ERASMUS UNIVERSITEIT ROTTERDAM
ERASMUS SCHOOL OF ECONOMICS

Panteia
Research to Progress

Master Thesis

Mobility Management for events in ArenAPoort

Jasper Tanis
August 2016

Handed in by

Jasper Tanis
Student Number: 358766

Supervision by

Giuliano Mingardo

Preface

By the completion of this master thesis my master studies in Economics & Business at the Erasmus University Rotterdam are finished. This thesis has been written during my time as an graduate intern at Panteia, a research and consultancy company based in Zoetermeer (the Netherlands). I would like to thank my colleagues and former colleagues at Panteia, in particular the colleagues in the team of Transport & Mobility, for providing me the opportunity to use their network and expertise to the benefit of my thesis. Additionally, I would like to thank Dick van der Goot and Gerben Zwart, who were my supervisors at Panteia, and I would like to thank Giuliano Mingardo, who was my supervisor at the Erasmus University.

During the course of writing this thesis, I conducted interviews with local stakeholders and experts in the field from other geographical areas and had the opportunity to use telecom data which has been provided by Mezuro. Without the help of these persons, I would not have been able to complete this thesis, and so I would like to thank everyone who has helped me in the progress of this thesis by being interviewed, providing information or providing data.

Last but not least, I would like to thank my family, without whose support I would not have been able to obtain a Master's degree.

I take full responsibility of all the content in this thesis. All the views are my own interpretation of the discussions and of the data, and do not have to reflect the opinions of those that have contributed to this thesis.

Jasper Tanis
August 2016

Abstract

In this master thesis, Mobility Management for events is researched. Events are defined here as happenings which are meant to attract large numbers of audiences. It is especially relevant to study mobility in the context of events, since the volume of mobility will be concentrated due to the relatively short time period in which the large number of audiences is making their journey to the location where the event is organized. As a research method, a case study design has been selected. ArenAPoort in Amsterdam Southeast is chosen as the appropriate case study, because it an area in which three event venues are located and because of the increase in both volume and diversity of mobility that the area has seen over the last few years. Interviews with an expert panel of local stakeholders are carried out, and additionally, telecom data has been used to illustrate examples and support the reasoning. Conclusions are that gains could be made in distribution of mobility by journeys to the area, in particular when the incoming mobility for events is in combination with the outgoing mobility for commuting traffic in the afternoon rush hour. Especially a modal shift from car to public transport would accommodate and relieve the pressure on the highway and the underlying road network. However, a distribution of car traffic across routes might be easier to accomplish than a modal shift from car to public transport. The advice is given that the best of both options could be accomplished, when it is managed to implement a successful Park & Ride policy, in which the area ArenAPoort belongs to the core of. By such a P&R, the first part of the journey of the visitor will be completed by car and the final part will be completed by public transport.

Keywords: Mobility Management, Behavioral Economics, Beter Benutten, events, ArenAPoort, Amsterdam, telecom data

Table of contents

1. Introduction

In the OECD countries, the number of hours worked per worker has been decreasing over the last decades, according to the OECD Statistics Database. Also, due to technological advances people spend less time at their households. This implies that over the last few decades people have been getting increasingly more time to spend to leisure activities (Burda & Wyplosz, 2009).

The fact that people devote more time to leisure activities has resulted in that nowadays people visit more events than they have done before. Events are defined here as happenings which are meant to attract large numbers of audiences. At the same time, because of commercialization and globalization, cities have become a brand and a competitor with other cities for investments, skilled people and tourism (van den Berg & Braun, 1999). Cities believe that events can bring them a *direct spin off* (people that visit events spend money in the city) and *indirect spin off* (events can contribute to the branding of a city). For this reason, cities are willing to facilitate the grow of the number of events and their size and are developing policies for this. To name an example: recently, the city of The Hague in the Netherlands has updated its policies on events for the reasons mentioned above (Klein, 2015).

Because of the grow of events and their size, challenges for cities organizing or enabling these events have become larger (STADIUM, 2013). First, how to secure the safety for all the people coming to these events and being in close neighborhood to another. Second, how to make sure that everyone who wants to visit the event is able to arrive at the event in time, making sure that emergency services are still able to go to where they need to go to and making sure that the nuisance of people living close to where the event is held is minimized (Verschoor et al, 2015). On the one hand, events are becoming economically and socially more important to cities, while at the other hand more and larger events go along with serious safety and mobility problems to deal with. Therefore, it is in the interest of cities and organizers of events to maximize expectations and to minimize risks and so to come up with solutions for the above mentioned problems. In my thesis, the focus will be on mobility problems for events and it will be tried to figure out which solutions are effective in dealing with these mobility problems.

1.1. Problem Statement

For most events, the incoming mobility flow of visitors is the largest just before the start of the event and just after the finishing of the event. The point where the number of people trying to get to the

event location and trying to get away from the event location is the highest is called the peak in mobility. Obviously, problems arising because of the large numbers of people that need to go to a particular location are the largest at the peak. Many examples can be mentioned in which the available transportation network is not able to accommodate the peak in such a way that the users of the network will not incur delays in their journeys. Due to the intense volume of transportation (mobility) movements from and to the area where the event is organized, the accessibility of the area will often be harmed and users are confronted by having to incur delays in their journeys.

1.2. Aim and research question

The main aim of this thesis is to investigate solutions that may contribute to spreading the peak in mobility for events, in order that this peak will be smaller.

To achieve this aim the following main research question will be answered:

How can be dealt with the mobility problems that arise from the organization of events?

The goal is to find solutions for mobility problems arising because of event-related journeys. With Mobility Management (MM), one tries to change the travel behavior of the visitors. When this succeeds, the peak will be more spread out and smaller, through which one can notice that the pressure of event-related traffic on the existing transportation network and all its users is smaller as well.

Literature about behavioral economics and other behavioral studies are being published in a fast pace. Our knowledge of the behavior of people and how to develop efficient policies that have an impact on behavior is developing at the moment. Also, some governments are starting to applying this knowledge in their policies and are setting up behavioral teams and are asking for studies in the behavioral field. One of the first and best-known of these teams is the Behavioural Insights Team (BIT), that has been set-up in 2010 by the government of the United Kingdom (Behavioural Insights Team, 2015). One of the teams that has followed the BIT UK, is the BIT team of the Dutch Ministry of Infrastructure & Environment.

The Dutch government has set up a program called ''Beter Benutten'' in which they try to convince people traveling by car during rush hour to and from their work, to make alternative travel decisions so that the peak during rush hour on the road network for specific bottlenecks is smaller. With this

program, some approaches to change the travel behavior of people from and to their work have been tried. Because of this, there is some knowledge on behavioral approaches in the context of mobility for the Netherlands. During the course of this thesis, an overview of the available literature will be given first, after which an effort is made to make a contribution to the already available literature and practical knowledge in the field.

1.3. Method of analysis

The research question is answered by following a Case Study Design. As a case study, the ArenAPoort has been selected. The case is studied by performing a qualitative analysis, which is supported by a quantitative example. For the quantitative analysis interviews with local stakeholders have been carried out, and additional background information has been obtained by consulting other experts in the field of Mobility Management. The supportive quantitative example is prepared by using telecom data.

Three sub-questions are specified, by which following the answers of these questions it possible to pose an answer on the research question:

(1) ''What are the problems that arise from the organization of events?'' (sub-question 1, SQ1)

(2) ''What are the possible approaches for the problems that arise from the organization of events?'' (sub-question 2, SQ2)

(3) ''What is the potential effectiveness of several approaches in solving the problems that arise from the organization of events?'' (sub-question 3, SQ3)

SQ1 is answered by given a detailed description on the accessibility and on where the accessibility is deteriorated due to mobility because of events. After that, SQ2 is answered by performing a SWOT-analysis on what the strengths and threats are regarding the accessibility of the area (following the answer of SQ1) and what developments and characteristics can be seen as opportunities or threats in developing approaches for the improvement of the accessibility of the area. Lastly, SQ3 is answered by the quantitative illustration for telecom data.

1.4. Structure of the thesis

This thesis continues by giving an overview of available literature in Mobility Management and Behavioral Economics, and by developing a tool by which the insights in these fields can be applied for

events. After this, the Method of Analysis will be specified in which the methodology is given first, after which the data is followed. SQ1 is answered in Chapter 4 - Case Study. After a detailed description of the case study, SQ2 is answered in the Analysis Chapter, in specific sections 5.1 – 5.6. A quantitative example in section 5.7 is following the qualitative analysis, by which SQ3 is answered. After all the sub-questions have been answered, the thesis finishes by stating the conclusions and mentioning the limitations of this research and recommendations for further research.

2. Theoretical Framework

Where people travel, a transportation network has to be supplied so that these people can move themselves from point a to point b. The supply in transportation infrastructure needed depends on the transportation mode selected, which is for example airports for airplanes, roads for cars and bikes and the relevant public transport network for public transport services. Building new transportation infrastructure and maintaining the existing one is relatively expensive (Koppenjan, 2005). Supplying transportation infrastructure to and enabling people and companies to travel is, however, massively important to keep the economy running. Without the right transportation network people cannot travel to their jobs, trade between companies is impossible, and going on holiday would be impossible for people to name a few examples. Without the supply of a fast and reliable transportation network; lots of production would not be made in the economy. *This combination makes it important that investments in the capacity of the transportation network are made as cost efficient (productive efficiency) as possible and the available capacity is used as efficient as possible* (Mallard & Glaister, 2008).

When more vehicles or people travel on the transportation network for a certain transportation mode at the same time as is available in capacity, the demand to transportation is above the capacity of the network, of which the consequence is delay for the users. Negative externalities come with delay. A negative externality is a negative consequence of the action of a decision maker on other parties that were not involved in taking the decision so could not choose to not be exposed to the negative consequence. The most important negative externalities as a consequences of delay in the transportation network will be mentioned. *First*, because of delay, people waste time waiting to get to their destinations in which they could be productive (lost production through delay). *Second*, it takes longer for goods to get to their destinations. As in time goods depreciate (some goods depreciate faster than others), this is at the expense of the output value of the economy and harms the competitiveness of the country. *Third*, when there is delay on the road network (congestion), additional greenhouse emissions occur, which damages the health of people living nearby and contributes to global warming. *Fourth*, besides additional greenhouse emissions, congestion in the road network is also at the expense of road safety. In literature it is proved that when there is congestion the chances for accidents are higher, although the number of fatal accidents is lower.

The most straightforward way trying to solve delay in the transportation network, is to invest in increasing the capacity of the network. Some studies argue that for the road network, increasing the capacity will also increase the demand and congestion will stay stable[1], but for the purpose of this reasoning it can be assumed that increasing the capacity will not result in a higher demand. In this case, investing in the capacity of the network will decrease delays and in that way will decrease negative externalities and will have a positive influence on the society's welfare. However, this will only hold when the positive influence on welfare of having less delays outweighs the extra investments that have to be made in the network.

Constructing additional capacity in the transportation network and maintaining the existing one is expensive and the budget that is needed is highly variable (Koppenjan, 2005). Also, the costs of not having enough of it are in most situations not for the investor but for the society. Therefore, it is often governments instead of private companies that are making investments in the transportation network. In order to minimize the expenses in transportation infrastructure capacity, it is in the interest of the government that the available capacity is used as efficient as possible by its users. In other words, *the allocative efficiency of the transportation system is to be maximized, in order to minimize the amount of investments required in the capacity of the network that is needed for preventing delays in the network.*

However, people and companies do not use the transportation network in an efficient way. It is possible to identify three main causes for this.

The first reason for this is that nobody owns the problem of delay in the network **(1)**. The sum of the users of the system benefit when individual travelers decide to travel in another way, however it is not in the benefit of one particular user to make an alternative decision (this phenomenon is called the prisoners dilemma) (Meurs, 2015). *In order to incentivize these individuals to make a travel decision which benefits the whole, you have to find a way to internalize these external costs.*

A second reason why the infrastructure is not used efficiently can be prospect theory **(2)**. Most humans tend to be risk averse when the outcomes of the decision they take are highly uncertain (Berveling et al., 2014). This indicates that these individuals will choose for the option with the most certain outcome. By providing information, it is possible to make a better estimate of what the outcome of a decision will be. *More informed individuals are able to make a better assessment of what the consequences of a decision will be, and will have a higher tendency to choose for (unknown) alternative options than the (safe)*

[1] See for example Duranton & Turner (2011).

standard option. Some users will make a different travel if they know that by travelling in another way, they avoid the traffic jam. To these people, the information needs to be presented somehow, because when the users do not know about these alternatives, they will not adapt their decisions.
Also, you have to think about the manner in which you communicate to the users of the system that alternatives are available (you need to have a communication strategy). *As humans are creatures of habit, they are not easily persuadable of changing behavior* **(3)** (Berveling et al., 2014). Inter alia, in order to convince humans to change behavior the message needs to be right to them, the communication channels need to be right so that they receive the message, the threshold for adapting behavior needs to be small etcetera.

Inefficient use of the available transportation network can occur in three forms:

(1) Inefficient use in time:
- Almost all people travel to work early in the morning and go home late in the afternoon, through which at early in the morning and late in the afternoon the capacity of the infrastructure can be under pressure, while at other times the use of infrastructure is below capacity (see Figure 1).

(2) Inefficient use between transportation modes:
- Most people travel by car through which the road network may be congested plus that there is a lack of parking spaces at some locations, while at the same time some public transport networks may be operating below capacity.

(3) Inefficient use between routes:
- Sometimes, when a lot of people do not know the area well, some routes can become congested, while some other routes (connecting the same locations to each other) can be faster as these routes are not above capacity yet.

Time, (available) transportation mode and (available) routes are the three relevant factors that play a role when someone makes a travel from point A to point B[2]. One needs to makes a decision on **(1)** in

[2] This is the short term decision on how to perform a travel from A to B, with the options that are available at the moment just before the travel is going to be made. You could also identify long term decisions that have an impact

which moment in time the travel from A to B will be made, **(2)** in which transport mode this travel will be made, and **(3)** via which routes (of all the available routes with the selected transportation mode) the travel from A to B will be made, taking into account the restrictions that limit the choices in the factors just mentioned. How the restrictions limit the choices for these three factors can be found in Table 1 ,along with an example to describe how the restrictions limits the choice in the particular factor.

Table 1: Restrictions for the factors that influence the mobility decision

Factor that influences mobility decisions	Restrictions for this factor	Example of the restriction for this factor
Time	The time that is to be arrived at the destination location.	There always are times at which events are about to start. Visitors for these events have to be at the event location before this particular starting time, if they do not want to anything of the event.
	The urgency by which the arrival time has to be met.	For some events with particular activities and for some visitors the urgency to not miss anything of the event might be higher than for other events and other visitors.
	The mean time of travel time from A to B and the variability in travel time.	In general, the mean time is longer when the distance to be travelled is larger *and* when the capacity in the transportation network is lower. In general, the travel time variability is larger when the

on the mobility of persons and companies. E.g. someone's decision on whether to buy a car or not has impact on his/her mobility options for the future. However, when the decision has to be made how to travel from A to B the car is either available as a transport mode, or is not available.

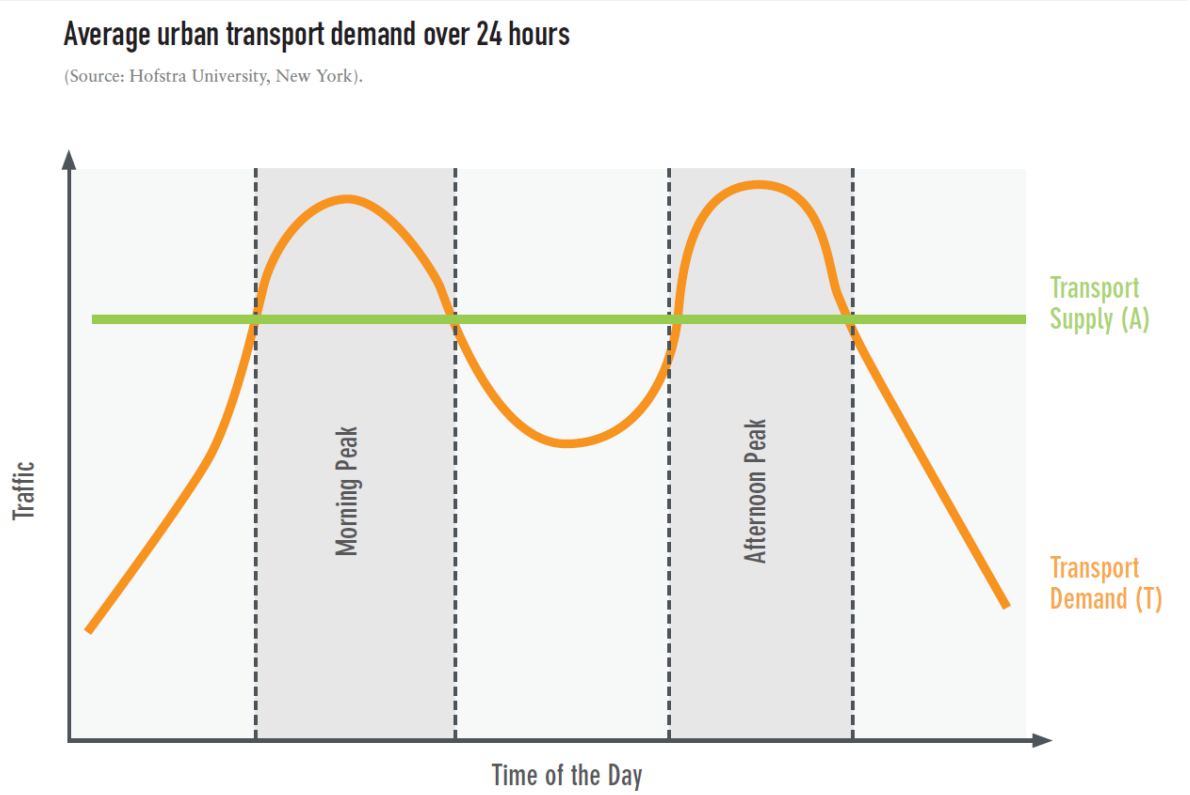
		distance to be travelled is larger *and* when the capacity in the transportation network is lower.
Transportation modes	Available transportation networks for each transportation mode.	Only when there is a network available from point A to point B for a particular transportation mode or a particular combination of several transportation modes (including transfer options), the mode or combination or modes is considered to be an option to choose for.
	The price of making the trip of point A to B for each available transportation mode, including prices at the destination location to park a car (for the road network).	The impact of price on the selected transportation modes is depending on the budget which is available for the travel and the sensitivity of price differences of the several options on the selected mode.
	The available of a car determines whether travelling with the road network is considered to be an option or is not considered to be an option.	A car is available when there is a possession of a car itself and when someone else has a car available.
Routes	The routes determine by which coordinates the travel is to be completed.	The available of routes can have an impact on the decision for both time and transportation mode.

For example, when you have to open a store you have to be in store when it is opening time, when there are no or poor public transport connections available, public transport will not be considered as an

option and when only one road makes you arrive at your location, you have no other choice than taking that particular road to arrive at the selected location.

In Figure 1 an example of inefficient use in the transportation network is presented. The presentation in this figure is the most familiar example of inefficient use of transportation network, which is the inefficient use in time of the road network (car traffic). The road network of very densely populated and prosperous cities become congested in the morning rush hour and in the afternoon rush hour, due to commuting traffic (EPOMM, 2013). Negative externalities due to congestion in cities are having such a large impact that this is an issue which is receiving lots of attention from politicians and policymakers.

Figure 1 : Capacity utilization on a day of the road network for a particular road (or part of a road) in a simplified world[3]



The top of the demand line is called the peak in demand for travel mobility from persons and companies. When the volume of the peak in mobility is higher than the capacity in the infrastructural network that is used for transportation, the network has under capacity, of which the consequence

[3] Source: http://en.envirocitiesmag.com/articles/sustainable-transportation-for-sustainable-cities/smart-mobility-challenges-and-solutions.php

often is delay. In the road network, delay caused because of under capacity occurs often in the form of congestion of traffic jam. If it would be possible to spread these mobility flows in time, routes and transportation modes, the transportation network is used more efficiently.

Important to mention is that Figure 1 portraits a simplified world. It assumes the transport supply to be stable across time. Meurs (2015) provides several reasons of why this is not the case:

- Accidents with vehicles result in a lower temporary capacity;
- Obstacles in the network result in a lower temporary capacity;
- Weather conditions have an impact on the capacity of several networks:
    - With rain and snow cars drive with a larger distance to one another, resulting in a lower temporary capacity;
    - Snow and low temperatures may cause problems for public transport networks, resulting in delays and dropped out vehicles.
- The transport demand also has an impact on the transport supply:
    - The more cars are on the road network, the higher the car intensity on the roads, the lower the driving speeds are, and the higher the chance is congestion arises (from a particular point);
    - The more people use public transport, the longer it takes before people board and alight the vehicles, the higher the chance is, a delay arises in the network.
- Non-optimal travel behavior – People try to maximize their own utility:
    - Prisoners dilemma -> affects both demand and supply in the transportation network:
        - Supply: from an individual point of view it might be optimal to drive at a certain speed or to take particular public transport vehicles, while the capacity of the system may be higher when individuals drive at a lower speed or wait for the next train.
        - Demand: this is the peak-shaving issue that belongs to the core of this work.
    - Also when the individual and the social interest align, individuals might still not behave according to their interests, due to reasons that will be mentioned in section 2.2.1.

2.1. Transportation Demand Management

As explained, congestion and delay is at the expense of productivity in the economy. Therefore, governments are applying measures with the purpose to reduce congestion and delay with the least amount of investments needed. These measures can be divided into two categories:

2.1.1. Hard Measures

The so-called hard measures, meant to solve mobility problems, can be regarded as investments in the capacity of the transportation network, according to the definition of the European Platform on Mobility Management (EPOMM, 2013). Due to these investments in capacity, more vehicles can make use of the available transportation network and more persons can be transferred through this network at the same time.

Examples of hard measures are:

- Enlarging the highway with one or more lanes, so more cars can use it at the same time.
- Increasing the amount of available parking spaces downtown so that more cars can park.
- Investing in new tram lines, so that trams can go to more places and transport more passengers.

2.1.2. Soft Measures

The so-called soft measures, meant to solve mobility problems, can be regarded as investments in the efficiency of transportation system. The capacity of the system is neither increased or decreased, but when these type of measures are effective, the system will operate more efficient. Therefore, one can say that soft measures promote the effectiveness of hard measures. The advantage of applying soft measures above applying hard measures is that soft measures do not require large investments (in infrastructure) and therefore have a more favorable cost-benefit ratio (EPOMM, 2013).

All the possible soft measures together can be put under the umbrella of the concept of Mobility Management (MM). These concepts are often used interchangeably and mean approximately the same. For MM, EPOMM (2013, p.7) gives the following definition: *"Mobility management is a concept for promoting sustainable transport and dealing with the question of car use by modifying the habits and behavior of travelers. The core of this mobility management is formed by "soft" policy measures such as information and communication, organization of services and the coordination of activities of the various partners.''*

2.2. Behavioral Economics

In several research fields, studies are published that focus on the behavior of individuals and groups in several occasions and on how to influence this behavior (Berveling et al., 2011). In economics, the direction that researches the behavior of people is called behavioral economics. Standard economic theory assumes that each economic decision maker makes rational decisions. These rational decisions are made by maximizing their own utility function. In doing this, they use all information that is available and all process the information in the same way **(1)**. Also, their preferences are constant in time which implies that if conditions are the same today as in the future, the decision maker will not make a different decision today as it would make in the future **(2)**. At last, decisions are made maximizing their own utility **(3)** and framing does not have an impact on the decision that is taken[4] **(4)**.

According to behavioral economists, several of these conditions are violated for a decision maker to make rational decisions. Lots of studies make similar conclusions about the assumptions that are violated in the rational decision making model by the actual behavior of decision makers. These are mentioned by Berveling et al (2011):

- People have inconsistent preferences in time (violating assumption 2):
  - Most people prefer satisfying their needs today, instead of having to wait to be able to satisfy their needs in the future.
- People are not only focused at their own utility, but they do take the utility of others also into account (violating assumption 3).
- People have difficulties making a correct assessment of the risks involved when they have to make a certain decision:
  - Because understanding all the risks involved is difficult, it is not possible to take all the available information into account when making a decision (violating assumption 1); and
  - Rules of thumb are used to overview the options. Therefore, the context in which situations are framed is having an impact on the final decision that is taken (violating assumption 4).
- People are incapable of making a correct assessment of their own skills, they are susceptible for social pressure and emotions may cause losing overview of all the available information (violating assumptions 1 and 4).

[4] Framing is the way in which information is presented.

- Humans are creatures of habit (violating assumption 1). In section 2.2.1, the consequences of this for the behavior of people is specified.

Assuming rational decision makers or not can have an impact on the outcome of economic models and on the policy recommendations that are following on these outcomes. In ex-post analyzes, one can take a better understanding of why the effects of certain policies are as they are, with the insights of behavioral economics. In ex-ante analyzes, one can make better predictions of the actual effects of certain policies when combining knowledge from standard economic theory and knowledge from behavioral economics.

2.2.1. Behavioral Studies in Mobility Management

Several insights from behavioral economics can be applied in Mobility Management. These will be mentioned in this section.

What influences decision making?

Berveling et al (2011) provide *four factors that influence the mobility decisions of humans*:

- **Habitual behavior:**
  - Decisions that are taken incidentally and have a larger impact on the life of people are carefully considered. Information is welcomed and will be taken into account when making the decision.
  - Most decisions are taken regularly and are taken in a routine fashion. The decision is not or barely considered and more information about the options will not be taken into account.
- **Personal attitudes and perceptions**:
  - Attitudes: In their lives, people develop norms and values that lead to a certain belief.
  - Perceptions: The beliefs of people influence the way they view the world.
  - Attitudes and perceptions influence the mobility decisions of people, restricted by their personal character and limitations.
  - Even though people differ, there are some consistencies between them in their decisions:
    - People do not like too many options to choose from – too many options lead to that no decision is taken whatsoever.

        - People are risk averse – through this people like to choose for the most secure option in their perceptions.
        - People tend to favor options they know, above new options.
        - People tend to favor fulfilling their needs today, above waiting to fulfill their needs in the future. Also: Benefits from a certain action today have a much higher weight in a decision than costs in the future that are a consequence of this decision.
- **The social environment** of people impose norms to them, according to which they adapt their behavior:
    - Descriptive norms: what most people do.
        - Most people might commute by car.
    - Prescriptive norms: what from a moral point of view people should do.
        - From a government point of view, they would like to see more people commuting by public transport and bicycle.
    - People follow the behavior of the leaders of the social group they belong to.
    - People tend to believe what people with expertise and authority on a certain topic say about this topic.
    - People do not like to break the promises and commitments that they have made to themselves or to others.
    - People tend listen and to do more for other people they like (that are similar to them in their view).
    - When something is rare, people tend to label it as good and valuable.
    - Reciprocity: when somebody does something for you, you want to do something back for him or her.
- **The physical environment** affects the way people behave:
    - Continuously, people get signals from the environment that they are in.
        - The way in which roads are equipped influences the speed at which drivers drive.
    - People like things that can be done easily as compared to things that are complicated.
    - The atmosphere in the environment affects whether people like the environment or not.

Who are the persons I want to adapt the behavior of?

When understanding better why people behave the way they do, it is possible to come up with measures that are effective in changing this behavior (ex-ante). However, in order to successfully come up with these measures some additional knowledge is needed:

Segmentation of groups

First, you have to make a segmentation of the entire population into groups. The effectiveness of a certain policy or measure will increase when at forehand you have described in detail what the group is you intend the measure for to be and when you make sure the communication about the policy and measure fit with the perceptions of this group. When a certain measure is targeted at a group that is too generally described;

- only a small number of people in the group will be hit by the measure, so only a small percentage of the segment group will respond to it;
- Also, some subgroups in the segment group may respond in a different (or opposite) way so when these subgroups would have been defined it would have been possible to foresee this and to come up with alternative measures for these different subgroups.

Groups can be segmented based on a few observable and more advanced criteria:

- Observable criteria -> relatively easy to measure as these are observable:
  - age, gender, residence, origin, disposable income etc. (in general)
  - In mobility management one could also identify groups by travel motive, the ownership or use of a certain transport mode, activities of people, cohabitation, physical condition, family, financial means and living.
- Advanced criteria -> relatively difficult to measure as for this you need to find a way to reveal the perceptions of people:
  - People that have the same observables may have different life styles and perceptions and will make different decisions through this.

After one has segmented into groups, one can identify which group is most likely to be the most willing towards alternatives and what alternative offers need to be developed so that these groups will ultimately indeed choose for the alternative.

Discontinuities

In the travel behavior of people, the main reason for non-rational behavior is habitual behavior (Berveling et al., 2014). Once people are used to a particular pattern, they will perform this pattern over and over again, and will not consider alternatives ways of doing things. When there is a discontinuity in this habitual pattern of people, people will reconsider their options at which there is a chance to make an offer to these people so that they will choose what the policy maker would like them to choose.

How can I use my knowledge of decision making and my insights into segment groups to successfully develop measures that are effective in changing behavior?

Kotler et al (1999) have developed a model in which is described which steps people are taking from the moment they recognize a need for themselves to the moment that they take a decision how to fulfill the need. These steps are taken both in deliberate considerations as in habitual behavior. This model is shown in Table 2, together with an example to show the way how this model works in decision making.

The way in which individuals go through these steps when making decisions depends on whether the decision is deliberately or habitually. These differences are outlined in Table 2 by comparing two examples of decisions to each other.

Table 2 : What happens in phase of decision making for deliberate and habitual decisions

Phase of decision making	Deliberate Decisions	Habitual Decisions
Recognition of needs	e.g.: Someone gets his/her fist job and needs to decide whether he/she needs to buy a car to commute or not.	e.g.: With which transportation model am I going to commute today? Usually, I commute by car.
Search for information	○ Possible options to commute are public transport, car and cycling. ○ What is the commuting time for each of these options?	○ Possible options to commute are public transport, car and cycling. ○ No effort will be made in searching for information, since the

	○ What are the commuting costs (in monetary terms) for each of these options? ○ What other advantages / disadvantages does a car give to me?	decision by which transportation mode to commute is already made and the outcome is car.
Weigh all the alternatives against another	Weigh all the advantages and disadvantages .	New information about alternatives will not be considered.
Decide	Buy a car when the advantages outweigh the disadvantages.	As this involves an everyday habit, the same decision will be taken every day.
Behavior after	When the decision is taken to buy a car, it is likely that almost every day the car is used for commuting (becomes a habit).	As this involves an everyday habit, the same decision will be taken every day.
Reconsideration	As long as there are no discontinuities, the decision will not be reconsidered.	As long as there are no discontinuities, the decision will not be reconsidered.

Once you have identified segment groups according to their observables, perceptions and social and physical environment, and there is a window of opportunity (discontinuity) so that habitual behavior will be reconsidered by certain groups of people, you can develop measures that are meant to persuade the targeted segment groups to behave differently:

1) You need to offer an alternative that is of enough quality against a price that is competitive enough;
2) You need to provide information so that all of the options can be weighted;

3) You need to provide incentives so that (temporary) the alternative is attractive enough so that some people are willing to try the alternative;
4) You need to motivate people to structurally change behavior (make sure that in the reconsideration the alternative is chosen again through which at some point the alternative has become the new habit).

2.2.2. Beter Benutten

In the Netherlands, insights of behavioral economics have been applied for soft measures in the program of Beter Benutten. A few of these soft measures applied will be mentioned. These are cited from the evaluation report of the first phase of Beter Benutten (Tertoolen et al., 2013):

- Rewarding the desired behavior and punishing the undesired behavior:
  - Can be done by both material rewards and punishments and by immaterial rewards and punishments.
- Making it easy to behave like it is desired:
  - Make sure the quality of the alternatives is good (includes partly hard measures).
  - Making sure it is financially attractive to use these alternatives.
- Making use of the social norm:
  - What is the generally accepted behavior in the social group you want to change the behavior of?
- Providing information, knowledge and feedback:
  - Provide information about the results of the desired behavior for participants themselves.
- Tryouts and inducements:
  - Convince people to try the desired behavior with a simple reward;
  - Make sure the experience of using the alternative is good, so that people want to perform the desired behavior more often.
- Making use of commitments:
  - People do not like to break their promises and commitments;
  - Measures in which conformations of participants towards other people and towards themselves are used.

Applications of these soft measures in actual situations have been mentioned in inter alia Tertoolen et al (2013) and EPOMM (2013).

2.3. Mobility Management for events

In this section, a framework will be provided in which the analysis which MM measures might be effective for event-related mobility can be performed.

2.3.1. Classifying events

There is a reason for people to travel themselves and to transport goods from location A to B. People want to arrive at particular places and goods needs to be sold or are in a manufacturing process. Most of the travel movements made, are to satisfy the needs of people. Therefore, in economics, demand to transport is called derived demand (Mallard & Glaister, 2008).

When you want to change the travel decision that people make, you need to know the reason or purpose why people are making that trip. Where are they coming from? Where are they are going to? Which particular need they want to satisfy at their destination? When one does not know the reason for the travel, it is difficult to come up with an approach that is successful in changing the travel behavior. Therefore, it is useful to get to know the background of why certain groups of people are making particular mobility decisions.

Meurs (2015) has made a classification for events. The mobility problem because of these events are of a different nature for each of these different categories of events, resulting in different approaches that are required for each of these different categories.

Meurs (2015) has classified events based on three characteristics:

1) The frequency by which events are organized (frequency of events).
2) The physical area that the event requires (location of events).
3) Whether the event is scheduled or not.

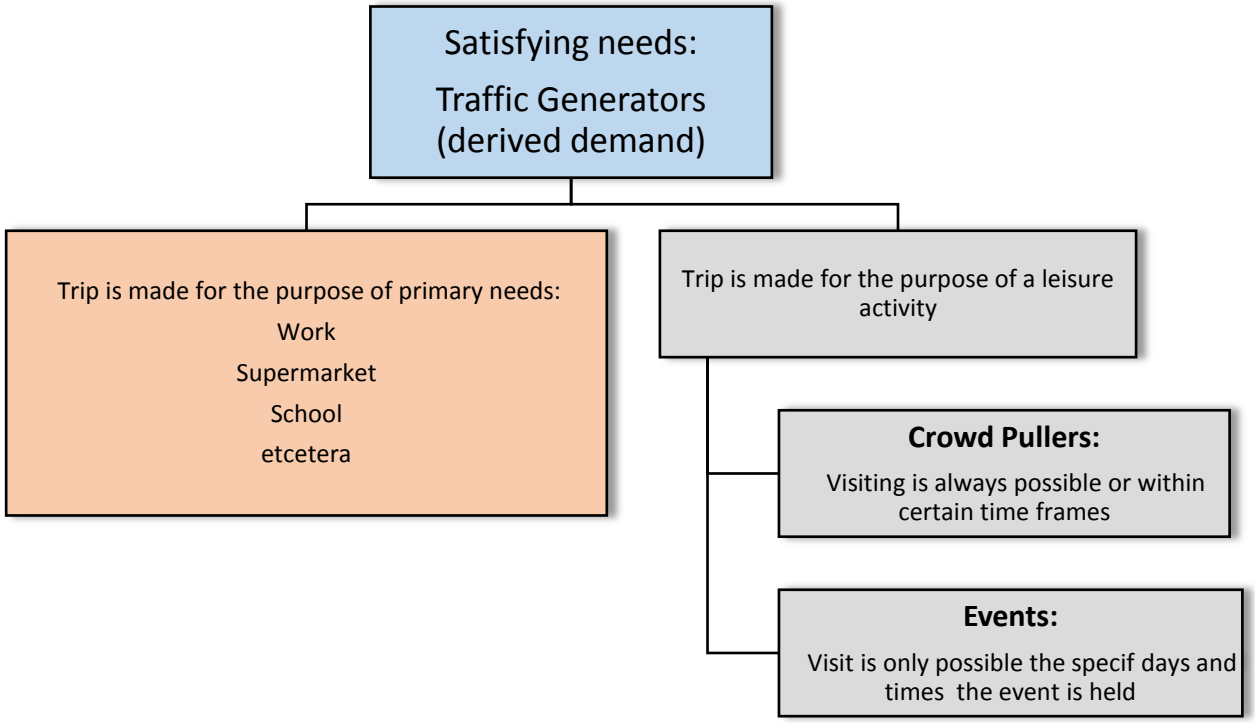
Frequency of events

Crowd pullers and events

First and foremost, Meurs (2015) makes a distinction between *crowd pullers* and *events*. The difference between the two is that you can always (or within certain frames) visit **crowd pullers**, while if you want

to visit an **event** you have to be at the event location at a certain day (or certain days) within certain times, because that is the moment the specific event is held. The common ground between the two is that for both the trip is made to a leisure activity. Examples of crowd pullers is a zoo, a theme park, a beach and so on. It is important to mention here that trips made to work, to school or to the supermarket and so on are not considered to be travels made to crowd pullers since these kind of trips are not made for the purpose of a travel to a leisure activity.

Figure 2 : Categorization of the reasons for making a trip



Source: own work based on (Meurs, 2015)

Repetitive events and one-off events

Meurs (2015) makes a distinction between events that are organized regularly or sometimes and events that are held only one time:

- Repetitive events are events that are being organized more than once in the same location
  - It is possible to learn from the best practices of the previous edition.
- One-off events are events that are being organized only once in the same location

- It is not possible to learn from the best practices of previous editions of the same event, so the solutions for the mobility problems have to be excogitated from (almost) scratch.

Comparison

The peak for crowd pullers will generally be smaller than the peak for events. The main reasons for this is the unique character of (most) events. As explained, events can only be visited within certain times at specific days, and if you do not go the event at these days and times, the next chance to visit the same event will be ranging from a few weeks to a few years to never again. When someone decides not to go to a specific crowd puller today, one knows that it is also possible to visit the same crowd puller within a day or within a few days time. Therefore, when two events are similarly attractive to the public you can say that the peak is expected to be higher for the crowd puller / event for which one has less often the possibility to visit. In general, an event will always be organized less often than a crowd puller, when following the definitions for an event and a crowd puller that is used in page 25. Following the same approach, a one-off event will be organized less often than a repetitive event.

Location of events

Meurs (2015) distinguishes three types of events, classified to the geographical location that they are held in:

- Line-event
  - Roads, bicycle paths, tram lines etcetera are crossing the event and so have to be closed for the event.
  - The main challenge is to keep the city accessible for both event-related traffic as other traffic, with the road closures that need to be made for the event.
- Point-event
  - The event is held in a physical space that is equipped especially for the event:
    - Stadiums;
    - Concert halls;
    - Ground on which a zoo is build.
  - The main challenge is to manage all the incoming and outgoing visitor flows, who all arrive around the same time and all leave around the same time.
- Area-event
  - The event is in a physical space that is not especially equipped for the event:

        - Square;
        - Park.
    - No roads are crossing the event and need to be closed for the event.
    - Depending on whether the event area is concentrated or spread out the main challenge is either to manage the visitor flows or to keep the city accessible for everyone.

Comparison

The smaller the area is the event is held in, the more visitors have to go to a particular physical spot, and the less visitors can spread themselves across the event area. Therefore, when two events are similarly attractive to the public, the peak is expected to be higher for events at which the event area is smaller. Using the definitions mentioned in page 27, the peak is expected to be higher for similarly attractive point-events and concentrated field-events than for line-events and dispersed field-events.

Is the event scheduled or unscheduled?

- A scheduled event is an event that is planned well in advance.
    - Mobility plans can be made and can be discussed with each other after which one can implement these for when the event is scheduled.
- An unscheduled event is an event that occurs spontaneously
    - Only just before the event starts you will know that the event is occurring:
        - Silent march after violence or a happening through which people mourn.
        - The arrival of a ship or airplane that a lot of people want to see.
        - The arrival of a person or a group.

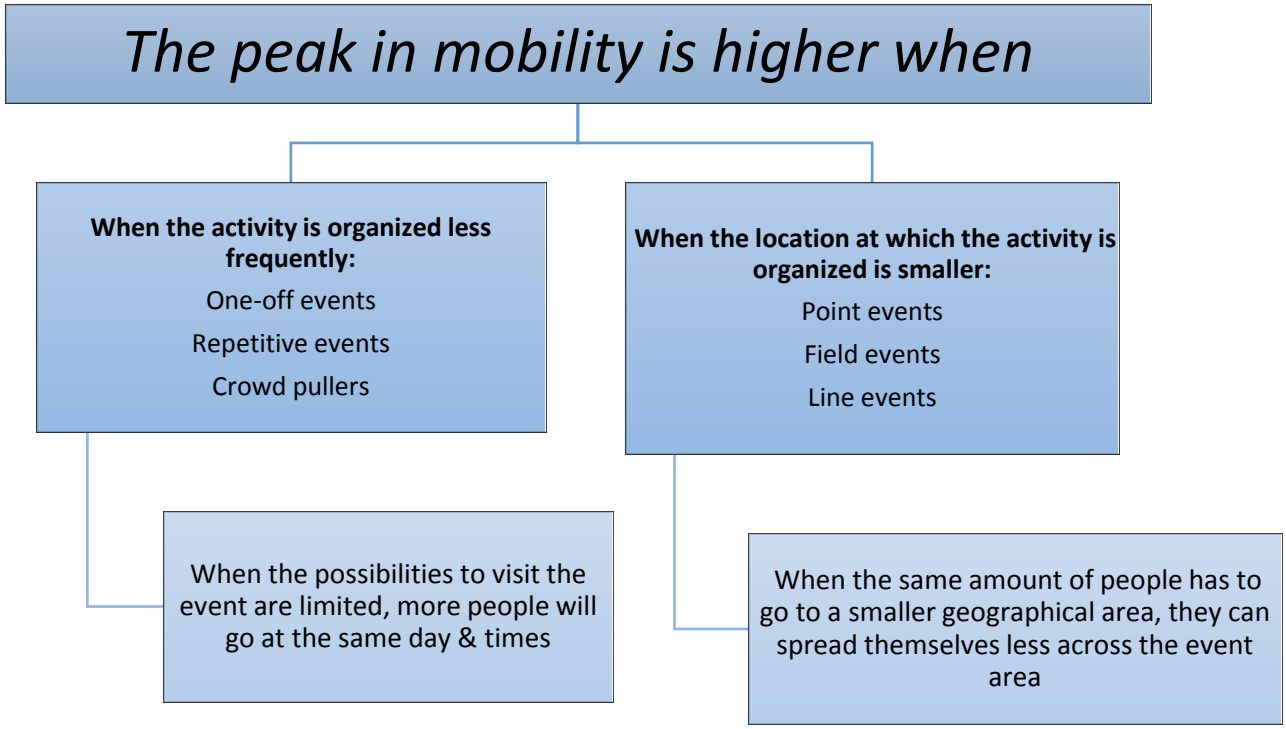
Comparison

As for scheduled events it is possible to develop and implement mobility plans, the event crowd is expected to be better manageable than for unscheduled events, for which all of the plans and preparations have to be done in a very short amount of time. As for unscheduled events all the plans are short term, the plans will always be reactive. For scheduled events, one can think long about the plans and therefore it is possible to develop proactive plans, that are intended to change the mobility behavior of visitors.

Figure 3 provides a summary for this section, which is chapter 2.3.1, for the issue that is receiving central attention in this thesis, which is the peak-issue. From this figure can be concluded that the peak-issue is most relevant for (ceteris paribus):

- An event that is organized once in the same location (one-off events), because it is not possible to learn from the best practices of previous editions;
- An event for which the physical area to which visitors will go to and leave from is the smallest (which is for point events), because the mobility problems are larger when more visitors have to go through and leave from a smaller physical area size.

Figure 3 : The peak in mobility for mobility generating leisure activities (Ceterus Paribus)



Source: own work based on (Meurs, 2015)

2.3.2. Risk analysis tools

In section 2.3.1 events of a different nature are classified into several categories. The framework which has been used for this can be regarded as a theoretical approach to the phenomenon ''mobility for events.'' In this section, a more empirical approach has been applied for this phenomenon. The focus

has been put on policy documents in which the conditions are specified which have to be met so that a license for organizing events can be granted. A license will be granted when the safety risks[5] in organizing an event are considered to be manageable. To determine in detail what the safety risks, some conditions have been specified which have an impact on the safety risks involved. In this section, the conditions which are specified in these policy documents as having an impact on safety are mentioned, and also it is mentioned what the expected impact of these conditions is to be for mobility.

In broad, three conditions can be identified; **(1)** the type of visitors that visits the event, **(2)** the profile of the area and **(3)** the profile of the event activities have an impact on the type of mobility for events. Below, these three conditions and the criteria by which these conditions are determined are mentioned. Also, it is specified what settings these criteria can have and how this will have an impact on mobility. The conditions are coming from the risk analysis tools mentioned in the event policy document from Rotterdam (2013) and Eindhoven (2014). The criteria and the impact that the settings of these criteria have on mobility have been mentioned in these policy documents or have been obtained by consulting several stakeholders in Rotterdam and Amsterdam (for a detailed explanation of how these have been used see ''Method of analysis – Methodology – Interviews'' chapter 3.1.3).

Profile of Area

The following criteria are included by the Profile of Area: Transportation Network, Other events and Other economic activities.

Transportation Network

A spatial network by which persons can move themselves between two points , this includes:

- Road Network (for cars and other motorized vehicles)
- Public Transportation Network (for public transport vehicles)
- Bicycle and walking network (for slow moving transport)

The accessibility of the area is regarded to be enhanced (+) when for each of these transportation networks the capacity in terms of persons or vehicles it is able to process, is higher (+) in a specified amount of time.

[5] Safety risks include much more than only risks which are cause by mobility, such as crowd management and terrorism risks. However, for the purpose of this thesis only mobility will be considered, and risks arising due to other reasons will not be included.

The following consequences for delay are expected when the accessibility is either enhanced (+) or deteriorated (-). (+) will indicate that there are less delays and (-) will indicate that there are more delays:

Table 3: Consequences for the delay in journeys when the accessibility is enhanced or deteriorated

ACCESSIBILITY	The number of delays (number of people which incur delay)	The amount of timed lost due to delay (time lost by people due to delay together)
Enhanced (+)	Lower (+)	Lower (+)
Deteriorated (-)	Higher (-)	Higher (-)

The accessibility for a specific event will deteriorate as a consequence of other movements. When the volume of these other movements becomes larger, the leftover capacity for visitors of an event to move themselves to and from the event site is lower.

Transportation demand for other reasons than visiting a specific event are subdivided into two categories:

Other events

When other events are also organized nearby, the density of transport movements will be higher, through which the accessibility will be poorer.

Other economic activities

The density of transport movements will be higher when there are more other economic activities active in the area around the same time as the event is organized, through which the accessibility will be poorer.

Profile of Visitors

The following criteria are included by the Profile of Visitors: Age, Departure Location and Alcohol.

Age

Several age profiles could be identified, the coherent mobility profile with the age profile has been outlined:

- Visitor who are minor are likely to be either brought with a car by the parents or complete the journey by public transport
- For visitors who are in the adult stage, the more years that the age of the visitor is counting, the more likely it is that a car available for the journey and so the more likely it is the journey will be completed by car as opposed to public transport (note: up to a particular age).

Departure Location

When a larger distance has to be traveled, the more likely it is the car, as opposed to public transport, will be used to complete the journey because the time gains of traveling by car as opposed to public transport are in general larger when the distance to be traveled is larger (in most occasions).

Alcohol

When the alcohol consumption per visitor at the event is considered to be high, it is less likely that visitors will complete the journey by car (since this will prohibit the car driver to drink much alcohol) and more likely that visitors will complete the journey by public transport or by taking a taxi.

Profile of Activities

The following criteria are included by the Profile of Event Activities: Day, Time of start, Ticketed yes or no and Categories in Meurs Classification.

Day

Events are mostly held in the leisure time of working people, indicating that most events are held:

- In the evening (after working hours)
- In the weekend (Saturdays or Sundays)

As a matter of fact, exceptions of this rule for some special events or for a specific target group are plenty.

Time of start

Three moments of starts are to be identified:

- Working days: in the evening
- Saturday: in the afternoon or in the evening
- Sunday: in the afternoon and to a lesser extent in the evening

Again, exceptions to this rule are plenty.

Ticketed yes or no

When ticked one knows in advance how many people will visit the event (when most of the tickets are pre-sold).

Categories in Meurs classification

Table 4: Categories in Meurs Classification (from section 2.3.1)

Type of event	Crowd Puller of Event (Repetitive or One-off)
Location of event	Line, Point or Area
Scheduled or unscheduled event	Scheduled or unscheduled

Analysis of the profiles

The profiles which have been described in this part can be subdivided into categories of profiles by the impact for accessibility which can be triggered with ''soft'' policy measures (can there be an impact yes or no), given other events and other economic activities. So to say, when policy measures for improving accessibility with transportation for events are implemented, transportation due to other events and other economic activities cannot be taken away and so have to be taken into account.

First, in the category of profiles by which no impact for accessibility is expected when soft policy measures are being implemented is the Profile of Area. The accessibility through the area profile can be improved by using a package of policies which consist of investments in infrastructure, which are considered to be hard policy measures. Second, in the category of profiles by which an impact for

accessibility can be established when soft policy are being implemented is the Profile of Visitors. The accessibility through the profile of visitors can be improved by using a package of policies by which the certain mobility choices of visitors are to be triggered. In order to develop such policies, first, a goal is needed (what choices do I want to trigger?) and second, policies can be developed (what policies can possibly trigger the choice which is desired?). In performing these two steps, the Profile of Activities needs to be taken into account, as this is a major determinant for visitors' mobility choices.

3. Method of analysis

In the previous chapter, an overview of literature is given for Mobility Management, Behavioral Economics (in Mobility Management) and how to apply these in the context of events. By providing the overview of literature, insights are obtained in how Mobility Management could be applied, what the role is of Behavioral studies in this field, and in particular how Mobility Management with behavioral insights could be applied for several type of events.

In the ''method of analysis'' chapter, it is explained in what manner the research question will be answered. To recall, the research question goes as follows:

How can be dealt with the mobility problems that arise from the organization of events?

This chapter will continue by providing the method by which the research question is to be answered in the Methodology section (3.1). In doing this, the subsequent steps which are taken in the analysis are given, including the coherent research question and method for each step. Following the Methodology, the input for the analysis is described in the Data section (3.2). Hereby, a subdivision is made in qualitative input (interviews) and quantitative input (Data).

3.1. Methodology

Describing the methodology for this thesis will be done by, first, describe the process by which the research method has been selected and will ultimately name the selected research method. In the thesis process, a number of interviews have been carried out. The methodology section continues by describing in what way the interviews are used in answering the research question.

3.1.1. Selection of research method

No study is capable of making a full assessment of Mobility Management in all potential situations in which different type of events can be organized. However, one may give an overview of the general consequences for mobility when events are organized and also what the different consequences are for mobility when these events differ in their nature and are organized in different situations (as is provided in the theoretical framework). As a subsequent step, it is possible to see to which degree Mobility (Management) for a certain event corresponds to the general approach of Mobility Management for these kind of events. Also, one can analyze in this step if and how the selected approach for a specific

event can contribute to the existing knowledge and approach there is, when applying Mobility Management for events.

The question arises what the best research method is for this approach. The research method has to be chosen so that the result of the analysis will provide very specific solutions for specific problems, as well is an answer on if and how these solutions can be used in other situations. When one is analyzing a specific phenomenon which is highly dependable on the situation or context that the phenomenon is in, rather than a general phenomenon (independent of the context), a case study is the advised research method (Yin, 2003).

Table 5 provides four conditions which have to be satisfied in order for a case study to be regarded as the most appropriate research method, according to Yin (2003). Also, it is specified in this table whether (and if yes, how) this condition has been met for this particular study. From the comparison in this table can be concluded that there is no reason to doubt that a case study is the right approach in this thesis.

Table 5 : Case Study conditions according to Yin (2003)

Condition	Has this conditions been met for this study and if yes, how this condition has been met
1) The focus of the study is to answer ''how'' and ''why'' questions	• How can Mobility Management be applied for this event? • Why is this particular approach the right approach for this event?
2) You cannot manipulate the behavior of those involved in the study (as a researcher you do not have an impact on the outcome of the study)	As a researcher, you do not have an impact on the behavior of thousands of people visiting an event.
3) You want to cover contextual conditions because you believe they are relevant to the phenomenon under study	As is argued in the theoretical framework, the type of area, the type of event, the type of activities, and the type of visitors (to summarize: context) has an impact on the approach which is required for the event.
4) The boundaries are not clear between the phenomenon and the context	It is clear that mobility due to events (phenomenon) have an enormous impact on (the accessibility of) an area, however, it is unclear what the magnitude of the impact is preciously for both the source area as the impact area.

Which case is selected for this study?

For this thesis research, ***events organized in the area of ArenAPoort*** are selected as case studies. The reason why this case has been selected is that this area has been growing over the last few years in the number of its functions and in the number of people it is attracting, with the stadium Amsterdam ArenA being the venue / function that is the largest crowd puller. This is indicating that over the last few years, the area has generated more need for transport

Reference 1: Gebiedsagenda (Areal Development Plans) ArenAPoort

Gebiedsagenda from ArenAPoort/Amstel III for the years 2016 – 2019

In the ''gebiedsagenda'' it is mentioned that accessibility is one of the key factors to focus at, when the ambition of making the area a more attractive place for businesses and visitors is to be accomplished.

from and to the area (after all it is attracting more people) and that the demand for transport has become more diversified (after all the diversity of functions in the area has increased). As mobility movements have become larger in volume and diversity, stakeholders in the area recognize that something needs to be done in order to ensure the accessibility of the area for everyone that adds value in one of the functions of the area. After all, it is recognized that when nothing will be done to ensure accessibility, the area will be less attractive to visit in the long term, which harms the competitiveness of every single function of the area.

3.1.2. Sub-questions

Answering the research question will follow a three-step approach, in which in each step a sub-question is answered. The three-step approach which will be followed is outlined in Table 6. In the second column of this table, the sub-question coherent to each of these steps is given. In the last column of this table, the method for answering the sub-question is given, for which a more detailed explanation can be found below the table.

Table 6: three-step approach for answering the research question

3-step approach in answering the research question	**sub-question**	**Method of answering the sub-question**
1) Describe the context in which the case study is performed (chapter 4)	*What are the mobility problems that arise from the organization of events?*	*By following the Profile of Area*
2) Mention Mobility Management solutions for the case study (chapter 5.1 – 5.3)	*What are the possible approaches for the problems that arise from the organization of events?*	*By following the Profile of Visitor, taking into account the Profile of Activities*
3) Name the effectiveness of Mobility Management solutions for the case study (chapter 5.4)	*What is the potential effectiveness of several approaches in solving the problems that arise from the organization of events?*	*Will be either an ex-ante analysis or an ex-post analysis*

The first sub-question is answered by following the Profile of Area for ArenAPoort. In other words, a description of the accessibility of ArenaPoort is done and subsequently, the bottlenecks are identified where the accessibility of the transportation system is deteriorated when events are organized in the area.

The second sub-question is answered following the Profile of Visitors, hereby taking account of the Profile of Activities. In doing so, possible approaches by developing soft measures for improving the accessibility when events are organized are identified. For every possible soft measures which is named, the questions, *What choices are to be triggered?*, and, *What policies can possibly trigger the desired choices?* are specified and answered.

The effectiveness of Mobility Management solutions can be measured in two ways. First, the effectiveness can be measured ex-post, which is referred to as an impact evaluation (O'Flynn, 2010). For an impact evaluation a system is required that measures both the situation ex-ante and the situation ex-post. In order to be able to draw conclusions on what has changed from the ex-ante situation to the ex-post situation, and on what part of that change in situation can be attributed to a particular measure or a particular combination of measures. Second, the effectiveness can be measured ex-ante, which is referred to as an impact assessment. In order to conduct such an impact assessment a system is required in which the potential effects and the magnitude of these effects of a particular measure or a combination of measures can be assessed.

In this thesis, measuring the effectiveness of Mobility Management solutions will concern an ex-ante analysis.

3.1.3. Interviews

Interviews have been carried out with local stakeholders that are involved in mobility for the ArenAPoort area. All of these interviews have followed approximately the same structure:

- What problems / bottlenecks are identified when events are organized;
- What measures are being taken to deal with the bottlenecks;
- What is done and what can be done to change the mobility decisions of people; in this way make a contribution towards a solution for the bottlenecks;
- Are any results available for to which extent particular solutions for bottlenecks have been effective in relieving the bottleneck;

- What is the involvement (what role) and responsibility of the stakeholder for the bottlenecks and in particular approaches which are intended to relieving the bottleneck.

For the stakeholder from different organizations, the emphasis have been put on other details (see Table 7).

Table 7 : What have been the discussions in interviews in Amsterdam

Contact	Emphasized in discussion
Frans Loman	• What Better Benutten projects have been implemented in the area in the past; • What Beter Benutten projects are foreseen for the future.
Marco Gerrese	• What is the involvement of the ArenA in managing inward and outgoing mobility; • Project Mobility Portal (subsidy for this project has been received from Beter Benutten).
Aafke den Hollander	• In what way traffic is managed and what organizations are involved in this; • Innovative solutions for the future with which at this moment experiments are being performed.
Chris de Veer	• Intelligent Transport System (ITS) and the application of ITS in practice; • How different solutions combined should results in a more effective approach towards bottlenecks.
Adri Verlaan	• Profiles of event visitors and associated risks involved regaring mobility; • Communication & coordination between the stakeholders in the area.
Erik Maitimo	• How the GVB deals with the incoming and outgoing visitor flows when events are organized; • How public transport use differs for different events (with different segment groups of visitors) and what different practices are applied for this? • Trends in public transport for the future
Sander Venneman	

3.1.4. SWOT-analysis

Answering the first sub-question *''what are the mobility problems that arise from the organization of events''* concerns a description of the context and of the phenomenon which occurs in this context. In other words, the context includes the type of area and transportation networks from and to the area (Profile of Area). Consequently, the phenomenon is described by the mobility which occurs in this

context and the problems which are caused by the phenomenon are the negative consequences for the accessibility of the area which are caused by the mobility for events.

After answering the first sub-question and after having an enumeration on the problems, one needs an approach through which it can be analyzed which measures might be effective in solving these problems. In other words, there needs to be an approach from which the second sub-question *''what are the possible approaches for the problems that arise from the organization of events''* can be answered following the answer of the first sub-question.

In order to make the step which has just been described, a SWOT analysis will be conducted. In a SWOT analysis, the strengths (S), weaknesses (W), opportunities (O) and threats (T) for developing approaches for a particular problem are given. These could be divided into internal and external. Internal is indicating what is within the issue that may either help be harmful in developing an approach. Strengths are helpful and weaknesses are harmful. External is indicating what is outside the issue that may either be helpful again or harmful again in developing an approach. Opportunities are helpful and weaknesses are harmful.

In this thesis, the SWOT will concern an analysis whether the accessibility of the area can be ensured when events are organized. This will be done by taking the following aspects into account, which have an impact on the accessibility of the area:

- The volume of mobility and the type of mobility (phenomenon)
    - The impact of the type of event on mobility (context)
    - The impact of the type of activities on mobility (context)
    - The impact of the type of visitors on mobility (context)
    - The impact of mobility due to other functions in the area (context)

The SWOT taking the aspects here into account can be performed for the accessibility of all the possible transportation modes, and for the possible combinations of transportation modes. By performing this SWOT-analysis, a good summary of the analysis is provided and it will be a useful tool to start with when developing approaches for the mobility problems which are deteriorating the accessibility of the area when events are organized.

Use of the several profiles in the SWOT analysis

In this SWOT analysis, the Strengths and Weaknesses (internal) and Opportunities and Threats (external) are structured for developing approaches which might contribute towards a more efficient use of the transportation system when events are organized. As is argued in the theoretical framework, the Profile of Area is considered as given for developing soft measures. No changes in the Profile of Area can be triggered by developing soft measures for a specific event. Therefore, the Profile of Area is considered to be internal in the SWOT analysis. After all, the Strengths (S) and Weaknesses (W) of the accessibility of the area can be outlined (by following the Profile of Area). Subsequently, it can be analyzed for a particular approach with the goal to enhance accessibility how this would use the strengths and deal with the weaknesses.

It is also argued in the theoretical framework that the Profile of Visitor and the Profile of Activities are considered to be the profiles in which changes can be triggered by implementing soft measures. When a particular measure is implemented, this might trigger a particular choice made the visitor in the Profile of Visitor. In taking the decision, the visitor takes account of the event it is going to visit (Profile of event Activities). For this reason, the Profile of Visitor and the Profile of Activities are considered to be external in the SWOT analysis. After all, the Opportunities (O) and Threats (T) for enhancing the accessibility in the area, by triggering a particular choice by the visitors, given their preferences and given the Profile of event Activities. Subsequently, it can be analyzed how these opportunities and strengths should be used in the approach by which the visitors' mobility choice is to be triggered.

3.2. Data

Several sources of information have been used in this thesis. First, telecom data has been obtained from Mezuro[6] (for a detailed explanation, see Appendix ..). Second, interviews have been carried out with an expert panel of local stakeholders. Last, reports have been read in which is written about the local circumstances when events are organized.

3.2.1. Expert panel

In Table 8, a list can be found consisting of the persons who are interviewed during the process of obtaining information for this thesis. Besides the list, there will shortly be described how information that the stakeholders have given is used in the process.

[6] For an in depth explanation of what telecom data has been obtained from Mezuro and of what can be done with this is given in Appendix 7.1.

Table 8 : List of interviews in Amsterdam concerning Mobility Management for the Amsterdam ArenA

Organization	Type of organization	Contact	Position
Rijkswaterstaat West Nederland Noord	Government, Road Authority	Frans Loman	Program manager Beter Benutten
Amsterdam ArenA	Stadium, landlord	Marco Gerrese	Manager Public Affairs
Municipality of Amsterdam	Government, city	Aafke den Hollander	Senior Advisor Traffic Management
Provence of Noord-Holland	Government, provence	Chris de Veer	Strategic Advisor Traffic Management
Police of Amsterdam, district Oost	Police	Adri Verlaan	Project leader events
Gemeentelijk Vervoersbedrijf (GVB)	Local Public Transport company in Amsterdam[7]	Erik Maitimo	Representative Business market
		Sander Venneman	Team manager Operations Metro

Besides these interviews, the time available for this thesis has also been used to walk one day alongside Sander Venneman (2016) from the GVB, in the outflow of visitors from the football match of Ajax – Excelsior (Sunday 21st February, kick-off: 14:30). During this day, it is shown how the GVB deals operationally with the large amount of visitors that all at the same time want to make a start with their journey towards home from the platforms in Station Bijlmer ArenA and Station Strandvliet.

[7] With a concession for ferry transport, bus transport, tram transport and subway transport.

Besides the interviews that have been conducted to get to know more about mobility management in and around the Amsterdam ArenA, several other interviews have been conducted in Rotterdam. The persons which have participated in these interviews and contributed to the study are given in Table 9.

Table 9 : List of interviews in Rotterdam concerning Mobility Management for events

Organization	Type of organization	Contact	Position
Municipality of Rotterdam	Government, city	Hans Goosens	Traffic Management
		Liesbeth Werdekker	
Municipality of Rotterdam	Government, city	Arjan Meurs	Program Manager
Rotterdamse Elektrische Tram (RET)	Local Public Transport company in Rotterdam[8]	Martijn Paalvast	Senior project leader

These interviews contributed towards the general knowledge about how mobility is managed when events are organized in Rotterdam. Although the discussions in these interviews have not been applied for the case study at the Amsterdam ArenA, they have contributed in obtaining in a deeper insight, which have helped in the discussions that were held in Amsterdam and in interpreting the results from the data.

3.2.2. Telecom data

Telecom data have been obtained from Mezuro. In order to conduct proper conclusions based on telecom data, the question of representativeness of the data first needs to be answered.

Representativeness Telecom data

In fact, the data derived from cellular phones are a sample of the total attendance of persons in a particular location at a given time. Therefore, the question of the representativeness of the sample for

[8] With a concession for bus transport, tram transport and subway transport.

the entire population needs to be answered. For this study, it needs to be answered what the representativeness is of telecom users counted in the sample among the visitors of the selected football matches in the Amsterdam ArenA. In other words: *Is the sample of cellar phones representative enough for visitors so that a reliable description of the situation is portrayed with this sample*? In this section, it is tried to answer this question as fully as possible.

Representativeness in general

The Dutch ''Centraal Bureau voor de Statistiek (CBS)'' National Statistics Agency has been the first to explore the external validity of telecom data (Offermans et al., 2013). The CBS concludes that the study that is conducted gives a good impression of the possibilities there are with telecom data. However, at that day further research needs to be done to check for the accuracy and external validity of the outcomes.

In the master thesis of Jens van Langen (2016), another assessment is made on the representativeness of telecom data. It is observed that when comparing Mezuro data with OViN[9] data, the likelihood that the both data sources are having the same representation of a trip, increases when the distance of a trip is larger. In trips with smaller distances, it is less likely that that the cells are changed in the travel made. Therefore, the external validity of the outcomes is larger when the distance of the trip is larger. A new scaling method, to improve representativeness, is proposed.

Representativeness in ArenAPoort

The ArenAPoort area has many functions and therefore causes a lot of mobility of a different nature from and to the area. Even the stadium itself does not only function as an event-location, but also functions as a P&R-location, as a tourist attraction, and as a congress center[10]. All the functions of the area and the mobility which is generated by these functions has been described, in section ... Because of all these different functions, not every person that is present around the stadium in the ArenAPoort area is there with the purpose to visit an event in the Amsterdam ArenA.

A higher presence of antennas in a fixed area size, means that the attendance of persons in a location can be determined more precise (Keij, 2014). It is argued, that the presence of antennas in the

[9] For an explanation about OViN see Appendix...

[10] These different functions of the stadium may be in use at the same time, however, when an event is organized inside the stadium, all the mobility from and to the stadium will be related to the event. The stadium does not function as a P&R-location, when events are organized, because the parking places are needed for the visitors of the event.

ArenAPoort area is that large, that it is possible to determine at the level of the Amsterdam ArenA stadium itself, what the attendance of persons is. In other words, it is possible to measure which persons visit an event in the Amsterdam ArenA, excluding the attendance of persons being around the stadium with another purpose.

The best manner to check for the representativeness of the data is by validating the outcomes, with outcomes from other sources of data. However, the process of deriving data from other sources is time consuming. In the time that was available for this study, it could not be managed to get more sources of data, other than the total amount of visitors that has attended the match, which has been obtained via the management of the Amsterdam ArenA Stadium. Therefore, it is possible to verify the incremented attendance (from the telecom sample) with the total attendance of visitors. However, it is not possible to verify any of the split ups into several segment groups that have been made with the telecom data. For this reason, the assumption has to be made (and cannot be checked) that when the estimated attendance of visitors (from telecom date) is verified by the actual attendance, the actual split up of visitors into several segment groups is approximately the same as the split up that follows from the estimated attendance.

4. Case Study

After this chapter, an answer is to be formulated on the first sub-question. To recap, the first sub-question goes as follows.

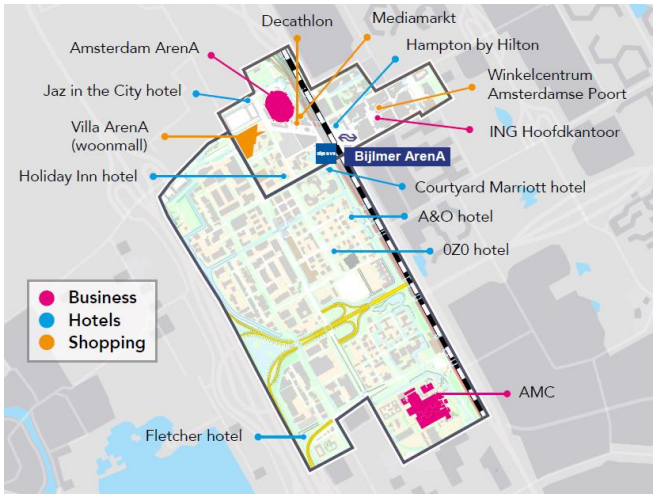
''What are the problems that arise from the organization of events?'' (sub-question 1, SQ1)

As is written in the ''Method of analysis'' chapter this will be done by describing the accessibility of the area of the case study ArenAPoort in detail, hereby following the Profile of Area which has been specified in the theoretical framework. Subsequently, the bottlenecks (where accessibility is deteriorated) when events are organized are identified, by which the first sub-question is answered.

4.1. ArenAPoort

ArenAPoort is an area in Amsterdam Southeast in which the stadium Amsterdam ArenA belongs to the core of. The ArenAPoort deploys several functions which all attract different kinds of demand for transport and corresponding mobility movements. By categorizing these functions, one could unbundle the total of movements in and out of the area into where these movements might have been for. For identifying the different functions the area has, the expert panel is consulted and additionally a regional analysis written by the municipality of Amsterdam is used (Gemeente Amsterdam).

Figure 4: Functions within ArenAPoort and the location of these functions



- Leisure: Leisure can be categorized into two types of leisure (also specified in the theoretical framework):
    - Events: the Leisure is completed at specific times; inside venues which have been built for the purpose of organizing events (point-events)[11] such as the Amsterdam ArenA, Ziggo Dome and Heineken Music Hall;

[11] For the ArenAPoort area the majority of events organized is inside a venue location, so for the scope of this study line-events and field-events are going to be ignored.

    - Crowd pullers: Leisure is completed at any time possible within the boundaries of opening times; performed into locations which have been designed to perform very specific functions, such as the Pathé cinema.
- Offices: Several companies / organizations have an offices in ArenAPoort. The best known are AMC (hospital), ING (banking), Deutsche Bank (banking), and Nuon Vattenfall (energy). In total, almost 50.000 people work in this area.
- Hotels: In the past years the hotel-sector has been growing in the area. Hotels are seen as a separate function, because the moment of accessing and leaving the area is (most of the time) not at the same day, whereas for the other functions people come and leave at the same day. Up to 2015, there were amply 500 hotel rooms, and in 2016 new hotels will be completed.
- Shopping: a wide variety of shop is located in the area, so for a diverse set of segment groups the area offers something in shopping. The best known are Villa ArenA (collection furniture stores) and Mediamarkt (electronics).

Due to the office vacancy rates, some offices in the area get other functions (Gemeente Amsterdam). Most offices that are vacant and being transformed, are being transformed into a hotel function. The hotel function is the function that has seen the fastest growth over the last few years.

Important to mention is that the area hardly has a living function, although on the other side of the railway, Amsterdam Southeast offers residential houses in Bijlmer. The living functions from Bijlmer and the other functions in ArenAPoort, are separated from each other by the railway. Also, one who is going by car to Bijlmer is expected to take a different exit at the highway than one who is going by car to ArenAPoort. Therefore, one can observe large volumes of commuters entering the area in the morning peak and leaving the area in the afternoon peak, whereas no reverse flows are observed for commuters that live in ArenAPoort.

By Table 10 an understanding can be obtained into at what moments in time people in general come into and go out of the area for the different type of functions. Also, when there is a particular pattern in time that is likely to evolve in terms of mobility, this will be mentioned. In general, one could identify two patterns to evolve. First, mobility could evolve in a concentrated pattern, indicating that most of the (incoming and outgoing) mobility occurs in very short period of time. Second, mobility could evolve in a dispersed pattern, indicating that the (incoming and outgoing) mobility that is occurring is spread in time. Important to note here is that it is evident that whether a pattern is considered to be

concentrated or to be dispersed is not discrete but rather a scale in which some patterns are tending to go to a more concentrated pattern and some patterns are tending to go to a more dispersed pattern.

One should note here that it is also possible that a visitor to the area travels to the area for more than one function (*multi-destination visit*). It will be emphasized if this is likely to be case where appropriate. Multi-destination visits could be seen as an opportunity to spread the peak for events.

Table 10: Functions within ArenAPoort and the type of mobility which is caused by these functions

Function of the area	Incoming mobility	Outgoing mobility	Pattern
Leisure (events)	Before start event (mostly in evenings and in weekends)	After the end of the event (mostly in evenings and in weekends)	Concentrated before the start of the event and right after the end of the event
Leisure (crowd pullers)	Any time during opening hours of the location (differs per location)	Any time during opening hours of the location (differs per location)	Dispersed with peaks (depending on if any special happenings occur at particular times)
Offices (working)	Moring rush hours (in weekdays)	Evening rush hours (in weekdays)	Concentrated in 07:00-09:00 and 16:00-18:00 in weekdays
Hotels (stay overnight)	Before check in at the hotel	After check out of the hotel	Moment of coming in and moving out is often not at the same day
Shopping	Any time during opening hours of the location (differs per location)	Any time during opening hours of the location (differs per location)	Most visitors come and go shopping at shop evenings and at Saturdays or Sundays

Out of all of these functions, events cause the most concentrated volumes of incoming and outgoing mobility in a short period of time. In order to ensure the accessibility of the area when events are organized, either enough capacity need to be provided to catch up (hard measures) or something else needs to be done which makes the peak more disperse in time, routes, and transportation modes (soft measures).

When a pattern is considered to be more concentrated, the flexibility to spread the peak is regarded to be smaller. A concentrated volume of transport movements in a short period of time is likely to follow when particular transport movements (for particular purposes) have to be completed in a very short period of time. This is likely to happen when many of the persons demanding these transport movements have to be (or feel like they have to be) at the destination location within a certain time. For dispersed patterns the opposed is expected to occur, through which could be concluded that the flexibility to spread the peak is regarded to be larger.

As can be read from Table 10, concentrated patterns are expected for the functions of Leisure (events) and Offices (working). Mobility patterns which are smoother (dispersed) with some peaks for particular times are likely to evolve for Leisure (crowd pullers), Hotels (stay overnight) and Shopping.

For events, three venues are situated in the area in close proximity to one another. These venues and the maximum amount of visitors that these venues will attract per event (that is: the capacity of the venue) is described in Table 11.

Table 11: Capacity of event venues in ArenAPoort

Venue	Capacity (maximum number of visitors)
Amsterdam ArenA (football match)	53,000
Amsterdam ArenA (concert)	68,000
Ziggo Dome	17,000
Heineken Music Hall	6,000

When multiple events are organized at the same time or around the same time, the stakeholders label this as the organization of a ***double*** (in two venues events are organized simultaneously) or the organization of a ***triple*** (in three venues events are organized simultaneously).

It is a relatively young area; only for a few years, the area is having the function it is having nowadays. The setup is spaciously and the accessibility is good in general, for both car and public transport. The Amsterdam ArenA is the crowd pullers that attracts the most visitors when it is in function. This implies that when the focus is on shaving the peak for the ArenAPoort, the largest gains in potential can be made with the peak of the ArenA.

4.2. Amsterdam ArenA

The Amsterdam ArenA is a stadium which started to function in 1996. Into the ArenA, several events are hosted and besides events the ArenA also performs other functions. The capacity of the stadium determines the maximum number of people that come to and go away from the ArenA when an event is organized inside the stadium.

Below follows a list of activities organized inside the Amsterdam ArenA:

- The most important function is the hosting of football (soccer) matches of the home team Ajax and the Dutch national team. Also, occasionally other matches are held in the stadium. The capacity of the stadium is 53.000 spectators with football matches.
- Also, concerts are held in the Amsterdam ArenA. The capacity with concerts is at maximum 68.000 spectators.
- At last, congresses and meetings are held inside the stadium. However, this is not generating that many people coming to the stadium as is for sport events and concerts.

When events are held in which large numbers of people gather into one location for, there will always be a peak in mobility for people arriving at the location of the event just before the start and leaving just after. Although the accessibility of the area is good, when an event is held in the Amsterdam ArenA the peak delivers problems for the infrastructure available, especially in combination with other events being organized in the same day and bad weather.

4.3. Accessibility of ArenAPoort

Mobility from and to the area can be accomplished by car, by public transport, by slow moving transport or by a combination of two or three of these transportation modes. Regarding public transport, the area can be reached by train, by metro and by bus. In this section, the transportation networks and the bottlenecks in the transportation network from and to ArenAPoort will be described in detail. In order to do this the expert panel has been consulted. Additionally, the Traffic Management Problem Statement for the ‘’Beter Benutten’’ program is used as a source (Metropoolregio Amsterdam). Last, a 2008 report on parking is also used as a source (Goudappel Coffeng, 2008).

4.3.1. Accessibility with car

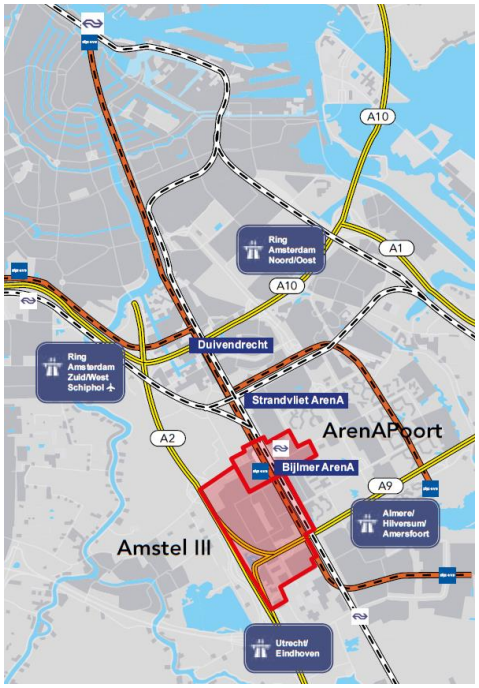
Regarding the road network, the general accessibility of the ArenAPoort area, is regarded to be very good. The area is in a rhombus of highways, with a secondary road network that offers access into the area from all the four corners of the rhombus. Also the available parking supply has been designed in such a way that parking is available from all the four access roads into the area.

The setup of the infrastructure, enables to possibly achieve a distribution of traffic coming from different directions, minimizing the chances for congestion on the secondary road network (see Figure 5).

However, in reality car drivers making a trip to the area do not make the drive to the area via the roads so that the optimal distribution of traffic is to be achieved. Most car drivers are driving into the area from the A2 exit onto the Burgemeester Stramanweg into the area (for both directions). When lots of visitors want to drive from this same highway exit into the area in a relatively short period of time, the result will be that these cars line-up (creating delays in the journeys of these car drivers). It could be that if these visitors would have driven via another (non-congested) route, the delays would have been much smaller.

From all the possible times that the incoming event peak needs to be absorbed by the car transportation network, the pressure on the network is the highest when this peak is to be absorbed in the afternoon rush hour (due to the additional traffic because of commuting traffic). Therefore, in the program of ''Beter Benutten'' the delayed car trips in the afternoon rush hour are receiving the most attention. In the Traffic Management Problem Statement for the ''Beter Benutten'' program, it is mentioned that for at least 152 days a year approximately 4600 car trips in the afternoon rush hour (per day) to the ArenAPoort area are made for the purpose of visiting events (leisure) (Metropoolregio Amsterdam). Out of these 4600 car trips, approximately 3000 of them are having a delay in travel time. Also, it is stressed that most of these car trips that are delayed are car trips which have been made on a relatively short distance.

Figure 5: Accessibility of ArenAPoort with car and train



4.3.2. Parking

In the area, there are in total around 16.000 parking lots. The total of parking lots is enough to satisfy parking demand, even when a ‘triple’ is organized in the area. The challenge is not to provide enough parking lots for everyone who needs one; also due to commercial initiatives, as well as providing parking at business parks. However, the challenge is how to allocate the available lots between the cars coming in from the highway, to prevent delay due to cars waiting in line for parking. However, hereby one should take into account possible conflicting interests there are between public and private parking operators and between private parking operators themselves. As there is enough parking supply available in the area, there is competition between the different

parking operators for cars when there are events. This is reflected by the lack of coordination there is among the parking operators in developing parking products which could contribute towards a more equal distribution of cruising traffic in time and in space. Taking a close look into the issue of coordination between the several parking operators requires a stakeholder analysis, which is beyond the scope of the research approach for this thesis.

In Table 12, it is mentioned what the expected average and maximum demand to parking is (in number of cars) from an event in each venue. The parking demand has been calculated in a 2008 report, in which an assessment is made of whether the parking supply can meet the parking demand, taking into account developments that were planned in 2008 for the years ahead (Goudappel Coffeng, 2008). Important to mention is that these numbers have been calculated based on actual parking numbers in the parking garages of Parkeergebouwen[12] in situations with and without events. Private parking garages and other private parking initiatives are not reflected by these numbers.

Table 12: Average and maximum expected parking demand for event venues in ArenAPoort

Venue	Capacity (maximum number of visitors)	Average parking demand (number of cars)[13]	Maximum parking demand (number of cars)[14]
Amsterdam ArenA (football match)	53,000	3,900	4,900
Amsterdam ArenA (concert)	68,000	6,000	7,000
Ziggo Dome	17,000	2,300	2,900
Heineken Music Hall	6,000	650	700

[12] Parkeergebouwen is the public parking provider in Amsterdam.
[13] Source: (Goudappel Coffeng, 2008)
[14] Source: (Goudappel Coffeng, 2008)

Inefficient distribution of available parking supply

An inefficient distribution of traffic on the highways to the area and the underlying road network within the area in the inflow is also having profound implications for **both** the inflow as the outflow regarding parking. The foundation for delay in the **outflow** is often the time that cars queue to exit the parking garages and other parking locations. Assuming each parking location has the same capacity of cars to exit the parking in some time period (ratio to available parking capacity), the time it takes for all the cars to exit the parking will approximately be the same when the cars are distributed evenly across the available parking capacity (each parking has the same occupancy rate). However, because the entry routes into the area are not used efficiently, the parking in the area is also not used efficiently. This is because people have a tendency to park to the parking which is the closest to the venue on the route that they are driving on, so the length of the walking route from the parking to the venue is as small as possible. Hereby it should be noted that the strength of this tendency is dependent on other factors than the length of the walking route as well, such as the variations in the price of parking for several parking locations, information which is provided on parking locations and the amount of open parking spaces for these several parking locations and the ability of persons to walk particular distances. It is recognized by the stakeholder that some gains can be made in the time that people queue to exit parking in the outflow.

In the part on congestion the foundation of congestion and consequently delay has been put on the exit of the highway, where cars queue to drive into the area. As an addition to this it can be observed that besides the exit of the highway, also the underlying road network could be a source for congestion and delay. It has just been described how a lack of capacity for cars exiting parking could be as a source for delay when the demand becomes too large. In the same way, a lack of capacity for cars entering parking could cause cars to queue for parking. Whereas cars queueing to exit parking are making a queue inside the parking, cars queue to enter parking are making a queue (outside) in front of the parking. Therefore, when too much cars queue to enter one particular parking location, this could create congestion on the underlying road network and finally on the exit of the highway as well.

Consequences for parking due to spatial development plans

At this moment, the neighboring municipality of Oude Amstel has spatial development plans at the location where currently P2 is location. This potentially limits the opportunity to spread cars between parking locations (in the long term), however, to which extent cannot be assessed within the scope of

this study. This issue of spatial development of the municipality of Oude Amstel is also something which could be included in a stakeholder analysis. This thesis will only focus on the short term, by which no immediate changes to the structure of the infrastructure can be made.

4.3.3. Public transport connections

ArenAPoort can be accessed by public transport from station ***Amsterdam Bijlmer ArenA***. This is a multifunctional station, because it used by trains and metros (although the platforms for trains and metros are separated for each other). Also the stations of ***Holendrecht*** and ***Duivendrecht*** (both train and metro), and ***Bullewijk*** and ***Strandvliet*** (only metro) are within walking distance from ArenAPoort.

Figure 6: Parking in ArenAPoort and public transport connections

In customer reviews held by the stadium Amsterdam ArenA, public transport is perceived very well. Visitors that come and go to and from a football match with public transport, appreciate their journey to be good. It is unknown, for which reason public transport is appreciated.

Accessibility with train

Most of Dutch railways are operated by the ''Nationale Spoorwegen (NS)'' (in English: National Railways), which is a public company owned by the Dutch state.

Most of the train timetables end around midnight, and only a few connections are in operation during night. Also for regional public transport connections (from train station with bus, train or metro to locations in the service area of station) most timetables end around midnight, with the exception of some special busses running with a low frequency during night. Through this, some visitors who have arrived by public transport in the area cannot go home with public transport after they have visited an event which ends late in the evening. This is especially the case for visitors that have to go locations in sparsely populated areas. Sparsely populated areas often have public transport connections and

frequencies that are inferior compared to more denser populated areas. Also, as the travel time is longer for visitors that have to travel a longer distance, limited public transport availability on the return trip is more often the case for areas at a larger distance from ArenAPoort than for areas at closer distance from ArenAPoort.

When a visitors to an event arrives by public transport, but cannot return in the same way as it has arrived, public transport will not be considered as a serious option to travel by compared to the car. For this reason, one can assume the share of public transport to be lower for events with a diverse crowd when it comes to origin location in combination with the end time of the event to be late in the evening or in the night.

Accessibility with the local public transport network

The public transport network in Amsterdam consists of ferry services, metro services, tram services and bus services. All of these services are operated by the ''Gemeentelijk Vervoersbedrijf[15] (GVB)'' (in English: Municipal Public Transport Service), which is a public company owned by the municipality of Amsterdam. The station of Amsterdam Bijlmer ArenA is near the end of metro connections 50 and 54. The city center of Amsterdam and Amsterdam Central Station can be reached with the metro from line 54.

Figure 7: The local metro network in proximity of ArenAPoort

Park & Ride (P&R)

The core of Amsterdam is very densely populated and popular area for business to settle in, for persons to live and work in, and for tourists to visit. Due to the so-called pull effect of Amsterdam in combination with the historical heritage of the city, there is barely space for cars to drive and to park in the inner city. To unleash the pressure of cars driving in and parking in the inner city, Amsterdam has developed a concept in which car drivers can park their car in outer ring of the city

[15] Some local bus services are not operated by the GVB but by Connexxion.

and can travel by public transport the remainder of their journey to the inner city. Such a concept is called Park & Ride (P&R).

Due to the reason which has been specified above, in Amsterdam, the P&R concept has been developed for the core (city center) of the city. As such, the stadium Amsterdam ArenA is functioning as a P&R location for the inner city, because of (1) its good accessibility by car in general (when there is no event organized, so no event peak) and (2) good public transport connections with the core of Amsterdam (for both metro and train). However, no P&R concept in which the Amsterdam ArenA is the core has been developed yet.

4.4. Negative externalities due to events in ArenAPoort

The event-peak in mobility is causing delay to occur in the journeys of visitors of events and in the journeys of others making their trip at the same time, same route and same transportation mode as the visitors of events. Where the (most of) delay exactly occurs has been specified by answering the first sub-question in section 4.4. In the theoretical framework, negative externalities have been mentioned as a consequence of delay. To mention the relevant negative externalities again, these are, **(1)** lost time and productivity by people and lost value of goods by companies due to delay and **(2)** when there is delay in the road network (congestion) additional greenhouse emissions occur and **(3)** when there is congestion road safety goes down. Although all of these negative externalities are relevant, some are having the biggest impact in the context of events in ArenAPoort. (1) is especially a problem when due to delay people cannot get to the event venue in time. (3) is very important to local policy makers. Also, road safety is extra in trouble when the time before the start of event is tight. Because people want to make it into the venue in time for the start, they try to do all what is in their abilities to do so. Some actions hereby might endanger road safety.

4.4.1. Negative consequences of delay identified by the expert panel

Congestion

When visitors of events (by car) are confronted by congestion, this is having consequences for other road users than event attendees as well. When visitors to exit the highway into the area, this could also create congestion on the highwa. Car drivers going to other places with this particular road in their route, are also confronted with congestion and delays. Two negative consequences of other car drivers (than event attendees) being confronted with congestion can be identified. First, these other car drivers

are confronted with delays due to movements of event visitors. Second, when visitors all line-up to exit the highway, but other road users want to drive through, this could have a negative impact for road safety in this particular road section.

4.5. Mobility for ArenAPoort – Summary and Conclusion Chapter 4

In this section, the first sub-question will be answered. To recap, the sub-question goes as follows

''What are the problems that arise from the organization of events?'' (SQ1)

This question can be answered by summarizing the chapter of the thesis. So to say, it is enumerated which challenges are faced when organizing (which) events and what further challenges are expected to be faced in the future.

Most transport demand within a relatively small time slot from and to the area is caused by the large event venues (Amsterdam ArenA, Ziggo Dome and Heineken Music Hall). So to say, the peak in mobility in the area is the highest for the three event venues in the area

- The first reason for this is that the capacity of these venues is higher than for other functions (such as the cinema, hotels and shopping malls), indicating that these venues attract potentially more visitors to the area than the other functions do.
- The second reason for this is that, as the opposite to the other functions, events organized within these venues have a starting time and a finishing time. Therefore, visitors tend to arrive just before the start of the event and tend to leave just after. For other functions, visitors to the area have more freedom and deciding when to come and when to leave, and therefore visitors will be arrive in a pattern which is more spread out.

The following bottlenecks have been identified from the peak in mobility for this area (Table 13). This table could be seen as the answer on the first sub-question. Public transport could alleviate some of the pressure there is on the road network and when more visitors would travel to the area by public transport, this would reduce negative externalities due to road traffic from and to the area. Therefore, the bottleneck which has been described for public transport could be regarded as the issue due to which public transport does not fulfill its potential to relieve pressure on road traffic.

Table 13: What are the bottlenecks in ArenAPoort / Answer on SQ1

In which transportation network the problem is incurred	What bottleneck is identified from the problem?
Road network	○ The A2 exit onto Burgemeester Stramanweg is congested lots of times when events are organized (especially in combination with evening rush hour), causes two problems / bottlenecks: • In the inflow, the flow-through of traffic going to other directions than ArenAPoort and having the A2 on its route is hindered; • Also, visitors are incurring (unnecessary) delay in their journey to the stadium; • In the outflow, visitors are incurring delay through that they have to queue to exit the parking.
Public Transport network	○ Most Public Transport timetables end around midnight, causes the following problem / bottleneck: • Some areas in the Netherlands cannot be reached by public transport from station Amsterdam Bijlmer ArenA, from a particular time; • Therefore, visitors that have went to the event venue with public transport, cannot make the same return trip, after a particular time.

4.5.1. Strengths & Weaknesses for Profile of Area

In this part, the SWOT analysis for the Profile of Area - ArenAPoort is provided. In this SWOT analysis, the Strengths and Weaknesses (internal) and Opportunities and Threats (external) are structured for developing approaches which might contribute towards a more efficient use of the transportation system when events are organized. As is argued in the ''Method of analysis'' chapter, the SWOT analysis is considered to be internal regarding the Profile of Area, and so the SWOT analysis will cover Strengths and Weaknesses for the Profile of Area. On top of that, if any possibilities are considered of developing successful approaches for multi-destination visits, given the Profile of Visitor and the Profile of Activities, this is regarded to be an Opportunity (O).

For this SWOT-analysis a remark has to be made regarding the mobility patterns of other functions. Whether it is relevant for the accessibility for events to shift these patterns in favor of accessibility for event mobility, is dependent on whether the mobility for events is in conjunction with mobility for other purposes. Naturally, mobility for other purposes will only delimit the accessibility for events when it will be in conjunction with mobility for events.

Other events and other economic activities (other functions)

Other functions will always have no impact or deteriorate the accessibility to the area for events. After all, due to mobility for other functions the leftover capacity for events will be smaller. There will only be no impact of other functions on to accessibility for events when the mobility for an event and the mobility of another function is completely separated from each other in time.

Analyzing the impact of other functions on either enhancing (strength) or deteriorating (weakness) the accessibility of the area, could be separated into three different aspects. These aspects are: Volume of Transport, Pattern of Transport and Moment of Transport. The impact that other functions in the area have on accessibility through each of these aspects, is outlined in Table 14.

Table 14: Impact of Mobility for several functions on accessibility for different aspect of transport

Aspect of Transport (columns) Function (rows)	Volume of Transport	Pattern of Transport	Moment of Transport (peak)
Leisure **(events)**	**The total volume of demand to transport is dependent on the amount of visitors which are going to the event**	**Concentrated**	**Before the start of the event and right after the end of the event, this is mostly in:** • **Evening** • **Weekend**
Leisure **(crowd pullers)**	unknown	Smooth	When a special happening is about to start or to finish, this will create a peak
Offices **(working)**	Almost 50.000 people are working in the area (maximum volume)	Concentrated	In morning rush hour (07:00-09:00) and afternoon rush hour (16:00-18:00)
Hotels **(stay overnight)**	In 2015 there were amply 500 hotel rooms and in 2016 new hotels will be complemented	Smooth	No peaks expected, moment of coming in and moving out is often not at the same day
Shopping	unknown	Smooth	There might be small peaks for shop evenings and weekends

Accessibility for each transportation network

Regarding the accessibility of the area, the main takeaways are summarized below in bullet points. As an addition, is given whether this could be regarded as a Strength (S) or as a Weakness (W) for the accessibility of the area:

- Road network: the accessibility via road is regarded to be very good and enables to achieve an optimal distribution of traffic across the various entry routes **(S)**.
- Parking: There is plenty of parking supply and this has been designed in such a way that enough parking is available for all the routes via which can be driven into the area **(S)**.
- Public Transport:
    - The station in the area Amsterdam Bijlmer ArenA is a multifunctional station for both the train as the local public transport network (busses and metro). The accessibility for both the national (train) and the local (Amsterdam) public transport network is regarded to be good **(S)**.
    - By several stakeholders in the expert panel it has been recognized that the full potential of public transport is not used.
    - Most public transport timetables end around midnight, through which particular parts of the Netherlands cannot be reached from station Amsterdam Bijlmer ArenA with public transport anymore, when an event finishes around or somewhat before midnight **(W)**.
- Park & Ride: No Park & Ride policy in which the stadium Amsterdam Bijlmer ArenA belongs to the core of has been developed yet.

5. Analysis

In this section, the results should enable to answer the following two sub-questions:

''What are the possible approaches for the problems that arise from the organization of events?'' (sub-question 2, SQ2)

''What is the potential effectiveness of several approaches in solving the problems that arise from the organization of events?'' (sub-question 3, SQ3)

These sub-questions will be answered by following the same structure for the interviews that have been conducted with the expert panel:

- What is the measure that is proposed?
- In what way should the measure contribute to spreading the peak?
    - In time
    - Between routes
    - Between transportation modes
- What behavioral change of actors needs to be triggered in order to spread the peak?
- In what way the desired behavioral change is to be triggered?

5.1. The events in ArenAPoort

In the theoretical framework a methodology is provided to classify events, following the approach of Meurs (2015). As a subsequent step, one could identify how mobility differs for the different type of events. The events organized within the three event venues in ArenAPoort (Amsterdam ArenA, Ziggo Dome and Heineken Music Hall) are all events which could be categorized into the same category in the framework of Meurs. In Table 15, a short recap of this framework has been given in the first two columns, in the third column it is given to which category these type of events belong and in the last column is given which mobility occurs with these type of events.

Table 15: Categorization of events in ArenAPoort and Mobility that occurs for these type of events

Type of indicator	Categorization	Event Venues in ArenAPoort	Consequences for Mobility
The frequency of events	• Crowd Puller • Event • One-off or repetitive event	Events are organized multiple times a year at specified moments ➔ Repetitive events	There will be a peak but (to some extent) this will follow the same pattern as for previous editions of similar events.
Location of events	• Line-event • Point-event • Area-event	Event is held in a physical space that is especially equipped for the event ➔ Point-event	All the visitors have to go to a particular point in space (which is the event venue) and will not spread themselves as such.
Is the event scheduled or not	• Scheduled event • Unscheduled event	Event is (almost) always ticketed en planned well in advance ➔ Scheduled event	It is known (to some extent) when the visitors will be making their journey towards the area, so it is possible to prepare for that.

By the expert panel of local stakeholders, similar observations regarding mobility are made as is concluded in the last column of Table 15. Example of this are mentioned in the next part. This is an indication for that the framework of Meurs could be applied in the context of ArenAPoort.

5.1.1. The type of activities per event

Activities can differ a lot for events which could be categorized into the same category by the framework of Meurs. This framework is categorizing the events based on their physical characteristics, not based on their activities. To give an example, two concerts in the Amsterdam ArenA will be categorized into the same category in the framework, which is, repetitive, scheduled events that are held in a venue. In that respect, the mobility for both of these concerts will be rather similar. However, some differences in

mobility might arise of which a part of might be contributed to the different type of activities for the two concerts.

In the theoretical framework three categories are identified by which events can differ by activities:

- Weekday: At which day of the week the event is organized?
- Time the event is scheduled to start: At what time of the day the event is scheduled to start?
- Ticketed yes or no: Is an entrance ticket required for access to the event site and how many entrance tickets are pre-sold?

In Table 16, the three criteria to categorize events based on the profile of activities are named again. Also in the second column it is given per criterion what the expected impact is on mobility, which is a repetition of what has been given in section 2.3.2 in the theoretical framework. To this table in the last column the result from consulting the expert panel on this criteria is given. This provides how mobility in ArenAPoort will differ for the different possibilities of activities profiles. From this table it can be concluded that for all three criteria the corresponding mobility for several profiles of activities does not differ much from what is written in policy documents for Rotterdam and Eindhoven and what has been concluded after consulting the expert panel in ArenAPoort.

Table 16: Profile of Activities in ArenAPoort and consequences for mobility

Profile of activity	Mobility for the profile of activity	Mobility for the profile of activity in ArenAPoort
Day	Events are mostly held in the leisure time of working people, indicating that most events are held: • In the evening (after working hours) • In the weekend (Saturdays or Sundays) As a matter of fact, exceptions of this rule for some special events or for a specific target group	Mobility is expected to most concentrated, when: ○ The event is organized in the evening of a weekday ○ At a starting time which is early in the evening.

	are plenty.	
Time of start	The time of start for most events will tend to have the following logic: • Working days: in the evening • Saturday: in the afternoon or in the evening • Sunday: in the afternoon and to a lesser extent in the evening Again, exceptions to this rule are plenty.	
Ticketed yes or no	When ticked one knows in advance how many people will visit the event (when most of the tickets are pre-sold).	Almost all the events in ArenAPoort are ticketed, so the ticket sales will give a good indication of what visitors are to be expected coming to the event.

5.2. The visitors of ArenAPoort

Not only the type of events (and the activities at events) does have an influence on mobility, but also the type of visitors that are making a journey towards the event, is having an impact on mobility. All events in ArenAPoort could be categorized into the same category by the framework of Meurs (2015), because the events are all organized in one of the three venues. However, the type of visitor which comes to an event in one of the venues differs per event.

In the theoretical framework, the following profiling of event visitor is identified based on policy documents in Rotterdam and Eindhoven:

- Age
- Departure location
- Alcohol

Note that these are policy documents in which criteria are specified for a license for organizing an event to be granted. Therefore, some criteria to segment visitor groups for events could me missing, as they are relevant for events in general, but are not relevant when criteria need to be defined for granting a permit license. Hereby it should be remarked that in ArenAPoort almost all events are organized inside on of the three event venues, and that these venues have a perpetual license to organize events inside, within the boundaries which have been specified by the license.

It is obvious that visitors could be characterized on way more determinants / characteristics. However, although it is easy to recognize that visitors will differ and some more characteristics, it will be, first, some characteristics will be hard to identify / reveal, and second, on some characteristics might be relevant for other issues but no different mobility behavior is expected based on these characteristics.

In the expert panel, it has been mentioned that visitors of football matches in the Amsterdam ArenA stadium can be distinguished on their frequency of visit. As is mentioned in section 4.2 almost all of the football matches played in the stadium are matches hosted by Ajax or the Dutch National Team. Matches of Ajax are played on a regular basis, the group of visitors is considered to be way more local and visits the stadium more often. Matches of the Dutch National Team are played occasionally, the group of visitors is way more nationwide and the frequency of visit to the stadium is way lower.

5.2.1. Visitors of different events and visitors of same events

Segmentation of visitors groups can be separated into two types of segmentation. First, several groups of visitors can be segmented between different events. For different events with different visitors groups other mobility patterns are likely to evolve. For example, for a concert with a lot of teenagers many kiss & ride movements are expected, whereas for a concert with visitors in their twenties, where a lot alcohol is sold or other stimulants are being used, many public transport and taxi movements are expected. As opposed to this, when not a lot alcohol is sold or other stimulants are being used the share of car movements is expected to be higher. *When a segmentation of visitor groups between different*

events is made, a better understanding could be obtained into why the movements of mobility are different for different events.

Second, several groups of visitors can be segmented within one particular event. When for a particular event the corresponding mobility movements are unbundled, for some of them the unbundling will result in very similar movements, whereas for other the unbundling will result in very diverged movements. In order to get a better understanding of these movements, group of visitors needs to be segmented within the particular event. To relate back to the examples which have just been provided, movements are expected to be rather similar, because the visitors of the event are not expected to make very different choices regarding mobility than other visitors of the event. These events attract a very unifying segment group. On the other hand, for many other events the group of visitors is much more diverse and so are the mobility movements from and to the event location. To give an example, a football match of Ajax is attracting a diverse crowd in many aspects such as age, drinking alcohol, frequency of event, fanaticism and so on. The matter that the visitors are different in so many aspects is resulting in very different mobility choices among these visitors. *Therefore, when a segmentation of visitor groups within one event is made, a better understanding could be obtained into the mobility movements for one particular event.*

5.3. Analysis of visitor choices

As is written in section 4.3., the most import criterion by which visitors for football matches of the Amsterdam ArenA stadium are categorized is the frequency of their visit to football matches in the stadium. Different mobility could be identified for several visitor based on the frequency of their visit. These are enumerated in Table 17 In the last row of this table, some similarities between frequent and non-frequent visitors are outlined.

Table 17: Analysis of similarities and differences in mobility for frequent and non-frequent visitors

Segment visitor group	**Consequences for mobility by segment group of visitor**
Frequent visitor	Are familiar with the area • They make the same journey every time there is a home match of Ajax • They appear to be very loyal to listen to communication platforms of Ajax and tend to follow advices which have been given by these platforms
Non-frequent visitor	Are not so familiar with the area • Many of these visitors are making the journey for the first time or at least are not making the journey on a regular basis • They tend to make more use of supporting systems that can help them in navigating to the area
Similarities between frequent and non-frequent visitors	Similarities between frequent and non-frequent visitors could also be found: • After the event has finished, the vast majority of visitors will leave the venue immediately.

5.3.1. Visitors using public transport

This part will be a general description of the visitor choice in ArenAPoort. In ArenAPoort many events are organized with very different activities and to which very different type of visitors are attracted. It is not in the scope of this thesis to identify all the possible activities and visitors groups for events. However, a more general description will be provided which is based on consulting the expert panel and analyzing the telecom data.

Two main categories of customers travelling with the GVB could be identified. First, there is the traveler from one location in Amsterdam to another. Second, there is the traveler from and to and from stations which are shared by GVB and NS to and from locations in Amsterdam. In the first situation, the GVB

provides the complete public transport journey and in the second situation, the GVB provides only a part of the public transport journey, where other public transport companies provide for the journey from and to Amsterdam.

With the division of GVB customers in the two categories here mentioned, with respect to events the GVB customer is likely to be someone living in Amsterdam, Amstelveen or Diemen. After all, visitors for events in ArenAPoort coming from public transport from outside Amsterdam, will likely take the train to station Bijlmer ArenA. However, at GVB two other types visitors / customers for GVB have been identified:

1) *Visitors making a daily visit to Amsterdam from their visit to the event*. When the event is in the evening, these visitors arrive early at the day by car or train in the area / city. These visitors are going by metro as a tourist to the city center of Amsterdam for a day, after which they return in the evening to visit the event they have tickets for. Often these type of visitors can be signaled when events are organized which attracts people that do not very often make a journey to Amsterdam, such as football matches of the Dutch National team and concerts of the Toppers.
2) *Visitors parking their car at locations close to metrostations, making a few stops with the metro to arrive at the event venue in ArenAPoort*. These visitors are doing this to prevent delays from driving into the congested ArenAPoort area. Apparently these visitors gain time when parking their car at a larger distance from the event venue, and by taking a few stops with the metro afterwards. Visitors doing this are familiar with the area and surroundings, and often make the same decision each time they visit an event within the ArenAPoort area. Examples can be seen with football match of Ajax, which has very regular visitors with season ticket holders.

5.4. External factors

So far, mobility for events has been described as something that is likely as something which is dependent on the area (functions and accessibility) and the type of events (with also the type of activities and the type of visitors). Besides these, there are also external factors which have an impact on mobility and negative consequences that mobility might have. These factors are regarded to be external because they cannot be changed by changing the area or changing the event is scheduled to be organized. By the expert panel, a few external factors have been identified. The effect of these external factors is mainly relevant for the road network, and so congestion and road safety.

- Weather conditions
- The time the sun is setting
- Possible road constructions and other blockages
- The combination with other events being organized around the same time in the area

5.5. Mobility Management solutions in ArenAPoort

5.5.1. Different approaches for various segment groups of visitors

In the theoretical framework (section 2.2.1.) four factors have been identified by which mobility decisions of people are influenced (Berveling et al., 2011). These factors will be mentioned again. It will also be mentioned how this will work in the context of the several segment groups of visitors which has been specified after consulting the expert panel. Lastly, possible approaches will be outlined by which a change in mobility decisions could be triggered.

Table 18: Impact of mobility decision determiners on segment groups of visitors for the Amsterdam ArenA

	Frequent Visitors	Non-frequent visitors
1) Habitual Behavior	Decision will be taken on a regular basis	Decision will be taken on an occasional basis
2) Personal Attitudes and Perceptions	There is no foundation to assume the attitudes and perceptions of frequent visitors to be very different from non-frequent visitors.	There is no foundation to assume the attitudes and perceptions of frequent visitors to be very different from non-frequent visitors.
3) The Social Environment	Frequent visitors tend to follow advices which have been given by the communication platforms of Ajax, as they have knowledge about these platforms and regard it to be trustworthy.	As non-frequent visitors do not have a very in depth knowledge about the area, they will look for information, hereby regarding information to more trustworthy when this is coming from a source which is regarded to be an authority on providing this information.
4) The Physical Environment	The impact of the signs given in the physical environment are regarded to be same for frequent visitors as for non-frequent visitors	The impact of the signs given in the physical environment are regarded to be same for frequent visitors as for non-frequent visitors

5.5.2. Using discontinuities in the approaches

In the theoretical framework (section 2.2.1.) two types of decisions have been identified (Berveling et al., 2014). Deliberate decisions are decisions which are taken occasionally and are carefully considered. Habitual decisions are repetitive decisions by which no alternatives for the decision are considered. Whether habitual behavior is performed or not for a segment group of visitors is given in (1) of Table 18.

In this part, it first be analyzed for each segment group of visitors in which type of decision it can be categorized. As a follow up, it will be analyzed if discontinuities can be used in developing approaches that should trigger different mobility decisions.

As can be read in Table 18 non-frequent visitors take a mobility decision occasionally. Therefore, it is likely that this decision is not repetitive and there are possibilities to influence the decision by providing information. Some conditions which have to be taken into account when looking at how the decision can be influences in the best way possible, is given in section 2.2.

Also it can be read in Table 18 that for frequent visitor the mobility decision has become a habit. However, for a large group of these frequent visitors it has been recognized that a part of the habitual decision is consisting consulting the communication platforms of Ajax. Therefore, there is a chance to have some impact on the mobility decision when information to these visitors is provided through these platforms.

Renovation plan 2020

By 2020, some parts of the stadium Amsterdam Bijlmer ArenA should be renovated to that the entry and exit capacity at the entrances is higher. No more seats will be added to the total of seats there is currently. After the renovation has been finished, better service can be offered to the visitors for these parts of the stadium.

This renovation will offer a window of opportunity to create a discontinuity in the habits of people to leave the stadium right after the match has finished. After all, when particular concepts could be offered which make it attractive for these visitors to stay some time longer in the stadium, this will make the after the match peak more smooth. Naturally, this requires that visitors are showing some potential interest in staying longer.

Also, not leaving the area immediately can be completed in the area, by visiting some other crowd pullers in the area, such as bars and the cinema. In this way, the visit is going from a single-destination visit to a multi-destination visit.

5.6. SWOT-analysis for developing approaches that enhance accessibility – Summary and Conclusion Chapter 5.1 – 5.5

On the next page, the final SWOT-analysis that will summarize the ''Analysis'' Chapter is given. After carefully considering and thinking about the analysis, suggestion for approaches could be developed which are likely to be effective in a solution for the accessibility problem which has been defined. These approaches will be summarized after the table.

Table 19: SWOT-analysis for developing approaches that enhance the accessibility of ArenAPoort

Internal Profile of Area	**Strengths:** ○ the accessibility via **road** is regarded to be very good and enables to achieve an optimal distribution of traffic across the various entry routes. ○ There is plenty of **parking** supply and this has been designed in such a way that enough parking is available for all the routes via which can be driven into the area. ○ For **public transport** there is a multifunctional station Amsterdam Bijlmer ArenA for train stops and metro stops, the accessibility for this station is regarded to be good for both the train network as the local metro network.	**Weaknesses:** ○ Most **public transport** timetables end around midnight, through which particular parts of the Netherlands cannot be reached from station Amsterdam Bijlmer ArenA with public transport anymore, when an event finishes around or somewhat before midnight.
External Profile of Visitor Profile of Activities	**Opportunities:** ➔ Conditions by which the choice of visitors make is likely to be fragmented are considered to be an opportunity ○ Because almost all of the events which are organized are ticketed, this allows to obtain a good understanding in advance of the mobility which will be demanded. ○ Multi-destination visits (combine with other crowd pullers, hotels, and in-stadium concepts) ○ Developing a P&R concept for frequent visitors which are familiar with the area ○ Frequent visitors are very loyal to communication by the platforms of Ajax ○ Non-frequent visitors are in the phase of seeking to information, since they do not have a lot of knowledge about the area.	**Threats:** ➔ Conditions due to which lots of visitors are likely to make similar mobility decisions are considered to be a threat ○ Events scheduled in weekdays at starting time early in the evening, since there is not much flexibility at the visitor to travel at different times and the incoming event peak can be (partly) coincide with the outgoing afternoon rush hour peak. ➔ the visitors who are completing the full journey by car will add up to the congestion ○ Also for these events, the chance increases the visitor completes the journey by car when this is regarded to be faster than public transport. ○ The older the visitors of the event are, the more likely it is the complete journey will be completed by car.

By considering Table 19 the second sub-question will be answered. To recap, the sub-question goes as follows:

''What are the possible approaches for the problems that arise from the organization of events?'' (sub-question 2, SQ2)

The following conclusions can be drawn from Table 19:

- The largest gains can be made by establishing a modal shift from car to public transport, however, for some visitor segments public transport is unattractive alternative to the car;
- Due to the extensive road network there is a possibility to establish a more even distribution of cars across routes, however, the impacts are expected to be limited as compared to the establishing a modal shift;
- There is a possibility to promote multi-destination visits, so that the time in which visitors make their journey will be more spread;
- There is a possibility for developing a P&R concept, especially for those visitors that consider it to be unattractive to complete the entire journey by public transport but do also not like having to queue to enter the area before the start of the event and leaving the parking after the finishing of the event;
- When developing approaches, one should take account of the communication platforms of Ajax for frequent visitors (of Ajax) and provide simple and clear information via platforms which can be found easily for to non-frequent visitors;
- One should take into account the limited flexibility to travel at other times and the relative urgency of visitors to arrive at the event in time when events are organized at weekdays with a starting time early in the evening;
- One should take account of the difficulty to get older people out of their cars into any form of public transport.

5.7. Quantitative Example

In the analysis, a qualitative approach has been applied in order to suggest policies which might be effective in dealing with mobility problems. This qualitative approach is supported by a quantitative example in this section. Telecom data have been analyzed, and the results are summarized in this section. Eventually, the results from the example could help in arguing pro or con particular policies to spread the peak. The detailed methodology behind the results from this example can be found in the appendix (section 7.1). The quantitative example will be used as an illustration or example in answering SQ3:

''What is the potential effectiveness of several approaches in solving the problems that arise from the organization of events?'' (sub-question 3, SQ3)

5.7.1. Aggregates

Nine datasets were given by Mezuro. These datasets are enabling to establish relationships between different characteristics of visitor movements. Table 20 presents how these datasets differ from each other. Also, it is possible to see in this table what the estimated number of total visitors is from the sample of the telecom network, for the different matchdays (estimation of the total number of visitors based on the visitors in the sample). The generalization of this sample is done by Mezuro.

Table 20: Datasets

Dataset	ArenA as a *destination point* (D) or an *origin point* (O)	Frequency in which the time of arrival or leaving is specified	Number of visitors on the 4th	Number of visitors on the 13th	Number of visitors on the 31st
1	O	Quarters of an hour	52.867	29.393	33.652
2	O	Hours	55.662	31.974	35.676
3	O	None	58.063	33.660	37.363
4	D	Quarters of an hour	53.158	30.218	33.647
5	D	Hours	56.241	34.758	37.663
6	D	None	58.007	37.869	39.783
7	O/D[16]	Hours	51.117	30.946	33.681
8	O (not specified to AB)	Quarters of an hour	57.794	37.133	39.563
9	D (not specified to AB)	Quarters of an hour	57.828	36.790	39.150

[16] Making the assumption that the point of origin when travelling to the ArenA is the same as the point of destination when coming from the ArenA.

5.7.2. Descriptive outcomes

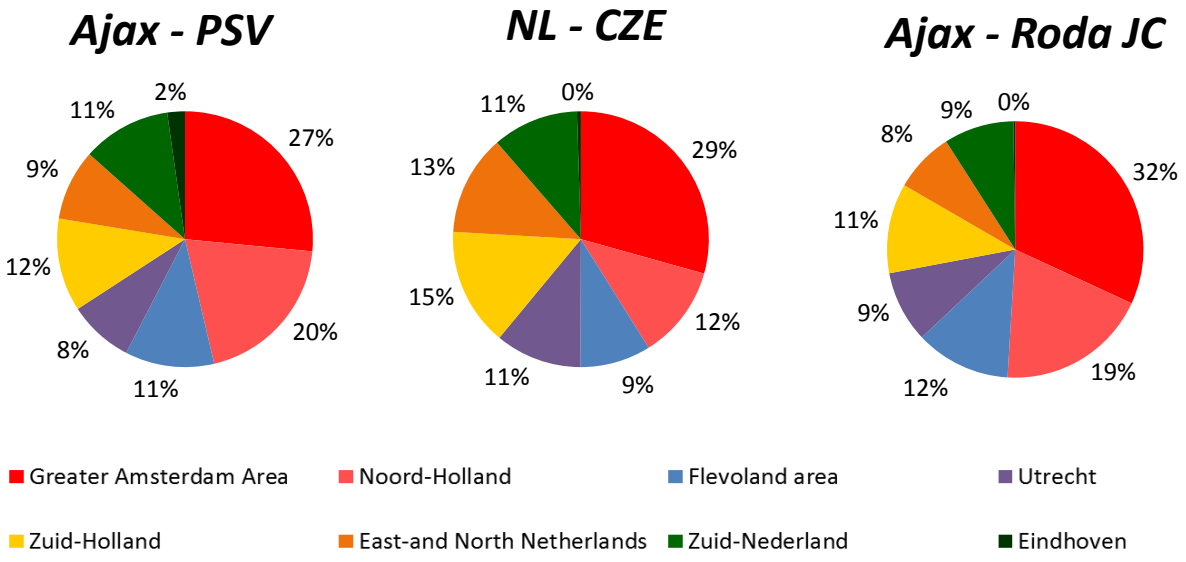
With the data that is provided by Mezuro, the following questions can be answered:

1) From which locations do visitors start their travel to the Amsterdam ArenA at matchdays?
2) To which locations do visitors go after their visit to the Amsterdam ArenA at matchdays?
3) At which times do visitors arrive when visiting the Amsterdam ArenA at matchdays?
4) At which times do visitors leave when visiting the Amsterdam ArenA at matchdays?
5) With which transport mode do visitors come and go when visiting the Amsterdam ArenA at matchdays?

1) Origin locations

The following pie charts present from which locations the travel to the ArenA has started for the different matchdays (cases) in Figure 8. These are presented in percentages of the total number of incoming visitors. The total number of incoming visitors has been given in Table 20.

Figure 8: Origin location for visitors of football matches in the Amsterdam ArenA, October 2015



No major differences are identified for the visitors share from each of these regions. Similar visitor shares coming from particular regions are identified for the home matches of Ajax. Comparing the home matches of Ajax with the match of Dutch National team, the largest deviation can be seen in the share

of people coming from Noord-Holland (20% for Ajax – PSV, 19% for Ajax – Roda JC, 12% for the Netherlands – Czech Republic). This is going to a larger visitor share for the regions of Utrecht, Zuid-Holland and the East and North of the Netherlands.

Figure A2 presents whether the origin location is within close distance of a train station or not. With this, it is assessed which visitors are in proximity of good public transport connections. This is the first step in the analysis which segment groups of visitors are receptive to using public transport instead of the car in their journey to a football match in the ArenA and what prospect needs to be offered to these people in order for them to make the decision in the advantage of public transport.

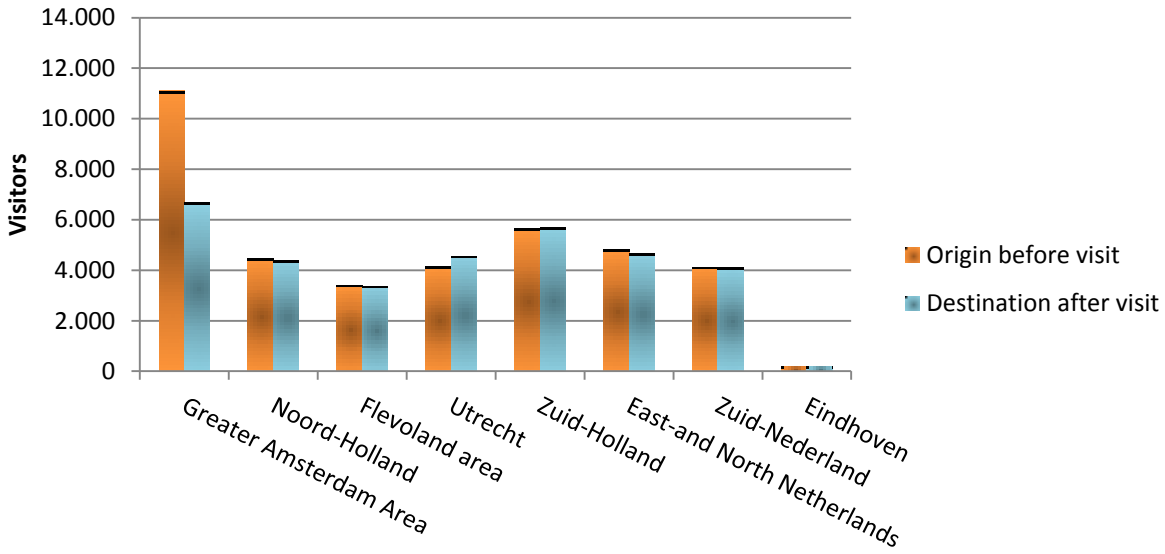
The split of visitors to train station availability generates a very similar outcome for all three football matches. It can be concluded that for the vast majority of visitors (87%), public transport is a transportation mode for which is an option for the visitor to choose for. For the remaining 13% of visitors, the distance to the closest train station is that large, that it is not likely these visitors will be receptive towards considering public transport.

2) Destination locations

The visitor numbers for each region in the inflow and the outflow of visitors is rather similar. From this it is possible to conclude that it is likely that people go to the same locations after the match as from where they came before the match. The exceptions to this rule will be discussed.

In Figure 9, one can see that the share of Amsterdam in the inflow of visitors to the stadium is higher than in the outflow of visitors from the stadium. A possible explanation for this can be that visitors who come from other places in the Netherlands than Amsterdam, arrive early on the matchday at the ArenA. They visit the city center of Amsterdam, and some time before the match is about the begin, these visitors come from the city center to the stadium. Once the match is finished, they return home again. As you can see in Figure 9, these people making a daily visit to Amsterdam, are likely to come from Utrecht and Zuid-Holland (as for these regions the outflow is higher than the inflow).

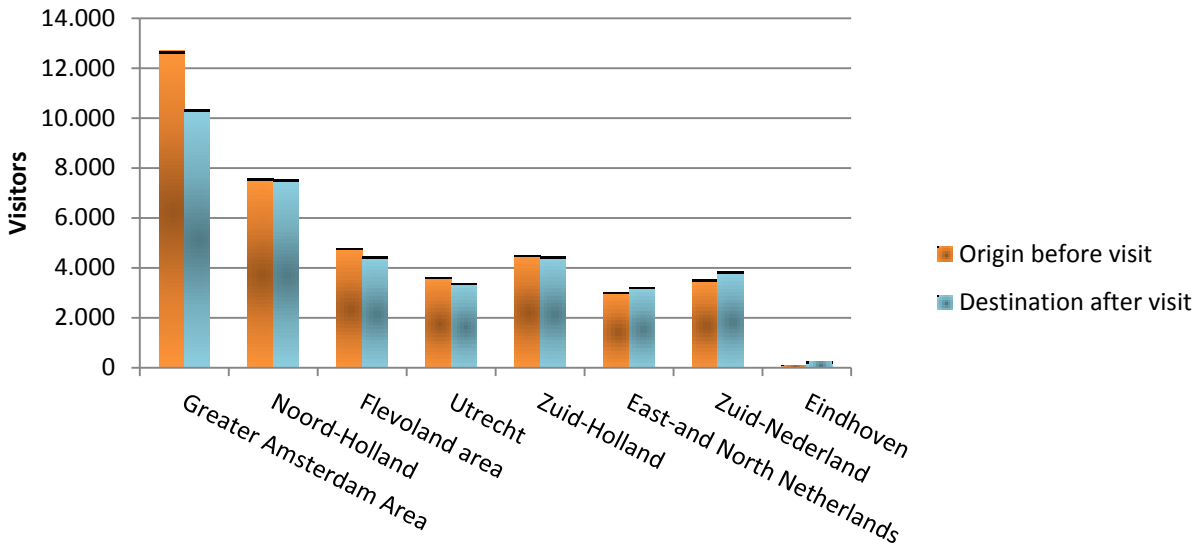
Figure 9: The origin and destination of the visitors of the Netherlands – Czech Republic in the Amsterdam ArenA



Also, it must be noticed that the largest contribution to this difference is made up of people of which it is not possible to identify from this data, which region they have went to after visiting the match. As can be noted in Table 20, the total amount of visitors in the inflow is 37.869, while the amount of visitors in the outflow is 33.660, according to the data. This means that from 4.209 visitors in the inflow it cannot be identified, whereas they went to in the outflow. This difference is almost entirely made up from the difference in the in-/ and outflow for the Greater Amsterdam Area, while for the other regions the number of visitors in the in-/ and outflow is rather similar.

A rather similar conclusion can be drawn for the match of Ajax – Roda JC (see Figure 10). As the share of the south of the Netherlands is higher after the match than before the match, the visitors making a daily visit to Amsterdam are likely to be supporters of the visiting team Roda JC (which resides in Kerkrade which in in Limburg).

Figure 10: The origin and destination of the visitors of the Ajax – Roda JC in the Amsterdam ArenA



3) Arrival peak

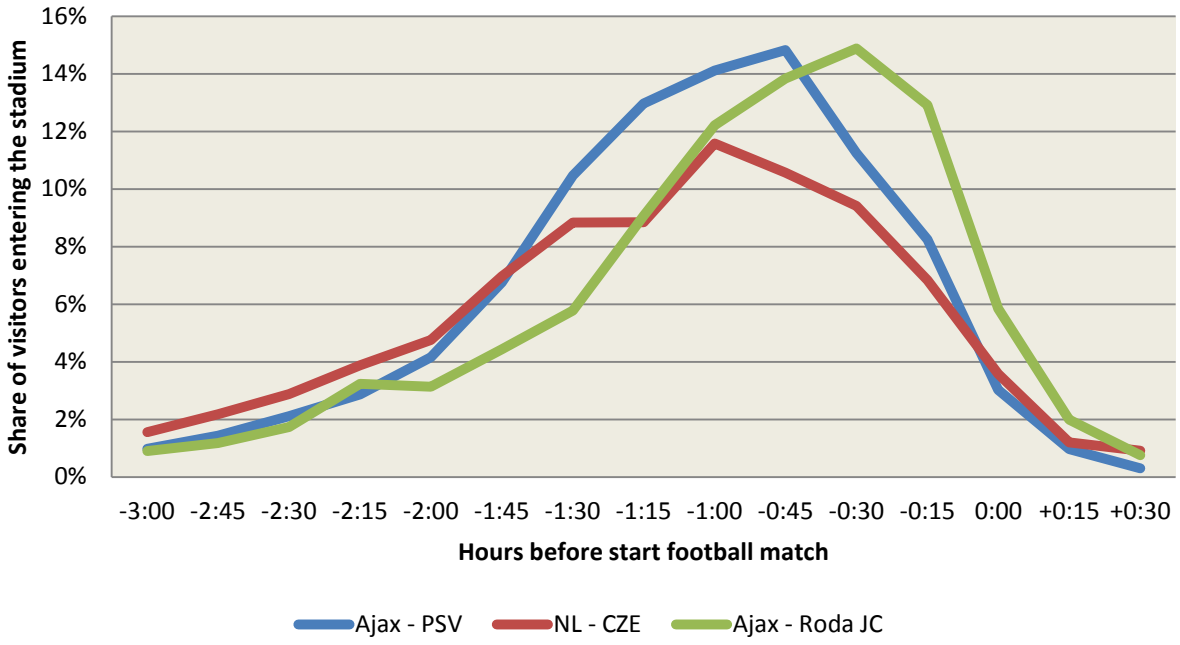
In Table 21 is repeated, what one should remember from Table 20. With this knowledge, continue with Figure 11, which shows where the arrival peak is for each of the three selected football matches.

Table 21: Football matches in the ArenA in October 2015 and the number of visitors according to the data

Match	Day	Starting Time	End Time	# visitors (entering the stadium)[17]	# visitors (leaving the stadium)[18]
Ajax – PSV	Sunday	14:30	16:15-16:30	57,794	57,828
The Netherlands – Czech Republic	Tuesday	20:45	22:30-22:45	37,133	36,790
Ajax – Roda JC	Saturday	19:45	21:30-21:45	39,563	39,150

[17] From dataset 9 in Table 20.
[18] From dataset 8 in Table 20.

Figure 11: Which share of the total visitors arrives in which time period before the start of the match

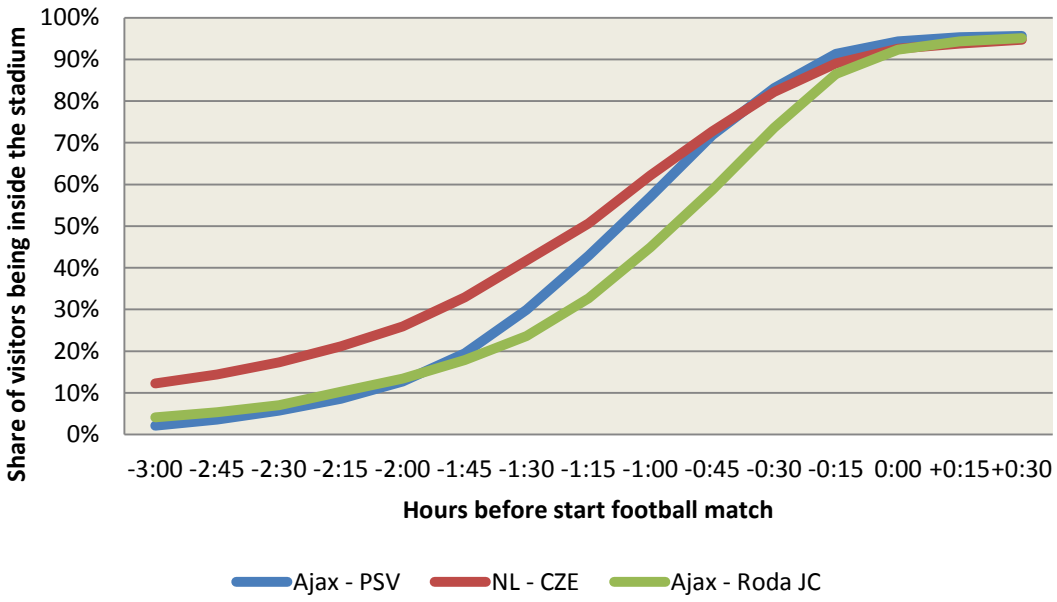


From Figure 11, the following can be concluded:

- The peak for football matches of the Dutch National Team is smaller than the peak for football matches of Ajax is;
- For the Dutch National Team the peak is one hour before the start of the match;
- For Ajax – PSV, the peak is 00:45 minutes before the start of the match;
- For Ajax – Roda JC, the peak is 00:30 minutes before the start of the match;
- For all three matchdays, more than 95% of the visitors are in the stadium, as the match is about to start (which can also be concluded based on).

These patterns are also reflected in Figure 12, which presents the cumulative inflow of visitors.

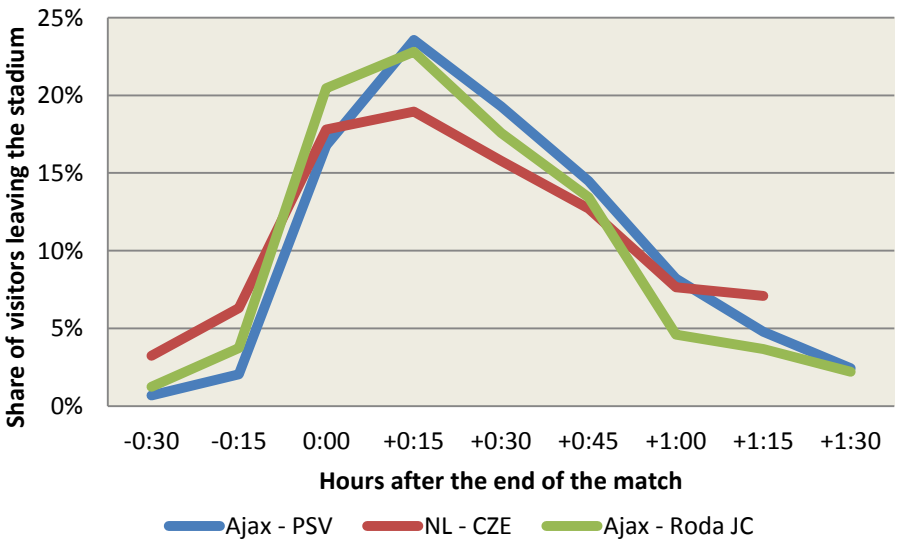
Figure 12: Which share of the total visitors arrives in which time period before the start of the match (cumulative)



4) Departure peak

Almost every visitor of football matches, wants to leave the stadium right after the match is finished or even a few moment before the final whistle of the match is heard. The only exception for this is observed when the match progress is in such a way that the end result will approximately with certainty

Figure 13: Which percentage of visitors leaves at what time just before and after the match



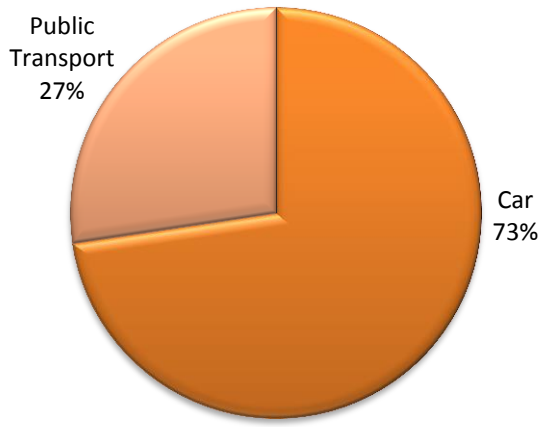
turn out to be negative for the home team. In that situation, some visitors leave the stadium before the end of the

match, because they are disappointed by the match progress (*early leavers*). For the three selected football

matches in the thesis, the match progressed towards a negative result for the home team with the match of the Dutch national team. If any early leavers are observed in the data, the most likely it is these will be observed for the match of the Netherlands against the Czech Republic.

Comparing the three football matches, the match of NL – CZE has been the match by which the most people left early (see left side of the graph). For Ajax – PSV, it is noticed that the most concentrated volumes of visitors leaving has been 15 minutes after the end of the match. A possible explanation for this can be that for this match the largest number of visitor waited to the final signal, before having the intention to leave the stadium. Two reasons can be mentioned for this, which are (1) the great importance of this match compared to the others and (2) the outcome of the match was unknown till the last moment. Because most people were leaving after the final signal, for this match compared to the other matches, the pressure on the corridor exits was the largest. Through this, more people had to wait at the exits before they could leave the stadium, hereby, incurring a delay (of possibly 15 minutes).

Figure 14: Modal split for football matches in the Amsterdam ArenA, October 2015 (average of the datasets)



5) Modal split

For all three matches, and for both the inflow and the outflow of visitors, the modal split does not differ much. Whether the visitors was travelling by car or public transport could not be identified for around 3% to 5% of the visitors. For the remaining visitors, Figure 14 presents the modal split between car and public transport.

This figure gives a rough estimation of the modal split. Slow-moving transport (bike and walking) and park & ride (P&R) movements are not captured by this estimate. Therefore, this figure provides an idea of the modal split, but more work has to be done in order to give a more precise estimate.

5.7.3. Correlations

Some more questions to be answered are as follows:

- Does the mode of transport differ for the different locations that visitors come from and go to?
- Does the time of arrival differ for the different origin areas?
- Does the time of leaving differ for the different destination areas?
- Do people that arrive and leave by public transport, make the journey at different times than people that travel by car do?

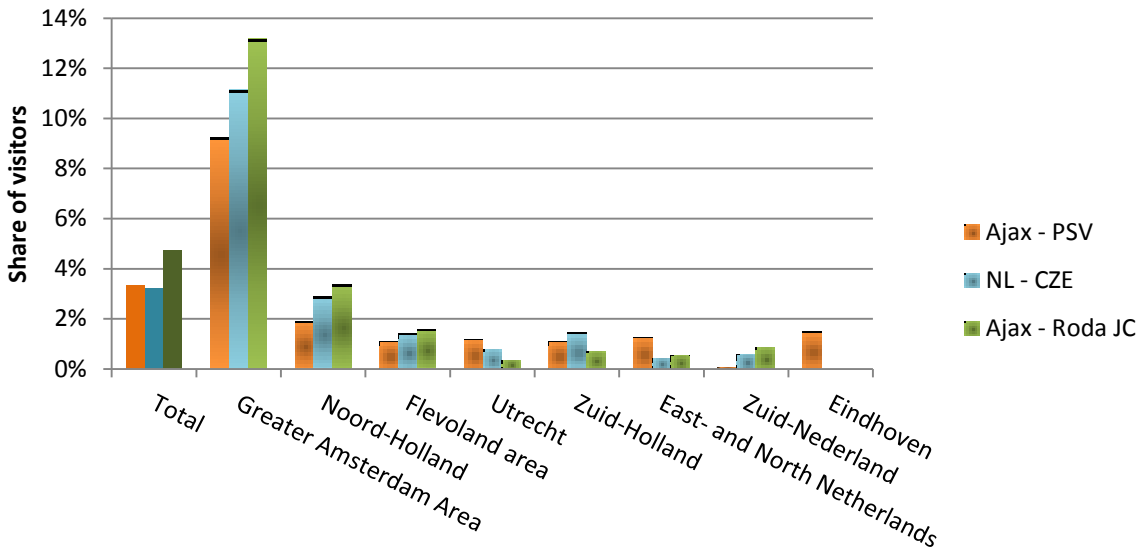
6) Mode of transportation for the different regions

Regarding the modal split and the way this differs for the different origin and destination locations, the outcomes are comparable, although important details differ for the several matchdays. The general outcomes and the differences between the arrival of visitors before the match and departure of visitors after the match is discussed in this section. The modal split for Eindhoven only matters with Ajax – PSV, as for the other matches the number of observations for Eindhoven is very low.

Mean of transport is unknown

When the share of the car and the share of public transport is added to each other, the total of this does add up to the total amount of visitors coming to or leaving to a particular region. Therefore there is a portion of the visitors (5%) for which is could not be assessed whether the journey has been made with car or public transport. It must be noticed that this portion is especially larger than average for the Greater Amsterdam Area (see Figure 15). For all the other regions, this portion is around the average. Visitors coming from and going to Amsterdam have a relative short trip towards the stadium and therefore the differences in travel time between the car and public transport will be smaller than the differences in travel time for the visitor that has to travel a larger distance to the stadium. It is possibly more difficult to identify from cellar techniques whether someone is travelling by car or public transport when the journeys for car and public transport are less distinctive from each other (in routes and travel time). This could be an explanation for why this share is higher than average for Amsterdam, whereas the other regions do not show such deviations.

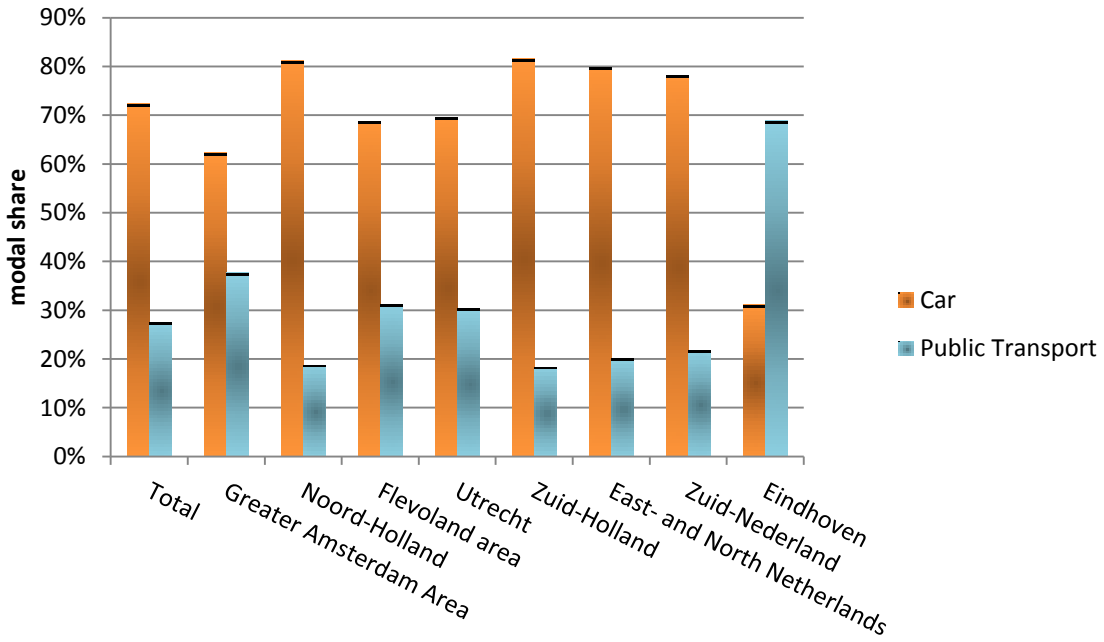
Figure 15: Share for which the transportation mode could not be revealed



Mean of transport is car or public transport

The modal split is rather similar for the different football matches. In Figure 16, the modal splits for the different areas in the Netherlands are presented. In this histogram, visitors are ignored for who the transportation mode could not be defined.

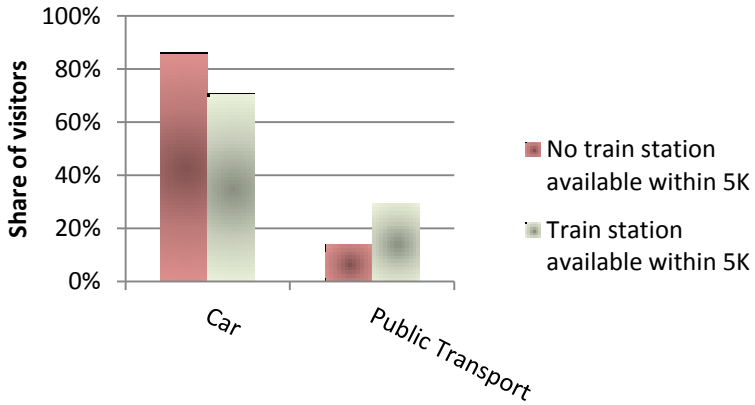
Figure 16: Modal split for visitors of football matches in the Amsterdam ArenA according to location of origin (inflow Ajax – PSV)



From Figure 16, the following can be concluded:

- Relatively more visitors use public transport to travel to the Amsterdam ArenA for Amsterdam as for the other parts of the Netherlands;
- Relatively less visitors use public transport to travel to the Amsterdam ArenA for Noord-Holland as for the other parts of the Netherlands;

Figure 17: Modal split for visitors of football matches in the Amsterdam ArenA according to whether the location of origin is nearby a trainstation or not (inflow Ajax – PSV)



- For the other regions in the Netherlands, the amount of visitors travelling to the Amsterdam ArenA by public transport is rather similar to the national average;
- *Most public transport movements are very likely to be short distance (approximately 1/3rd to ½ of the public transport*

movements from and to the ArenA are within Amsterdam).

You would expect that people who are not leaving to the ArenA from a location nearby a train station, will almost never choose the train as a transportation mode. The extra time it takes to arrive at a train station with public transport will be that much, that the travel time with public transport is way higher than with the car. Also, in some cases, public transport may hardly be available. Figure 16 confirms the expectation just mentioned. In this figure, you can see that share of public transport in the modal split is higher for visitors who are coming from locations with good train connections (i.e. are within 5 kilometers distance from a train station).

7) Time of arrival for different origin regions

In general, every visitor wants to enter the stadium just before the start of the match. After all, any time sitting in the stadium waiting for the match to begin could have been spent on anything else. However, nobody wants to take the risk of losing any minute of the match, so the visitor wants to minimize its chance that the stadium will be entered at a time that the match has already started. Therefore, a safety margin regarding time will be taking into account so that if any incident occurs during the journey, the visitor still has the opportunity to arrive at the stadium in time.

When looking at the pattern in which visitors from the different regions in the Netherlands arrive at the ArenA, the pattern is pretty similar for all three matchdays. In general, visitors from Amsterdam arrive a bit later than visitors from other areas. The shorter the journey is, the shorter the travel time is and the lower the chance is any incidents occur through which the journey is delayed. Visitors from Amsterdam makes the shortest trip to the ArenA generally, which also means that the travel time deviations from the average travel time will be the smallest for visitors from Amsterdam. Therefore, visitors from Amsterdam have to take into account the smallest safety margin of all visitors, to still have the same chance the stadium is accessed in time.

Many other factors have an impact on the chance that the visitors arrives at the stadium in time (before the match starts). Below, I few are mentioned:

- Reliability of the transportation mode which has been chosen for;
- The capacity of the transportation network for the transportation mode which has been chosen for;
- Time of the day at which the journey is made;

- Day in the week at which the journey is made.

8) Time of leaving for different destination areas

As previously stated, most visitors will leave the stadium just before and after the final whistle which signals for the end of the match. Exceptions to this rule have been found for the match of the Netherlands against the Czech Republic, which can be explained by the disappointing match progress for the home team.

Some regions in the Netherlands, cannot be reached from train station Amsterdam Bijlmer ArenA with public transport after a particular time in weekdays and weekends. This is due

1) The timetable of the train stops some time after midnight, with the exception of some night trains connecting a few major cities with each other;
2) Also the timetables of regional public transport connections stop after midnight (with the exception of some night busses), which makes it difficult for persons living at some distance from a train station to arrive at home with public transport by night, even when it is possible to reach the train station closest to their homes by train.

As written before, it is not likely that a visitor will choose to go by public transport when the visitor knows it is hard to make the same journey in the reverse way with public transport after the match. Several solutions for this problem could be used. *As a first solution*, the visitor can decide to go by car and to not take the gamble of public transport. *As a second solution*, the visitor might decide to leave the stadium before the end of the match. *As a third solution*, the visitor can stay in the area for one night, and go out in the area or stay a night in one of the hotels in the area or somewhere else in Amsterdam.

For the third solution, it is hard to conclude anything with the data available for this thesis. After all, when there is a mismatch between the amount of visitors in the inflow and the amount of visitors in the outflow, one does not know whether that is because of a measurement error, a generalization error, or because people have stayed in the area for a long period of time. For solution one and two, conclusions can and will be made with the data available.

With the three selected matches a case studies, the case where this issue is expected is the match of the Netherlands against the Czech Republic. This match has ended at a Tuesday evening between 22:30 and

22:45. Also, as is previously concluded (in section 6.2.1. – P.52), the location of where the visitors come from is more dispersed across the country as compared to home matches of Ajax (for which the origin location of visitors is more concentrated within Amsterdam, Noord-Holland and Flevoland). Therefore, the problem of not having the possibility to make the same journey reverse as forth is more an issue with matches of the Dutch National team than for matches of Ajax.

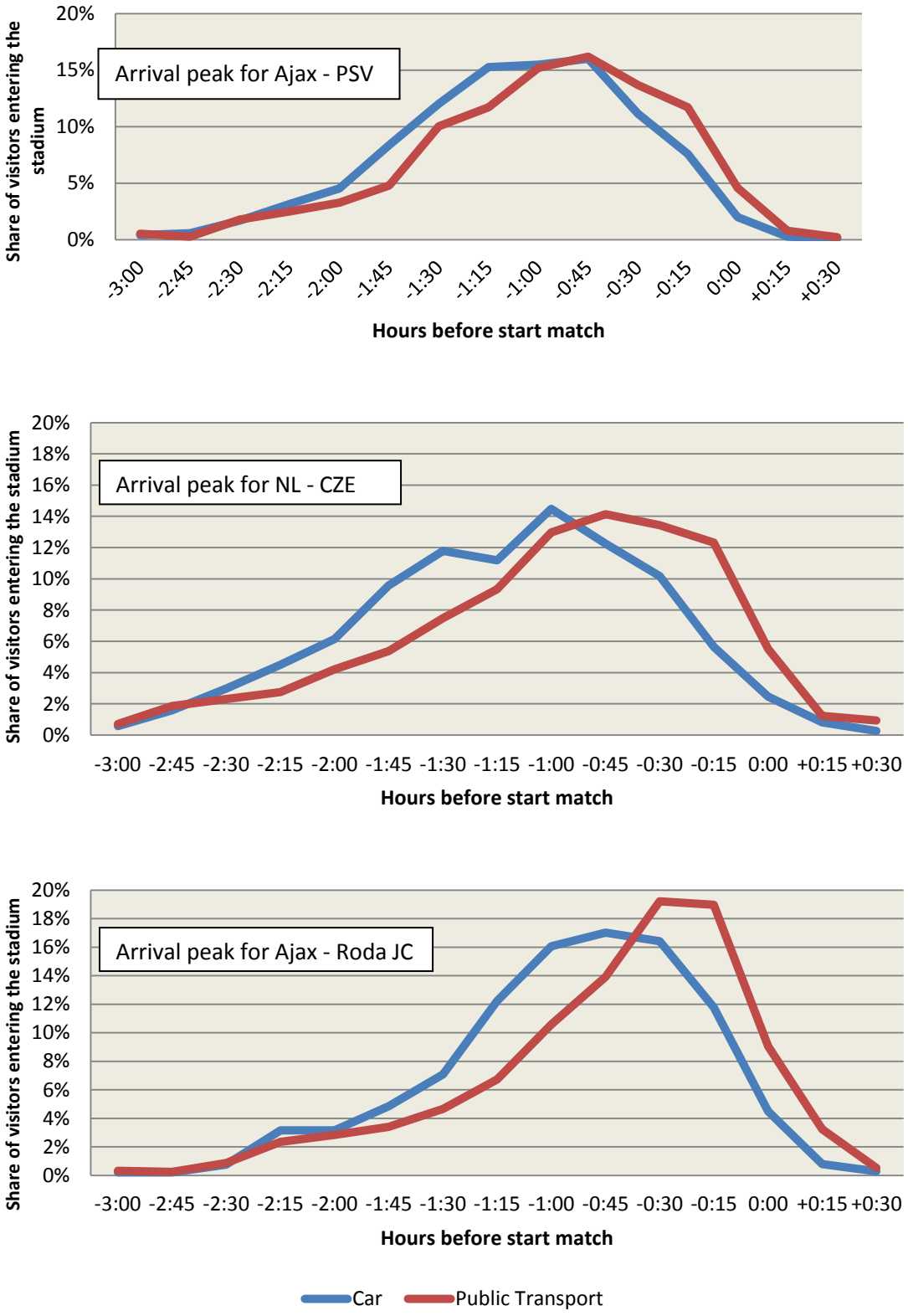
When analyzing the time of leaving for the different destination regions, no large deviation in the general pattern is found for the different regions. This indicates that it is not likely that visitors that come from regions farther away with worse public transport connections, do not have the tendency that go with public transport and leave early from the match. Therefore, public transport might have lost potential customers due to the timetables in this match.

9) Transportation mean and time of the journey

Peak prior to the match

For two of the three matches, NL – CZE and Ajax – Roda JC, you can see that the peak in public transport is shorter before the start of the match than for car (which indicates that public transport users arrive at a latter time). Also for Ajax – PSV, more people travelling by public transport arrive shorter before the start of the match than people travelling by car do. However, the peak at Ajax – PSV is both for public transport and car 0:45 before the start of the match. This can be seen graphically for all three matches in Figure 18.

Figure 18: The arrival peak for both car and public transport



With public transport, people have usually a longer travel time than with car, unless the route of the car is that congested that large delays are incurred. The car gains time compared to public transport, because:

1) With the car one can start the journey at any time that one wants to start the journey, whereas with public transport one has to take account of the time schedule of public transport;
2) With the car, one can drive straight to the destination, whereas for public transport one sometimes has to change trains or to another public transport mean;
3) With the car, one does not stop at locations where one does not need to stop, whereas public transport stops and waits at every location which is in its time schedule.

Public transport can gain time on the car in one aspect:

1) When there is congestion on the road network, the car has to wait in the traffic jam, whereas when its busy in public transport, the public transport vehicle can continue moving forward (unless there are that many people in the vehicle that safety in the vehicle is in danger).

The advantage in travel time of car compared to public transport depends for a large part on whether the journey is started from a location which is close to a train station or not. When there is a journey to be made to the train station before one sits in the train, chances become larger that the car is faster than public transport.

Reference 2: Reference to own work - section 4.3.3

It is not likely that a visitor will choose to go by public transport when the visitor knows it is hard to make the same journey in the reverse way with public transport after the match. Several solutions for this problem could be used. *As a first solution*, the visitor can decide to go by car and to not take the gamble of public transport. *As a second solution*, the visitor might decide to leave the stadium before the end of the match. *As a third solution*, the visitor can stay in the area for one night, and go out in the area or stay a night in one of the hotels in the area or somewhere else in Amsterdam.

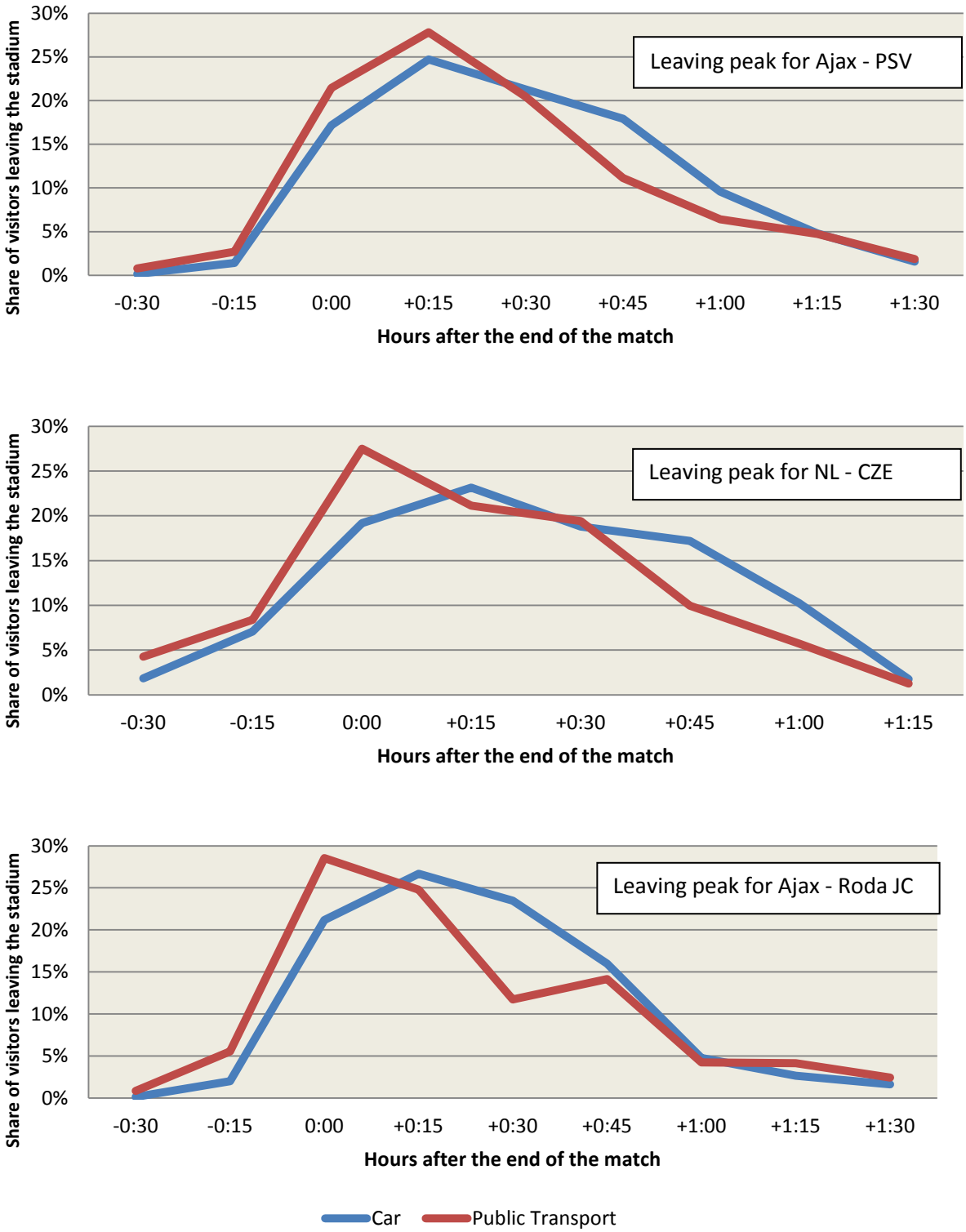
Peak after the match

Regarding the outflow, more visitors left ''early'' (as the final minutes of the match were still played or straight from the final whistle) when they were using public transport, for the two matches that were played on evenings during weekdays. This pattern of public transport users leaving ''early'' could not be found for the Ajax – PSV match, which was played on a Sunday afternoon. The explanation for early

leavers can be that that public transport users are dependent on the availability of public transport (the public transport timetables), whereas car users can go everywhere at any time as long as they are in possession of a car. As a lot of public transport timetables end at midnight during weekdays, public transport users might have to leave early in order to get home in time, also depending on the exact location where these visitors need to go to.

Possible solutions a visitor might apply for this issue have been discussed in this thesis (see Reference 2). Also, it is recognized that within the scope of this thesis it is hard to conclude anything on the third solution, and it is also concluded that it is not likely that many visitors will apply the first solution. With the observations regarding travel time in relation to transportation mean, some visitors might have applied the first solution.

Figure 19: The peak after the match for both car and public transport



5.7.4. Conclusion on the quantitative example

By the conclusion of the quantitative example, sub-question three will be answered as fully as possible:

''What is the potential effectiveness of several approaches in solving the problems that arise from the organization of events?'' (sub-question 3, SQ3)

In section 5.1 - 5.5 it has been analyzed what might be effective approaches in a solution for the accessibility problem which has been specified in Chapter 4. This has been done by following a logical line of reasoning (qualitative approach). In order to make an assessment on what the expected impact is from these approaches on improving the accessibility, the impact has to be quantified. For conducting a reliable assessment of the impact in this study, the availability of data has been to limited. The efforts in the data collection phase of this study has resulted in the availability of telecom data. The telecom data, of which the outcomes have been presented in this section (5.7) give an insight into the behavior of visitors for different events (football matches) in the Amsterdam ArenA. These outcomes are confirming the expectations beforehand, which have been developed after the qualitative analysis. However, the data is available at such a high level of aggregation, that it is almost impossible to go one step further from providing an illustration of the situation to conducting an assessment of the expected impacts. On top of that, the results will always be more reliable when they are confirmed by more data sources than only one source.

Although it is not possible within the scope of this study to conclude anything on the effectiveness of approaches, these data sources can be a useful tool with regard to performing both ex-ante and ex-post analyses. To give an example, in this section (5.7) figures have been shown on the development of mobility and ultimately the moment (in terms of time) that the peak is going to be. Ones these figures are made both beforehand and after the implementation of a measure (or approach), one could see what has changed in the development of mobility and whether the measure has realized the desired results (whereby of course other developments which are having an impact on the development of mobility should also be taken into account).

6. Conclusions and limitations

In this chapter the research question will be answered, conclusions will be drawn and (policy) recommendations and limitations are stated.

The research question to be answered is as follows:

How can be dealt with the mobility problems that arise from the organization of events?

When the demand to transportation is higher than the capacity of the transportation network can offer in supply, the consequence will be that the users of the system will incur delay in their journey. This phenomenon occurs for three particular dimensions, which are time of the journey, the transportation network by which the journey is completed (e.g. car or public transport) and the route by which the journey is completed. It is argued that this phenomenon is especially likely to occur when journeys are made with the purpose to visit events. When delays occur, the accessibility of the area is deteriorated, and so this is regarded to be a mobility problem.

There are two different sets of policies by which delay due to the intense volume of transportation movements can be dealt with. First, hard measures can be implemented, which basically implies that investments will be made in increasing the capacity of the system (supply based policy). Second, soft measures can be implemented, which is defined by investments being made in policies that are meant to alter the demand by triggering alternative mobility decisions (demand based policy). In this thesis, the research question will be answered by focusing on soft policy measures.

As a research method, a case study design has been selected. As a case study, events organized in the ArenAPoort area in Amsterdam Southeast have been chosen. Answering the research question occurs by following three-sub questions, which are answered for the case study ArenAPoort. These sub-questions are as follows.

''What are the problems that arise from the organization of events?'' (sub-question 1, SQ1)

''What are the possible approaches for the problems that arise from the organization of events?'' (sub-question 2, SQ2)

''What is the potential effectiveness of several approaches in solving the problems that arise from the organization of events?'' (sub-question 3, SQ3)

By following the answers on the sub-questions, an answer on the research question is to be formulated. For doing this, a risk analysis tool has been developed, which has been based on policy documents in Rotterdam (2013) and Eindhoven (2014). In this tool, three separate profiles have been identified by which different characteristics of different kind of events can be categorized following three distinct categories. First, there is a category which covers the Profile of Area, by which the area and the accessibility of the area is analyzed. Second, there is a category which covers the Profile of Visitors, by which the decisions taken by the visitors of events can be explained. In explaining the choices of visitors, the third category which covers the Profile of Activities should be taken into account.

SQ1 can be answered by following the Profile of Area for ArenAPoort. SQ2 and SQ3 can be answered by following the Profile of Visitor, hereby taking into account the Profile of Activities.

6.1. Conclusions

Before it is possible to give an answer to what might be solutions for the problems, the problem itself must first be defined (SQ1). So to say, it has to be defined where the accessibility of ArenAPoort is harmed when events are organized. In this research it is concluded that the exit of the A2 onto the Burgemeester Stramaneweg into the area is regarded to be the main bottleneck for this area. Especially when visitors of events make a journey to the area in the evening rush hour, more car drivers are likely to incur delay and are likely to occur longer delays in the journeys, when travelling via the highway passing this exit (SQ1, answer).The source of delay is two-fold. First, delay is incurred in congestion (in the inflow) and second, delay is incurred in queueing for parking (which holds for both the inflow and the outflow).

After the problem has been defined the question arises which approaches might be helpful in a solution for the problem (SQ2). Finding a solution via soft policy measures can be broken down into two steps, of which the **first** is stating a goal (*what choices are to be triggered?*), and of which the **second** is wondering which might help in reaching the goal (*what policies can possibly trigger the choice which is desired?*).

What choices are to be triggered?

It is recognized that the largest gains in improving the accessibility can be made when there will be a modal shift from completing the journey by car to completing the journey (partly) by public transport. However, it also to be noted that triggering a modal shift from car to public transport might be very difficult to accomplish. The margin of triggering a modal shift is likely to be the smallest for short-distance trips as opposed to longer distance trips. This is because the potential benefits are higher on journeys with shorter distances, and therefore it is more likely the benefits of making a modal shift will outweigh the costs for visitors making journeys on shorter distances. There are two explanations for this. First, the potential time gains of public transport as compared to car are likely to be larger when a journey is to be made on a shorter distance. The first explanation is connected with the second explanation, which is that in Amsterdam and surroundings, public transport availability is much better than in less densely populated area of the Netherlands. Due to this, the service area of public transport is bigger and frequencies are higher, which results in more options, more service and shorter journeys.

As an alternative to completing the entire journey by public transport, the last part of the journey can be completed by public transport whereas the first the first part will be completed by car. As delay is always the most likely to occur in the last part (where transport movements from all different directions come together), looking at solutions should be focused on the last part. If many effort has to be made in convincing visitors for a modal shift for entire journey, similar results might be accomplished when the effort is focused on only convincing visitors to complete the last part by public transport. The most obvious manner of doing this is to develop a P&R concept in which the ArenAPoort belongs to the core of. When such a concept is successfully implemented, the bottleneck of the A2 exit into ArenAPoort and queuing for parking in the area might have some relieve in pressure. Two (possible) reasons can be identified for visitors to participate in a P&R concept. First, a lower parking price (and low price or free public transport ticket) for P&R parking as compared to parking in the area might trigger participation. Second, a shorter waiting time in queuing for parking for P&R compared to parking in the area can also trigger a decision which is helpful in reaching this objective.

There is a potential in spreading betweeen car routes, however, this potential is regarded to be smaller than the potential in a modal shift. Although the potential might be smaller, going via a different route might be easier to trigger by visitors. If a visitor is convinced that going by another road will be faster, the visitor is likely to go by this road. The reason why people queue for the same highway exit is that

either these visitor are not familiar with alternative routes or either the visitors are not convinced that travelling via these alternative routes will make their journey faster.

The potential that is possibly to be made in time is depending on the time of the peak before the start of the event. The shorter before the start, the smaller the potential is. The reason for this is that the visitor wants to be at the event location at the start of the event, and that there might be a potential to make the journey earlier but that the potential to make the journey later is limited to the starting time. The potential is even smaller in the afternoon rush hour, as a lot of visitors do not have a lot of flexibility in travelling at an earlier time either.

6.2. Limitations & Recommendations

What policies can possibly trigger the choice which is desired?

Now that it is known which choices are to be triggered, the following question on how to trigger these choices can be answered. By the answer of this question, the conclusion is finalized, SQ2 and the research question is answered and policy recommendations are provided. The following bullet points give the main possibilities for policies to be developed with the goal to trigger the changes that have just been mentioned in section 6.1:

- As there are more functions and the other functions are becoming more attractive, there are more possibilities for multi-destination visits.
- As by 2020 the stadium Amsterdam ArenA is to be renovated (the renovation is supposed to be completed by 2020) and more catering concepts are to be included, there is a possibility for a discontinuity for frequent visitors of the stadium and to create longer visits within the stadium, both before and after.
- Frequent visitors will not reconsider decisions quickly, however, they are loyal to communication platforms of Ajax. These platforms could be used in providing advices.
- Non frequent visitors will take their time to plan and search for information about the journey to be made. They might be willing towards listening to advices which are provided by platforms which provide the information in a clear and short manner, and which can be found easily.
- There are possibilities for a P&R policy to be developed, in which the ArenAPoort area belongs to the core of. Hereby one should identify which segment groups might be the most willing to participate in such a concept:

- Visitors making a journey on a longer distance are less likely to complete the entire journey by public transport, but it is unknown to which extent they might be willing to complete a part of the journey by public transport and it also unknown the portion of the journey the visitor is willing to complete by public transport at maximum.
- Visitors who (1) do not want to compete the entire journey by public transport but also (2) do not like losing time having to queue to drive by car into the area, in the inflow, and to exit the parking, in the outflow, might be the segment group of visitor which are willing to participate in P&R.
- It is more difficult for older visitors to trigger a modal shift from car to public transport.
- Also the limited flexibility of most visitors to consider alternative transportation options when events are organized in weekdays with starting times early in the evening should be taken into account.

6.2.1. Limitations of this research & Suggestions for further research

Limitations of this research

Three important limitations of this research have to be mentioned. First, due to considerable size of the expert panel which has been consulted and the support of telecom data an in-depth analysis on mobility from and to this area has been provided, following a qualitative approach with a quantitative example. However, because of the high level of aggregation of the data and the lack of additional data sources, it was not possible to quantify the approach.

The second limitation is that the conclusions of this thesis are applied on the selected case study, which is events in ArenAPoort (Amsterdam Southeast). No study has been conducted on to which extent the results and conclusions for this case study, can be applied in other cases (other contexts) as well.

A third and final limitation is on the content of one main conclusions following the analysis. It is concluded that a P&R concept, at which the ArenAPoort is at the core of, can be successful in improving the accessibility when events are organized. Although this is the right conclusion from a theoretical perspective and after considering the SWOT analysis, it is a conclusion of which the practical implementation has not been studied. In other words, it has not been studied what might be good locations for a P&R and what the desired and available capacity is for developing such a concept at several possible locations. Also the potential of using P&R from the demand-side has not been studied.

Suggestions for further research

The suggestions for further research are on filling the gaps (limitations) which this thesis study has not been able to cover. On top of that, an additional suggestion for a stakeholder analysis is made:

- Search for more data sources to be able to conduct a quantified assessment of the effectiveness of possible approaches, hereby not ignoring the effort which has already been made, and hereby taking account of the efforts which are ongoing in this area regarding ''Smart Mobility'' as part of the program of ''Beter Benutten'' and other initiatives (*suggestion for the data collection phase*)
- Conduct a study on to which extent the results for this thesis study can be generalized towards other contexts than the context of ArenAPoort (*suggestion for research on the generalization of the results*)
- Conduct a study on the actual implications of introduction a P&R concept and one step further, on what are good locations for P&R, considering several factors which might play a role in both the capacity utilization of transportation systems as the decisions which are likely to be made by visitors of events (*suggestion for studying the feasibility of one the recommendations*).
- The study for this thesis does not include the question for an analysis on what the impact of particular measures or approaches will be for several stakeholders in the area, and does not include an assessment of whether these are desirable outcomes or not. By SQ3 an answer is to be formulated on what the aggregated impact for mobility is expected to be. As many more effects in many more fields of particular measures are likely to be expected, it is suggested that these impacts are first to be assessed before implementing particular measures (*suggestion for a stakeholder analysis).*

7. Appendix

7.1. Telecom data

The question to Mezuro was, to produce input which enables to establish relationships between the following characteristics of the movements from and to the stadium:

- Location from which the journey to the Amsterdam ArenA is started ***(using the ArenA as a destination point)***;
- Location that is the destination for a journey from the Amsterdam ArenA ***(using the ArenA as an origin point)***;
- Time of arrival at the Amsterdam ArenA (using the ArenA as a destination point);
- Departure time from the Amsterdam ArenA (using the ArenA as an origin point); and
- Mode of transport with which the travel from or to the ArenA has been made (for both the ArenA as a destination and as an origin point).

Due to privacy reasons, results will not be shown for a cell when these could be traced back to an individual person (van Langen, 2016). Observations in one cell drop as a result of specifying to many characteristics one wants to know about the mobility movements, as well as one wants to know something about a specific characteristic into to much detail (at a smaller aggregation level). Therefore, you need to specify that what you would like to know about mobility in such a manner that **(1)** *the level of detail and the amount of characteristics is good enough that something meaningful can be concluded based on it* and that **(2)** *the level of detail is not that high, that for a lot of cells observations drop to a level which is too low and are omitted, which violates the reliability of your claims*.

Table A1 presents on what aggregation level the mobility characteristics are measured.

Table A1: How are the variables measured?

Characteristic of mobility movement	Measurement level
Location (origin and destination)	AB (explanation follows)
Time (of arrival and departure)	1) Quarters of an hour 2) Hours
Mode of transport	Car, Public Transport (PT) or could not be identified

7.1.1. Regional Classification

The location of origin and destination needs to be specified in such a way that something meaningful can be concluded about:

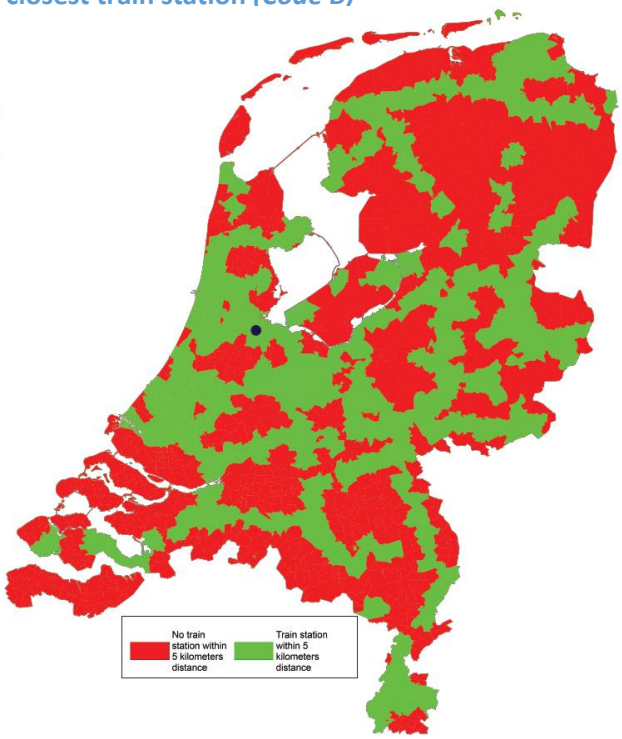
1) The access route of visitors (for both car as public transport); and
2) The travel time of visitors (for both car as public transport);

➔ *Without violating the conclusions, by having too many observations deleted*.

Whether the geographical classification is determined in such a way that these conditions are still valid, is subject to own assessment. In either way, it depends a lot on what is subject to research, and which outcomes have priority above which other outcomes. As this is a study that focusses on shaving the peak; the time in which people arrive and leave, the chosen modality, and the region where the visitor comes from and goes to (as an indication of whether departing ealier of leaving later can be an option) are all three relevant variables and indicators.

Figure A1: Regional classification of the Netherlands to groups of PC4 (*Code A)*

Figure A2: Regional classification of the Netherlands to the location of the PC4 to the closest train station *(Code B)*



Several ways to categorize all the possible origin and destination locations have been tried. As a final result, the AB code in Table is used to determine origin and destination locations. In this code the **A** represents the geographical location of PC4 into 8 areas, which takes account both of the access route to the stadium as the distance to travel to the stadium. The **B** represents whether the PC4 is within 5 kilometers distance from a train station or not, to indicate whether taking the train can be an alternative towards taking the car. Figure A1 and Figure A2 show how all the possible origin and destination locations within the Netherlands are categorized according to A and B

One must note than this classification corresponds to none of the administrative or statistical classifications in the Netherlands, and that therefore there are no existing corresponding names for this regional divide yet. For this reason, the regions are labelled by the author himself, taking account of the geographical (administrative or statistical) region that takes the most of the area (if any).

For defining the A, one should note that once the distance to the stadium increases, larger areas with more inhabitants have been specified, because it is more likely that the farther away from Amsterdam, the fewer visitors for football matches in the ArenA there are. The exception to this rule is defining the municipality of Eindhoven as a separate region within the larger area of the South of the Netherlands.

This is done because there has been organized transport coming from Eindhoven for the Ajax – PSV match (in Table A2) for the travelling away support fans, which is tried to be captured by defining Eindhoven as a separate region.

The reasoning behind defining the B to train station availability is that when the distance is to the nearest train station is larger than 5 kilometer for a PC4, the travel time of public transport compared to the car becomes that large that the train is not considered to be a reasonable alternative. Mobility Management should not be focused on those visitors for who public transport is not a reasonable alternative to the car, but it should focus on those visitors for who this is.

Table A2: The structure of the geographical breakdown of the Netherlands into code AB

Letter	Letter represents	Code	Code represents	Note
A	Geographical location within the Netherland to the 4 letters of the postal code (PC4).	1	Amsterdam	Greater area; Amstelveen and Diemen included
		2	Noord-Holland	Without Hilversum
		3	Flevoland	With Kampen, Hilversum and Amersfoort
		4	Utrecht	Without Amersfoort, with Culemborg
		5	Zuid-Holland	Without Hoeksche Waard, Voorne-Putten and Goeree-Overflakkee
		6	East-and North of the Netherlands	Gelderland (without Culemborg), Overijssel (without Kampen), Drenthe, Friesland and Groningen.
		7	South of the Netherlands	Zeeland, Zuid-Brabant and Limburg and with Hoeksche Waard, Voorne-Putten and Goeree-Overflakkee (in Zuid-Holland)
		8	Eindhoven	Municipality of Eindhoven
B	Is the train an alternative to the car for the travel to the ArenA, specified in PC4.	1	Yes	There is a train station available within 5 kilometer distance
		2	No	There is no train station available within 5 kilometer distance

Using this code, the Netherlands will be divided into A*B = 8*2 = 16 areas from which visitors can come before the event and can go to after the event. *In order to find out if it is likely that enough visitors come from each of these areas, the amount of inhabitants living in each of these 16 areas is identified*. This is done by taking an abstract of the number of inhabitants per PC4 for the year 2015 from the Dutch National Statistics Agency (CBS). When the amount of inhabitants for a particular area is low, it is unlikely that a lot of visitors are coming from these areas. In order to perform this analysis, the assumption is made that most visitors come from their homes before the match and also return to their

homes after the football match. Also, it is kept in mind that the amount of visitors coming to the stadium is likely to be larger at a shorter distance from the stadium than at a larger distance from the stadium, and Eindhoven is treated as an exception to the rule, especially for the Ajax – PSV match. In Table A3, you can find the amount of inhabitants for each of these 16 areas.

Table A3: Amount of inhabitants for each of the AB-regions

Code	**What does the code indicate**		***# inhabitants***	***Inhabitants in % of total in NL***	***Inhabitants in % of total in Code A***
AB	**A represents**	**B represents**			
10	Amsterdam	No	*49.405*	*0%*	*5%*
11	Amsterdam	Yes	*885.695*	*5%*	*95%*
20	Noord-Holland	No	*253.215*	*2%*	*16%*
21	Noord-Holland	Yes	*1.307.180*	*8%*	*84%*
30	Flevoland	No	*187.460*	*1%*	*18%*
31	Flevoland	Yes	*881.210*	*5%*	*82%*
40	Utrecht	No	*227.645*	*1%*	*20%*
41	Utrecht	Yes	*922.500*	*5%*	*80%*
50	Zuid-Holland	No	*358.410*	*2%*	*11%*
51	Zuid-Holland	Yes	*2.908.430*	*17%*	*89%*
60	East- and North of the Netherlands	No	*1.417.995*	*8%*	*31%*
61	East- and North of the Netherlands	Yes	*3.162.180*	*19%*	*69%*
70	South of the Netherlands	No	*1.728.255*	*10%*	*43%*
71	South of the Netherlands	Yes	*2.316.170*	*14%*	*57%*
80	Eindhoven	No	*135*	*0%*	*0%*
81	Eindhoven	Yes	*220.790*	*1%*	*100%*
		Total	***16.826.675***	***100%***	

When (hypothetically) in each of the 16 regions that are defined, the same amount of persons are living, each AB-region will have 6,25% of the total amount of persons living in the Netherlands.

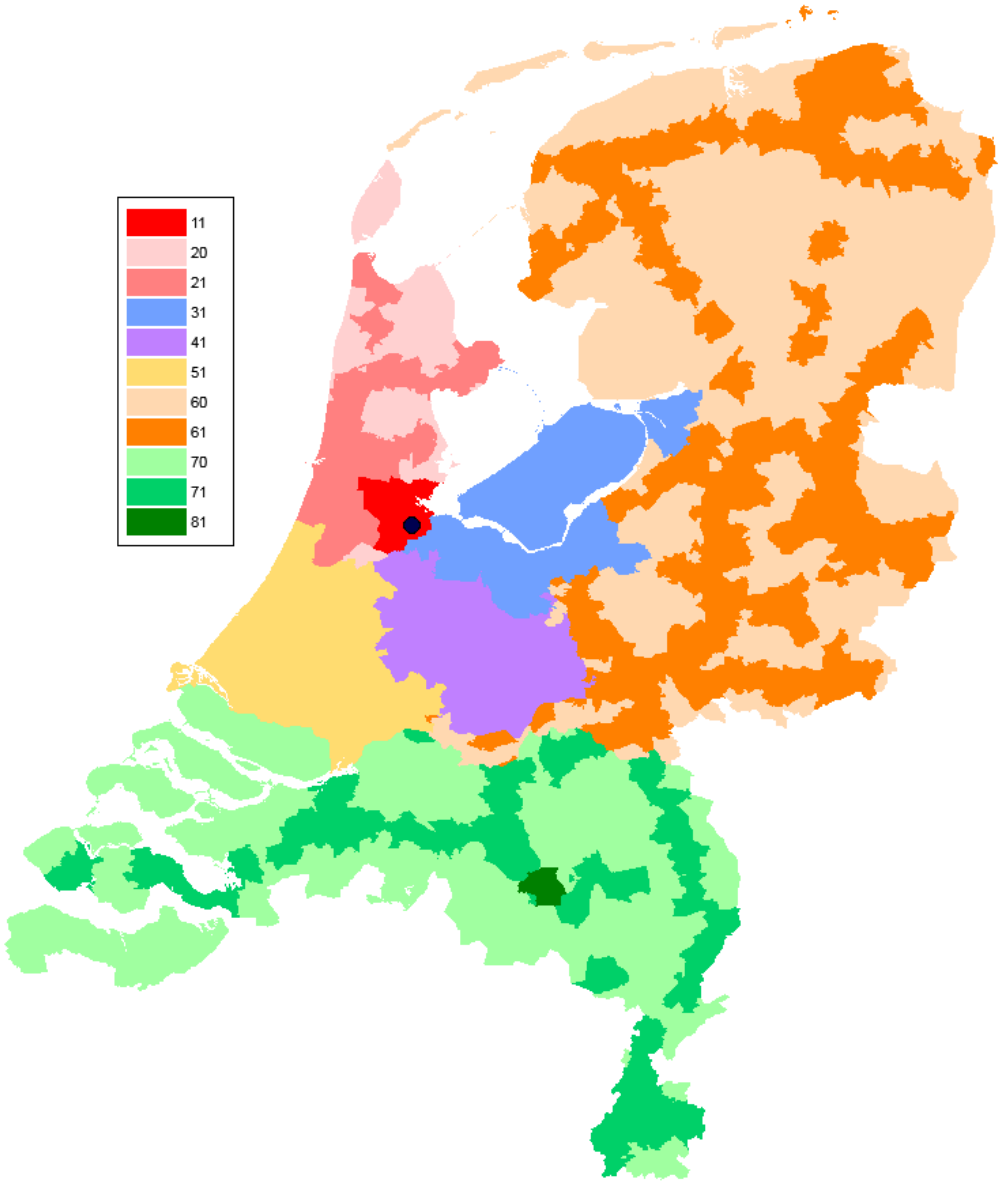
In Table you can see that the share of the area in the total amount of inhabitants is lower than 5% for AB-code 10, 20, 30, 40, 50 and 80. For these areas, there is a risk that the number of visitors coming and going from and to these areas is that low, that it is not possible to provide a representative sample. In

order to account for this risk, some changes have been made to the geographical classification AB. First of all, almost the entire area of Greater Amsterdam is covered by the local public transport network of the (local public transport provider) GVB. Those parts that are not covered are also the parts of Amsterdam, in which few inhabitants live. Therefore, code 10 will be added to code 11. The public transport connections of Utrecht to Amsterdam are good in general. Therefore, code 40 will be added to code 41. The same holds for Fevoland, and Zuid-Holland. As the amount of persons in code 70 (Eindhoven) is negligible, 70 will be added to 71. *The reason that Eindhoven is a separate category and not incorporated in the South of the Netherlands, is that for Ajax – PSV it is expected that a lot of away visitors leave from Eindhoven (home city of PSV) with organised transport.*

As for Noord-Holland those parts that are not within 5 kilometers distance of a train station, also do not have a good connection with the train network of the NS, it is decided that the code of 20 will not be added to 21. Besides the bad train connections, this area is also in the Ajax market area, so it is expected that enough visitors come from both code 20 as 21, so that the sample will be still representative when holding them separate.

This results in categorizing the Netherlands as is done in Figure A3.

Figure A3: Regional classification of the Netherlands according to AB, adjusted



8. Bibliography

Behavioural Insights Team. (2015). *Update Report 2013-2015.* London: Behavioural Insights Ltd.

Berveling, J., Derriks, H., van de Riet, O., Smit, R., & Storm, M. (2011). *Gedrag in beleid: Met psychologie en gedragseconomie het mobiliteitsbeleid versterken.* Kennisinstituut voor Mobiliteitsbeleid (KiM). Ministerie van Infrastructuur en Milieu.

Berveling, J., Schaap, N., & Storm, M. (2014). *Macht der gewoonte: 'Meestal doen we, wat we meestal doen.'.* Kennisinstituut voor Mobiliteitsbeleid (kiM). Ministerie van Infrastructuur en Milieu.

Burda, M., & Wyplosz, C. (2009). *Macroeconomics: A European Text* (5th ed.). Oxford: Oxford University Press.

Directie Veiligheid Gemeente Rotterdam. (april 2013). *Nota Evenementenvergunningen Gemeente Rotterdam.*

DIRECTIVE 2010/40/EU. (2010, July 7). DIRECTIVE 2010/40/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. *Official Journal of the European Union*.

Duranton, G., & Turner, M. A. (2011, October). The Fundamental Law of Road Congestion: Evidence from US Cities. *The American Economic Review, 101*(6), 2616-2652.

EPOMM. (2013). *The smart way to sustainable mobility in European countries, regions and cities.* Brussels: EPOMM - European Platform on Mobility Management.

Gemeente Amsterdam. (n.d.). *Gebiedsagenda Amstel III 2016-2019.*

Gemeente Eindhoven. (februari 2014). *Evenementenbeleid in Eindhoven.*

Goudappel Coffeng. (2008). *Parkeren in het Centrumgebied Amsterdam - Zuidoost.* Ontwikkelingsbedijf Gemeente Amsterdam.

Keij, J. (2014). *Smart phone counting: Location-Based Applications using mobile phone location data.* Delft: Delft University of Technology.

Klein, K. P. (2015, Juli 20). *Bestuurlijke Stukken DSO/2015.632 - RIS 283920 : Grootschalige Publieksevenementen.* Retrieved from Gemeente Den Haag: http://www.denhaag.nl/home/bewoners/gemeente/document/Grootschalige-publieksevenementen.htm

Koppenjan, J. (2005). The formation of public-private partnerships: lessons from nine transport infrastructure projects in the Netherlands. *Public Administration, 83*(1), 135-157.

Kotler, P., Armstrong, G., Saunders, J., & Wong, V. (1999). *Principles of marketing* (2nd ed.). London: Prentice-HallEurope.

Mallard, G., & Glaister, S. (2008). *Transport Economics: Theory, Application and Policy.* Palgrave Macmillan.

Metropoolregio Amsterdam. (n.d.). *Probleemanalyse & gedragsanalyse Beter Benutten II.*

Meurs, A. (2015, October 19). Mobiliteit bij evenementen - Gemeente Rotterdam. (J. Tanis, Interviewer)

Offermans, M., Priem, A., & Tennekes, M. (2013). *Rapportage Project Impact ICT; Mobiele Telefonie.* Centraal Bureau voor de Statistiek.

O'Flynn, M. (2010, October). *Impact Assessment: Understanding and assessing our contributions to change.* Retrieved from International NGO Training and Research Centre: http://www.intrac.org/data/files/resources/695/Impact-Assessment-Understanding-and-Assessing-our-Contributions-to-Change.pdf

STADIUM. (2013). *About Large Events*. Retrieved December 25, 2015, from STADIUM - ITS for large events: http://www.largevents.eu/large-events/

Tertoolen, G., Swankhuisen, C., de Vree, R., & Ruijs, K. (2013). *Grip op Gedrag.* Utrecht: XTNT Experts in Traffic and Transport.

van den Berg, L., & Braun, E. (1999). Urban Competitiveness, Marketing and the Need for Organising Capacity. *Urban Studies, 36*(5-6), 987-999.

van Kats, J. (2014, July). Supporting Incident Management with Population Information Derived from Telecom Data. *Thesis*, 132.

van Langen, J. (2016). *The Attractiveness of Cities: Determining city attractiveness using mobile phone location data.* Faculty of Science, Department of Information and Computing Sciences. Utrecht: Utrecht University.

Verlaan, A. (2016, Januari 11). Ensuring safety for events in the Amsterdam ArenA. (J. Tanis, Interviewer)

Verschoor, E., Homan, T., Huisman, G., & Hoogenraad, M. (2015). Evenementen - een feest voor de bezoekers of een nachtmerrie voor de wegbeheerder? *Nationaal Verkeerskundig Congres.* Zwolle: ARCADIS NL - divisie mobiliteit.

Yin, R. K. (2003). *Case Study Research: Design and methods* (3rd ed.). Thoasand Oaks: Sage.