, 2016). Besides looking at the annual reports of the NS, we also look at other countries. When we compare different situations, a better insight in the real problem in The Netherlands can be given. When you google on 'crowded trains India' you sometimes do not even recognize the train because of all the people hanging at the sides. Do we, speaking for the NS, actually have a problem? It might be true that people who travel with overcrowded trains value the NS lower than people who always have a seat (Knockaert, Peer, &

Verhoef, 2013). It is true to say that customer satisfaction is important for the NS, therefore a comparison with other countries is valuable which introduces the final question of this thesis.

Subsection 3: Other countries

''Is the situation of overcrowded trains really exceptional in The Netherlands compared to other countries?''

1.3. Methodology

To give the reader as many insights as possible and to be able to draw conclusions about the policy of the NS, I will perform a case study for Rotterdam. Preceded by an extensive elaboration of theoretical papers the theory about policy making can be used in practice in the case study. This thesis is a qualitative study which connect theory to practice. The papers used in this thesis mainly concentrate on railways only. However, other markets like the energy market and water management proved to have similarities in policy making. Especially peak management is used broadly. Other theories that are reviewed in this thesis are strategic fare pricing, modal shift, policies in other countries and this thesis uses the outcomes from a large research called Spitsmijden in de Trein. The case study focuses on Rotterdam since Rotterdam has many students, a large demand for public transport and because it is a business centre. For the case study local parties have been interviewed in order to get more detailed information about the policy making and their point of view regarding the suggested policy of the NS. A summarizing table at the end of this thesis forms the basis to suggest different policies to solve the problem.

1.4. Structure of the Thesis

With the theoretical background discussed in section 2 it will be easier to understand the tactics of the NS and to judge whether they were right or not. The actual case study is executed in section 4 preceded by an elaboration of the NS in section 3. How they work and what their rationale is behind this plan gives the needed background information for the case study of students in the public transport in Rotterdam. In the case study the NS, as initiator of this plan, and the parties to whom was asked to change their business somehow, are interviewed which will be compared to the literature from section 2 . The conclusion and further recommendations can be found in section 5. My goal will be to find the best argument among all involved parties and implement this to the others. What will be the consequences for them?

2. Literature review

This part forms the basis of this thesis. With an extensive explanation about the subject, the different parties that are involved and the models they use, this literature part is essential. First, I will start with discussing the possibilities for public transport companies like the NS (Section 2.1.). The NS thought about a plan to lower the peaks during the rush hours and decided to suggest that students should not longer travel by train during those hours. There is a lot of literature about peak management. So, first we assume that the NS can overcome the problem by themselves with better scheduling, peak management and pricing strategies. In the next part, it is assumed that the NS tried everything to solve the problem of overcrowded trains internally, so that all involved parties of this plan should now look at their contribution (Section 2.2.). The universities and the students themselves should be able to react and be flexible somehow. With some help from researchers from the project Spitsmijden in de Trein the theory can be combined with some practical data. This research is in short a field experiment held in The Netherlands to show the value for people to commute by train during the rush hours (Knockaert, Peer, & Verhoef, 2013). Section 2.3. is about the difference between The Netherlands and other countries. It might be completely normal to see very high peaks in train use during the rush hours. With the data from other countries, it can be concluded whether or not the NS is relatively underperforming and that it should act like other foreign railway companies.

2.1. Public transport companies: Peak management, strategic pricing and a modal shift

New trains cost up to 20 million Euro a piece and it takes approximately 5 years to procure while the cost of building new tracks can easily cost billions and take at least ten years to implement (Henn, Karpouzis, & Sloan, 2010). For this reason, the NS sought for alternative and cheaper options. Short term solutions can in turn buy time for executing long term projects. Passing on the problem to students sounds like a short term solution. The question remains: can railway companies like the NS solve it internally? Historically, peak management seems to give useful solutions to excessive demand. Overcrowded trains during peak hours are a result of excess demand. The first results can be booked by improved peak management.

2.1.1. Peak Management

The definition of a peak can be stated as*: "Peaks occur when a firm accustomed to operating under market constraint conditions occasionally encounters peaks in market demand that temporarily exceed the firm's supply capacity* (Ronen, Coman, & Schragenheim, 2001)." This is exactly applicable to average railway companies. Within certain timeframes, the so-called peak hours, the demand exceeds the capacity and the trains get rapidly full. In the paper of Ronen, Coman and Schragenheim

about peak management, capacity is of great importance. A simple distinction between protective capacity and excess capacity is made in figure 1.

Figure 1: Protective capacity versus Excess Capacity

Protective Capacity	
A given amount of extra capacity at non-constraints above the system constraint's capacity used to protect against statistical fluctuation.	
Public transport companies	Keep some extra space in reserve by having idle trains ready to respond on excessive peaks

Excess Capacity	
A situation where the output capabilities at a non-constraint resource exceed the amount of productive and protective capacity required to achieve a given level of throughput at the constraint	
Public transport companies	Having not all chairs occupied which is always the case in off-peak hours.

Figure 1 explains the two types of capacity followed by the example for public transport companies. Protective capacity depends on the number of trains owned by the railway company. If there is a shortage of trains, the protective capacity is low. Excess capacity is inefficient capacity (not used). Railway companies do not like excess capacity, but in off-peak hours this is inevitable (Ronen, Coman, & Schragenheim, 2001).

This distinction between protective and excess capacity is important for measuring the bottlenecks. When a railway company shows the ability of having protective capacity for every situation, larger-than-normal peaks will not occur. Excess capacity is only zero in a perfect efficient market. The goal is to reduce the excess capacity to a minimum, but have sufficient protective capacity in case of disruptions or other causes for delay.

The paper of Ronen, Coman and Schragenheim (2001) also differentiates between peaks and can be seen in figure 2. Not every peak is just a peak in demand. Railway companies cannot just ride on half capacity on a busy day and say that they were surprised by the enormous demand.

The four peaks that are distinguished are:

- **Classical Peak Management**: In this peak **s**easonality is involved and it is therefore easy to predict.
- **Unexpected Christmas**: Result of planning failure. The peak was predictable, but the firm did not prepare well.
- **Rapid response:** All materials are prepared for unpredictable peaks. For this peak you must think far ahead.
- **Opportunity/Crisis management**: Real problems which can possibly cause bankruptcy or closure. Solutions are outsourcing, rapid decision-making and alliances with competitors.

Figure 2: 4-peak-matrix

		Peak Occurrence	
		Expected	Unexpected
Firm's Condition	Prepared	Classical PM	Rapid Response
	Unprepared	'Unexpected Christmas'	Opportunity/Crisis Management

Figure 2 is about the four different situations in which peaks occur and in which they can do harm to a company. Both the responsiveness of the company and the occurrence of the peaks play a role. Peaks that are unexpected are difficult to react to. On the other hand, peaks that were foreseen, do not really have to be a problem. Peak Classification (Ronen, Coman, & Schragenheim, 2001)

The next step in peak management after recognizing the peaks is to make better forecasts. With proper forecasting, future peaks can be minimized. Thinking in solutions sounds simple, however, there are many factors that influence future demand. The slidesets of Professor Wolfgang Maass from the Saarland University explain the simple model with linear relationships. Inputfactors price, type of adverstising, day of the week and time of the day must be considered, as well as the outputfactors turnover, sales volume and number of customers (Maass, 2011). The railway companies could for example raise the price during the peak hours such that the demand decreases drastically. In case the turnover stays at the same level with less customers during the peak hours, the people who can afford this fareprice might be more satisfied during their trip. However, in countries in which the railway company is state-owned, general accessibility of the train is of great importance. Railway companies could use two strategies to match demand and capacity according to a paper about service management (Fitzsimmons & Fitzsimmons, 2003). Figure 3 shows those strategies.

- **Managing demand:** level capacity throughout time irrespectively of the demand.
- **Managing capacity:** adapt the capacity to the forecasted demand.

In case a railway company decides to use demand management, people who do not like to travel in overcrowded trains will travel off-peak. This method is not very customer friendly. A policy of managing capacity with more and longer trains during the peak hours and lower frequency during the summer seems more realistic in practice.

Figure 3: Demand and Capacity management

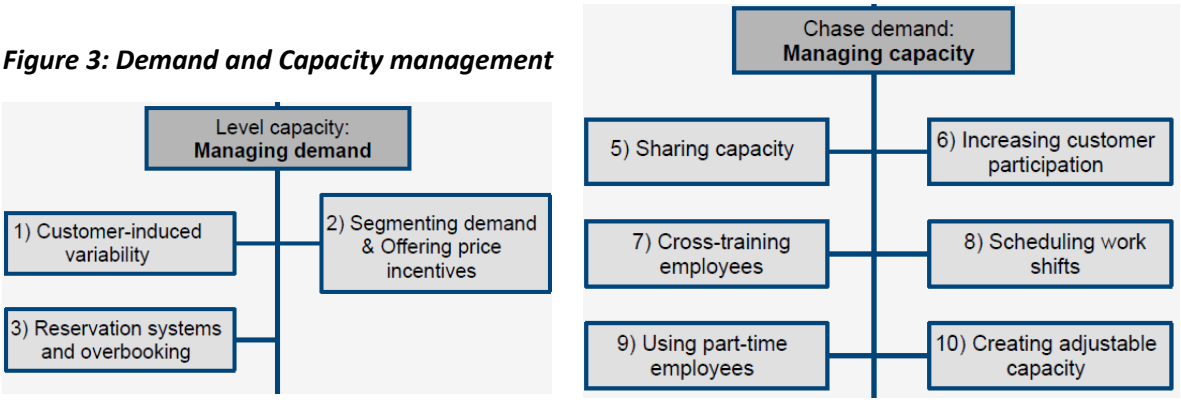


Figure 3 shows the the differences in policy between managing demand and managing capacity. On the left, the demand with three policies and on the right the capacity with six possible policies (Fitzsimmons & Fitzsimmons, 2003).

First we look at how the railway company should manage the capacity. In case of a large peak, they could be helped out by other transport modes offering the same routes at comparable speed. Sharing capacity is already used in the airline industry where in case of low demand multiple airlines arrange a combined flight. This 'codesharing' has positive effects on the profit margin as the party is sharing with more partners (Zou & Chen, 2017). The railway company could sign alliances and allow other operators on the railway to collaborate in case of fluctuating demand. Both in the peak hours and in off-peak hours, they could benefit from other players in the market. Another interesting policy for the railway companies would be to reschedule the work shifts and to hire part-time employees.

When we look at the demand side, the policies that might help to flatten the demand peaks are offering price incentives and other pricing strategies. In the next part this will be discussed in detail.

2.1.2. Strategic fare pricing

In case we want to manage the demand, Fitzsimmons and Fitzsimmons (2003) propose the policy of strategic fare pricing. The idea of higher prices at higher demand is used in almost every commercial sector. When we look at the possibilities for a railway company there are two options:

- Adopt the fare price to the time of the day.
- Adopt the fare price to the real-time demand.

Both options sound valid, but with a huge difference in investments. Real-time data is costly to obtain and to process. New systems should track the current rate of overcrowdedness of the trains. Another question will then be whether people from small rural places should pay the same price as someone from Rotterdam while the rural train is almost empty. Digging deeper into this suggestion, real-time fare prices based on the percentage of seats occupied per train at that moment could be an idea. Saying that it would be unfair to people who check in later or at another station compared to

people who live close by the starting point, sounds reasonable. However, the people who occupied a seat early travel a longer distance and people who get in for one station could be punished by higher fare prices. Those people can also commute by bike.

A practical example of a model to tackle demand peaks by real-time pricing comes from the energy market in California (USA). An experiment with real-time costs was conducted among 1142 commercial users and industrial businesses who paid a price which was dependent on the current demand and supply of energy. Before this 4-year research project, those customers paid in three classes: peak, shoulder and off-peak. With the real-time costs the awareness of the participants increased, notwithstanding that they paid on average slightly more than before. The positive outcome was that the peak demand was lower which could also help the railway companies in decreasing their peaks. A drawback of this method is the price for changing the systems into real-time ticket machines. For the customers it might be somewhat confusing to see different prices every time they travel by train, but with a great investment, this method might work as well (Borenstein, 2009).

When we apply time-dependent costs to a lesser degree than above, the project 'Spitsmijden in de trein' suggested a daily reward for people who change their commuting time to off-peak hours (Knockaert, Peer, & Verhoef, 2013). This incentive for people to get a reward by avoiding the peak hours is however more complicated than the day-time adjusted fare prices. The reward system is sensitive to fraud and someone must keep track of all the rewards that were given to the customers. It would be less work when we just look at the peaks and suggest higher prices at these hours. More on this project in the next section.

That implementing higher peak prices is easier said than done, is shown in the BART-research where a survey was completed in San Francisco in order to find strategies to fight against the demand peaks. Many other policies must be considered. Where the NS is not sharing their statistics with others, this San Francisco survey has been filled in by 52,000 commuters. The results are freely available (Nygaard, 2008). It looks at the origin versus destination and other factors like gender, age, time of the trip and compares that with data from the decade before. The main contribution of this report to this story is that railway companies with large demand peaks could use two strategies as can be seen from figure 4.

Figure 4: Pricing strategies versus Support strategies

Pricing Strategies	Support Strategies
Peak fare princing	Bicycle access
Station-specific surcharges	Land use oriented development
Fare pass programmes	Promotion of alternative transit modes
Peak parking pricing	Passenger flow enhancement mechanisms

Figure 4 shows the two categories of demand management strategies according to the San Francisco survey. In the left column the pricing strategies with 'peak parking pricing' as new topic in this paper. In the right column are the support strategies which try to smoothen the trip as good as possible (Nygaard, 2008).

The supporting strategies to smoothen the peaks are simple. Bicycles cover a lot of floor space which is undesired during peak hours. When having a good look at the NS, they already banned bicycles during the peak hours. The land use development is, in a small country as The Netherlands, very interesting. Future tracks cannot be built in de city center without a proper zoning policy. To have reasonable low costs, the railway companies really should think years ahead. Next are the chances to flatten the peaks by promoting other transit modes during the peak hours. The customer satisfaction goes down with overcrowded trains during rush hour, while people might be more satisfied with a guaranteed seat in a bus or a tram. The last supporting strategy that might help is having good records of your customers. When you expect a peak you can react to that and try to solve the problem. Without any data this will not work.

The pricing strategies from this study form the main part of this section. A railway company in a country where it is state-owned can, as price-setter, ask whatever they want for a ticket. Of course there is some pressure from the Government to keep the train accessible for all social classes, but asking a higher price during the rush hours can discourage people to commute by train. In combination with supporting other transport modes, this might be a policy encouraged by the local Government. Higher parking prices at rush hours is the next interesting policy. Many commuters go by car to a nearby train station. In case the local Government applies a parking policy that makes it unattractive for commuter to pay the maximum daily price for parking their car next to the station. Commuters will go more ofter by bike or will reconsider the train as mode of transport. An actual example of victims of a parking policy is my hometown Barendrecht. The local station has free parking, but the stations of Lombardijen and Zwijndrecht (the two closest to Barendrecht) have recently changed the parking policy. People need to pay for parking and many of them drive to Barendrecht for the free parking. Local research showed a lot of cars on the parking-deck come from other places than Barendrecht (Schakel, 2016). If all local policymakers decide to implement paid parking around the train station, the NS will miss customers at every hour of the day and probably more people commute directly by car. This might not be the ideal solution, but parking policy certainly is something to be aware of.

The last pricing strategy mentioned in the San Francisco survey is fare pass programmes. When railway companies offer specific monthly subscriptions people be influenced in their behavior in a subtle way. Suggest a 20% reduction at off-peak hours starting from 09:00. Many commuters that would normally leave home around 08:30 might consider a minor shift. Spreading the demand by smart monthly subscriptions is possible.

A small note to this is made by Strbac is his paper about demand management where he emphasizes the value of price differentials between the products that are offered. During peak demand periods prices should be significantly higher than in off-peak periods in order to justify the investments in obtaining all those different products (Strbac, 2008). Simply said, the price for the off-peak card should be significantly lower than the student card or the 'always' card.

Not only in the commuting sector peak management is needed to prevent shortage on capacity, also water management, transit and electricity service suffer from temporary peaks.

Reduction of the underlying need for peak travelling in train transport seems to be the optimal solution. However, previous research showed that for watermanagement people are willing to response on the price change of water. The price was higher in the morning and just after dinner. The participants turned on the dishwasher at a different times to save money. For train transport, a larger compensation is required to get some participants, but when you can implement this on a large scale and could get a better spread of working hours and different schedules for students, man can get full control of the peaks. The point is that price responsiveness vary by income group which raises the social question that water, or in this case train trips, should be available for everyone at a price that do not significantly influence the wealth of people (Renwick & Archibald, 1998).

2.1.3. Modal Shift

The last policy discussed in this paper is creating a modal shift. In case the railway company is in real trouble due to very large peaks, stimulating people to use a different mode of transport might help. Of course, potential passengers who do not use the train anymore cause a decrease in the number of customers. On the other hand, some situations of extreme overcrowded trains like in India desperately need a modal shift. In some cases or in some countries this is not possible because of an outdated infrastructure, but a modal shift can be seen from different perspectives.

When the railway company desires a modal shift from train to other transport modes, it indicates problems with the pricing strategy or peak management. Creating a modal shift might thus not be a good solution for a railway company, nevertheless, it is a good indicator of structural problems.

An interesting table about the effectiveness of different policies on modal shift is explained in a paper of de Jong, Gunn and Ben-Akiva. They used a meta-model for passenger transport to show the simulations made for 2020. In the following table the outcomes are summarized. Note that the effectiveness is measured from road to other modes (de Jong, Gunn, & Ben-Akiva, 2004). Assuming that for train transport it is the other way around, a high effect of parking policies would mean that people tend to use the car less and therefore more often commute by train. For the railway companies this table might be helpful to focus their business plan on. Most investments are medium or are financed with Governmental revenues (taxes). The railway companies could therefore promote a certain policy to their own favor and try to control their customer base. The effectiveness for the railway companies is shown in figure 5 in the fourth column.

Figure 5: Effectiveness of policies on railway companies

Policy	Effectiveness (road→ other modes)	Investments needed	Effectiveness (Rail→other modes)
Intermodality	Low	Medium	High
Interconnectivity	Low	Medium	High/low
Congestion and road pricing	High	Low/gov. rev[3].	Low
Parking Policies	High	Low/gov. rev.	Low
Rail and fluvial interoperability	Low	Medium	-
Market liberalization (rail)	Low	Medium	High/low
Cost internalization	High	Low/gov. rev.	High
Maximum speed limits	High	Low	Low
Public transport pricing	Low	Medium	High
New urban public transport	Low	Medium	Low
Fuel price increase	High	Low/gov. rev.	Low
Housing and employment densification	Low	Medium	Low

Figure 5 explains the effectiveness of different policies on a modal shift. The second column shows the effectiveness of the policies for a modal shift from car to other modes and the fourth column from train to other transport modes (de Jong, Gunn, & Ben-Akiva, 2004). The investments needed to execute this policy can be seen in the third column. Investments are either high, medium or low. Public policies like a parking policy is funded by the Government.

The meaning of the fourth column will be elaborated next. Especially the meaning of 'low' and 'high' might be confusing.

[3] Gov. rev. = Governmental revenues (income from taxes)

High effectiveness in modal shift (Train → Other)

When increasing the intermodality people have multiple alternatives and choose more often for other transport modes. Secondly, cost internalization give higher ticket prices since external costs are incorporated in the ticket price or form a gap in the budget of the railway companies. In both ways it means less customers. The third policy that would result in a shift from train to other modes (especially cars and other private transport) is higher public transport pricing.

Uncertain effectiveness in modal shift (Train → Other)

Interconnectivity means a better communication and connection between different transport modes. A more sophisticated network result without doubt more satisfied customers, but the modal shift is uncertain. Another policy that can work out both ways is the market liberalization for the train sector. What happens if the railway company is losing power to competitors is not sure. Deutsche Bahn is already active on the Dutch railroad with Arriva and is planning to expand their business throughout Europe. With more competition for the railway companies, ticket prices may drop, which attracts more customers to commute by train, but the particular railway company will have a smaller market share (OVpro, 2015).

Low effectiveness in modal shift (Train → Other)

It is clear that with stricter parking policies, speed limits and congestion pricing, people tend to shift from car to other transport modes. For the railway companies, these policies can help in extending their customer base. Other factors are an increase of the fuel price, more centralized housing and employment (limited parking space) and an improvement in the inner city public transport. If the railway company wants to target a certain group of customers, these policies might help. For example, with car-free zones in cities, the railway company sees a direct increase of the number of potential customers. It might even help in filling the excess capacity. Low effectiveness does not mean that railway companies can not use this policy. This also works the other way around. If a railway company wants to attract more customers, the policies that were labelled ‘low’ in the fourth column of table 1 can help.

2.2. Educational institutions and students:The implications on shifting timetables

This section is about the effect of the suggested policy from the NS on the other parties. A sum up of all parties will be made and in section 4 the theoretical feasibility of this suggested policy from the NS will be tested. When we have a look at the main question of this section, we see that the policy is unilateral. The NS has a problem and it is trying to solve it by forcing the customers to change their

behavior. Support from the universities and students is needed to make the suggested policy an executable policy.

'Assuming that the NS can force universities to change the timetables in NS's favor, would this, in theory, be a solution to the given problem?'

Not only the universities are involved, also the students and the other transport modes are affected by these suggestion. The paper from Spitsmijden in de Trein helps to reveal the behavior of people that are lured with rewards for off-peak travelling. In case the lectures are shifted to the afternoon students will not receive any rewards for avoiding the peak hours because there is no valid reason for students to go by train in the morning rush hour. Nevertheless, the behavior of commuters shows similarities with that of students. Simply, work or school related trips must be made at a preset time whereas leisure trips can be made at any time of the day. The commuters and the students may value the rewards differently, but, in essence, they show many similarities in this research. Before focusing on the involved parties, a more in debt explanation of Project Spitsmijden in de Trein is given.

2.2.1. Project summary

Whether the NS has supporters for the plan of banning students from rush hours can be shown by doing a small scale test with commuters. The main question is: *"Are people in the first place willing to avoid the rush hours?"* Also important: *"Are the companies cooperative in shifting their schedules?"*

Project Spitsmijden asks whether, and to which extent, train commuters who already possess a monthly subscription can be tempted to commute in off-peak hours by offering them a financial reward (Knockaert, Peer, & Verhoef, 2013). The average costs for the train subscription of the participants in this research is €239,55 per month. The goal of Spitsmijden was to spread the demand in such a way that the NS did not need to have protective capacity for the peaks. It is expected that both the NS and the commuters will profit from smaller peaks. The NS has less excessive capacity and can expand the network with a smaller investment because they do not have unexpected peaks anymore. For the commuters, this project might find out to what extent the customer satisfaction increases. Are the commuters happier in less crowded trains?

During the 9 months of project Spitsmijden in de Trein over 1000 commuters used a mobile app which registered at what time they were on each station. The commuters only needed to enable their location (GPS) on their mobile phone. In 2009 Frans Glazener did some research for Transumo. It turned out that people are not willing to change their normal public transport card into an off-peak card with a 20 percent reduction for off-peak commuting (Glazener, 2009). With this outcome

Spitsmijden had to focus their research more on the underlying reason why people commute during the rush hours.

The rewards during the 15-18 weeks of the 'reward period' were half of the time high and the other half low. Travelling at off-peak hours, dependent on the travel distance, gave rewards from €1,50 to €4,50 per trip as can be seen in figure 6.

Figure 6: Different treatment for participants in 'Spitsmijden in de Trein'.

Travel distance	High reward	Low reward
less than 25 km	€2,50	€1,50
25 – 40 km	€3,50	€2,50
More than 40 km	€4,50	€2,50

Figure 6 explains the different treatments for the participants of the project 'Spitsmijden in de Trein'. Every participant had a period with high reward in case he or she avoided the rush hour and a period with relatively lower rewards. The rewards were paid monthly on the bank account of the participant. The sum of the reward depended on the travel distance (Knockaert, Peer, & Verhoef, 2013).

With different rewards this research tries to observe the actual incentive to avoid the rush hour. In case the results are the same for both reward categories, money is not the factor that influences the time of departure. Next to the time of departure and arrival, participants were asked to rate how crowded the train was during their trip, if there were spare seats and what grade (1-10) the overall satisfaction for the week would score. To get reliable outcomes, the group of participants should be compared to an equivalent group of non-participants. In the research of Spitsmijden in de Trein surprisingly many high-educated people participated and since many of them work for the Government or as teacher/researcher, it is expected that this group will have more flexibility than average. According to van Boxtel (CEO NS) students are the best traceable group and they are expected to be flexible. The outcomes of Spitmijden in de Trein can therefore be useful to project this on the students, the universities and on other modes of transport.

Next, the universities and the students will be discussed, supported by the outcomes of Spitsmijden in de Trein.

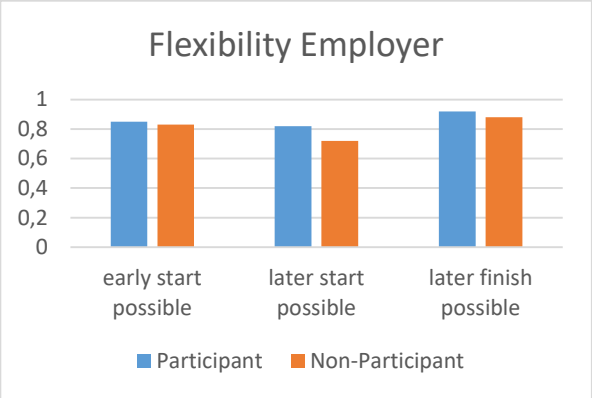
2.2.2. Universities

Universities are large businesses with many employees. For example, the Erasmus University had 2743 employees and over 27000 students at the end of 2015 (EUR, 2015). As in the paper of Ho, Deris and Zaiton, the Erasmus University works with timeslots. In most cases the timetabling is so complex that mathematical algorithms are used to optimalize the timetable for students and professors (Ho, Deris, & Zaiton, 2009). When we assume for now that finishing later with lectures do not cost more than on a normal working day (08:00 – 17:00), we can have look at the flexibility of the

employer (university) and the employees[4]. The first question will not be whether it is too costly to shift the lectures to off-peak hours, but whether the employer and employees are able to make this shift. The costs are not important for this moment, because the NS is partly state-owned, so eventually, the universities get compensated somehow.

The first important results from 'Spitsmijden in de trein' are those of the cooperation from companies and the possibility to avoid peak travelling. In Spitsmijden in de Trein, both the employer and the employees were contacted.

Figure 7 and 8: Ability of peak-avoidance by personnel and employers



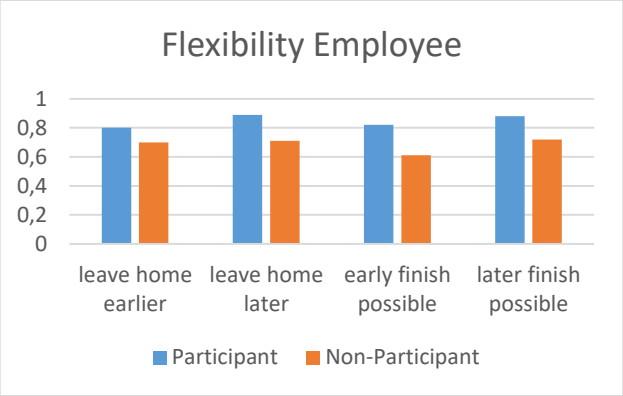


Figure 7 explains the flexibility for the employer in the case of Spitsmijden in de Trein. Assuming that the average participant of Spitsmijden in de Trein is very similar to the people who commute during the morning rush hour, these figures show very much potential. We see that finishing at a later time would be approved by 92% of the partcipants and 88% of the non-participants. Figure 8 explains the flexibility for the employees. Both 'later' options got a approval-rate of nearly 90%, which could be useful to shift the workinghours (Knockaert, Peer, & Verhoef, 2013).

From the Figures 7 and 8 it becomes clear that for the majority of the people commuting by train at off-peak hours is possible. Both the employer and the employees are well above 80 percent who answer 'yes' to this question. For the control group with non-participants the type of job, or maybe children at home, allow them less frequently to travel at off-peak hours than the group of participants. The other reason is that non-participants do not get a reward for travelling at off-peak hours, so it is evident that the incentive to do so will be lower. The same yields for shorter trips where people get a smaller reward and thus have a lower incentive. This difference in incentives is normally not resulting is a trustworthy research, but in this case it shows the potential for the groups that would consider to change their behavior and travel at off-peak hours. Concluding, employers and employees are very flexible. According to van Boxtel (CEO NS) students are flexible as well. Apparantly students and commuters are not that different.

[4] Teachers, researchers, security, technical staff etcetera

When we look at the newspapers from around the time of the announcement of the NS for banning students during peak hours, we see that not all universities are eager to change anything in their behavior. The Utrecht University (Bronkhorst, 2016) and the Hogeschool of Utrecht (Persbureau, 2016) are willing to cooperate in this plan and the same yields for the universities of Groningen and Enschede (Voermans & Nieuwenhuis, 2016). For the universities of Amsterdam (Wolthekker & Strikkers, 2016) and Nijmegen (Wienen, 2016) the opposite is true. They do not want, or they have no possibility to change the timetables. For the NS bad news, since both universities are on a busy route. The Erasmus University is willing to look for space in the timetables, but says that on most days the EUR is already teaching students until 7 p.m. Furthermore, Rotterdam seems not to be a major bottleneck for the NS (Smalling, 2016).

One of the most important outcomes of this research is the extent of which people willing to change their departure time. Spitsmijden in de Trein found convincing results for the NS. People are really willing to change their schedule, but expect something in return. The motivation of the reward triggered many participants to start later and finish early compared to their usual behavior. This sounds like participants work on average less hours, but with the large timeslots (2.5 hour peak in morning and afternoon) people can fall into the same group and still start earlier than before. When we look at the optimal departure times for both participants and non-participants we get figure 9.

Figure 9: Optimum departure time for train-commuters

Time	Participants	Non-Participants
MORNING		
Before 06:30	9,6%	4,5%
06:30-09:00	67%	92%
After 09:00	22%	3,9%
AFTERNOON		
Before 16:00	21%	9,2%
16:00-18:30	69%	88%
After 18:30	10%	2,5%

Figure 9 shows the difference in departure times for both the participants motivated with the reward and the non-participants during the same period. As can be seen, the peaks are smaller for the participants. Furthermore, the biggest change of schedule is in the morning. 22% of the participants commute after 09:00 versus 3.9% of the non-participants (Knockaert, Peer, & Verhoef, 2013).

Optimum departure times are, with the implementation of the reward-system, still during the peak hours, but to a much lesser extent than the non-participants. With the rewards, 25 percent less people travel in the morning rush hour and 19 percent less in the afternoon rush hour. These numbers would mean a serious reduction of crowdedness in trains during the peak hours. A form of reward in off-peak hours for students and commuters might be a good idea.

After knowing the optimal departure times, the optimal reward should be measured in order to be able to implement this project sometime in the real world. To get this data, Spitsmijden used a choice theory (stated preference) and the output from the participants who used the app (revealed preference). The outcomes of this research gives value to several factors that influence the customer satisfaction like longer travel time, off-peak departure, crowded trains and the chance of delay. In the next section, where students are discussed, this data will be used.

2.2.3. Students

To see what students prefer when we talk about the time of the day for lectures, a small step to neuroscience must be made. According to the article of Kevan Lee (2014), researchers found that the best ideas come early in the morning when the memory is still empty. Students should, according to neuroscience, be able to study best between 8 and 11 A.M. Lee also mentiones that other research showed that people are most creative when they feel the groggiest. However, when we assume students not being artists, the early morning is the time for the best performance (Lee, 2014).

The NS is asking students the opposite. Lectures that are shifted from the morning to the late afternoon do not only result in less attention from students, they also have problems with their jobs. The Nibud institute did a large study about students and their financial behavior. The part about jobs shows that 71% of the Dutch students have a job for, on average, 15 hours per week (Nibud, 2015). When we look at the type of job, we see that 16% of all students[5] work at a bar or pub and also many other students have a job at night. When we do some simple calculations 16% of 700.000 students means at least 112.000 students are not able to combine study and work anymore. There are of course other jobs for students, but the fact that they revolt against the plans of the NS seems justified. Many students blame the NS for not using enough trains. With the partly state-owned status, the NS has a 10-year target to limit the costs of the student public transport card to 750 million Euro. With the current annual costs of 1000 million Euro, a different policy is inevitable. During the peak hours, 25%-30% of the train kilometers come from students (Folia, 2016). Therefore, this group is relatively easily unified, which is harder to do with commuters who work for thousands of different companies.

To return to Spitsmijden in de Trein, students might be easier to trace as a group, but their critique on - and valuation of train trips are very likely to be the same as the commuters. The NS could benefit from this data from Spitsmijden in de Trein because it provides and individual valuation of certain characteristics during a trip. When the NS uses this data for determining the pricing strategies or thinks about different prices for the monthly subscriptions, they might please the students with a

[5] 22,5% of all working students

tiny reward for off-peak travelling for example. For the ease of this research, students who have lectures around the peak hours are assumed to value the following characteristics the same as commuters:

- Crowdedness
- Delays
- Shift personal schedule to pre-peaks
- Shift personal schedule to post-peaks
- Longer travel time

The participants have complaints about how crowded the train was during their trips. In the morning rush hour 60 percent says it was crowded or too crowded, and in the afternoon rush hour this rate is even higher (69%). With the reported on-time arrival of 74% in the morning and 72% in the afternoon[6], commuters who travel every day to their job and back home by train, had to wait on average 2,65 trips per week for longer than 5 minutes. Furthermore, 30% of the participants mention a shortage of seats during the trip which is on average 6,08 stations in length. The average satisfaction during the reward-period is between 6,8 and 7,2 out of 10. Weekends are excluded in this research because people use the train for other purposes than commuting and there are normally no peaks at weekends. Another interesting outcome is that 31% of the trips start in the morning at the top 10 most counted stations where 67% arrive at the top 10 stations with the most arrivals (Knockaert, Peer, & Verhoef, 2013). This is explained by the centralized businesses in the Randstad which makes stations in Rotterdam, Utrecht, The Hague and Amsterdam popular as destination. The same we would expect from students who use the train. They come from surrounding villages and travel every day to the university in the city center.

From the research it seems that a change of reward during the reward-period does not change the behavior of the participants. People did reschedule and changed the time of departure and are reluctant to change this again for a different reward. However, over a longer period, like a permanent introduction of the rewards, people might follow the path with the highest rewards.

When we look at the number of trips that were made within each five-minute timeframe in figure 10, Spitsmijden did clearly work. The peaks from 06:30-09:00 and 16:00-18:30 are still there, but looking at the red line before peak 1, a huge peak of commuters took that train in order to receive a reward.

[6] On time rate for NS trains is according to their own research among the highest in Europe: 89,5%. The target set by the Government is 93% (NS, 2016)

Figure 10: Number of trips before, during and after treatment from participants of Sptismijden in de Trein

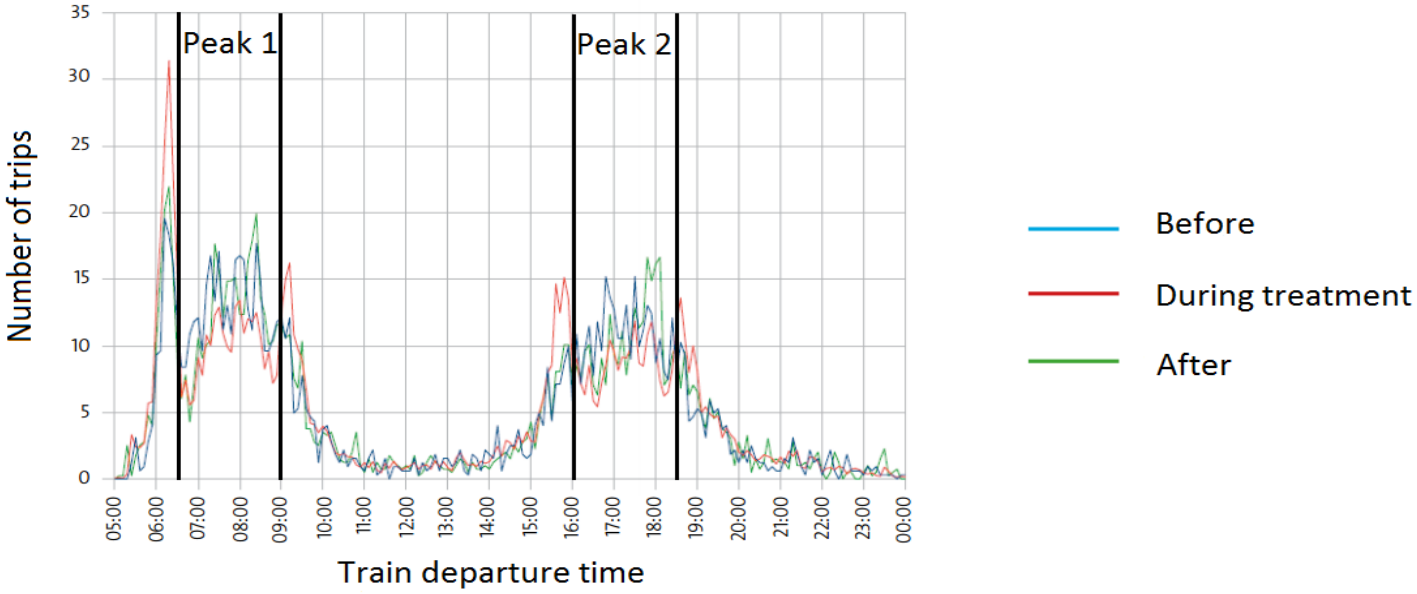


Figure 10 shows the differences in peaks with a reward system (red line) and compares those peaks with the situation before (blue line) and after (green line) the treatment period (Knockaert, Peer, & Verhoef, 2013).

To a lesser extent the same can be observed before and after peak 2 (Knockaert, Peer, & Verhoef, 2013). Participants really showed that leaving home early has some value. In this case a reward was given, but also less crowded trains and probably less delays[7] are valued in a way.

Looking at the weekdays shows us that on Wednesdays (25% less trips during peak hours) and Fridays (24% less) people are more flexible and therefore go more often by train at off-peak hours.

Interesting after the reward-period was finished, still 6,1% less trips during the rush hours were made by of the people who participated. The awareness and the benefits of a less crowded train can still be measured after the project had stopped. The question remains in this case whether the reward was the incentive to change the behavior or that less crowded trains caused this change. With raised awareness some people will voluntarily travel by train at off-peak hours because they value this experience higher. Those people do not need a reward. Others still do. In the following table, the final results of Spitsmijden in de Trein are showed. For every factor that is time-sensitive in figure 11 (marked by a **T**) the value in Euro is per hour.

[7] Assuming that it takes longer to get people in and out a train at peak hours which cause on average more delays

Figure 11: Valuation for trip specific characteristics for participants of Spitsmijden in de Trein

Factor	Value	
Longer travel time (T)	€26	
Travel before optimal departure (T)	€13 (morning)	€6,10 (afternoon)
Travel after optimal departure (T)	€6,80 (morning)	€6,20 (afternoon)
Crowded	€0,40 (just enough seats)	€1,40 (people need to stand)
Delays (T)	€16 (>2,5% more than 10 min delayed)	+ €2,10 (chance even >10% for >10 min delay)

Figure 11 shows the value for 5 characteristics of a train trip. For example: a participant of Spitsmijden in de Trein values an 1 hour early departure by €13. Half an hour is valued by €6,50 (Knockaert, Peer, & Verhoef, 2013).

Not all outcomes can be combined. A delay automatically increases the travel time, so those values can not be taken together. In the other cases we are able to find a total value for a student that travels at another time than before. Say person A leaves home 30 minutes earlier and returns in the afternoon 15 minutes earlier. The train was crowded at both times. There were some spare seats in the morning and people had to stand in the afternoon. The chance of delay of that train is 2%.

$$Value = 0{,}5 * 13 + 0{,}25 * 6{,}10 + 1 * 1{,}40 + 0 * 16 = €9{,}43$$

The NS is probably not going to reward 'the average' commuter every day with €9,43 for not travelling during the peak hours. The most important information from this part is that the value for crowded trains and overcrowded trains is almost negligible. Assume that with the average trip length of 6 stations, people want €1,40 in return for standing the whole 112-minute trip from Roosendaal to Amsterdam Centraal[8]. On the other hand, a train with a delay of an hour on a reliable track is valued by €16. Nevertheless, students seemingly not care about crowded trains. And the question for the next section is thus: do we actually have a problem in The Netherlands when we compare the crowdedness in trains with other countries?

To conclude this part, the NS should not worry about crowded trains since the participants from Spitmijden in de Trein did not value this very high. Longer travel times are valued very high, but this is quite uncommon in The Netherlands. The factor the NS should focus at is the mindset of people. They seem to value the deviation from the optimal time of departure very high. If the NS can somehow change the flexibility of people to travel before or after the peaks without rewards, the trains will be way less crowded in the rush hours.

2.3. Passenger train transport in other countries

This part focuses on the differences between the Dutch Railways and that of other countries. Those other countries should be similar in wealth and population density since the share of train use in less

[8] Which is 6 stations

developed countries differs a lot from The Netherlands or other Western-European countries. For every country some statistics are given. The basis is The Netherlands, so 135% means 35% higher than in The Netherlands.

The main goal is to find the bottlenecks for the NS when we compare data from other countries. Has Germany for example similar problems with peak hours and a surplus of students? Are the monthly subscriptions the same in Belgium, or do they have a more sophisticated system? The last goal of this part is to find and discuss a country that uses the reward-system for off-peak travelling in trains.

When we look at the statistics, The Netherlands scores with 11% of the total passenger kilometers with train above average compared to EU-28 (Eurostat, 2016). Other countries with much train transport are France, Sweden, Denmark, Austria, Hungary and Switzerland (highest with 17 %). For those countries the average annual inland travelled kilometers per person is around 1300 kilometers per year. The Netherlands scores lowest in use of buses and trolley buses (3,3% of passenger kilometers). This might explain why train transport is so popular in The Netherlands. Of course, population density and car usage should be compared over all those countries to formulate a conclusion about the excessive train use in The Netherlands, but as we are going to see, in Switzerland the railroad is more often used than anywhere.

The countries that are discussed are Belgium, Switzerland, Germany, France and India. These countries have been chosen because of their similarities with the NS and their different policies for serving students in the best possible way. Each chosen country has a different headline. You might wonder why Great-Brittain was excluded. Since the Brittish Railways are commercialized, the three largerst parties does not really cooperate. I found some difficulties in merging the numbers and find an overarching policy.

2.3.1. Belgium – Private or state-owned?

Comparable to the NS, which will be explained in the next section, the NMBS is not entirely privatized. After the European Union compelled the NMBS to allow competition, they raised three holdings. One for the infrastructure, one for the trains and one for the customers and employees. The NMBS are called a ‘private company with state influence’. They act autonomously and suffer from enormous losses, but in the past the Belgian State took over a loss of 7 billion Euro (Matthijs, 2015). In Belgium similar complaints as in The Netherlands exist. Trains are overcrowded, often delayed and huge losses are made (now 4.5 billion Euro loss) by the NMBS. Like many countries do, Belgians have a envious sight at the Swiss who carry 18.000 people per kilometer railroad with 33.000 employees while the NMBS works with 34.500 employees for 11.000 people per kilometer railroad (PV, 2015). The difference in ticket price on the other hand is enormous. Efficiency come

with a price. For similar distance like Bern to Geneve people in Belgium pay 20 Euro, while in Switserland the price is 60 Euro.

NMBS – Nationale Maatschappij der Belgische Spoorwegen, België	
Annual customers	220.000.000
Distance travelled	10.000.000.000
%Railvolume	131%
%Customervolume	67%

Figure 12: Statistics for NMBS

The following policies are implemented to fill this gap. After a large research from the Belgian Government, the following measurements were suggested (Verbauwhede, 2015).

- Ticket prices up (at least 10%)
- Efficiency of employees up with 20% (fire 7.000 people)
- Cuts in infrastructure development

The idea is that after many years of Governmental support, the NMBS should now act completely privately. By cutting costs and increasing the ticket price, the first step towards financial independency is made.

For Belgian students the reduction on a train ticket is 80 percent. With a proof of admission at a university students can travel for a couple Euros on a selected route. Other than in The Netherlands, students have to pay for the train, although the price will not discourage them from peak-travelling (NMBS, 2014). During the peak hours the NMBS has so-called P-trains. With an increased length of the train and higher frequency, people travel in the morning from the suburbs to the business centre and vice versa in the afternoon. In the weekends and at non-peak hours the P-trains are spare (Fadholi, 2012).

2.3.2. Switzerland – Number one, but with a price.

Many railroad companies dream about the SBB[9] for their efficiency and profitablility. The Swiss Government owns 100% of the shares. Demographically seen, Switzerland can be compared to The Netherlands except for the fact that railroads in the Alps makes it more difficult than in flat countries. The last few years around 3% of the operation income was profit (SBB, 2015).

According to the numbers in figure 13, the SBB is the only country that gets an higher customervalue than railvolume compared to The Netherlands. 38% more customers on the same length of track with the same number of employees. This means higher efficiency. Other sources show that the Swiss train is twice as much used in terms of modal split than in The Netherlands. 17.1 Percent of all passenger kilometers are made by train (Statista, 2014) versus 9.3 percent in

SBB – Schweizerische Bundesbahnen, Switzerland	
Annual customers	442.000.000
Distance travelled	17.500.000.000
%Railvolume	100%
%Customervolume	138%
Employees	33.000

Figure 13: Statistics for SBB

[9] Schweizerische Bundesbahnen

The Netherlands (Statista, 2014). With the knowledge that the train goes straight through the mountains and that roads do not in every case, this difference is understandable. It gets harder when we look at the fare prices in Switzerland. As mentioned at the NMBS the Belgian and Dutch passengers pay times three time less compared to Switzerland for a similar distance. Since Switzerland is known for its high prices, the Bigmac-index helps us to see whether the fare price is too low in Belgium or just high in Switzerland (The Economist, 2017). The $6.35 versus $4.06 shows rougly 60% higher prices in Switzerland, which not fully explains the 300% price for train tickets.

For students between the age of 16 and 25 the SBB has the 'Halbtax-karte' meaning that you can travel in almost every train and bus for half the price. One year Halbtax costs CHF185 (SBB, 2017). Knowing that the fare price in Switzerland is between two and three times as high as in The Netherlands, students in Switserland pay the full price in The Netherlands. There are only a few sourches that report crowded trains in Switserland. One of the short term projects in Switzerland is to build new tracks. The Swiss call this 'Eisenbahnprojekte' with as goal to improve the infrastructure. Furthermore, trains in peak hours are going to ride every 15 minutes at busy tracks from 2021 and SBB-employees who travel together to a central point now get in one train before the peak starts to give 25% of the seats back to the customer (Aargauer Zeitung, 2014).

2.3.3. Germany – Expand your business instead of improving locally

The case in Germany is a bit different. Demograpically seen, Germany is large compared to The Netherlands. People use the train for local trips. Of course the trains are crowded in the direction of the city center in the mornings and vice versa in the late afternoon. The difference is that what we see in The Netherlands one large area (Randstad) for most of the destinations is the case in every German city. For that reason, the Deutsche Bahn is less dense and sees all kinds of local bottlenecks. For international rail transport the competition from air transport is fierce. The advantage of travelling from A to B in a short time through the air outweighs the advantage of cheaper train travelling (Dobruszkes, 2011). The reason why air transport is more popular than rail transport is mostly because of the accessibility of every destination without transfers. For example, the train from Barcelona to Amsterdam has stops in Marseille, Lyon, Paris and Brussels which is not as efficient as the airplane. For inland train transport the same patterns will be observed in larger countries like Germany with much distance between cities. Most people going from Hamburg to Munich will go by airplane. In The Netherlands, inland air transport is unnecessary because of the small distance. For the students and commuters, DB has several options. The DB25, DB50 and the

DB – Deutsche Bahn, Germany	
Annual customers	2.007.000.000
Distance travelled	79.300.000.000
%Railvolume	1033%
%Customervolume	627%
Employees	195.000

Figure 14: Statistics for DB

DB100 card where the number stands for the reduction of the fare price. The DB50 card for students cuts the price in half. Of course, a certain amount of money should be paid annualy to make use of this card.

Similar to the Swiss SBB, all the shares belong to the state. Next to improving the infrastructure in Germany, DB also tries to do business outside the German borders. A well-known public transport company called Arriva is from DB. Deutsche Bahn had plans for a privatization, but due to the financial crisis, this was postponed. The 2015 loss of 1.3 billion Euro was planned to be compensated with an IPO of Arriva and DB Schenker. The German Government stopped this plan and DB is still making losses (FD, 2017). When we look at the ratio between railvolume and customervolume in figure 14 we see that DB is not as dense as The Netherlands and Switzerland. Overcrowded trains should be, with this number, less common and thus is DB more interested is expanding their business throughout Europe (DB, 2015).

2.3.4. France – peak hour tariffs

The railway company of France, the NSCF is 100% state owned. The NSCF has three divisions. The SNCF-travellers, the SNCF-logistics[10] and Keolis which is the international division (SNCF, 2016). Based on area, France is similar to Germany. This means lots of kilometer railway and a larger traveldistance. To overcome this problem NSCF has the TGV which is a highspeed train. With the TGV you can go from Amsterdam to Montpellier in the South of France within 8 hours for €87 Euro (NS International, 2017). For the TGV people need to make a reservation in order to have seat. For local trips, a reservation system is probably not going to work, moreover, standing in a train for 20 minutes during the rush hour is not valued that high by the participants of Spitsmijden in de Trein. The TGV is compared to the situation in Germany a real competitor to the airplane. Commuters that need to work for a couple days in Paris do not neccesarily need an inland flight.

SNCF - Société Nationale des Chemins de fer Français, Frankrijk	
Annual customers	1.123.000.000
Distance travelled	83.200.000.000
%Railvolume	945%
%Customervolume	351%
Employees	193.700

Figure 15: Statistics for SNCF

A problem for the SNCF is the amount of debt. The current amount of 50 billion Euro, of which 43 billion comes from infrastructural investments, is paid for by the French Government (Reuters, 2016).

For managing the peaks, the SNCF has introduced a timeschedule with the discount per hour (SNCF, 2015).

[10] Geodis as distributor and responsible for the supply chain and logistics

Figure 16: Discount in the French trains based on the time and weekday

Monday	0h-6h30	6h30-8h	8h-17h	17h-18h30	18h30-0h
Tuesday	0h-6h30	6h30-8h	8h-17h	17h-18h30	18h30-0h
Wednesday	0h-6h30	6h30-8h	8h-17h	17h-18h30	18h30-0h
Thursday	0h-6h30	6h30-8h	8h-17h	17h-18h30	18h30-0h
Friday	0h-6h30	6h30-8h	8h-14h	14h-20h	20h-0h
Saturday	0h-0h				
Sunday	0h-15h			15h-20h	20h-0h

- Blue period: 50% reduction for children, week-end cards, Seniors and Students
- White period: 25% reduction for children, week-end cards, seniors[11] and students

Different than other countries is the price for students defined by the peaks. On hours where trains are crowded, students get less reduction (SNCF, 2017). You can see this as a reward system for off-peak travelling. In The Netherlands, students have no incentive to change their departure time, whereas France has, according to the statistics from figure 15, a way less dense rail network.

2.3.5. India – don't be protective, use knowledge from outside

Totally different in demographics, wealth and business plan, is India. Nevertheless, according to the statistics in figure 17, India is very interesting to look at. Indian Railways has 28 times the length of railroad and 25 times the number of customers (Indexmundi, 2014). Since we know that the Dutch Railways are one of the most dense railways in the world, India is pretty close, but how? Indian Railways is 100% state-owned and it uses foreign investors to improve the infrastructure. For example, a bullettrain between Mumbay and Ahmedabad is going be made by the Japanese (The Economic Times, 2016). India Railways have accepted that the knowledge for train transport can be found outside the Indian borders. The current railroad in India costs commuters eight hours for this trip. The Japanese-built bullettrain get you at your destination in two hours. The same would hold if The Netherlands would allow Deutsche Bahn to compete with the NS as passenger transporter. The knowledge of business doing from large worldwide companies like DB can help the NS to overcome the bottlenecks.

Indian Railways	
Annual customers	8.107.000.000
Distance travelled	1.159.000.000.000
%Railvolume	2857%
%Customervolume	2533%
Employees	1.331.000

Figure 17: Statistics for IR

For students, the Indian Railways are not very cooperative. Lots of paperwork has to be filled in, and you need to apply for the 'student concession'. After the permission is granted, the student receives 50 percent reduction on a regular ticket. On the other hand, the ticket price in India is low. Since they

[11] 40% reduction in first class, 25% in second class.

have over 8 billion customers on a yearly basis, the Government is focusing on getting the train accessible for everyone. Crowded trains are not seen as a problem.

2.3.6. General similarities

As we have just seen, all countries use different policies and deal differently with students. Of course there is one similarity: why people use the train as transport mode. People, especially those in the suburbs, need to go to their work in the morning. Since everyone starts at approximately the same time, traffic jams are inevitable. People prefer in many cases the train for its reliability. The paper of Buehler and Pucher focuses on the likelihood of different population subgroups to use public transport. The research was done in the USA and in Germany. Assuming that Germany has some similarities in terms of public transport with The Netherlands, the outcomes can be useful for further research. In figure 18, subgroups are made on age, gender, employment, car possession, population density, city population and day of the week (Buehler & Pucher, 2012).

Figure 18: Survey results from public transport use expressed in odds-ratios

		Odds-ratio
Gender	Female	1,00
	Male	0,95
Age	16-24	1,00
	25-44	0,19
	45-64	0,18
	65+	0,13
Employment	Unemployed	1,00
	Employed	0,99
Car Possession	0	1,00
	1	0,26
	2	0,16
	3+	0,11
Population per sq. km	< 300	1,00
	300<1500	0,95
	1500<4000	1,19
	4000+	1,89
Metropolitan area population	Rural area	1,00
	<500000	1,20
	500000+	2,10
Day of the week	Weekday	1,00
	Weekend	0,50

Figure 18 shows the different odds for using the public transport or not for 7 different questions. With the odds-ratio no percentages of public transport use can be extracted. Only the percentual difference within the group. For example, the chance of using the public transport in the weekend is 0,50 compared to the weekdays (Buehler & Pucher, 2012).

From this figure we see what was expected. Most of the train users in Germany are students at the age of 16-24. Students are the main users for public transport. Figure 1 shows, besides that the

majority of the train users are student[12], there is no big difference between employed and unemployed people. This implies that, measured over a whole day, the group of commuters is as big as the group of unemployed or 'not in workforce'. Next to employment and age, car possession is important. From the results can be concluded that the chance of making use of a train for people without a car is four to ten times higher than people with at least one car. Also very dense areas with over 4000 people per square kilometer are almost twice (odd: 1,89) as likely to use the train compared to rural area. According to this research, students without an own car who live in dense areas in large cities travel on weekdays most often by train. In the chosen European countries, this is exactly the reason for the peaks.

[12] The group of 16-24 is smaller than 25-44, but assuming a even distribution over the age between 16 and 44, the odds-ratio shows a factor of 5. Concluding that students are the most frequent users of the train.

3. NS

The last theoretical section is about the NS itself. Other than the previous section, this part is strictly focused on the NS. The theoretical models from section 2 can be used for all public transport companies. Section 3 is about the past, the present and the future of the NS. Why is the NS working like they do today? What legal form suits them best? What are the propects for the near future? These questions need to be anwswered in order to understand the business of the NS. For example, a different legal form may change everything. This section is written in chronological order and starts in 1839.

3.1. Past

Since 1839 it is possible for Dutch citizens to travel by train. The original idea was to connect the ports of Rotterdam and Amsterdam to the German hinterland, but the first Dutch railroad was made between Amsterdam and Haarlem, shortly after followed by a connection between Amsterdam and Rotterdam. In 1900 the train was, with the absence of a massive car-industry, the most important way to move people between cities (van den Broeke & Faber, 1989). Ironically, the total length of the railroad in The Netherlands has changed only a little since 1900. Of course, lots of stations have been build ever since, but the route is almost unchanged in over a century (NS, 2017). After some mergers the NS was established in 1937 with the Government buying all the available shares. Between 1937 and 1994 the NS was officially privately-owned, but with major state-influence. After the car revolution in the 1960's, the NS seemed to accept that public transport had no future and stopped with the investments, maintenance and updating the business plans. After the oilcrises in the 1970's, the demand for cheaper public transport exploded. The NS however was, at the time, not ready for that many customers. The NS decided to change everything at once which resulted in an administrative mess (van Mierlo, 2001). From 1995 the NS lost its administrator role on the Dutch Railways, which meant more competitors, less subsidy and less influence on future rail developments. An interesting article was written by professor van Mierlo from the Maastricht University who writes about the privitization and deregulation of state-owned companies (van Mierlo, 2001). In the last sections of his paper the privitization of the NS is under review. According to van Mierlo, the following flow-chart (figure 19) should have been used:

Figure 19: The four steps to a successful privitization

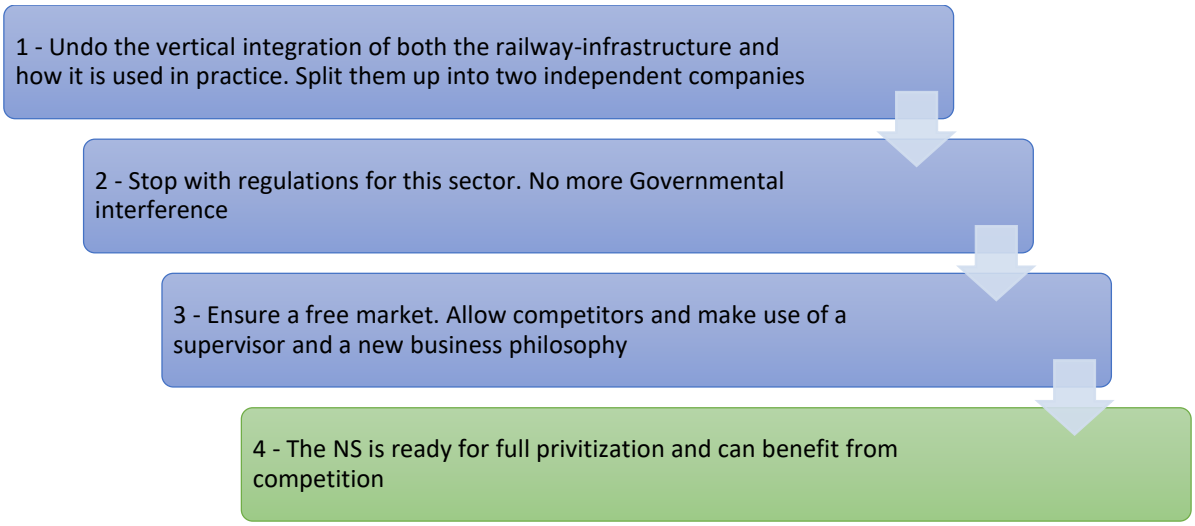


Figure 19 explains the 4 steps used from a six-step model to see what the NS should do to retain its market share in the modal split. In the 90's, the Dutch Railways loses its marketshare to the car. Because of the Governmental interference and the prudence to invest heavily in a modern rail network, the NS should adopt this four steps, says van Mierlo (van Mierlo, 2001).

It went wrong at the first step. The companies responsible for infrastructure, capacity, scheduling, customers, freight transport and maintenance still had its own monopoly. The interdependency between those companies was still large, while the first step emphasizes the independency. In this case, the Government can pull its hands off, but competitors can not enter due to the huge entry barriers caused by the cooperation of small businesses.

3.2. Present

They have nowadays two departments with different regulations. The state manages the infrastructure, management and maintenance on the Dutch railway with the NS as main advisor. The freedom of the NS is nowadays limited to customer services, shops, stations and materials. Especially the customer services determine the satisfaction level of the customers. Providing real time information about the next arrival or departure, shelter at the station and good customer-service on- and off train. Inside the train people appreciate seating availability, cleanliness and features like Wi-Fi and power outlets as highest. Moreover, the NS is always trying to improve is the schedule reliability (Outwater, et al., 2008).

Figure 20: Privatised versus State-owned

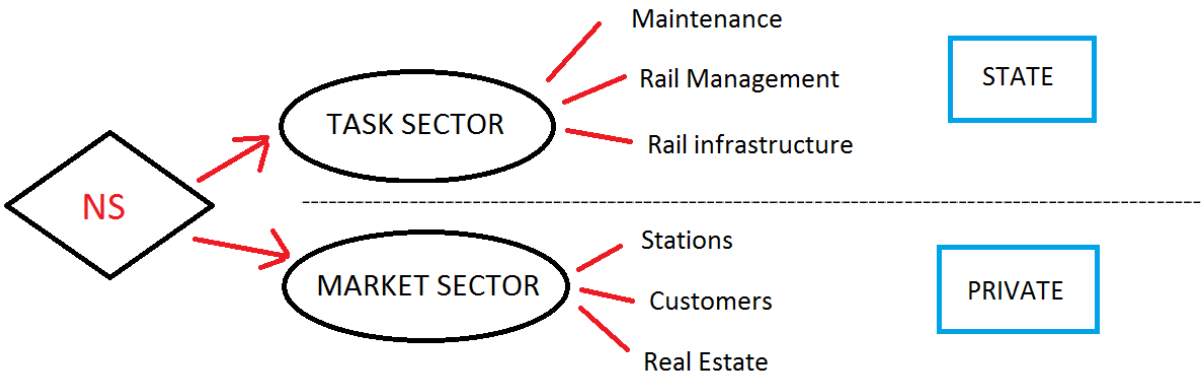


Figure 20 explains the different challenges for the Dutch Railways. On one hand the maintenance of the railroad and the infrastructure is state-owned. The Dutch Railways take care of the stations, how to attract customers and they have some influence in real estate (Verbart, 2004)

When we have a look at figure 20, the NS as company becomes more clear. The Dutch Government helps with financing, building new tracks and third party negotiations. Now we have a better insight in the market structure and their core competencies, a better look at their options to earn money should be made. As observed in figure 20, the NS has freedom to decide about the ticket prices, which shops are on their stations and what amounts will be invested in their materials. Recent newspapers tell about the divestiture of exploited shops on the stations[13] (Cohen, 2015). The NS reacts to the critique from the union with the need for more specialized business doing. From now on the NS is focusing only on the railway, as they are even planning to dispose Q-Buzz, which is currently their backup bus company in case the trains are heavily delayed. It seems that the NS wants to turn their structure 180 degrees, but for what reason?

3.3. Peak management at the NS

To meet the demand from the customers the NS tries to be as efficient as possible by changing the timetable annually and by increasing the frequency in peak hours and decrease in off-peak hours (Dienstregeling, 2017). These adaptations to the changing market can be linked with the theory of peak management and capacity. The firm's condition is either prepared or unprepared. Prepared firms have created enough backup for sudden peaks during the off-peak periods. Unprepared firms will suddenly be surprised by a peak and then start to react to it. The peak occurrence has to do with the 'expected' and 'unpredictable' factors that create peaks. The paper of Ronen, Coman and Schragenheim addresses the differences between expected and unpredictable peaks. In the figure below some examples are given for the NS.

[13] Smullers, Kiosk, Broodzaak, AH to go, Hema and others.

Figure 21: Predictable and unpredictable peaks for the NS

Predictable Peaks	Unpredictable Peaks
• Normal daily peak hours	• Bad weather (snow, heavy rains)
• Events like a soccer match or a concert	• Broken materials, obstruction
• Reductions by advertisements	• Less accessibility in other transport modes
• Start Academic year (more students)	

Figure 21 explains the the difference between peaks that can be foreseen and peaks that might surprise the NS. The unpredictable peaks form the focus for the NS, since these peaks might cause serious delays or dissatisfied passengers (Ronen, Coman, & Schragenheim, 2001).

It is clear that the NS can adjust their materials to the rush hours on Monday until Friday at 06:30 - 09:00 and 16:00 – 18:30. Other pre-known events like a soccer match of Feyenoord are captured by the NS with extra trains. Peaks caused by specific advertising might be a solution to get lower peaks and a better spread over the week. Events that can't be foreseen will exist anyway. Electrical wires and low temperatures does not match very well. Also workings on the highway or expected congestion will move people to the train stations. Delays give peaks and peaks cause delays.

We can now fill in the matrix from figure 2 for the NS. The upper-left part would normally give no trouble, so probably the NS will be in either of the other three sectors. A matrix like in figure 22 is very useful to see the bottlenecks of a company that is having problems with peak demand. As can be seen from the matrix for the NS the expected peaks are generally well prepared by the NS. The only exception might be the start of the academic year in September when the number of students going to the University or the Hogeschool is relatively large. The NS is having trouble with the capacity during such events.

Figure 22: 4-peak matrix from Ronen, Coman and Schragenheim filled in for the NS

		Peak Occurrence	
		Expected	**Unexpected**
Firm's Conditions	**Prepared**	Normal peak-hours Events Advertising	Bad Weather
	Unprepared	Start academic year	Broken Materials Less other transport modes

Figure 22 brings the theory of a firms' reaction to peaks in practice. The NS could either be prepared or unprepared and the peak can be expected or unexpected. Broken trains are definitely unexpected and for the NS it is difficult to be prepared for such events (Ronen, Coman, & Schragenheim, 2001).

The unexpected peaks are the real bottleneck for NS. For bad weather they have had some good alternatives like bus companies and spare trains, but with sudden technical failures or forensic investigations a massive peak as consequence cannot be foreseen. Moreover, the NS is on most

routes at maximum capacity with one train every 15 minutes. However, excessive delays and full trains cannot be fully blamed on the students. They form a highly predictable group and with enough capacity, the NS would have no problems during peak hours. The NS can have a look at the theory. The 80-20 Pareto Principle which states that in 20 percent of the time you get 80 percent of the revenues is true for the NS (Sanders, 1987). With five so-called peak hours, they stick quite accurately to this principle (5/24= 20,8 %)[14]. During those peak hours a peak in revenues will be seen, while the customer satisfaction tends to go down.

Excess capacity is everyday's business at the NS. Trains will not have a 1.00 people-to-seats ratio every moment of the day. Therefore, this is not a major problem for the NS. On the other hand, the NS tries to optimize the used capacity because transporting less people than the capacity allows, costs money. A more severe problem is the protective capacity. The NS would have protective capacity with good working FYRA trains. However, this billions-costing investment only resulted in broken trains. The NS was blamed by the Dutch Government for their focus on making money and the protection of their strategic position rather than having focus on the customers[15] (Tweede Kamer, 2015). Better peak management will thus help the NS both financially, with a more efficient capacity use, and in terms of the happiness of customers. Currently, the NS is managing capacity with more and longer trains during the peak hours and lower frequency during the summer and holidays.

Peak management does not always work since unforeseen circumstances like in the bottom-right corner of the matrix from figure 22. The other policy discussed in the theoretical part is pricing strategies. The NS is currently differentiating between the type of passengers by offering different monthly subscriptions. The NS can, as price-setter in The Netherlands, ask whatever they want for a ticket. Of course there is some pressure from the Government to keep the train accessible for all social classes, but asking a higher price during the rush hours, like in the example of the SNCF in France, can discourage people to commute by train. In combination with supporting other transport modes, a very possible solution might be there.

The NS is working with all kinds of monthly paid public transport cards as is summarized in figure 23.

[14] 5 /24 hours per day
[15] The FYRA-project was financed with tax money which raised the anger towards the NS

Figure 23: All different subscriptions for the NS

Product name	Monday-Friday	Weekend	Price 1 month	Price 1 Year	Calculated price per day
Off-peak	09:00-16:00 & 18:30- 06:30	Free	€99	€1188	€3,25
Weekend	No	Free	€32	€384	€3,68[16]
Always	Free	Free	€410	€3996	€10,92
All PT[17] free	Free	Free	€388	€4655	€12,71
Students	Free	60% of normal ticket price	€89[18]	€1068/€2529[19]	€6,93
Section[20]	1 preset route	1 preset route	---	---	€1,74

Figure 23 shows the different monthly/yearly subscriptions offered by the NS. The left column shows the name, the second and third column show the features of each subscription and the last two columns show the price as mentioned on the NS website (NS, 2017).

The NS is thus differentiating on type of passenger and on the day of the week. It might be a solution to have different fare prices at different times of the day because the NS can calculate the optimal price for lower peaks. The peaks found by Spitsmijden in de Trein are from 06:30-09:00 and 16:00-18:30. The NS could ask a premium for passengers who travel by train at these hours. Figure 10 shows the average peak on an average working day for the NS.

Another policy that the NS could conduct is to sign alliances and allow other operators on the railway to collaborate in case of fluctuating demand. Both in the peak hours and in off-peak hours, they could benefit from other players in the market. Theory also mentioned to reschedule the work shifts and hire part-time employees. Nevertheless, the NS is facing a shortage of material, so this could not yet be applied in practice.

3.4. Future

In the next couple decades, a lot will happen with the rail network in The Netherlands. Both the demand can change and even the role of the train as transport mode is not ensured until 2040. Former member of the Dutch parliament and current policy advisor for the NS, Frank Visser wrote the Spoorvisie 2040. He has a lot of knowledge about the bottlenecks for the NS. He starts with the factors that determine demand at a certain point in time. Travel time, number of changes between A and B, spread of trains over the day, frequency and punctuality. Visser mentiones that the NS should be especially in the Randstad very competitive to the car as transport mode. Busy highways in the

[16] Price based only on weekend-days. So 2/7 of the year.
[17] Public Transport
[18] The amount of money students loan from the Government for the student PT card. **Value for the student** https://duo.nl/particulier/student-hbo-of-universiteit/ov-en-reizen/reisproduct-regelen.jsp
[19] Based on the €97 fine for illegal use of this card for every 14 days (DUO, 2016). **Value for the NS**
[20] Depends on the length of the route

peak hours make the train in many cases the faster mode. A major problem according to Visser is the kilometer railroad per inhabitant of the Randstad[21]. In the Ruhr area, Frankfurt and the Flemisch rhombus[22], the density of railroad is between two and three times higher. The most complaints about overcrowded trains come from people in the Randstad. Visser acknowledges that the cooperation between the different modes of public transport is limited and that the capacity for rail transport is insufficient. To overcome the problems, both the efficiency on the current railroad and the infrastructure need enhancement. According to the advisory paper of Visser, figure 25 and 26 are made to see all the future measurements for both categories.

Figure 25: Efficiency measures for the current railroad

Listen to the customers	Customers value quicker trains, more frequent trains and more direct routes as highest.
Improvements on current rail network	More rail kilometers, less industrial transport on the same rail as used for public transport, allow higher speed.
More simple price structure	Same price throughout the country, card for all transport modes and bikes and toilets, open the market.
Travel information easy and up-to-date	Information for all transport modes available at train stations, departure time for nearest station along highways.
More influence for customers in transport policy	Public data about customer satisfaction and crowdedness at particular stations, less complicated refunding.

Figure 26: Infrastructure enhancements and innovations

Invest in innovation	Train 2.0. Overtake while still riding. Full automatic trains without a driver (like in cars and metro).
New and more stations	Make the Government responsible for stations (now, the NS is partly responsible), cut costs at smaller stations.
More Public transport marketing	Provide free gifts for new customers, show the strong features of the NS, show passengers that they are important.
Better connection at switch of transport mode.	Cooperation between metro and train, public bikes at all stations, more large free parking lots for trains users.
Stimulate public transport in cities	Provide all kinds of services around train stations, shorten the route towards the station for bikers.

Figures 25 and 26 distinguish the two strategies for the NS. Improving what is already there (25) or thinking out of the box and try to expand by innovations (26). All ideas come from Visser and are feasible before 2040.

[21] Area between The Hague, Rotterdam, Utrecht and Amsterdam
[22] Area between Ghent, Brussels, Antwerp and Leuven

Another long term measurement is suggested by the Ministry of Infrastructure and Environment. In 2028 trains must have a similar frequency as the metro. On the most used routes trains depart every 10 minutes. The main goal of this plan is to spread the passengers in the peak hours over 6 trains per hour instead of 4. Before this increased frequency is possible, stations need to be adjusted, more railroad should be build and the railway crossings should be safer to prevent accidents. The slogan of this idea is: 'First improve the railroad, then increase the number of trains' (Ministry of I&M, 2016).

4. Case Study: Public transport in Rotterdam during peak hours.

Rotterdam is a crowded city with great dependency on public transport. Rotterdam is a business center for commuters coming from the suburbs. Besides, Rotterdam has all sorts of higher education with the Erasmus University and multiple buildings from the Hogeschool Rotterdam. Rotterdam has its own public transport company for metro, buses and trams in the Rotterdam region. Although the RET is not responsible for the public transport by train, many of the train users also use the metro or tram. The RET is probably having the same issues with overcrowded metros during the peak hours. This case study reviews the possibility of the full implementation of the NS's plan to ban students from the peak hours in the city of Rotterdam. By interviewing all local parties involved, this study tries to give the reader a better understanding about the feasibility of this plan. The build up of the case study is the same as in section 2. First, it will start with the public transport companies. The NS and the RET must work together and compete at the same time. Section 4.2. is about the (local) actors involved. The national Government, represented by the Ministry of Education, Culture and Science (OCW) and the local Government represented by De Verkeersonderneming. De verkeersonderneming is involved in logistic cases about the traffic and public transport in Rotterdam. Section 4.3. resulted from an interview with Spitsmijden in de Trein. This is a completed experiment funded by the Government and supported by educational institutions, but it cannot be placed in either of those sections. Section 4.4. is about the educational institutions and the students. Is the Erasmus University able to change the schedules? Is the Hogeschool Rotterdam different in that case? And how are students responding to this idea. Section 4.5 at last is a table which will summarize the policies for all parties involved in Rotterdam followed by the local policy suggestions.

4.1. Public transport companies: The NS and the RET[23]

Public transport in Rotterdam is slightly different than in other cities with an university. Next to the function of 'student city' Rotterdam has a major busniness centre. When we look at the 12 university cities, Rotterdam has the third-most HBO and University students according to the DUO-database (DUO, 2017) Only the cities of Amsterdam and Utrecht have more students. The difference is that Rotterdam is not in the top three most crowded routes and Utrecht and Amsterdam are (RTL Nieuws, 2016). The fuction of the NS is more national. They transport people from suburbs to the cities whereas the RET acts locally with metro, tram and bus. There might be a difference in policy, problem recognition and suggested solutions. Both the NS and the RET will be discussed separately.

[23] Rotterdamse Elektrische Tram N.V.

4.1.1. NS

The main focus, resulting from the interview with the NS, is different from the orginal problem statement. Where CEO first proposed to shift timetables such that students do not need to travel by train during the peak hours, the NS now announces more widespread solutions. The focus is not only on students, also commuters and people who visit events by train are mentioned. Furthermore, the NS says that excluding students and students only from peak hours is absurd and that the spread of demand over the day is of more importance than banning certain groups of people.

To understand better how the NS can make such statements, the network surrounding the NS is important. The ministry[24] has contact with the schools and has the authority to reward or penalize schools for the results. The NS cannot force schools to change their schedules. Furthermore, when we look at the public transport card for students the NS is not the only party that has a say. All public transport companies together with the ministry decide about the strategy and policy. The NS does not fear the 90.000 students who recently got the student card because this group generally got a more local type of education and are probably not going all by train.

The first suggestion the NS gives is a minor difference in starting times in case multiple large schools are clustered. The largest clusters in Rotterdam are Kralingse zoom (30.000 students) and Dijkzicht/Coolhaven (27.000 students) (van der Burg, Cankaya, van Noort, & Boshouwers, 2015). The NS proposes that those clusters should have at least 3 different starting times. For example one school at 08:15, one school at 08:30 and third at 09:00.

This is more compassionate thinking than shifting the timetables from all university and highschool students from 08:30 to at least 10:00. The next question asked to the NS was whether there is actually a problem with overcrowded trains during the peak hours. The NS mentions that they do not look at other countries. They are satisfied with the customer response in The Netherlands and take them very seriously. Matching the customer demands to the supply of trains is their daily task, but in a dense area like Rotterdam, the guarantee of having a seat during the peak hours is more of wishful thinking. When changing the demand from customers seems impossible, the use of extra material is suboptimal solution according to the NS. For the Randstad area where Rotterdam is located in, creating extra capacity by building new railroads and buying more trains will on the short term result in extra pressure on the infrastructure due to construction areas and detours. Since the problem of overcrowded trains is a real time problem, the main focus of the NS is now on the change of behavior

[24] Ministry of Education, Culture and Science (OCW)

of train users. With the help from local Governments, students, universities and initiatives like MyOV[25] the NS is trying to spread the demand as much as possible.

The NS suffers from the ongoing confrontation with groups of customers that complain in the media. On time percentage, overall customer satisfaction and other positive points remain underexposed. Consciousness about the environment and the increasing potential for people to work from home or follow lectures from home are the future solutions according to the NS. Higher flexibility for students and employees combined with the change in behavior results in a better spread of train users over the day.

4.1.2. RET

Different from the NS is the RET. Where the NS is transporting people from outside the city to a central point in the city centre in the morning and vice versa at the end of the day, the RET brings the customer to the front door by tram, bus or metro. Research on a national scale showed 20 percent of the public transport users being student, for the metro in Rotterdam this percentage is 28. When we look at the table below, we see that the metro is very popular in Rotterdam. To show the scope of the metro compared to the train in the Rotterdam area, we see in figure 1 that the train stations in Rotterdam have around 132.000 passengers per day. When we include all the common stations for both the NS (train) and the RET (metro) we find similar numbers. Although the metro is used for smaller distances, we can conclude that the metro is huge in Rotterdam. RET and the NS thus probably have the same issues regarding overcrowded vehicles during the peak hours.

Figure 27 and 28: RET – passenger details and daily customers for the NS in Rotterdam.

RET	Bus	Metro	Tram
Single trip customers (mln)	30	86	42
Passenger kilometers (mln)	114	556	124
Average trip length (km)	3,8	6,5	3,0
Material	274	145	112
Customer satisfaction	7.6/10	7.6/10	7.8/10
On-time %	92,50%	93,80%	87,90%
Average number of seats	43	104	56
Total capacity	89	271	181
Annual need of capacity (#vehicles)	1230	2189	2072
Use of energy per passenger km	0,55kWh	0,13kWh	0,20kWh

Daily Regional NS passengers	
RDM Alexander	16.756
RDM Blaak	23.368
RDM Centraal	85.246
RDM Lombardijen	6.206
RDM Noord	2.254
RDM Zuid	3.031
DH Centraal	77.783
DH Laan van NOI	14.516
SCH Centrum	18.630
Sum	243.141

Figure 27: Core numbers from the vehicles used by the RET. The average number of seats is based on the most recent types of vehicles and the annual need of capacity is calculated by $customers\ divided\ by\ (material * total\ capacity)$*. Figure 28 shows the daily passengers for NS stations in Rotterdam* (Treinreiziger.nl, 2017) *and the stations where the RET is offering metro trips* (RET, 2017)*. The numbers are a daily averages, so multiplying with 365 gives 88.7 million passengers per year compared to the 86 million RET metro passengers per year. Furthermore, the RET has recently extended their metro network with the acquisition of the Hoekse Lijn. The NS*

[25] A mobile application where people can voluntarily avoid the peak hour in return for loyalty points. Those loyalty points can be redeemed at the kiosk or other affliated companies.

offered the last train trip towards Hoek van Holland on March 31st. The RET will reuse the railroad for the metro (van Gompel, 2017).

Looking at the numbers in figure 27 and 28, similar problems with overcrowded vehicles during the peak hours were expected for both the RET and the NS. The first question to the RET was whether the NS has contacted the RET about possible solutions and the consequences of the different policies. The RET pointed out that there is contact between the NS and the RET about peak management. Every year the RET tries to match capacity and demand based on the expectations for the coming year. When problems occur, the RET confirms to have enough capacity to change some minor things in the schedule. Problems with overcrowded vehicles during the peak hours are less common with the RET. Underground passenger transport suffers less from malfunctions caused by bad weather. Furthermore, during the peak hours passengers can get in a metro every 4 minutes. The reliability of the metro is, based on these arguments, estimated higher. For this reason, the RET does not have a peak in the morning rush hour. Since the goal of the passenger is different (smaller distances and used instead of walking or cycling), the peak for the RET is more in the middle of the day with the exeption in the morning of metro E towards Rotterdam. The RET admits that with a further increase of passengers (especially metro) a better spread of passengers over the day might become their first priority. Nevertheless, the RET has no problems yet and says just be awaiting for the consequences from the policy of the NS. The RET mentioned in a report from De Verkeersonderneming that an increase in the quality of the public transport cannot be achieved by extra seats. The RET focuses on more frequent departures and better accessibility for students and car users.

4.2. Actors involved

Since the NS is partly state-owned, more parties than just the public transport companies are involved in this case study. For this section the Dutch Ministry of OCW and De Verkeersonderneming are interviewed. The national Government is important because they implicitely own the NS. The national Government seems the only party that can prevent a top-down approach of policy making by the NS. The Ministry is in contact with the educational institutions, with the public transport companies and with the city counsel and thus has a good overview of all the interests. On behalf of the Government and the NS, the researchers from Spitsmijden in de Trein are important as well. In Section 2.2. this project is already explained theoretically, but hearing the rationale behind this report adds to the case study. Lastly, De Verkeersonderneming is a company funded by local logistics and transport companies and the local Government. On behalf of those clients, De Verkeersonderneming is doing research in all kinds of infrastructural cases. A report about the public transport in Rotterdam will be discussed in detail.

4.2.1. Ministry of Education, Culture and Science

The Dutch Government is in this case represented by the Ministry of Education, Culture and Science and by the Ministry of Infrastructure and Environment. Questions regarding this topic are solved by both Ministries. A taskforce was invoked to optimize the infrastructure in the public transport sector with as main target to improve the quality of the education. When students are at school in less time, in a less crowded public transport at different times of the day, both the quality of the public transport and the education can improve. The Ministry of Infrastructure and Environment is busy with research about the change of behavior. According to 'Beter benutten onderwijs en openbaar vervoer'[26] the awareness of train users who can possibly go to work or school at different times or in a different way are the focus group. In the long term, price changes related to the spread of passengers over the day, are possible as well (Bussemaker, 2016). The Ministry recognizes the differences per region. For example, the public transport in Groningen is percentage-wise more used by students in Rotterdam. The case of Rotterdam is different compared to many other cities that host an university. Only Amsterdam and Utrecht have similar features: both a large business district and lots of students. For Groningen different starting times for students might already solve the problem of overcrowded trains in the morning rush hour. In Rotterdam this single measure is not sufficient. In anticipation of the report from De Verkeersonderneming, the behavioral change of students and commuters is just as important.

The Ministry of Education, Culture and Science mentions in the interview that the NS is free to make policies in their own favor. When it comes to overcrowded trains during the peak hours, the Ministry acknowledges the problem. The Demissionary Minister has founded the Taskforce because of this problem. In this research they try to find solutions in the behavioral part featuring students. Regarding the universities, the Ministry says that every school has the right to refuse the plans of the NS about a possible shift in timetables or teach students more at home. The question whether universities are eager to cooperate with a semi state-owned company like the NS because their subsidy depends on this, was answered with a clear 'no'. Not the NS nor the Ministry obliges schools to change their educational system. The subsidy for schools depend on the number of enrolled students and the number of graduates and not on their willingness to cooperate with the NS.

The Ministry of Education, Culture and Science emphasizes once more that their focus is on improving the quality of the education in The Netherlands. Especially in Rotterdam, more factors play

[26] Translated: make better use of education and public transport

a role in overcrowded public transport than students only. The Ministry tries to initiate a diaglogue between the NS, the Taskforce, the Universities and the local Governments.

4.2.2. De Verkeersonderneming

De Verkeersonderneming is funded by local businesses and the local Government. They are active in the area of Rotterdam and the main focus is on the infrastructure. Past projects about prevention of traffic jams by rewarding people who left the car at home were a success. Other connected companies that use the knowledge of De Verkeersonderneming are the Port of Rotterdam, Gemeente Rotterdam, MRDH[27], Ministries and Beter Benutten and therefore De Verkeersonderneming can be seen as the representative of the city of Rotterdam. In most cases De Verkeersonderneming develops a mobile application which encourages participation even more.

De Verkeersonderneming is also working on projects on behalf of the local Government of Rotterdam about crowdedness in public transport and how to prevent it in the near future. De Verkeersonderneming has had no contact with the NS about overcrowded trains. In the report they perform a stakeholderanalysis with the wishes from all parties involved and in their last section they did an analysis of the behavior of commuting students (van der Burg, Cankaya, van Noort, & Boshouwers, 2015). When we look at a report from De Verkeersonderneming about the ideas to force a modal shift in the large group of students in Rotterdam, we see that 40.000 out of 90.000 of the RET passengers in the morning peak hours are students. The RET has found 28% of their passengers being student, so this means that especially in the morning rush hours, students from Rotterdam use the public transport massively. For the RET, this might not be an issue, since they did not report overcrowded vehicles. Contrary, the NS transports all the students who do not live in Rotterdam to the University or Hogeschool. The NS has thus a large peak of students in the morning rush hour. This is exactly why De Verkeersonderneming was founded. Forming a bridge between the public transport companies and the students but also between commuters and the Government. De Verkeersonderneming is an essential link between the public transport companies and the students in Rotterdam. De Verkeersonderneming has full focus on the area of Rotterdam which makes them indispensable for this case study.

The first question that comes up is whether the public transport in Rotterdam is too crowded and if so, are students responsible for this? When we look at the numbers, we see 130.000 students in total in Rotterdam. Not every student has an student public transport card, but still 40.000 students were counted during an average morning peak hour. The main clusters are around the Erasmus University and the Hogeschool Rotterdam. When we have to believe the NS, Rotterdam is crowded. However,

[27] Metropolitan region Rotterdam-The Hague: http://mrdh.nl/

the RET says that their passenger limit[28] is only reached accidentally. De Verkeersonderneming mentions that all parties had different stakes. The Erasmus University and the Hogeschool Rotterdam were not very helpful and the NS and the RET do not feel the same about the current situation. De Verkeersonderneming therefore focused on a solution involving students. With subsidized projects like 'Fiets een stuk & doneer geluk' students can cycle to school instead of using the public transport and raise money for a charity fund (Filedier, 2017). Of course, the cyclepaths in Rotterdam are not used to have 40.000 cycling students in the morning rush hour. Some adjustments must be made.

De Verkeersonderneming agrees with the NS that students can make the difference between overcrowded trains and a flatter peak in the morning rush hour. Students are definitely better traceable than the average commuter. A bottleneck in rewarding students who avoid the rush hour is that students are expected to be in class and that this possibly encourages truancy. Schools that have no possibility to change the timetables do not like such initiatives. An idea suggested by De Verkeersonderneming is to reward students who avoid the public transport in exchange for lower tuition fees. More about the willingness of students and the educational institutions in the next section.

4.3. Spitsmijden in de Trein

Other than the Taskforce from the Government is Spitsmijden in de Trein. This report is written by representatives from all Dutch public transport companies, researchers, advisors and the Ministry of Infrastructure and Environment. This research is unique because of the cash reward for the participants who did limit their train use during the peak hours. Behavioral insights and being able to value different characteristics of train use are very important for this case study. Spitsmijden in de Trein did not point to students prior to this experiment, but their main goal was to see which group of passengers is most sensitive to change their behavior regarding travelling to work or school stimulated by a reward. Spitsmijden in de Trein did not focus on the fare price (a reward would mean a reduction of the fare price for some participants, for students this would mean that they earn money), but on those people who are able to change their behavior for a longer period. Passengers might value the NS higher if they are travelling off-peak and have a seat. Spitsmijden in de Trein tries to find those passengers. Results from Spitsmijden in de Trein shows on the short term a learning curve for the first 2 or 3 weeks. After this period passengers tend to commute at other times. In the long term[29] 70% of the participants still showed different behavior.

[28] For the RET only if not all people can get in the metro, tram or bus. For the NS this limit is at 175% of the comfort standard in which all passengers have a seat (van der Burg, Cankaya, van Noort, & Boshouwers, 2015).
[29] 2 months after the reward period.

A second point Spitsmijden in de Trein stresses is that of strategic fare pricing. Peak pricing is used in different ways in many countries. The Dutch Government is counteracting this plan because it wants to keep the train accessible for all people. An idea would be that people who have a job and use the train in the morning rush hour pay a higher peak-price. Spitsmijden in de Trein found that 10-20% higher prices during the peak hours would be optimally.

A question about the effects of a full privatization of the public transport sector in The Netherlands was answered with respect to the theory. Competition normally leads to lower prices and better customer services, but the public transport sector is more complicated than the theory tells us.

4.4. Schools and Students

The last two groups that are important to interview for this case study are the local schools and the students of Rotterdam. The Erasmus University and the Hogeschool Rotterdam have been sent questions about timetabling and other problems regarding the wish of the NS. The Hogeschool Rotterdam unfortunately refused to answer the questions due to other priorities. For the Hogeschool Rotterdam some plausible assumptions are obtained from research from De Verkeersonderneming and Goudappel Coffeng together woth Youngworks. The Erasmus University and the Hogeschool Rotterdam offer different types of education which will become clear soon. Note that the Hogeschool Rotterdam is not the only Hogeschool in Rotterdam, but it is the only local school and still had 18.655 enrolled students in 2016[30]. Regarding the students, again the research from De Verkeersonderneming and Goudappel Coffeng together with Youngworks is used. Those numbers are reliable and the samplesizes of those reports are large.

4.4.1. Erasmus University Rotterdam

With over 26.000 students in total and almost 23.000 students on the campus, the Erasmus University located in Rotterdam Kralingen claims to be full. The Facultyoffice, responsible for scheduling the lecture halls, classrooms and the examroom, mentions that the pressure on the rooms is getting huge. On this point in time it is all just fitting, but in case a building is temporarily closed because it is under construction, not all students fit anymore. The Erasmus Univerisity is planning lecture between 08:00 and 19:00 and exams can even last until 21:30. Reading this might satify the NS because the Erasmus University is offering lectures in the late afternoon, but the opposite is true. Because of almost optimal use of the buildings, the Erasmus University is full throughout the entire day. The Facultyoffice mentions that they will help the NS by shifting the early

[30] According to DUO. https://universitaire.bachelors.nl/aantal-studenten/

lectures to the middle of the day if they are able to. Another issue for the Erasmus University is the stepwise change from mass lectures to more personalized and small-scale lectures. The Ministry of Education, Culture and Science even supported more mandatory lectures and physical education because this improves the quality of the education and makes the Dutch universities competitive to those in other countries. More digital education seemed a solution, but the Facultyoffice discouraged that idea.

Assuming that a shortage of space is no issue, the next question for the Facultyoffice was whether the professors, the guards, the cleaners and of course the students like the idea of working days from 11:00 till 19:00. The Facultyoffice mentions that for non-teaching personnel this would not be an issue. The campus of the Erasmus University is almost 24/7 accessible and many buildings have opening hours from 08:00-0:00, so those people already work in shifts. Differently, professors send their preferences to the Facultyoffice and are not used to give lectures at night. When all professors need to change their schedule this is going to give some murmur, not to mention the students.

Summarizing, the Erasmus University is willing to cooperate with the NS. However, the current situation of a full campus, more personalized education and already using the maximum capacity in the afternoon, will not allow the Erasmus University to do so. The Facultyoffice comes with two possible solutions. First, use empty office building for housing students. Looking at the Rivium next to the university campus, the empty buildings could relatively easily be restructured for student housing (AD, 2016). Second, professors might accept the nightly lectures when there is a compensation. The Erasmus University has not bugeted this. Moreover, the NS is asking for a change, so they should suggest a certain compensation.

4.4.2. Hogeschool Rotterdam

The Hogeschool Rotterdam is offering students somewhat more practical education on a lower level than the Erasmus University. An important difference between both forms of education is the number of contact hours for the students. At the Erasmus University 12-16 contact hours per week is quite normal, while at the Hogeschool Rotterdam offers education with more mandatory lectures in smaller groups. Another difference is that most students from the Hogeschool Rotterdam are Dutch and many of them live at their parents house somewhere close to Rotterdam. The Hogeschool Rotterdam is located at six buildings in Rotterdam and all are easily accessible by public transport.

The different types of students are discussed in the next part of this section. However, after reading the differences between the Erasmus University and the Hogeschool Rotterdam, two policies stand out.

- Invest in more digital education for students from the Hogeschool Rotterdam since they have on average more contact hours than students from the university. Possibly only the lecures from 08:00-10:00.
- Change the behavior of students from the Hogeschool and make them bicycle to school instead of going by train for 10 kilometers. Many students live nearby and could potentially use the bike to get to class in the same time as the public transport.

Unfortunately, the Hogeschool Rotterdam did not had time to respond, so it remains unclear whether the above mentioned policies are feasible.

4.4.3. Students

In section 2.2. became clear that students does not like the suggested plan of the NS because they would not be able to keep their parttime job and they would miss the social activities when the morning rush hour is forbidden for students. It is true that students are relatively flexible and therefore the idea of the NS can be understood. De Verkeersonderneming discouraged rewards for students who do not go by train during the morning rush hour because it is difficult to control whether those students actually go to school or stay home and get money. The alternative is changing the behavior of students such that many of them change the transport mode from home to school. A report from Goudappel Coffeng and Youngwork about students and mobility looks at all kinds of demographic characteristics to reveal the motivation for students to use a certain mode of transport. The most important findings are that (Goudappel Coffeng & Youngworks, 2015):

- 25% of the passenger kilometers are made by students.
- Students with an immigrant background use the public transport three times as much than students without an immigrant background. In Rotterdam over 50% of the inhabitants is called ‘immigrant’ (Jansen, 2015). Immigrant students link cycling to a low status.
- Students feel more or less forced to use the public transport, because the costs for owning a car are often too high.

Public transport is thus very popular amongst students. According to many parties, a change of behavior might help the NS in this case. Returning to the report from De Verkeersonderneming shows us that 80% of the students feel attached to the schedule made by school. The other 20% call themselves ‘free students’ and they admit to travel to school for other reasons than class. When the Erasmus University and the Hogeschool Rotterdam cannot reschedule, the students need to change somehow. De Verkeersonderneming has found from a representative sample of 1200 students from different levels and age that 30% of the students that use the public transport during the morning rush hour could possible go by bike since the distance from home to school is less than 9 kilometers.

Another 16% of the students, living between 9 and 15 kilometers from school are potential e-bikers. A total of 46% would mean 18.500 less public transport users in Rotterdam (van der Burg, Cankaya, van Noort, & Boshouwers, 2015). This sounds good for the NS and bad for the RET, since they have no problems with overcrowded vehicles. On the other hand, both public transport companies lose passengers. The question remains, how are students going to be compensated since they feel no urge to avoid overcrowded trains?

4.5. Policy suggestions

All the parties that are involved in the case of Rotterdam have been elaborated. A schematic summary of all the policies is given in figure 29. After figure 29, the policy suggestions will continue.

Figure 29: Case Study Summary *Motivation Pro and Con is based on the statement: Students should be banned from rush hours in order to get less crowded trains.*				
	Main Drive	**Motivation Pro**	**Motivation Con**	**Preferred policy**
PT Companies				
NS	• Financial rewards • Customer Satisfaction • Increase accessibility	Students are the best traceable group and customer satisfaction will go up with less crowded trains.	Not really fair to ban students from the peak hours. A better spread of all types of passengers is needed.	• Flatten the peaks • Raise awareness and change behavior
RET	• Financial rewards • Customer Satisfaction • Be the best local transporter • React to the NS	Students form a large group of passengers during the rush hours.	The RET has no problems with overcrowded vehicles. The RET reacts to the NS since a lot of train users switch on a bus, metro or tram.	• Do nothing
The public transport companies have different interests. The NS acts on a national scale while the RET focuses only on the Rotterdam area. Many of the customers of the RET did travel with the NS towards Rotterdam. When the NS gets different peaks during the day, the RET will adjust their schedule as well. Money combined with satisfied passengers form the main drive for profit-seeking companies like the RET and the NS.				
Government				
Ministry of OCW	• Quality of Education	The Dutch Government is partly owner of the NS. Thus, the ministry will not thwart plans of the NS.	The Ministry strives for better education. Transport for students should be smooth.	• Listen to the Taskforce and the local Governments for the best regional policy
Verkeersonderneming	• Connect all local parties for infrastructural issues	46% of the students who go by train could be a cyclist. Students are indeed easily traceable.	Banning all students will not work. Furthermore, De Verkeersonderneming is active in Rotterdam. There are no big problems in Rotterdam.	• Change behavior • Make people use the bike more often • Cooperate with schools • Loyalty programmes
Research showed that many train users during the morning rush hour could use another transport mode. This is meant with ‘a change of behavior’. The Ministry forwards the policy advice to parties like De Verkeersonderneming and Spitsmijden in de Trein. Those local advisors, as we may call them, both saw potential in a reward system.				

Project				
Spitsmijden in de Trein	• Independent field research	Students are flexible, so they could start after the morning rush hour.	Students are not the only group. Employers and employees are also very flexible. Banning people will not work, positive motivation works better.	• Reward people who have changed their behavior
Spitsmijden in de Trein is doing research for many actors involved. It does not have an opinion about the suggested plan of the NS itself, but tries to report in an impartiall way. For this reason, this project is named separately from the Government. Spitsmijden in de Trein showed that rewarding passengers might be the optimal solution to change the behavior.				
Education				
Erasmus University	• Quality of Education • Accessibility of the campus • Satisfaction of students and personnel		Impossible to shift the lectures from the morning rush hour to the afternoon. Capacity is being used the whole day.	• Compensate the University and the professors and students for working/studying in the evening
Students	• Spend little time travelling to school • Leave school smarter than before • Social contacts	Some students do not like to study in the early morning	Lectures in the evening does not allow jobs and social contact.	• Compensation • Loyalty programmes
The Hogeschool Rotterdam did not cooperate, so their motivations are not included. The Erasmus University and the students do not like the ideas of the NS. Both ask for a compensation.				

Figure 29 gives an overview of all the outcomes from the interviews. The representatives from each company in the interview can be found just before the bibliography.

The Case of Rotterdam is interesting because Rotterdam is known both for its traffic jams and for its intensively used local public transport. The RET is a large stakeholder in the local public transport since they are the only who offer metro and tram trips. Changing the policy in Rotterdam involves thus more actors than only the NS and the schools. The RET, which is partly funded by the local Government, and local policymakers decide about the implementation of a new policy in in the public transport in Rotterdam. The RET mentions in the interview to wait and react until the NS is changing their policy and only in case that such a policy leads to overcrowded vehicles for the RET. The NS has strictly seen the freedom to change all rules including prices. The Dutch Government will interfere in that case and will argue that the train should be accessible for all income classes. All policies have their pro's and con's. Four different suggested policies will be discussed on their feasibility in Rotterdam.

4.5.1. Peak tariffs

The only policy not suggested by any of the parties. This policy might be too strict and can cause a huge modal shift. Therefore, a combination of peak tariffs with one of the other policies enables it to compensate for exceptions. This is the suggestion:

People are going to pay more for travelling between 06:30-09:00 and 16:00-18:30 and less than the current tariffs on the other hours. Based on the interview with Spitsmijden in de Trein the following numbers are expected to be optimal. The morning rush hour is more crowded than in the afternoon, so add €2 for a trip in the morning and €1 in the afternoon. For people who travel for free because the employer pays the bills, the employer will eventually change the schedule somehow or make the employee pay for the premium. For students, I suggest a 20% contribution for trips made during the peak hours. Just like they are used to in weekends (they pay 60% of the normal ticket price in weekends). The suggested price increase does not directly stimulate passengers to choose another transport mode, but they are motivated to travel at least once per day at off-peak hours since the daily costs are then comparable with the current situation. An increase of the fare price with 10 to 20 percent was the best incentive for people to become aware of their time of commuting according to Spitsmijden in de Trein.

4.5.2. Loyalty Programmes

A policy that can be used instead of peak tariffs is a loyalty programme. Receiving points for every trip at off-peak hours and keeping all tariffs at the same level. People are rewarded for good behavior and not punished for inevitable trips. If the NS can find good rewards for the loyalty points, passengers might spread over the day automatically. Some experiments were done with free sandwiches and drinks, but the NS can also cooperate with shops that sell high-tech gadgets. People

like loyalty programmes, especially when you can share your points. The whole family can start gathering points.

For students I would suggest the same programmes. Although, this might encourage truancy, students are normally smart enough to go to school. Moreover, there is no punishment for travelling during rush hours.

This policy needs some investments. Since the NS is facing overcrowded trains, and the RET not, I suggest that the NS will invest in a loyalty programme. A nice thing would be to involve local companies for more diverse rewards.

4.5.3. Raise awareness, go by bike.

Cycling could solve the problem of students going altogether by train in the morning rush hour. With the public transport card for students, the NS is getting their money anyway. The problem for the NS comes with the long term behavior. When the students from now avoid the train even after graduating, the NS will lose customers. This policy is thus a short term policy. With the increasing rate of people who work from home and the digitalizing education, the NS needs to think long term. When students go by bike, the RET will have the same problem, because people who travel short distances (like customers from the RET) will be encouraged to go by bike. Rewarding students who go to school by bike instead of train can be very costly, but combining this policy with a loyalty programme or peak tariffs, students are willing to change their mode of transport (van der Burg, Cankaya, van Noort, & Boshouwers, 2015). Research from De Verkeersonderneming showed promising numbers with 46% of the students being potential cyclists.

The best option for the NS to execute this policy is by expanding the public bicycle network from the NS[31]. There are currently 300 places where you can rent a bike, but in most cases this is around train stations. So instead of avoiding the train, people avoid the metro, tram or bus which shifts the problem to the RET. Other opions could be involving local bike shops where participants can save for a reduction for a new bike for every cycled kilometer during the rush hour. Also, permanent 'cycling for charity' has its advantages. According the the interview with De Verkeersonderneming, people are increasingly becoming aware of the unpleaseant crowdedness in the public transport. With this suggested policy, people are changing their behavior and the NS and RET can react to this.

4.5.4. Compensate Schools and Students

According to the interview with the Erasmus University they are not able to change the schedule. Students showed in other research that a reward for off-peak travelling is needed to change their

[31] The NS is facilitating public bikes for a low price. http://www.ns.nl/deur-tot-deur/ov-fiets

behavior (Goudappel Coffeng & Youngworks, 2015). Both argue that the NS should compensate them. The Erasmus University mentions that the solution might be to receive extra subsidy to reward the teachers for giving lectures in the evening. Since both the NS and the Erasmus University are (partly) from the State, this could be financed by the Dutch Government. The problem with this policy is that it is unclear how costly it is going to be. Compensation of educational institutions and students is probably the most expensive option out of the 4 suggested policies. However, if the problems for the public transport companies are getting worse, this policy can work.

5. Conclusion

This thesis discusses the theory about peak management and strategic pricing. It gives an overview how difficult it is to shift timetables at schools and change policies. Many parties would bear the consequences from the suggestion of the NS. This suggestion forms the thread of this thesis.

"What policies could the NS use to reduce the number of students during the rush hours?"

Of course this is not a 'yes' or 'no' question. Yes, this thesis shows it is possible to ask all the involved parties to adapt to a different situation. No, the NS cannot force them. The source of this situation is overcrowded trains and the frequent use by students. Just banning them from the rush hours could in theory help the NS. In practice students organize Championships Train Travelling with as many as possible participants. Also, the Dutch Government wants to keep the public transport accessible for all social classes. Another policy must be chosen.

The case study shows the innovative ideas of local Governments like Spitsmijden in de Trein and De Verkeersonderneming. Especially in the case where the local public transport company, responsible for metro, tram and bus, says that there is no problem. Let people who live close go by bicycle for charity or loyalty points. Stimulate people with a reduction on the fare price to travel off-peak. All these policies have been discussed in this thesis.

Most of the suggested policies by the interviewed parties need an investment. An investment by who? The NS argues that it is trying to raise awareness for the situation and that it tries to change the behavior of the passengers. Raising awareness can be achieved by the local cycling initiatives and a behavioral change is possible with smart pricing. Raising the fare price at times with a shortage in capacity and lower the fare price at times you do not expect many passengers.

This research is not about banning certain groups of people from the train. It is about spreading people over the day. With these policies the NS will be able to control the peaks in the near future which in turn increases the so demanded customer satisfaction.

6. Limitations and recommendations

6.1. Limitations

This thesis is rather qualitative. Being able to show the numerical consequences of implementing a suggested policy would help. On the other hand, discussing multiple policies that all have their pro's and con's is in essence qualitative. The NS cannot be blamed for being protective with data. This thesis used data from the experiments from Spitsmijden in de Trein and De Verkeersonderneming. This data is very helpful, but not completely focused on the students. Therefore, it was difficult to go in-dept in the case of the students. By broadening the subject with educational institutions, local Governments and projects, this thesis showed the helicopter view needed for such policies.

Another limitation is about the interviews. Since it is very hard to interview enough students to get a representative sample, I assumed the information from Spitsmijden in de Trein and De Verkeersonderneming to be true. All students have their opinion about the suggested plan of the NS. It would be very interesting to find similar conclusions based on own research.

Lastly, the miss from the interview with the Hogeschool Rotterdam is a pity. Rotterdam has different types of education, so I expect deviations in the answers and possibly even other policy suggestions.

6.2. Recommendations

Future research would be easier with data from the NS. Organizations like IPSOS[32] collect data from train passengers. This information would be very helpful in order to do research on this topic. Another recommendation is to do research that is fully focused on the similarities and differences between the NS an for example the Swiss Railways. What can they learn from each other?

At last, I would recommend the NS to start with price differentiations between the peak hours and off-peak hours. Being able to research the suggested policy in section 4.4.1. will give very good insights in the travel motives for the passengers. This thesis was all about getting control over the peak demand. With different prices on different times of the day, this will happen.

[32] IPSOS collects data for the NS about the type of subscription on specific routes. More information on: http://www.ipsos-nederland.nl/actueel/ipsos-blog-overzicht/over-veldwerk-reisomvang/

Interviewed contacts:

- Mark Adriaans – Education & Policy at The Facultyoffice of the Erasmus University. Documented on March 15, 2017
- Theo Konijnendijk – Coordinator of innovation and development at RET. Documented on March 27, 2017
- Adem Cankaya – researcher at De Verkeersonderneming. Connected me with SSSR and the NS. Documented on March 28, 2017
- Naïma Larbi – Webcare & Center of External Relations of the Hogeschool Rotterdam. Documented on April 5, 2017
- Rivka Staudt – Department Management and Citizen - Ministerie van OCW. Documented on April 7, 2017
- Dirk van Vliet - Segmentation Manager at NS, focus on the student. Contacted via Thijs van Daalen. Documented on April 10, 2017
- Ronald Haanstra – Project manager at ARS Traffic and Transport Technoloogy B.V. *Responsible for Spitsmijden in de Trein.* Documented on April 25, 2017

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