Improving regional bus transport

Seeking possibilities to attract new users and maintain the current users in The Netherlands

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Summary

This research analyzes possibilities to attract new users to regional public transport, while maintaining the current users in an effective and efficient manner. To be able to attract users, it is necessary to know who the most potential users are. A literature study has revealed that the most potential users are users who travel with the purposes of commuting, business, education, and recreation. Travelers with these purposes are more sensitive towards improvements in public transport than those that travel with other purposes, and they have a higher participation in the transport system. However, purposes of travelers can change numerous times per day. For that reason it is interesting to know what type of people travel the most with the before mentioned purposes across all modes. For educational purposes, these are people who attend all types of educational facilities up to academic education. For the other purposes, working people that do not work at home make the most trips. An analysis of the purpose distribution of public transport trips yields that other proportions are valid; there are barely trips with recreational and business purposes, some trips with commuting purpose, and a lot of trips with educational purpose. It means that gains are possible among these groups, if their needs regarding traveling are fulfilled. Further literature study and a case study showed that there is need for improvement of the image of public transport. This means that on the one hand there is a need for operational improvements such as reliability, door-to-door travel time, and directness and on the other hand there is a need for better communication with the passenger.

Now that the potential travelers and their respective needs are known it is possible to define measures that are focused on these groups and their needs. Measures have been designed in the following categories: reliability/travel time, information provision, attractive fares, and the reputation of public transport.

To be able to select the best measures, a qualitative evaluation was performed. In this qualitative evaluation the opinion of experts within the field of public transport was sought. These experts are individuals from transport companies, transport authorities, consultancies, and travelers' associations. There are several qualitative evaluation methods available. A short literature research has been performed to see which form of qualitative evaluation fits better within the purpose and constraints of this research. This resulted to be the policy Delphi method. To minimize time consumption, the choice has been made to perform this method using online questionnaires. The opinion of the experts was sought within two rounds, where in the first round participants got to rate the measures and suggest improvements; and in the second round people got the opportunity to rate the measures again and to react on the ratings and suggestions of the first round. This resulted in the selection of express services and transfer guarantees as the best measures along with throughput measures as the best suggestion. These measures have been defined as follows in this research:

- **Express service:** The idea behind the express service is that it performs at higher speeds and increased reliability compared to regular services. This is possible since the express service skips the stops that are used less often, and drives on a shorter route where possible. In order to increase the service are of the express service bus stops, bicycle facilities are installed.
- **Transfer guarantee:** This is a guarantee that a traveler can transfer between a regional bus line and another form of public transport. The guarantee that is proposed here is conditional: transfers are only guaranteed if waiting for a delayed vehicle does not have consequences for the feasibility of the schedule of the waiting vehicle.
- **Throughput measures:** Measures to increase throughput of intersections and/or road sections with capacity constraints.

It is very interesting to know how large the actual impacts of these measures are on the number of travelers. For that reason a short literature study was performed to indicate which impact assessment method fits better within the constraints of this research. This resulted to be the travel time elasticity method. The measures have been quantified by using a non-fictional case study. In the case study the

impacts of the measures on one regional bus line S have been analyzed. Line S connects a city with 50,000-100,000 inhabitants with a number of towns with less than 50,000 inhabitants. The line also has connections with two railway stations.

The impact of express services on the number of travelers has been quantified in two scenarios: In the first scenario express services are provided in peak hours only, and regular services operate in off-peak hours; in the second scenario express services are provided in combination with regular services in peak hours, and only regular services are operated in the off-peak hours. The impact assessment has yielded an increase of 1.8% in the number of travelers in the first scenario, and an increase of 0.9% in the number of travelers in the second scenario.

The impact of transfer guarantees on the number of travelers has also been quantified in two scenarios: in the first scenario there is a five minute transfer time in between the vehicles and in the second scenario there is two minutes transfer time between the vehicles. The impact assessment has yielded an increase of 1.3% in the first scenario and an increase of 2.1% in the second scenario.

The impact of throughput measures is very case specific and information is required on local problems and the extent thereof. This is why throughput measures have been quantified by looking at the impact that these measures have had in a couple of cases. In the first scenario 10% of the scheduled service time can be attributed to traffic induced delay, and in the second scenario 20% of the scheduled service time can be attributed to traffic induced delay. The impact assessment has yielded an increase of 0% in the number of travelers in the first scenario and 1.0% in the second scenario.

Logically these measures also have costs attached to them. They are only attractive to implement if their cost benefit balance is favorable in a reasonable term. This is why a short cost-benefit analysis has been performed, where the direct costs and benefits for transport authorities, travelers, and transport companies have been calculated for periods of 5 and 10 years at the price level of the year 2009. The benefit-cost balance for the society can be seen in the table below.

Measure	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Express services	€338,000	€853,000	€29,000	€213,000
Transfer guarantees	€23,000	€155,000	€263,000	€581,000
Throughput	€321,000	€627,000	€879,000	€1,366,000

The throughput measure is more beneficial for the society than the express services and transfer guarantees. However, this is not the most beneficial measure for the current and potential user. The most beneficial measure for the current and potential user is the transfer guarantee, followed by the express service, and the throughput measure.

In short, the current problems of the regional bus trip chains can be addressed efficiently and effectively by targeting reliability and door-to-door travel time through the provision of express services and transfer guarantees with the support of throughput measures. Since these measures have been designed based on the needs of the current travelers and potential travelers, they will attract new users and also maintain the current users.

Samenvatting

In dit onderzoek wordt er gezocht naar mogelijkheden om op een efficiënte en effectieve manier binnen regionaal busvervoer nieuwe gebruikers aan te trekken en de huidige reizigers te behouden. Om nieuwe gebruikers aan te kunnen trekken is het noodzakelijk om te onderzoeken wie de meest potentiële gebruikers zijn. Literatuuronderzoek heeft aangetoond dat de meest potentiële gebruikers reizigers zijn met de verplaatsingsmotieven woon-werk, educatief, zakelijk en recreatief. Zij zijn het meest gevoelig voor verbeteringen in het openbaar vervoer dan gebruikers met andere verplaatsingsmotieven en tonen een grotere vervoersprestatie. Verplaatsingsmotieven van gebruikers kunnen verscheidende malen per dag veranderen. Om deze reden is het interessant om te achterhalen welke groepen mensen over het algemeen het meest reizen met de bovengenoemde motieven. Voor het motief educatief betreft het scholieren en studenten. Voor de andere motieven gaat het om werkende mensen die niet thuis werken. Als er gekeken wordt naar de verdeling van openbaar vervoer (OV) ritten dan is het te zien dat de motieven anders verdeeld zijn dan als er gekeken wordt naar het transportsysteem in zijn geheel. Met het OV worden nauwelijks ritten gemaakt met een recreatief of zakelijk motief, soms worden ritten gemaakt met een woon-werk motief en veel ritten hebben een educatief motief. Dit betekent dat er mogelijkheden zijn om groei te realiseren als er aan de eisen en wensen van deze potentiële reizigers word voldaan. Om te achterhalen wat deze eisen en wensen zijn, werd er een aanvullende literatuurstudie uitgevoerd en is er een casus bestudeerd. Dit heeft aangetoond dat er behoefte is om het imago van het openbaar vervoer te verbeteren. Dit betekent enerzijds dat operationele verbeteringen als betrouwbaarheid, reistijd van deur tot deur en directheid noodzakelijk zijn; en dat er anderzijds behoefte is aan betere communicatie met de reiziger.

Nu het bekend is wie de meest potentiële reizigers zijn en wat hun behoeftes zijn, is het mogelijk om maatregelen te definiëren die gericht zijn op het aantrekken van deze groepen. Deze maatregelen zijn ontworpen in de categorieën van betrouwbaarheid/reistijd, informatievoorziening, aantrekkelijke tarieven en reputatie van het OV.

Om de beste maatregelen te kunnen selecteren is er een kwalitatieve evaluatie uitgevoerd. Hierin vond de beoordeling plaats op basis van de mening van experts op het gebied van OV. Deze experts zijn werkzaam bij vervoerders, vervoersautoriteiten, adviesbureaus en reizigersverenigingen. In de literatuur worden er verschillende kwalitatieve evaluatiemethoden genoemd. Een beknopt literatuuronderzoek heeft aangetoond dat de Delphi methode voor beleid het beste past binnen de randvoorwaarden van dit onderzoek. Om tijd te besparen is er besloten om deze methode uit te voeren met behulp van elektronische vragenlijsten. Hier zijn de meningen van de experts in twee ronden verzameld waar in de eerste ronde de deelnemers de mogelijkheid kregen om de maatregelen te beoordelen en suggesties te geven ter verbetering; en in de tweede ronde de deelnemers de mogelijkheid kregen om te reageren op het resultaat van de eerste ronde en om de maatregelen opnieuw te beoordelen. Dit heeft tot de selectie van de maatregelen sneldiensten en overstapgaranties geleid samen met doorstromingsmaatregelen als ondersteunende maatregelen. De uitvoering van deze maatregelen kunnen op verschillende manieren worden ingevuld. In dit onderzoek werden ze als volgt ingevuld:

- **Sneldienst:** Het idee achter de sneldienst is dat het snel en betrouwbaar is vergeleken met een reguliere dienst. Dit wordt mogelijk gemaakt doordat de sneldienst een aantal minder gebruikte halten overslaat en waar mogelijk een kortere route rijdt. Om het invloedsgebied van de sneldiensthalten te vergroten worden er fietsvoorzieningen geplaatst.
- **Overstapgarantie:** Hier wordt een garantie aan de passagier geboden dat de aansluiting tussen de regionale buslijn en een andere vorm van openbaarvervoer gehaald wordt, mits dit geen gevolgen heeft voor de haalbaarheid van de dienstregeling van het wachtende voertuig.

» **Doorstromingsmaatregelen:** Maatregelen om de doorstroming bij kruispunten en wegvakken te vergroten die te maken hebben met capaciteitsproblemen.

Uiteraard is het zeer interessant om te onderzoeken hoe groot de effecten van deze maatregelen daadwerkelijk zijn op het aantal reizigers. Daarom werd er een beknopt literatuuronderzoek uitgevoerd om een kwantitatieve evaluatiemethode te selecteren. Beste methode om binnen de kaders van dit onderzoek te gebruiken is de reistijdelasticiteitmethode. De effecten van de maatregelen op het aantal reizigers gekwantificeerd op basis van een non-fictieve casus. In deze studie werden de effecten op buslijn S geanalyseerd. Deze lijn verbindt een kern van meer dan 50,000-100,000 inwoners met een aantal kernen met minder dan 50,000 inwoners. Lijn S doet ook 2 treinstations aan.

Het effect van sneldiensten op het aantal reizigers werd in twee scenario's gekwantificeerd. In het eerste scenario worden sneldiensten alleen in spitsuren aangeboden in en in de daluren alleen reguliere diensten; in het tweede scenario werden sneldiensten en reguliere diensten in de spitsuren gecombineerd en werden alleen reguliere diensten in de daluren aangeboden. Het resultaat van de calculatie geeft aan dat sneldiensten in het eerste scenario tot 1.8% meer reizigers leiden en in het tweede scenario tot 0.9% meer reizigers leiden

Het effect van het aanbieden van overstapgarantie werd ook in twee scenario's gekwantificeerd: in het eerste scenario zijn er 5 minuten aan overstaptijd en in het tweede scenario zijn er 2 minuten aan overstaptijd. Het resultaat van de calculatie geeft aan dat het aanbieden van overstapgarantie tot 1.3% meer reizigers leidt in het eerste scenario en 2.1% in het tweede.

De invloed van doorstromingsmaatregelen op rittijden aan de hand van een aantal casussen bepaald. Daarna werden de effecten in twee scenario's gekwantificeerd: In het eerste scenario werd er aangenomen dat 10% van de vertraging van een busrit door het overige verkeer wordt veroorzaakt en in het tweede scenario werd aangenomen dat dit percentage gelijk is aan 20%. Het resultaat van de calculatie geeft aan dat het invoeren doorstromingsmaatregelen tot 0.0% extra reizigers leidt in het eerste scenario en 1.0% extra reizigers in het tweede scenario.

Het implementeren van de bovengenoemde maatregelen brengt kosten met zich mee. Om deze reden is er een beknopte kosten-baten analyse uitgevoerd, waarin de directe kosten en baten voor vervoersautoriteiten, reiziger en vervoerders zijn uitgerekend voor perioden van 5 en 10 jaar op het prijspeil van het jaar 2009. Een totaaloverzicht van de baten-kosten saldo's zijn in de onderstaande tabel zichtbaar.

Maatregel	Scenario 1		Scenario 2	
	Na 5 jaar	Na 10 jaar	Na 5 jaar	Na 10 jaar
Sneldiensten	€338,000	€853,000	€29,000	€213,000
Overstapgaranties	€23,000	€155,000	€263,000	€581,000
Doorstroming	€321,000	€627,000	€879,000	€1,366,000

De doorstromingsmaatregel is winstgevender voor de gemeenschap dan de sneldienst en de overstapgarantie. Dit is echter niet de meest voordelige maatregel voor de huidige en de potenti√´le reiziger. De meest voordelige maatregel voor de huidige en potentiële reiziger is de overstapgarantie, gevolgd door de sneldienst en de doorstromingsmaatregel.

Kortom, de huidige problemen van de regionale busketen kunnen efficiënt en effectief worden aangepakt door de betrouwbaarheid en reistijd van deur tot deur te verbeteren.Dit kan door het aanbieden van sneldiensten en overstapgaranties met ondersteuning van doorstromingsmaatregelen. Gezien het feit dat deze maatregelen zijn ontworpen op basis van de behoeften van de huidige en potentiële reizigers zullen ze zowel de huidige reizigers behouden als nieuwe reizigers aantrekken.

Preface

The thesis that lies before you is the result of eight months of research at Goudappel Coffeng on possibilities to improve regional public transport. This has been an amazing experience, in which I got acquainted with the stakeholders of the public transport sector, and their respective points of view. I also found out what the difference is between how the public transport system is supposed to work, and how it actually works.

I would like to thank all the people that have helped me in one way or another during this research. I am not really sure how many people have contributed to this research, but I do know that they are many. I am grateful for the cooperation of the participants of the policy Delphi, and those that I have personally interviewed: Thank you for your time and your valuable contributions. What I also know is that I received outstanding support and/or assistance from colleagues, friends, my girlfriend Andra, my sister Eva, my mother Marvis and my father Stanley. It did not really matter what kind of help I needed, but I could always count on them.

My gratitude also goes to my roommates Elwin and Marco for the pleasant working environment, and the many gallons of the much needed cappuccino with sugar. Last but not least I would like to thank my mentor Ties Brands and my supervisors Peter Baas, Jing Bie, and Eric van Berkum for their guidance and provision of useful feedback during this research.

Arnhem, January 15th 2010

Ray Bodok

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1. Introduction

People have the need to transport themselves from one location to another, in order to be able to carry out their activities which are separated by space. Through centuries this need has evolved in the traffic system of today, in which the traveler most of the time has a choice between different modes. One of the more sustainable modes is public transport: it has the potential of transporting large number of passengers in few vehicles, minimizing the burden on the traffic system and the external effects.

Despite the sustainability of public transport, it has a small share of the modal split both in terms of kilometers and number of trips. This can be attributed to societal developments like increasing individualism (Koolen & Tertoolen, n.d.), urban form trends (deconcentration), and aspects of public transport modes like limited flexibility, availability, and comfort. One form of public transport that has more unattractive aspects is the regional bus. This bus type often operates at lower frequencies, more often in less urbanized areas, and has low penetration rates as it does not go deep into residential areas.

Regional lines have faced declines in ridership levels during recent years, which is why transport companies feel the need to cut costs. One way to cut costs is by reducing the number of provided transit lines. This leads to a reduction in attractiveness of the regional bus, which in its turn leads to more decline of passengers, creating a vicious circle. Transport companies face declining revenues, which is why transport authorities are required to increase levels of funding if they want to maintain these bus lines. These developments have lead to this research on improvement of regional public transport.

This document presents the results of a master thesis research at Goudappel Coffeng. The following sections will outline the research framework and the research methodology.

1.1 Research Objective

The objective of this research is to design a set of measures that effectively and efficiently increase ridership levels of regional bus lines by addressing the problems of regional bus trip chains that are currently affecting its current and potential users.

1.2 Research Questions

The main research question is: How can the current problems of regional bus trip chains in the Netherlands be addressed efficiently and effectively in order to maintain the current users and attract new users to regional bus lines?

This research question can be divided into several sub-questions:

» What are the problems of regional bus lines?
» Who are the potential users of regional bus lines?
» What are the needs of potential users of regional bus lines?
» What type of measures can be used to address the problems of regional bus lines?
» What are the impacts of these measures on the number of travelers?
» What are costs and benefits of these measures?

1.3 Scope of This Research

This research is performed to obtain recommendations on regional public transport in the Netherlands. In the Netherlands, public transport companies are awarded a concession which gives them the exclusive right to operate bus lines in a specific region for a specific period of time. This period of time is often equal to 5 years. In this concession the transport authority specifies the level of service that it wants the transport company to provide. The transport company is selected based on competitive tendering where the company that offers the package with the best price/quality ratio is awarded the concession.

Regional bus lines are supposed to have a connecting function, in which they connect different concentrations of human beings with each other. This means that there are also regional bus lines that have to operate in multiple concession regions creating complex legal and operational situations. Dealing with these issues falls outside the scope of this research.

In the current setting regional bus lines operate to get travelers, but the level of service is determined by the transport authority. The transport authority also covers more than 50% of the expenses of transport companies. The complex interactions between demands of potential users, travelers, the transport company and the optimization of these interactions fall outside the scope of this research.

This research will focus on the most potential users, which should be the cornerstone of the public transport system. The interaction between these potential users, the provided level of service, the desired level of service, and the willingness of the transport companies and authorities to comply with these demands draw the framework of this research. Within this framework possibilities are sought to increase the share of potential users that actually use public transport efficiently and effectively, and the magnitude of the corresponding efforts that are required and their respective results are made transparent.

1.4 Research Outline

This section outlines the contents of this report; *see Figure 1.1* for an overview.

This research starts with an analysis of the potential users, which can be found in chapter 2. The first element of the problem analysis is the definition of users. In this section the current types of regional bus lines users is analyzed, by analyzing the characteristics of these users, in which extent do these users use public transport, and which are the segments that have the most potential for growth. The second component of the problem analysis is the user needs analysis. This analysis comprises of the identification of the segment specific needs of the door-to-door trip of the users based on literature and a case study. The final component of the problem analysis is an analysis of the current performances of regional bus lines. This problem analysis is twofold: First an objective analysis is performed to get an overview of the current performances of regional bus lines; then a subjective analysis is performed by means of literature research, a case study and interviews with stakeholders to get an overview of the perceived performances of regional bus lines. The result of this chapter is a framework for the design of measures.

The next component of this research is the design and selection of measures, which can be found in chapter 3 of this thesis. These measures have been designed within the framework that is provided by chapter 2. The measures are grouped in the four categories: reliability/travel time, information provision, attractive fares, and reputation of public transport. The selection of the top ten measures is based on criteria that are used in the Policy Delphi method.

The third component and 4th chapter of this research encompasses the expert based qualitative evaluation of the ten measures that have been selected in chapter 3. After review of several qualitative evaluation methods, the Policy Delphi method is selected. Then the necessary preparations are made and the expert opinion of professionals in the public transport is inquired in two rounds by means of an online questionnaire. The result is a selection of the three most effective, feasible, desired, and important measures.

The impact of these three measures on ridership is quantified in the fourth component of this research, which is the 5th chapter of this report. In this quantitative assessment a case is used to quantify the impacts of the measures on travel behavior is quantified after which elasticities are applied to these impacts in order to obtain the alteration in number of travelers. Finally, the possible impacts in other situations are discussed.

In the fifth component of the research the costs and benefits are calculated by means of a short cost-benefit analysis, which can be found in chapter 6. In this analysis the direct costs and benefits will be

calculated for the different stakeholders for each of the measures that have been quantified in the chapter 6. The results of this chapter are used as input for calculation of the costs and benefits.

Finally, chapter 7 contains the last component of the research which contains the conclusions and recommendations on seeking possibilities to improve ridership levels efficiently and effectively.

Figure 1.1: Overview of the chapters of this research

2. Analysis of The Regional Bus Transport System

This chapter analyses regional bus transport system in general. First the characteristics of the users of the transport systems will be analyzed, creating an overview of the characteristics of users per type of users. From these characteristics the most potential users can be extracted. Secondly, the user needs will be assessed. This involves the assessment of the general needs of users and needs of the most potential groups. Third, the actual performances of regional public transport will be analyzed along with the perceived performances of regional public transport. This is done based on literature and a case study. Finally, the results will be summarized and conclusions will be drawn concerning the most potential group of users, their corresponding needs and the modifications that are required to fulfill those needs.

2.1 Definition of Users

In this section different forms of segmentation will be assessed and a choice will be made for the segmentation of users in this research.

Not all users are the same. Each user has different characteristics, a different background and different preferences. This may lead to different travel behavior among users. It is an impossible task to adapt the transport system to the needs of all users, let alone the needs of public transport which is a collective form of transportation. This leads to the segmentation of users. The categorization of users is a complex problem. Since no extensive research on segmentation will be performed during this research, there is no opportunity to use 'the ideal' segmentation basis. Segmentation must be done based on the segmentation that has been used in different research.

There are several ways to segment users (Rijkswaterstaat, 2005):

Easy to measure, with little significance

- Situational characteristics
- Travel Behavior
- Context specific motivations, needs
- Attitudes and conceptions
- General norms, values and lifestyle

Difficult to measure, with high significance

Trip motive is widely used in the transportation field and is applied more consistent than other segmentation bases. This is why segmentation will be done based on trip motives in this research. The use of trip motives means that the type of users will be identified by using the type of trips. Thus the assumption is made that travelers with the same motives show identical travel behavior. Due to minor inconsistencies in the use of trip motives in the literature, the trip motives will have to be merged. The following classification will be used in this research:

- Commuting, business, education (CBE)
- Visit, stay-over (VS)
- Recreation
- Shopping/groceries (SG)

2.1.1 Targeting User Segments

Trip motives of individuals can change several times during a day. This makes it difficult to target these

traveler segments on the longer term. One way to target users is to look at the social groups that these segments belong to. Social groups indicate the primary way that individuals participate in the society in terms of employment or education. The need for transportation is derived from the desire of performing activities that are separated by space. The Central Bureau of Statistics (CBS) uses the following classification of social groups (CBS, 2009):

- **Persons younger than 6 years:** These persons have limited participation in the society due to their young age.
- **Students/Pupils:** Pupils are persons that attend primary school aged 6 or older and those that attend secondary education. Students are persons that attend higher education. Thus their main activity of these people is education.
- **Unemployed persons or persons that are seeking employment:** These persons are adults that are currently not employed that may or may not be seeking employment. They do not participate actively in the society because of their unemployment.
- **Persons working less than 30 hours a week:** The main activity of these persons is employment, but they spend less than 30 hours a week on employment.
- **Persons working more than 30 hours a week:** The main activity of these persons is employment and they spend more than 30 hours a week on employment.
- **Persons who are working at home:** The main activity of these persons is employment but these persons work at home. Their participation in the transport system is significantly less than those of other working people.
- **Retired people:** These are persons that have participated actively in the society in the past but do not and are not seeking to perform educational or employment activities anymore.
- **Disabled people**: These are persons that have limited participation in the society due to their physical disabilities.

The relationship between social groups and trip motives will be assessed in section 2.2

2.2 Potential of User Segments

In this section an assessment is made of the potential of the user segments. The potential of a user segment is the function of the travel behavior of the segment and the sensitivity of the segment for improvement. These two elements of potentials will be analyzed in the following sub-sections.

2.2.1 Travel Behavior of User Segments

To get an idea of the potential of these segments of travelers for public transport in general and regional bus lines to be more specific, it is interesting to analyze the travel behavior of passengers in general across motives and the distribution of regional bus passengers among motives. Due to limited availability of data on regional bus transport on the national scale the distribution of trips on bus, tram, and metro will be used instead.

Figure 2.1 shows that the distribution of number of trips per user group differs in bus, tram, and metro

(BTM) differ from the distribution of trips in general. The recreation group is relatively smaller for bus, tram, and metro while the CBE group is relatively larger for BTM.

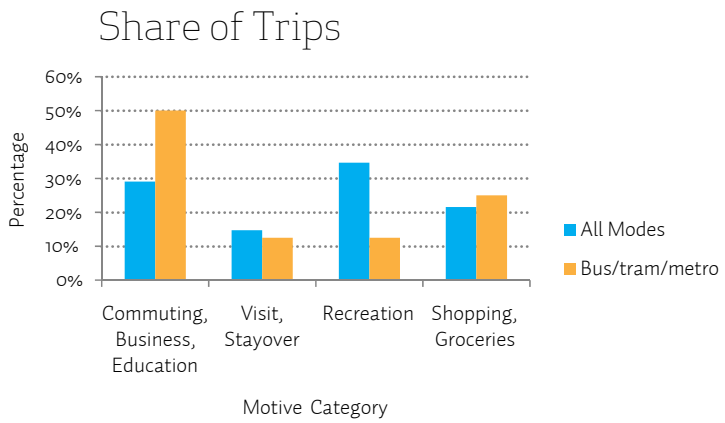


Figure 2.1: Share of trips per motive category (RWS-DVS, 2004)

To get an accurate impression of the potential of these segments, the number of daily trips per motive category must be analyzed. *Figure 2.2* shows that the number of BTM trips is quite small when compared to other modes. Since CBE users use BTM the most and CBE trips are relatively common one would say that CBE has a high potential. This of course would be true if the same amount of effort is necessary to get all types of users to use the bus.

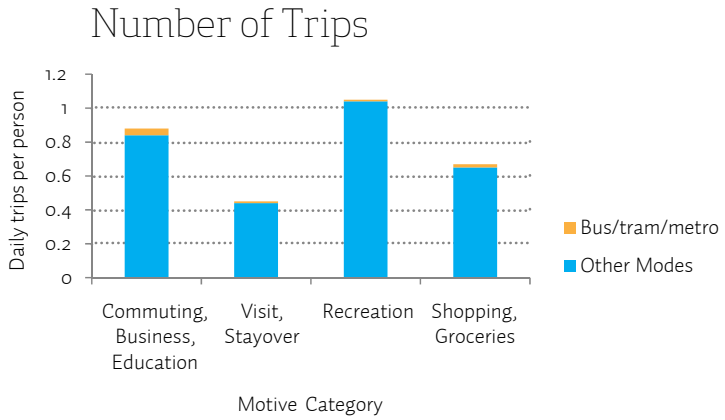


Figure 2.2: Absolute modal share of trips in number of trips per day per person (RWS-DVS, 2004)

Social groups

There is a certain relation between the social groups and travel behavior: People who more active in the society travel more. This can be seen in *Figure A.1* in the appendices. Persons that work less than 30 hours and persons that work more than 30 hours a week account for 85% of the trips, and this share has been slightly growing the last few years. This means that these two social groups form very interesting targets when applying measures.

Considering the fact that persons that work less than 30 hours a week and persons that work 30 or more hours a week make the most trips, it is interesting to see what the distribution of trip purposes is among these social groups. As was mentioned before, trip purpose is the most widely used segmentation basis in transportation. *Figures 2.3* and *2.4* indicate that among these two social groups, the purposes recreation and commuting/business/education have a larger share and this share seems to be growing.

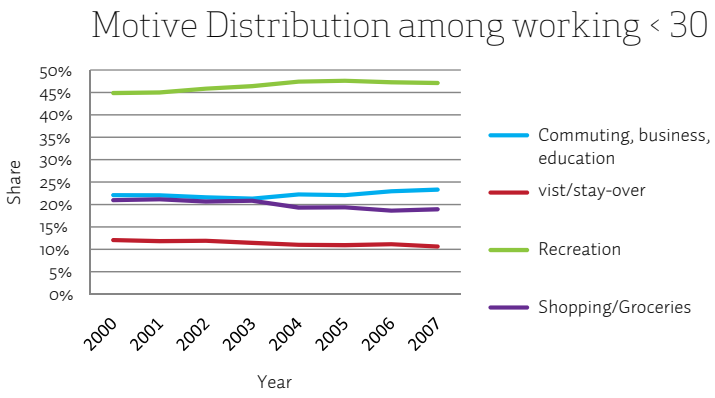


Figure 2.3: Distribution of motives among people that work less than 30 hours a week (CBS, 2009)

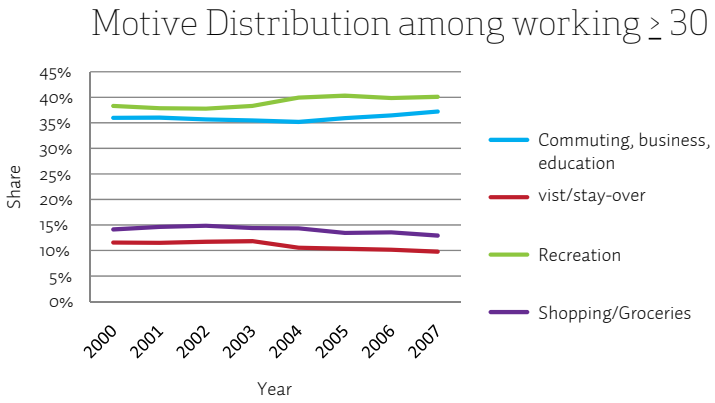


Figure 2.4: Distribution of motives among people that work 30 or more hours a week (CBS, 2009)

There is a growth potential if the current system does not attract the largest group of travelers. If the current system already attracts the largest group of travelers there is little room for growth. *Figure 2.5* shows that the current public transport product attracts students/pupils the most, which is not the largest group of travelers. Thus the number of public transport users has a potential to grow. The share of PT among this social group has remained relatively constant throughout the past, while the number of people that work 30 or more hours or less than 30 hours that are using public transport is declining steadily. This it is why it is important to assess the needs of social group in order to make regional public transport attractive for the users (see section 2.3).

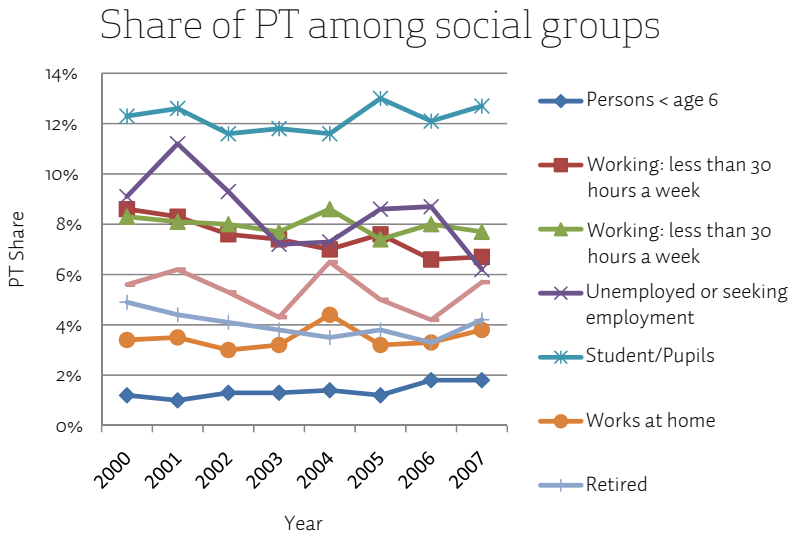


Figure 2.5: development of the share of PT among social groups (CBS, 2009)

Car Availability

The alternatives that individuals have at their disposal may play an important role in their mode choice. This is why an analysis will be made to determine the relationship between car availability, share of trips and use of public transport.

Figure 2.6 shows that the share of daily trips is proportional to car availability. This suggests that availability of a mode leads to increased mobility. *Figure 2.7* indicates that the use of public transport increases with decreasing car availability. This means that the most potential lies in focusing on the travelers that do not have a car available and those that do not have a car available all the time. The use of public transport among people who possess a driver's license and occasionally have a car at their disposal is gradually increasing.

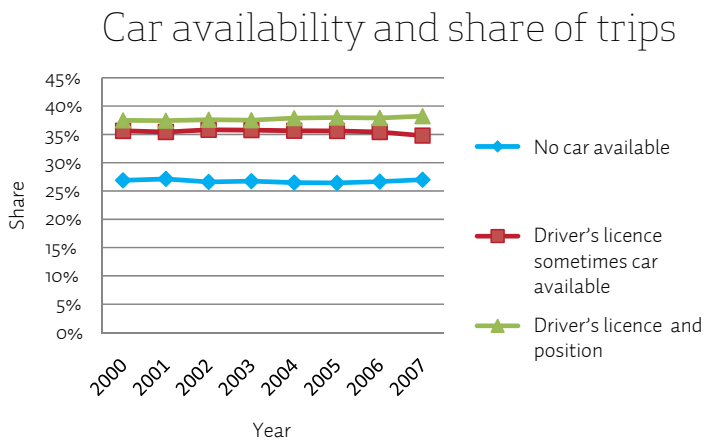


Figure 2.6: Car availability and corresponding percentage of daily trips (CBS, 2009)

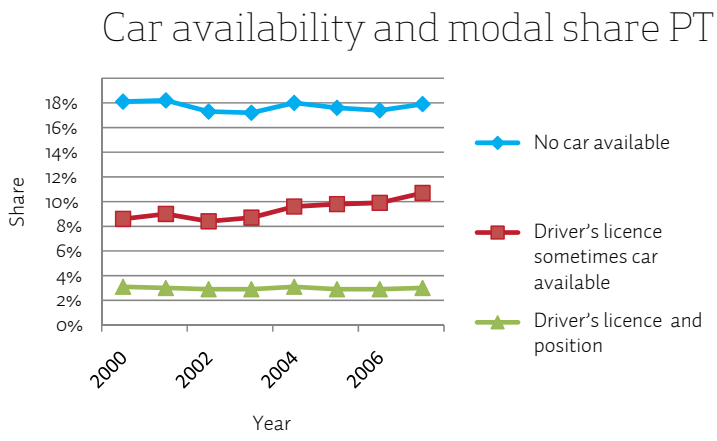


Figure 2.7: The impact of car availability on modal share of PT (CBS, 2009)

Thus the availability of a car is an important factor in the decision to travel with public transport or not. Higher car availability translates to higher mobility for the individual, but lower probability to travel with public transport. Car ownership has been increasing steadily in the past (CBS, 1998) and is expected to increase in the future.

2.2.2 Sensitivity of User Segments

The sensitivity of the different segments to general improvements is an indicator of the potential to attract these segments to regional public transport. Sensitivity in this research indicates how sensitive a group is to changes in the quality level of regional public transport. The sensitivity of the user segments can be analyzed by using the travel time factor model. This model has been developed by Goeverden and Van den Heuvel (1993) based on revealed preference surveys. The model describes the relationship

between door-to-door travel time ratio between the car and public transport and the share of public transport:

$$S_{PT} = \exp(a_1 \cdot TTF^2 + a_2 \cdot N_T + a_3 \cdot F^{-1} + a_4) + a_5$$

Where:
S_{PT} is the share of publictransport in the modal split
TTF is the travel time factor
N_T is the number of transfers
F^{-1} is the frequency
$a_1 \ldots a_5$ are segment specific parameters

Table 2.1: Segment Specific Parameters

Segment	α_1	α_2	α_3	α_4	α_5
Car Available					
Commuting, Business, education	-0.68	-0.20	-1.50	0.20	0.01
Visiting, Stay-over	-2.00	-0.20	-1.50	0.20	0.01
Other: Recreation, SG	-0.60	-0.20	-1.50	0.20	0.01

The only other mode that the model takes into account is the car. This makes the model unsuitable for use where other modes are considered to have a significant share in the modal split. The bicycle has a significant share in the modal split in the Netherlands, but is considered to be a significant contender for trips that are smaller than 7.5 km (Ministry of Transport, Public Works, and Water Management, 2009). The average trip length in regional bus lines is between 12 and 13 km, this means that the bicycle does not play a significant role in the modal split of regional trips. This means that this model can be applied in calculations of regional trips.

The parameters of the model have been calibrated on a revealed preference survey. Since the model does not directly describe the relationship between variables like comfort, perceived cost, experience, reputation and the share of public transport, one would initially think that these hidden variables are described by the parameter α_5. These variables assumed to be motive specific. This is not the case however, since this parameter only varies if the car availability varies. The only parameter that varies per user segment is α_1. Since the model is developed based on revealed preference research and the needs are assumed to change with the motive categories, these effect of the hidden variables are assumed to be described by α_1 i.e. incorporated into TTF. This means that the model actually takes generalized travel times into account. Generalized travel time is composed of the sum of the monetary cost of the journey divided by the value of time and the various travel time components (Balcombe, et al., 2004).

The sensitivity of users can be measured by calculating the (generalized) travel time factor elasticity. The elasticity will indicate how big the effects will be of changes to regional supply. Elasticity is defined as:

$$E(S_{PT}, TTF) = \frac{\partial S}{\partial TTF}\frac{TTF}{S_{PT}} = \frac{\exp(a_1 \cdot TTF^2 + a_2 \cdot N_T + a_3 \cdot F^{-1} + a_4) \cdot 2 \cdot a_1 \cdot TTF^2}{\exp(a_1 \cdot TTF^2 + a_2 \cdot N_T + a_3 \cdot F^{-1} + a_4) + a_5}$$

Using this formula yields the elasticity graphs shown in *Figure 2.8*. The parameters that have been used here are those where the users have a car available. This means that larger improvement is needed to get them in to public transport i.e. the figure shows how sensitive they are for changes in the level of service (TTF) in the worst case scenario.

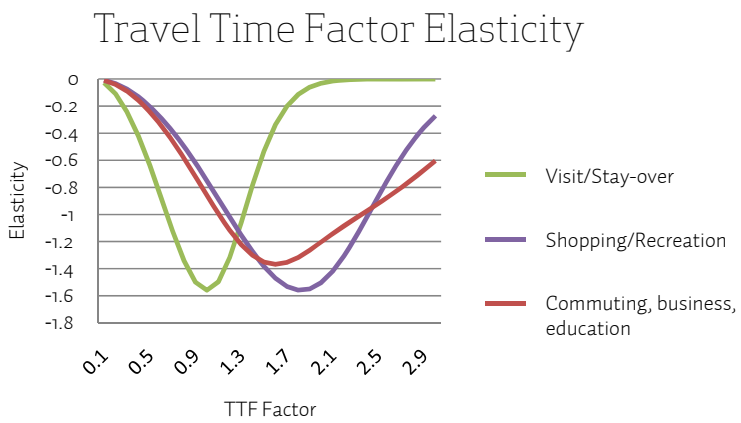


Figure 2.8: Travel time factor elasticity per segment with corresponding travel time factor

Figure 2.8 shows that travelers with trip purposes CBE and shopping/recreation are the most sensitive for changes in the level of service. Thus users with these purposes require the least effort to attract to regional public transport. Users with these purposes can be attracted by focusing on the social groups that travel with these purposes the most. Figures *figureA.2 figure A.3* in the appendices show that recreational trips are relatively equally distributed among social groups, while the most trips with purpose CBE are made by persons that work 30 hours or more and less than 30 hours along with students/pupils. This underscores the conclusion of the previous section that the most potential users are non-at-home working people and pupils/students.

It is important to note that the TTF model is used as an indicator of the sensitivity of segments and that it is not assumed to perfectly describe the sensitivity of the user segments to changes in the public regional transport supply.

2.2.3 Summary

The most potential segments of travelers are travelers that commuting/business/education trips and recreation trips which are predominantly non-home-working people along with pupils/students that do not always have a car at their disposal. They are the most potential segments since they have a larger share in the modal split in terms of number of trips made and because they can be persuaded with the least effort to use public transport. Most of the pupils/students are now users of public transport and most of the current users of public transport are students and people who make shopping/groceries journeys. Especially the students are to be considered PT captives. This research focuses on keeping the current users and attracting new users by focusing on commuting trips and recreational trips.

2.3 User Needs

This section summarizes literature on the general needs of the traveler from which the needs for the regional bus trips will be extracted. Then the section continues with a definition of the needs of the most potential segments, after which it will finalize with a summary.

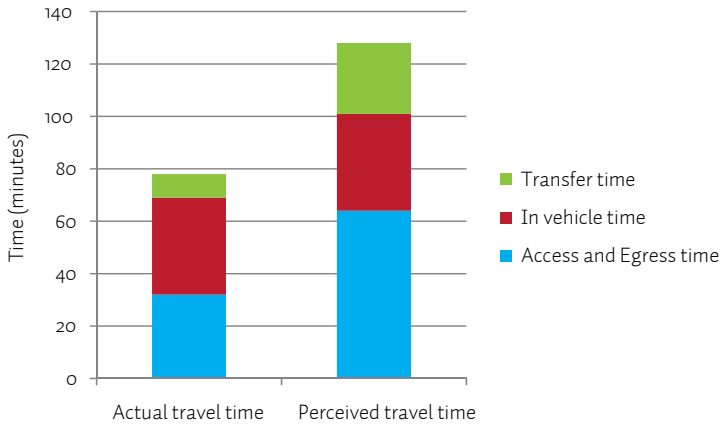
2.3.1 General Needs

This section gives an overview of the user needs in general, after which an overview will be given per component. The factors that influence mode choice are related to user needs. These factors are the following (Ceder, 2007):

- Price and availability of each mode;
- Quality of service of each mode;
- Trip characteristics for each particular trip;

» Socio and demographic characteristics of the traveler.

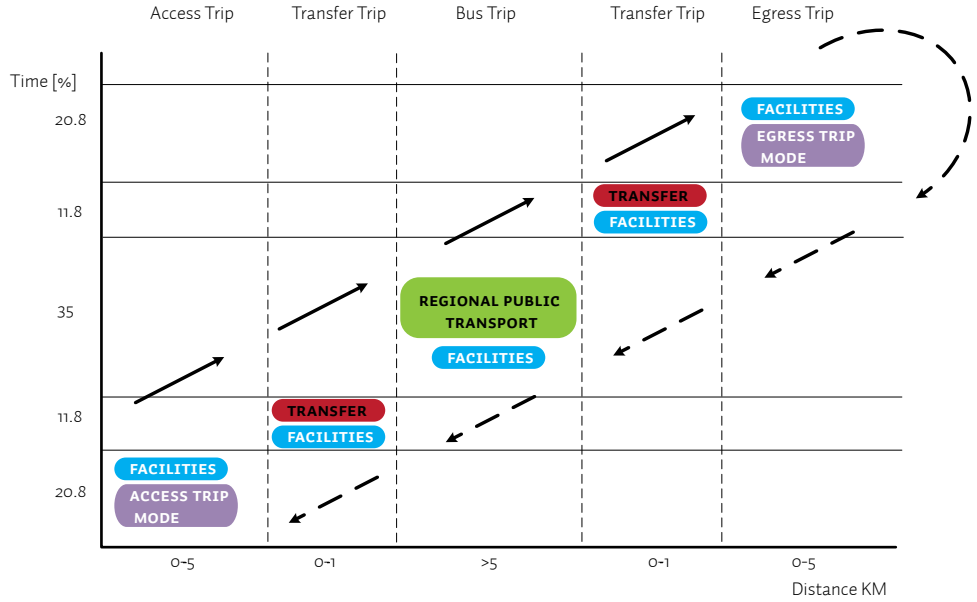
Several of these factors are external and cannot be influenced easily if at all. Choices are made between modes, which means the prices and availability of that mode would need to be influenced in order to get people to use public transport. This is of course if one assumes that travelers have a perfect perception of the costs and performances of each mode. *Figure 2.9* shows that this is not the case. The figure illustrates that travelers overestimate the travel time for train trips. Train trips are more reliable than other public transport trips, because they are not subject to traffic induced delays. This means that a higher perception error could be expected in regional bus transport. Research has also shown that non-users



have a more negative perception than current users (Heath & Gifford, 2002).

Figure 2.9 Actual travel time versus perceived travel time for an average train trip (Hagen, 2004)

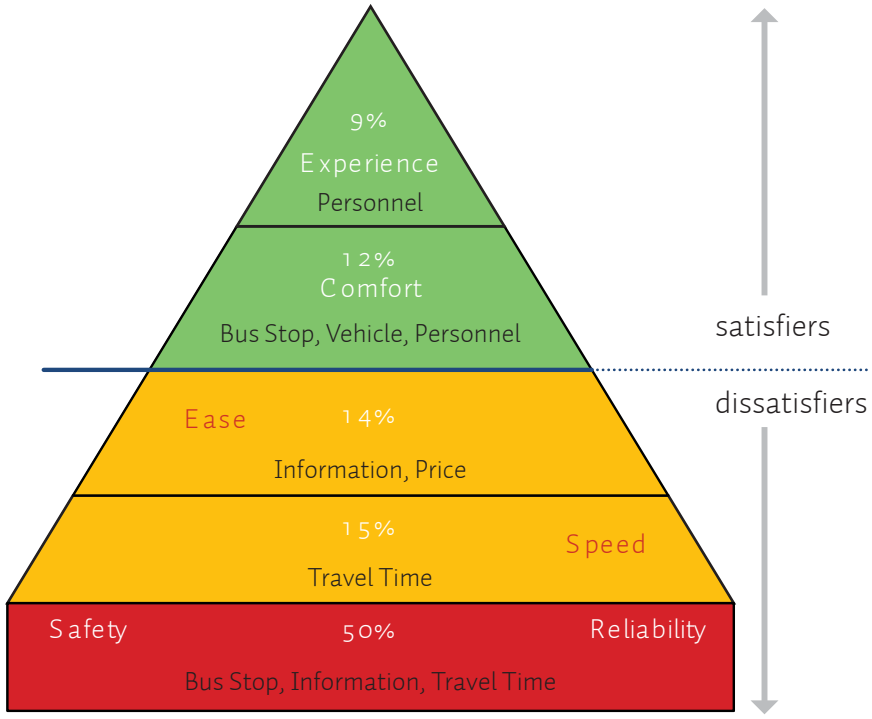
As *Figure 2.9* implies, the use of public transport means the use of a chain of trips. This chain is illustrated in *Figure 2.6*. This chain comprises of access trips, transfer trips, the regional bus trip, egress trips and waiting. In this research, waiting is considered as a part of the transfer trip. *Figure 2.6* also shows the average duration and length of each component of the chain of trips. The figure illustrates that a majority of the time that a passenger spends in public transport is not spent in the main component of the chain of trips. Thus the improvement of regional bus transport means improving a chain of trips that includes regional bus lines, the door-to-door trip. If the other components of the trips do not fulfill the needs of the traveler, the traveler will not choose to travel with the regional bus line. The other compo-



nents of the trip chain will be assessed in the following sub-section.

Figure 2.10: Regional public transport trip chain based on RWS-DVS (2008) and Rijkswaterstaat Directie Limburg (1993)

Some research has been done to illustrate what are the needs of travelers and the hierarchy of these needs. Van Hagen (2004) first distinguishes satisfiers and dissatisfiers, and then defines the types of satisfiers and dissatisfiers. The research of Van Hagen (2004) does not say where elements such as



price and information fit in the hierarchy of consumer needs. This is why some specifications have been added to components of the pyramid (see *Figure 2.11*).

Figure 2.11: pyramid of consumer needs adapted from Van Hagen (2004)

Enoch & Potter (2002) identify a number of requirements to satisfy existing customers and growing by modal shift:

- A pleasant waiting environment;
- Good reliability;
- An easy to understand network;
- An easy to understand ticketing structure;
- Easily accessible vehicles to those with heavy shopping, prams and pushchairs, and wheelchairs;
- A direct service with easy interchange;
- A frequent service, even during the evenings and on Sundays;
- Good value for money;
- Friendly and helpful staff;
- Comfortable, clean, well heated and ventilated vehicles.

These requirements more or less correspond with the pyramid of consumer needs.

Access and Egress Trips

As *Figure 2.10* shows, a largest part of the door-to-door travel time is spent outside public transport (65%). The majority of the time spent outside public transport is spent on access and egress trips (64%). The longer the trips, the more important the satisfiers; while in shorter trips dissatisfiers are more im-

portant.

Most of the access and egress trips are carried out by foot in regional trip chains. A large majority of the bus travelers lives within a distance of 400 meters of a bus stop (equal to 5 minutes walking). If one wants to attract travelers that live beyond that distance, one has to consider installing bicycle facilities. The use of radial routes to bus stops has a psychological effect on travelers since they can see the bus stop from a greater distance. Moreover, using radial connections increases the service area of bus stops (Kennisplatform Verkeer en Vervoer, 2006). ROVER (Public Transport Users Association) has stated in an interview that passengers want to minimize the effort needed to use a bicycle as a mode for access and egress trips. Guarded bicycle sheds are not always necessary at all bus stops. A decent bicycle shed is often considered as more proper at bus stops in rural areas according to ROVER.

The KPVV (Knowledge Platform Traffic & Transport) states that egress trips are more crucial than access trips, since there is more resistance in bridging the spatial gap between the bus stop and the final destination. This is due to the relatively unknown area and the absence of the bicycle. There are far fewer possibilities to widen the range of the egress trip than in the case of access trips. The PT-Bike (public transport -bike) can be offered in case of frequently used bus stops. Maps of the area in the vicinity of off-boarding bus stops can also come in handy (Kennisplatform Verkeer en Vervoer, 2006).

One factor that is influencing access and egress trips is the Sustainably Safe program. This concept limits traveling speeds in living areas to 30km/h, with help of infrastructural measures such as speed bumps. This sometimes makes it difficult for transit companies to operate in these areas, which can lead to adaptation in these transit lines. These lines will skip penetration of living areas which increases the length of access and egress trips significantly. This problem has been indicated by both ROVER and a public transport company. When transport authority was asked about this problem in an interview they recognize the existence of the problem and in fact they are in a dilemma: They finance both the Sustainably Safe concept and public transport.

Transfer

The transfer is a part of the trip where the amount of distance traveled is the smallest of all components of the chain of trips (see *Figure 2.10*). Despite this fact, transfers still account for 23.6% of the total travel time. Since the main element of the transfer is not traveling but waiting, the user needs requirements change. Users prefer to wait in comfortable, neat, safe areas with protection from weather influences (Balcombe, et al., 2004). Transfer times increase with decreasing quality of connections, where quality is defined as the combination of the actual time that is required to make the transfer and the reliability of this transfer time. Stops along regional bus lines often do not have bus shelters. According to Movin' (2007), the transfer situation, information, transfer time and reliability are the important factors of the transfer.

2.3.2 Needs most Potential Segments

In this sub-section the needs of the most potential segments will be analyzed. Section 2.1 revealed that the most potential social groups are persons that work 30 or more hours a week, less than 30 hours a week and students/pupils. These social groups make trips with purposes CBE and recreation. This section contains an analysis of the needs for the purposes commuting, business, education, and recreation. Each type of user has different needs i.e. will require different performances of public transport.

Commuting/ Business

Commuters are a very diverse group of travelers, since there are many types of labor. The most important factor is the degree of flexibility of workplaces as people that do not have fixed working places have varying OD-pairs. These people do not use public transport that often, so it is this section of public transport users that may need to be targeted to increase the level public transport use among commuters. The most important need of commuters is a reasonable travel time. The commuter also has needs concerning the variability of travel time, i.e. there is a need for certainty. This translates into

the desire of the individual to exercise control over its own outcomes. Uncontrollable events may elicit feelings of anger, frustration and stress and may lead to individuals to search for information about how to increase personal control or opt for behavioral alternatives providing more controllable outcomes (Van Vucht, Van Lange, & Meertens, 1996). The assumption could be made that providing information will increase certainty. Travelers making commuting and business trips are more interested in traveler information than users with other purposes (Chorus, 2007).

Commuters are interested in travel time and comfort that competes with the car, departure and arrival times that are coherent with working hours. Seat availability and a relaxing environment are also requirements of this group and on longer trips the ability to work also becomes an important need. A good reputation of public transport is also important for this group of travelers. Travelers must be able to confirm to their colleagues that public transport is a good option. Commuters also want very frequent egress trips where egress trips are long. The need for low fares is desired if the employer does not reimburse the costs. In this case the fares must compete with the variable costs of the car. Less interesting are access trips and good accessibility (Movin', 2007).

Education

Two types of persons that make educational trips are defined here: students and pupils. Students are persons attending higher education while pupils are persons that attend primary school aged 6 or older and those that attend secondary education. Parents play an important role in the decision of the pupils to travel with the bus or not. Pupils travel over relatively long distances (24-30 km) on average. The pupil is interested in coherence between the bus arrival times and school hours, also in cases of cancelled lectures. The pupil is also interested in low fares; this might be related to the low income levels of pupils. The bus needs to have a cool, young image and the travel times of the bus need to compete with the bike and scooter. The pupil is less interested in good accessibility, luxurious buses, comfort, and travel time that is competitive with the car (Movin', 2007).

The student likes flexible departure and arrival times due to the very flexible starting and finishing times of lectures. The students also like travel time that competes with the bicycle, scooter, and the car. The bicycle and scooter are used for short trips and the car for longer trips. The usability of the student public transport pass is also of importance. In the Netherlands students are allowed to choose between free and unlimited traveling with public transport on weekdays or in weekends. Less interesting for students are luxurious buses, comfort, accessibility, and fares (Movin', 2007).

Recreation

The group of recreationists is very diverse since there are a lot of activities that can be categorized as recreation. The recreationists often travel in larger groups which makes public transport expensive. Since there are more people traveling together, there is also a higher chance on the availability of a car in the group (Movin', 2007).

The recreationists like frequent and direct service to highly visited attractions or a connection with at most one direct and guaranteed transfer. Comfort is more important for this group of travelers, so they would like a pleasant bus shed, vehicle interior, and waiting area. They also would like clear information at home, at the destination, at the bus stops, and during the trip. They would like good accessibility for seniors and buggies and seating that allows more social interactions (Movin', 2007).

2.3.3 Summary

There seems to be a misperception of the performances by PT users and non-users, and a significant portion of the journey with public transport is not spent in public transport. In general, there are a number of elements that public transport users are interested in. These elements can be divided into satisfiers and the dissatisfiers. The dissatisfiers are elements that have to meet the requirements of the users or else they will be dissatisfied. The dissatisfiers account for 79% of the user needs. Core elements in the dissatisfiers are safety and reliability, which account for about 50% of the needs. Other dissatis-

fiers are ease and speed, which account for 19% of the user needs. The satisfiers are the elements that will enhance the trip experience like the comfort during the door-to-door trip and the experience of the door-to-door trip.

Since each user type has different purposes, they have different needs. Users that make commuter and business trips need a reasonable and reliable travel time that competes with the car. The departure and arrival times of the buses must be coherent with working hours, and there must be frequent egress trips available. This group of users also needs comfort that competes with the car. Public transport users with educational trip purpose need coherence with school hours. This might mean flexible service in case of students. Low fares are also needed in case of pupils. Both educational users and commuters would like to identify themselves with the use of public transport i.e. public transport needs to have a good reputation. Recreationists need comfortable, frequent, and direct service to highly visited attractions. Clear information is desired at home, at the destination, at the bus stops, and during the bus trip.

2.4 Performances

This section consists of an analysis of regional bus transport performances. Performance of regional bus transport is defined as the trend in usage of regional bus lines during recent years. This section will first analyze the (perceived) performance of public transport by seeking literature, and then it will analyze public transport performance by looking at the performance in a specific case.

2.4.1 Literature Research on Performance

This sub-section will first analyze the general performances of public transport, and then it will provide an overview of how the traveler perceives the performance of public transport. There are a number of ways to measure performance (TAS Passenger Transport Publications, 2007):

» Volume changes (passenger journeys/passenger kilometers)
» Changes in profitability;
» Changes in cost levels;
» Levels of capital investments;
» Customer satisfaction and service reliability.

The general performance section will elaborate on volume changes in public transport, while the perceived performances section will elaborate on customer satisfaction on regional bus lines. Information on profitability, changes in cost levels, and levels of capital investments are not publicly available.

General Performances

There is a belief among public transport consultants that there is a vicious circle in regional public transport (*Figure 2.12*). It starts with a decrease in the number of travelers, leading to a reduction of the number of bus lines, which leads to longer access and egress trips and longer travel times, ultimately strengthening a mode shift i.e. a decrease in the number travelers.

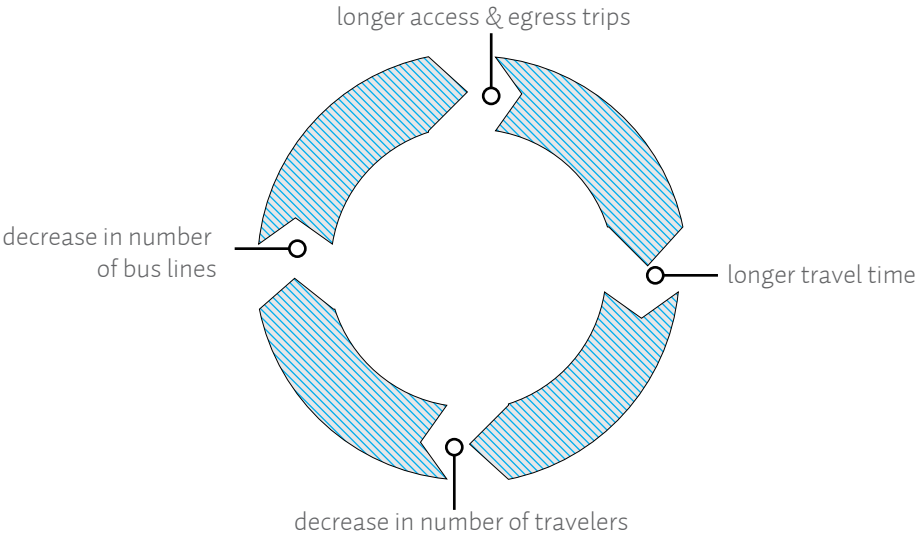


Figure 2.12: vicious circle in regional public transport

A more detailed version of this vicious circle can be seen in *Figure 2.13*, where the influence of societal developments on the revenue of the public transport operator can be seen.

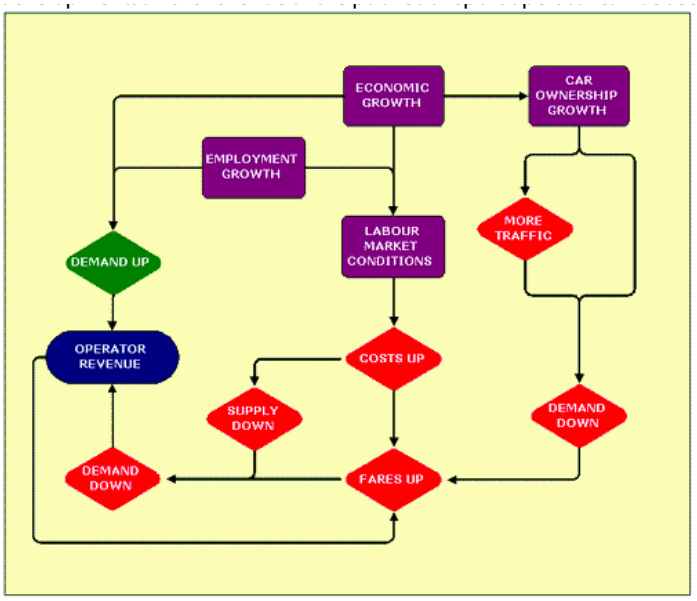


Figure 2.13: Vicious Circle according to (TAS Passenger Transport Publications, 2007)

The question is what does research say about the performances of bus companies on regional bus lines. This is why this section will analyze literature on the supply and demand developments in public transport. The performance can be measured in several units, of which the most commonly used are trip kilometers, number of trips, and number of trips per passenger. Both the number of trips per passenger and the number of trip kilometers have been declining between the years 2000-2007, taking the year 2000 as the base year.

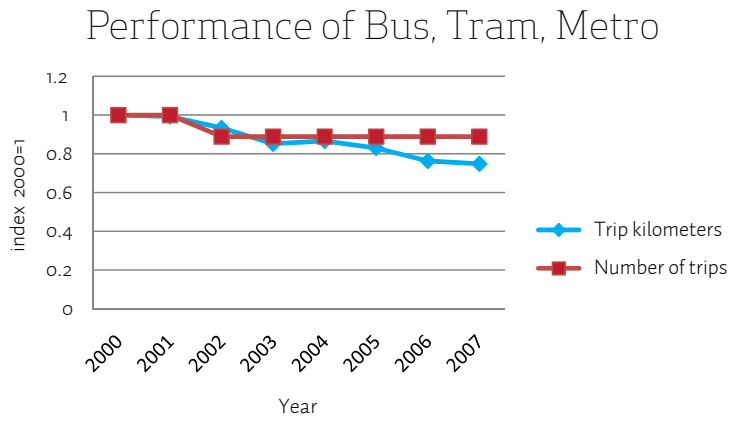


Figure 2.14: Performance of bus, tram, metro (Rijkswaterstaat, 2008)

There is also evidence that the supply has been declining: The number of bus lines and the number of served bus stops have been declining with 6.1% and 10% respectively between the years 2000-2007 (NEA, 2008). It is important to note that the above performances are overall performances. This means that the performance may differ per area, and that performances of city buses, the metro, and tram are included in this equation. An analysis of regional 46 bus lines in two different regions in southern Netherlands revealed a decline of 1.5% between 2007 and 2008. The numbers differ per concession area, one concession area shows a decline of almost 12% in the number of passengers which means that the other concession area has experienced an overall increase in the number of passengers on their regional bus lines. The CBS has done research on the development of the number of passenger kilometers per purpose (see *Figure 2.18*). All purposes are showing a decline in the number of passenger kilometers in bus, tram, and metro (BTM). The International Association for Public Transport (2004) indicates sociological, politico-economic changes as causes for reductions in public transport ridership, which correspond with new demands regarding time and more flexibility of schedules, and an increasing share of leisure activities.

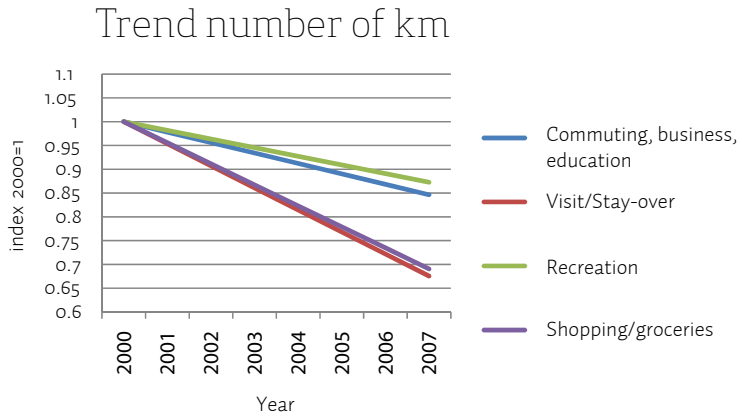


Figure 2.15: trend of number of km per trip per purpose in BTM (CBS, 2009)

Perceived Performances

Now the general needs and performances are known, it is interesting to see how the regional bus lines are performing according to the traveler and what improvements the current users and non-users think that are needed. There is no research with an exclusive focus on the perceived performance of regional bus transport, which is why the assumption is made that the problems that occur in public transport in general include the problems that occur in regional bus transport.

Not a lot of research has been carried out to get an impression on what aspects need to be improved in public transport in general, let alone regional public transport. The most logical way to get an idea of what needs to be improved is to ask the respondents what they think that needs to be improved.

Another way is to look at the problems that are facing regional public transport according to the traveler. Little research has been done on how to attract passengers other than to increase or improve supply in terms of operational performance and capacity. An interesting research is a research by the Knowledge Institute for Mobility (KiM) where they compare scores of riders and non-riders. The result of this research can be seen in *Figure 2.16*.

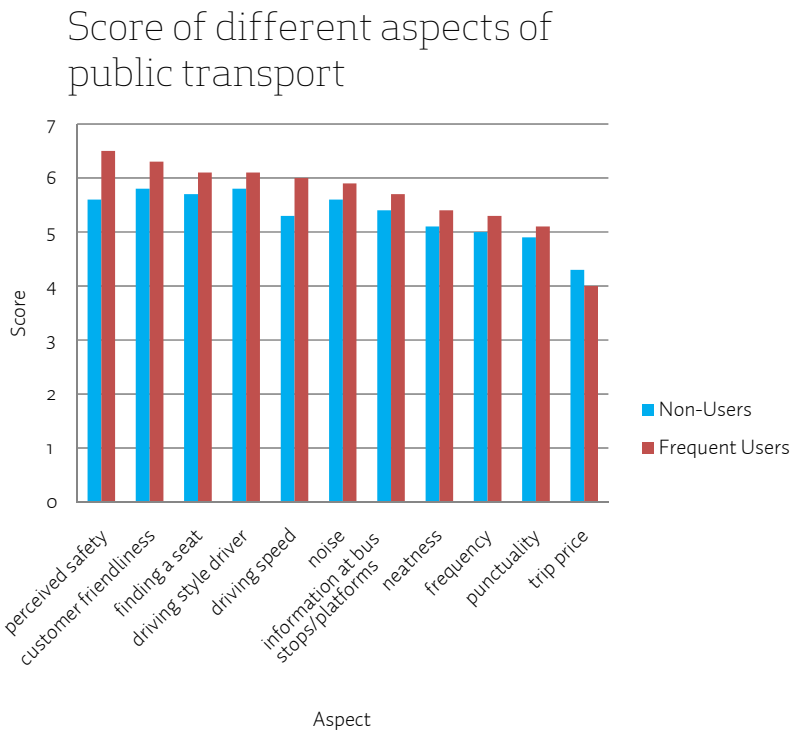


Figure 2.16: Score on a scale of 1-10 of different aspects of public transport (Knowledge Institute for Mobility policies, 2007)

One must be careful when interpreting results from a research of this kind. The respondents were asked to give a mark for the different aspects. *Figure 2.16* does not indicate large differences between users and non-users. In an ideal situation the respondents are asked to mention an aspect of public transport that they would like improvement on. A research close to this one is mentioned by Ceder (2007), and can be seen in *Figure 2.17*. There is a huge difference between the two figures: *Figure 2.16* does not show significant differences between users and non-users, while *Figure 2.17* indicates large differences. The desired improvements in the distinct studies yield are also different. It is not logical that the current users of public transport have the same opinion about public transport than the non-users. If that was the case, there non-users would probably not be non-users or vice versa. This is confirmed by both Ceder (2007)and Enoch & Potter(2002) which indicate that key factors that satisfy existing users are different from those that attract motorists i.e. non-users.

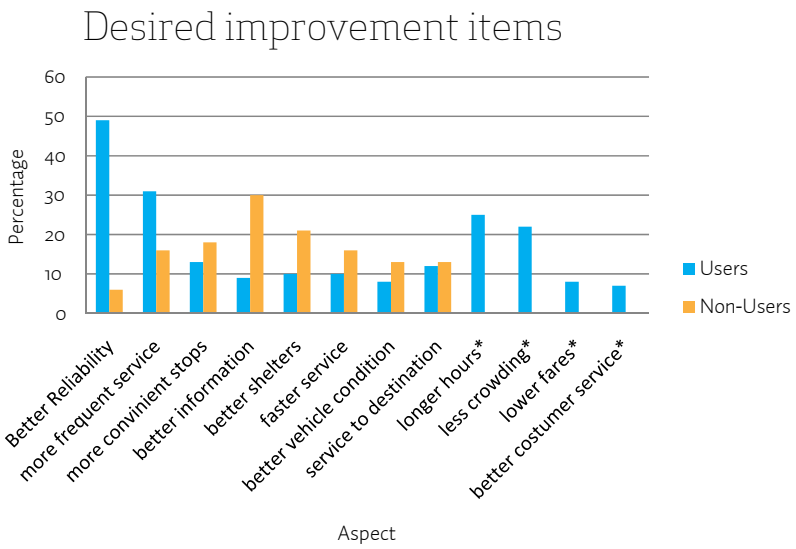


Figure 2.17: Desired improvement items of users vs. non-users in percentages (Ceder, 2007)

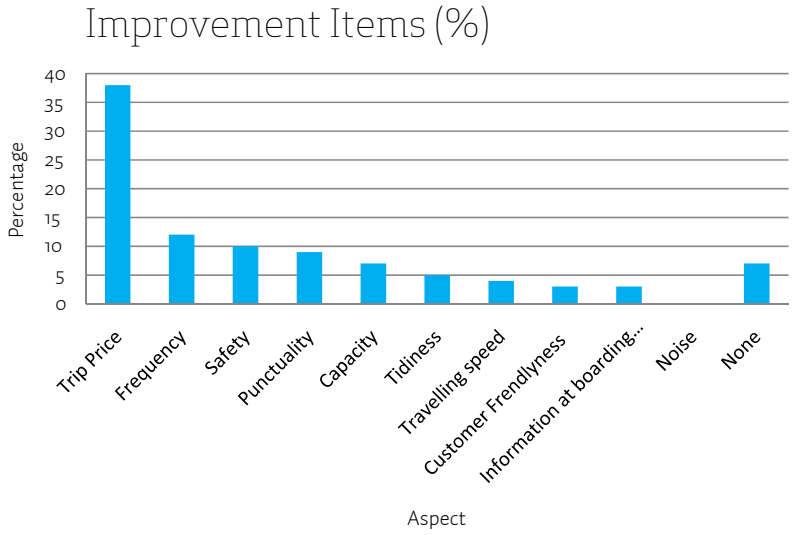


Figure 2.18: Desired improvement items according to Dutch citizens (Rijkswaterstaat, 2007)

Nevertheless, there is some information available on the improvement items of public transport (see *Figure 2.18*). This is the only Dutch research, up to this point, that asks individuals what they think that has to be improved in public transport. However, the research does not say what the target group was and how the questions were presented. Presumably these categories of answers were provided. The same is assumed for the research presented by Ceder (2007).

Other Reports

The reports that have been written to get an impression on what the current users think of public transport element in common i.e. they are based on research that has been performed under the current travelers. These reports are: PT-Costumer barometer (Kennisplatform Verkeer en Vervoer, 2008), OV-Loket Report of September- December 2008 (OV loket, 2009), and the chain-monitor (Stichting OPC, 2009).

The PT-Costumer barometer, unfortunately, is often used as a measure of the performance of transport companies. In this research, respondents (riders) are asked to rate different public transport aspects by indicating a score on a 10-point scale. This does not say anything at all about the change number of travelers, reasons for increased/decreased ridership, change in number of passenger kilometers, or change in revenue. Furthermore, a decrease in the number of travelers might lead to an increase of the

score given by riders when a service is e.g. fully adapted to the needs of a small group of travelers and does not meet the needs of a larger group of travelers. The OV-loket periodically gives reports on complaints filed by public transport users. This organization recommends travelers to file complaints at the transport company first and only file a complaint at the OV-loket if the former did not yield results. The chain-monitor is an analysis of the chain of trips performed by PT-users by analyzing a set of trips chains made and online questionnaires.

Nevertheless, these reports give an indication of the needs of public transport users. These reports and some others indicate the following problems:

» **Comfort problems:** There seems to be an overall lack of attention for comfort problems. Comfort problems are caused by behavior of personnel, payment difficulties, insufficient protection of the passenger against weather influences (Steensel, 2002;OV loket, 2009;Kennisplatform Verkeer en Vervoer, 2008).

» **Capacity problems:** The use of material seems to be disproportional to the occupancy, especially in peak hours. Capacity problems are also considered to be safety problems when buses are overcrowded (Steensel, 2002; NEA ,2008).

» **Availability problems:** Availability problems are twofold. There are availability problems with buses if they are offered at low frequencies and are not available within reasonable range; and there are availability problems when there is lack of access/ egress trip modes. Furthermore, there is a decrease in the number of bus stops and bus lines in the last years (10.1%, 6.2%). High quality access and egress trips are not always available (Steensel, 2002; OV Loket, 2009; NEA, 2008).

» **Transfer problems:** There are large transfer problems, mainly reliability problems. Users think they will miss a connection 93% of the time. Reliability is indicated as top concern of riders (Stichting-OPC, 2009; KpVV, 2008; Ceder, 2007)

» **Safety problems:** There has been a steady decline in both on-trip and bus shelter safety perceptions in the last years. There is also a lack of bicycle storage facilities(Stichting OPC, 2009)

» **Fare problems**: Users are also dissatisfied with the fares of public transport. PT users consistently indicate fares as a problem for public transport. A common complaint is that public transport is too expensive (Rijkswaterstaat, 2007; KpVV, 2008). According to ROVER users are faced with different fare structures throughout concession regions that are not always attractive for the travelers.

» **Information problems:** Passengers are subject to false information on web sites, stations, and from personnel. Information scores low in every research that has investigated this issue (Stichting-OPC, 2009; KpVV, 2008), and indicated as top concern of non-riders (Ceder, 2007).

Of these problems, information, fare, transfer, and availability problems are the most consistently signalized problems. The above mentioned problems of the public transport product in combination with a bad reputation lead to a bad image of public transport according to the KiM (2009) and ROVER. The poor reputation is a consequence of poor public relations and advertising strategies. The bad image leads to a reduction of travelers according to ROVER (*Figure 2.19*). ROVER indicates a good image of public transport as a need of the traveler. Thus the image of public transport is a function of the demand for PT, supply/performance of PT, PT information, and social/administrative contexts.

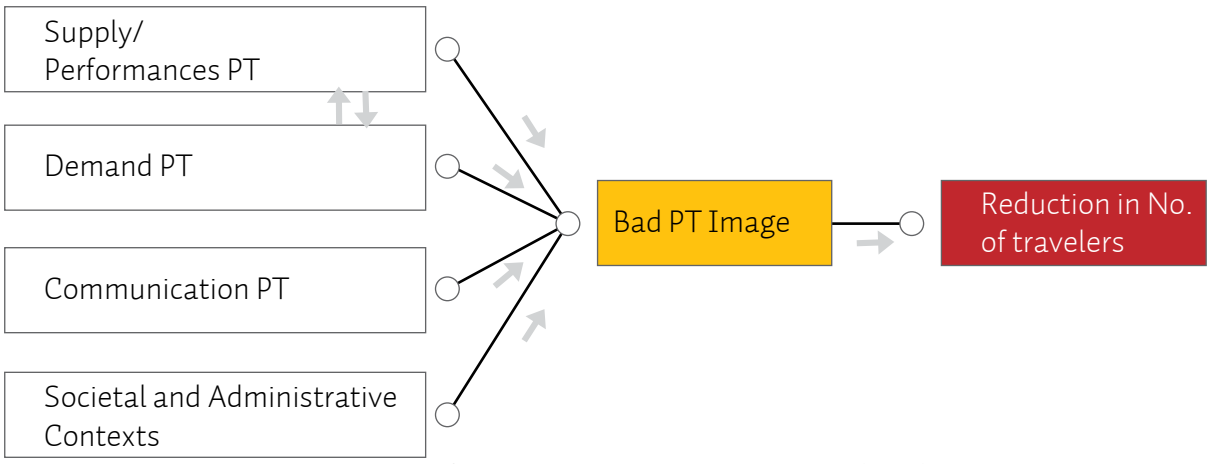


Figure 2.19: Causes reduction in number of travelers based on ROVER and KiM (2009)

The image of public transport depends on some issues which cannot be influenced by public transport. One of those is demographic changes, which falls under societal and administrative contexts. Bus operators continue to rely on key groups such as non-car owners, young people and elderly people for the bulk of their patronage. The fact is that these groups are in decline. The number of households without a car is decreasing every year, and on average each household which buys a car reduces its use of bus services by approximately 60% (Balcombe, et al., 2004).The number of young people in the country is falling, amongst the elderly two factors seem to play a role: firstly, the proportion of elderly people who have a car is rising, and secondly the volume of travel by the elderly people is falling. In short, the industry's core markets are reducing in size steadily and there is a risk that they will be too small to support commercially viable services in all but a very few areas. The bus operators in the Netherlands rely heavily on government subsidies, which cover approximately 50% of their costs (Goudappel Coffeng, 2008). Nevertheless, the industry needs to maintain and increase its revenue in order to fund existing levels of service, and invest in the future: the result is a continuing spiral of increasing fares. This leads to the vicious circle that can be seen in *Figure 2.13* (TAS Passenger Transport Publications, 2007).

It is important to note that regional bus transport is considered to be transport between at least two agglomerations. This means that bus lines are not always in urban/densely populated areas. Public transport functions at its best when in dense areas, so traditionally regional bus lines are bus lines that experience low ridership levels more often. This means that these lines face specific forms of problems more often, which are explained in *Table 2.2*.

Table 2.2: Relationship between agglomeration size and the severity (High- Medium-Low) of typical public transport problems (Ministerie van Verkeer en Waterstaat- DGP, 2007).

Problem		Agglomeration size			
		Small (14.000-50.000)	Small-Medium (50.000-100.000)	Medium-Large (100.000-300.000)	Large (300.000+)
	Throughput	L	L	M	H
	Node availability	M	M	M	L
	Transfers	H	H	M	L
	Travel Demand	H	H	M	L
	Seat availability	L	L	M	H

Summary

The use of public transport use has declined in terms of the number of passengers (not everywhere), number of passenger kilometers, and passenger trips. This can be attributed to a decline in the number of buses, the number of bus stops. This confirms the presence of the vicious circle that was indicated in the introduction of the performances section. But there are also other developments which have an

influence on the decline of the use of public transport. Low travel demand and poor transfers are traditional problems of regional public transport since the bus lines traditionally operate with a connecting function i.e. they connect different concentrations with each other. These problems are accelerated by the traditional focus of bus operators on groups of travelers that are becoming smaller. Besides this, research has shown that users desire more frequent service, more attractive fares, better information/ communication, better reliability, and image of public transport.

2.4.2 Case Study

This section contains an analysis of public transport and its users in a non-fictive case. This case focuses on a region in the Netherlands of which the name cannot be revealed due to confidentiality obligations. The section will explain the characteristics of the users of the transport system in general, followed by an analysis of the performances of the regional bus lines in the region(s), after which conclusions will be drawn about measures that have been taken in this region. This case study is performed based on a confidential bus line research of a transport company

Users

More than 90% of the regional bus lines users are from the category CBE. However, 86% of the CBE users of these bus lines have an educational purpose. This means that commuters and recreationist are not attracted by the regional bus lines in this case area. Besides this, it can be noted that 53% of the PT users are captives on average. An average of 42% of the users transfer to another mode after their trip with the regional bus line, which means that these users did not reach their final destination with the regional bus lines in this case .

Performances

The performances in the area can be measured by analyzing the number of passengers that use the regional bus lines. The exact number of passenger per bus line is not available. But there is information on the average occupancy of the buses for an average working day. This data is available from the year 2000 thru 2008 for the bus lines 1-11. In recent years changes have been made to the quality of the service by applying an effective paint scheme and by improving information provision at bus stops.

Figure 2.20 shows the development of the average occupation in the last years. The figure shows a general trend of increasing occupancy, even though not all lines show an increasing trend. It is interesting to see the measures that have been taken and the effect that this has had on the occupancy. For this purpose three lines will be selected: 2, 5, and 7.

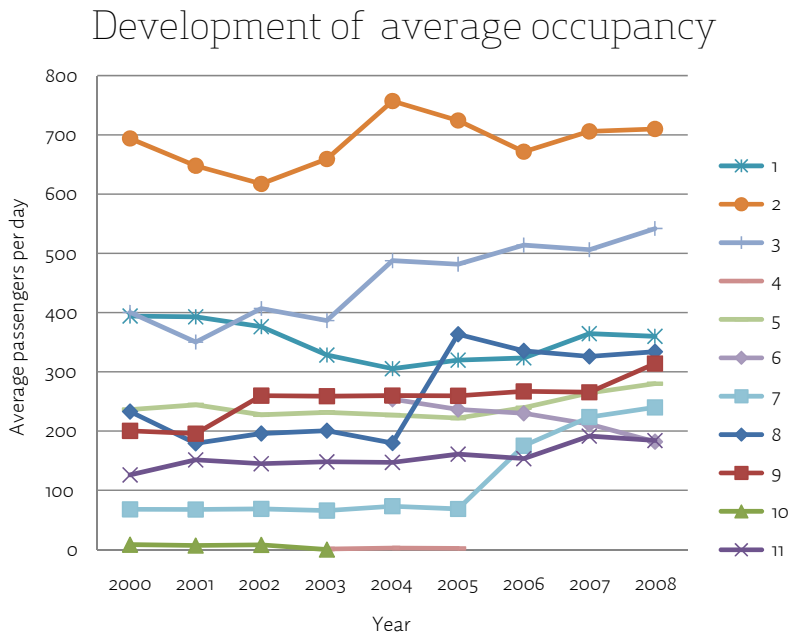


Figure 2.20: Development of the average occupancy between 2000 and 2008

Line 2 runs from a large city (>150.000 inhabitants) and has a higher frequency. This may be the reason why this line has a higher average occupancy. The route of this line is relatively direct, which means that the travel times on this line are smaller than the other lines. *Table 2.3* shows the journey durations from start to finish of each line. This table does not say anything about the duration of the trips for passengers, but gives an indication on the possible duration of these trips.

Table 2.3: Total trip duration of selected bus lines

Bus line		Total trip duration
	2	29 minutes
	5	86 minutes
	7	43 minutes

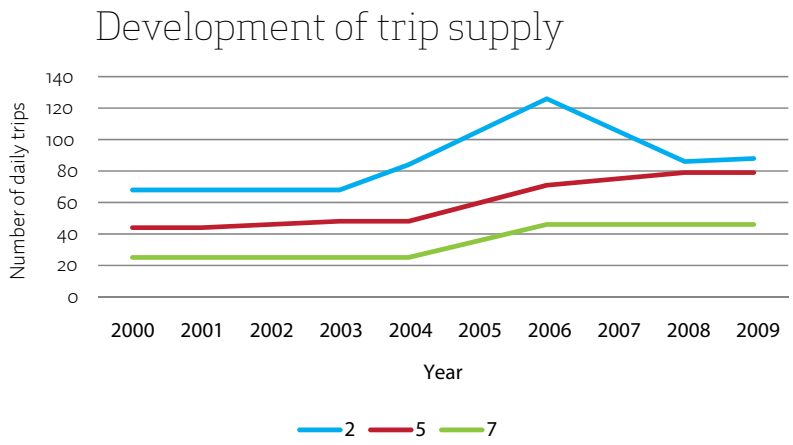


Figure 2.21: Development of trip supply on lines 2, 5 and 7

Access and Egress Trips

Figure 2.22 shows the access and egress modes for the lines 5, 7, 8-11. The figure shows that walking is predominantly used for access and egress trips. There are also a lot of captives in the buses (53%); this may extend the distance that travelers are willing to walk to a bus stop. The figure shows that walking is the most important way for passengers to access and egress.

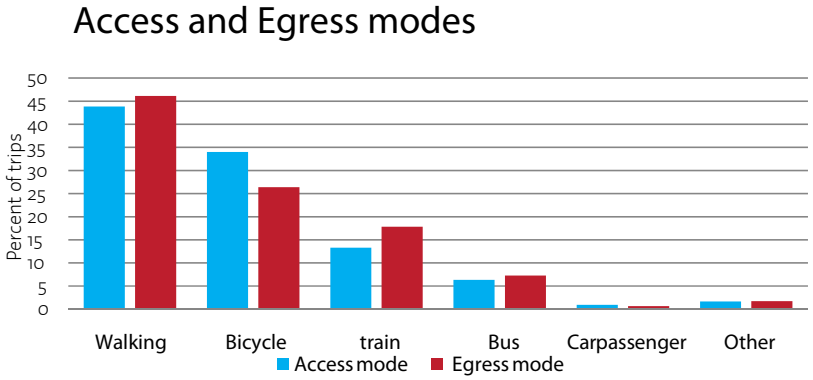


Figure 2.22 Access and egress modes

The bus line research of the transport company also asks passengers to comment on the bus lines. For the bus lines 8, 9, and 11 this yielded the results that can be seen *Figure 2.23*. This figure shows that users desire operational improvements the most: They would like better connections, more punctual service, and higher frequencies. It is important to note that these desired improvements only regard the current users, and not all potential users.

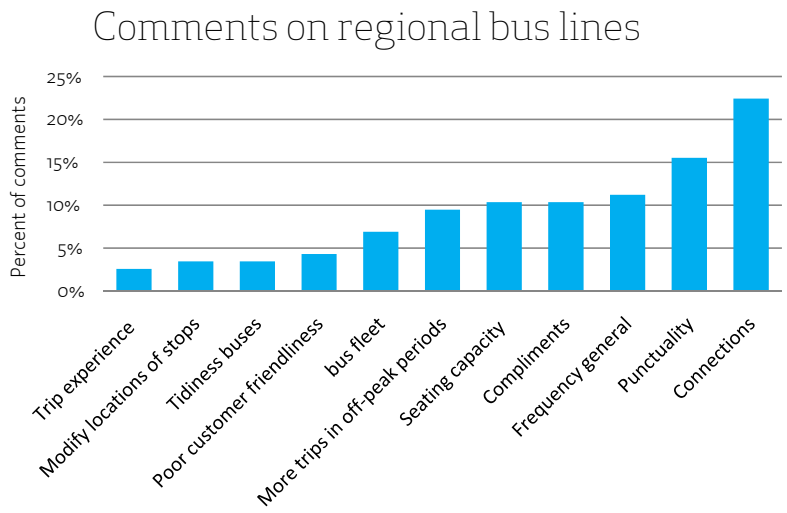


Figure 2.23: Comments on regional bus lines in the case study

Transfer

Transfers are important in regional bus lines because these bus lines connect agglomerations with each other and do not travel much into these population centers. A bus line research of a transport company indicates connections as e problem: 22% of the comments given are related to connections between different bus alternatives or between busses and trains.

Conclusions case study

The regional bus lines in the case are experiencing increased occupancy. This improvement is caused by an increased trip supply, provision of information in buses and the effective use of paint schemes. Improvements can still be made by improving reliability and availability of the services. 77% of the users in this case have an educational trip purpose. This means that either the origins and destinations that are connected by this service are not attractive for other groups, or that the service for these OD-combinations is not of the desired quality. This however does not have to be a problem if the buses are full. Furthermore, 53% of the users are captives. The higher this percentage of captives, the less attractive the bus line for travelers. This probably means that there are problems with the quality of the service (dissatisfiers) or that the OD-pair is not interesting for traveler. Finally, 42% of the users transfer to another mode after alighting. This means that for a lot of users these bus lines are only a portion of a larger chain of trips which does not have the regional bus line as the main trip element.

2.5 Results and Conclusions

In this chapter the users of regional bus lines have been defined, the needs of the users have been identified and the actual and perceived performances of regional bus lines have been analyzed. In this section the results of the analysis of the regional bus system are analyzed, and then the conclusions are drawn.

Results

The results of this chapter form a framework for the design of measures that is carried out in chapter 3.

Table 2.4: Participation and sensitivity of user groups

User Group (motives)	Participation (National) 2007	Participation (Case) 2007	PT Participation (national)	PT Participation (Case)	Sensitivity for improvement
	%trips	%trips	% All Trips	% All Trips	H-M-L
CBE	29	23	4.5	0.54	H
Visit/Stay over	15	14	2.2	0.27	L
Recreation	35	46	0.95	0.00	H
Shopping/groceries	22	17	2.99	0.27	H

Table 2.4 indicates that the CBE and Recreation segments show the largest potential for growth since the groups are substantially larger and are more sensitive to improvement than other groups. Besides this, the selected area knows a relatively low overall percentage of public transport use in terms of number of trips.

Table 2.5: Participation of social groups

Social group	Participation	PT participation	CBE	Recreation
	% trips	% of trips	% of trips	% of trips
Persons < age 6	0	1.8	11	11
Working: less than 30 hours a week	35	6.7	22	14
Working: 30 or more hours a week	50	7.7	31	10
Unemployed or seeking employment	3	6.2	2	12
Student/pupils	6	12.7	28	11
Works at home	3	3.8	2	14
Retired	1	4.2	1	13
Disabled	3	5.7	2	15

In order to know what social group to focus on, it is of interest to know what the participation of the different social groups is in transportation in general and in public transport. Since the motives CBE and Recreation have a larger share, it is interesting to know which social groups perform these trips the most. *Table 2.5* shows that the non-at home- working people account for 53% of the trips. Together with the students and pupils, this group account for 81% of the trips. Pupils/students are well represented among the current users of public transport, so these are the current users that must be maintained. The users that must be attracted are the working social group. This chapter has revealed that the participation of these groups in traffic and transport stable to slightly growing. The average PT participation of these groups on the other hand is only 7.2%. Persons that are working less than 30 or 30 or more hours a week and students/pupils have a considerable share of the CBE trips, while all groups have a relatively equal share in recreational trips. In short, CBE and recreational users can be targeted by focusing on working people that do not work at home, students, and pupils.

The question is what these groups need in terms of improvement. These needs have been determined based on the assessment of the current actual and perceived performances. The items that require improvement have been summarized along with their relative importance. The result can be seen in *Table 2.6*.

Table 2.6: Relative importance of aspects to user groups

User Group		CBE (H-M-L)	Recreation (H-M-L)	Total
Category	Aspect			
Safety	Safety	M	M	M
Reliability	Reliability	H	M	M-H
Ease	Information	H	H	H
	Directness	M	H	M-H
	Attractive fares	M	H	M-H
Comfort	Comfort	L	H	M
Experience		M	H	M-H
Speed	Access/Egress trips	M	L	M-L
	Activity-service temporal coherence	H	L	M
	Travel time	H	M	M-H
	Reputation	H	L	M

Conclusions

The most potential travelers are people that travel with the motives commuting, business, education, and recreation. These types of trips are made the most often by working people (excluding those that work at home), pupils and students. They have the most potential since they participate more in the traffic system and because they can be persuaded to use regional bus transport with the least effort.

The number of trips, number of trips kilometers, and the number of passengers are declining in regional bus lines. This does not occur everywhere, in some regions there are steep declines visible and in other regions there are gains visible. Nevertheless, the overall picture is that there is a decline visible. This is caused by a number of factors: Societal developments like individualism lead to an increased car possession, which reduces the use of public transport. As a consequence, transport companies decrease their supply in terms of trips and served bus stops. This makes regional bus lines more unattractive since access and egress trips become longer. Besides this the sector has failed to take steps to convert regional bus transport into a more commercial sector with a focus on the needs of the most potential travelers.

These travelers have the highest need for a fast and reliable door-to-door trip, attractive fares, high quality of information and a good/positive reputation of public transport.

3. The Measures

This chapter consists of two sections on the design of measures and a selection of the top 10 measures based on the framework that has been provided in the conclusions of the previous chapter.

3.1 Design of Measures

The framework of in section 2.5 indicates a number of aspects that need to be improved. These aspects will serve as categories for the design of measures. There are a number of categories in which the measures can be designed:

- Safety
- Reliability
- Information provision
- Directness
- Attractive fares
- Comfort
- Egress trips
- Activity-service temporal coherence
- Travel time
- Reputation of public transport

The measures that are designed in this chapter are mainly focused on the category that they belong to. Components of other categories may be necessary in order for the measure to work in practice. Communication is always necessary to get the most of an operational measure. On the other hand, only communication will not solve operational problems (see *Figure 2.11*). A gross list of measures has been generated leading to a total of 28 measures. These measures can be seen in section I of appendix B.

3.2 Selection of Measures

The number of measures to be selected does not have to be too much on the one hand, since evaluating a higher number of measures in a qualitative analysis leads to a result of lower quality. On the other hand, one would like to evaluate as much measures as possible in the qualitative analysis in order to get an idea how the respondents rate the measures. This is why 10 measures will be selected and will go through the evaluation process in the following chapters. The evaluation criteria for the selection of the top ten measures are the same criteria that are used for qualitative evaluation in the Delphi method: desirability, feasibility, importance and confidence. The Delphi method is an expert based qualitative evaluation method. For a detailed description of these criteria, see section I of appendix C. Desirability, importance and confidence are segment specific criteria. This is why the measures have been rated on these criteria looking from each potential group: CBE and Recreation. A score is awarded to the measure on each criterion on a four point scale where 1 represents a low score and 4 represents a high score. A unipolar positive scale is used here since the measures will not be rated as having a negative effect. If this was possible the measure should not have been designed. This ultimately gives measures with a comparable total score. The final score of a measure is the summation of all scores from all points of view. The result of the scoring can be seen in section II of appendix B. The top ten measures are measures of the categories reliability, travel time, information provision, access and egress trips, attractive fares, and reputation of public transport. The selected measures can be seen in the sections below.

3.2.1 Reliability/Travel Time

Three measures have been selected in the category of reliability and travel time. The first measure that has been selected in the category of reliability/travel time is the provision of transfer guarantees.

Providing transfer guarantees entails that public transport operators guarantee transfers for a certain time interval (e.g. 5 minutes). This involves transfers between trains and buses as well as transfers between conventional buses and small scale initiatives like the 'neighborhood bus' (buurtbus in Dutch). In the latter, the regional bus is to be considered the backbone of the system. Intelligent Transport Systems can be used to track the location of the vehicles to:

» determine if the vehicle has already arrived
» If the passengers have had sufficient time to transfer,
» When the arriving vehicle can be expected
» If waiting has an effect on the feasibility of the schedule

The other two measures that have been selected in the category of reliability/travel time are measures to improve on time performance. On time performance can be offered by:

» **Using express services** in peak hours, and using express stops. These express stops are upgraded regular stops where there are possibilities to rent PT-bikes or to put private bikes in storage. This eventually makes it possible to use peak hour routes, also shortening the travel time.
» **Providing the drivers with incentives for their on-time performance.** Buses are only given priority at intersections if they are on time or if they are delayed. This can be determined with the IVU system (IVU Traffic Technologies AG, 2009) or a similar system. Early departure often has a bigger impact than late departure, which is why the priority is given conditionally. Drivers that perform exceptionally well will be rewarded with a bonus either monthly or annually. The on-time performance of drivers is tracked with the IVU system.

3.2.2 Access and Egress Trips

The measure that was selected in the category of access and egress trips was the provision of innovative alternatives access/egress modes:

» **PT-bike alternatives** should be made more available. This increases the willingness of the travelers to take regional public transport since they have faster egress trips i.e. can cover a longer distance in the same time interval. The use of PT-bike could (optionally) be sponsored by the PT operator. Travelers should be able to pay with the OV-chip card for the use of the PT-bike.
» **The Region Taxi** can also be used for deeper penetration of scarcely populated areas. Payment of the Region Taxi should also be incorporated in the OV-chip card scheme.

3.2.3 Information Provision

Two measures were provided to improve information provision, of which the first is information prior to departure. There are a number of ways that information can be provided prior to departure. First of all, transit operators should develop relationships with realtors in order for them to provide (not upon request but always) their clients with transit information in their soon to be living areas. Mode choice decisions are long term decisions, which correspond with a number of things including living location, proximity to work, and occupation. Besides this, users should be able to seek information through every widely used communication channel. This means that real time departure times and schedule information should be available through:

» **Mobile Phone:** Nowadays applications can be downloaded on mobile devices. This means that public transport operators can offer downloadable software on the internet. GPS equipped telephones could also benefit from a PT-navigation system, where the user is actively guided through its use of public transport from prior to departure to the final destination i.e. not only pre-trip guidance.

» **Telephone line:** Riders should be able to dial a number and get information on their alternatives. This is already available.

» **Internet:** this communication channel offers the most opportunities, as more interactive graphic display methods can be used, where GIS can also be applied. This gives the traveler a clear view of how the trip can go.

» **Television:** Teletext can be used to offer on-demand information on the public transport alternatives in the area, where the information is displayed upon entry of postal codes/house number combinations. With the increasing use of digital television, more modern digital alternatives can also become available, like the MHEG-5 or DVB-MHP (superteletekst).

» **Internet:** Information by entry of their postal code and or address passengers can see the nearest bus stop location and real-time departure times, along with schedule information.

The second measure that was selected in the category of information provision is on-board information provision. In this measure real time information is be given in the bus. This should be information on

» **The next stop:** The name of the stop, the estimated time of arrival, and points of interests. Commercial companies can buy a "point-of-interest" as long as passengers are not overloaded with information.

» **Transfer locations:** These should be announced in a more detailed manner. Information should be given on transfer options including what the options are (if there are a lot of options time intervals should be used), how much the transfer time is (real-time) and optionally where the transfer locations are.

» News headlines can be provided through the on-board information displays.

3.2.4 Attractive Fares

Two measures were selected in the category of attractive fares of which the first one is using business-to-business strategies. In this measure transit companies sell discounted tailor made packages to employers, after which employers either provide the employees with the tickets or sell these tickets to these employees. Bus companies can provide ads in exchange for cheaper tickets. Transit Companies can also sell discounted tailor made packages to event organizers. This can be Included in the event tickets e.g. tickets to soccer matches.

The second measure that has been selected in this category is rewarding passenger for their use of PT. There are several ways to reward passengers for their use of PT:

» **A fare capping system** can be introduced. Fare capping limits the amount of money that an individual spends on public transport per time interval.

» **Loyalty programs** can be used: Passengers can earn miles for using PT. These miles can be used to for free travel in public transport, or they can be used to purchase a product outside the public transport sector.

3.2.5 Reputation of Public Transport

Three measures have been selected to improve the reputation of public transport. The first measure is the use of paint schemes. Buses should be made more attractive by:

» Giving the bus a paint scheme that is coherent with the area it is in,

» Giving the bus names of community/national heroes or celebrities and involve the community in naming the buses.

» Identifying buses with a green label, indicating the environmental friendliness of the bus vs. the car. The environment is becoming increasingly important for citizens.

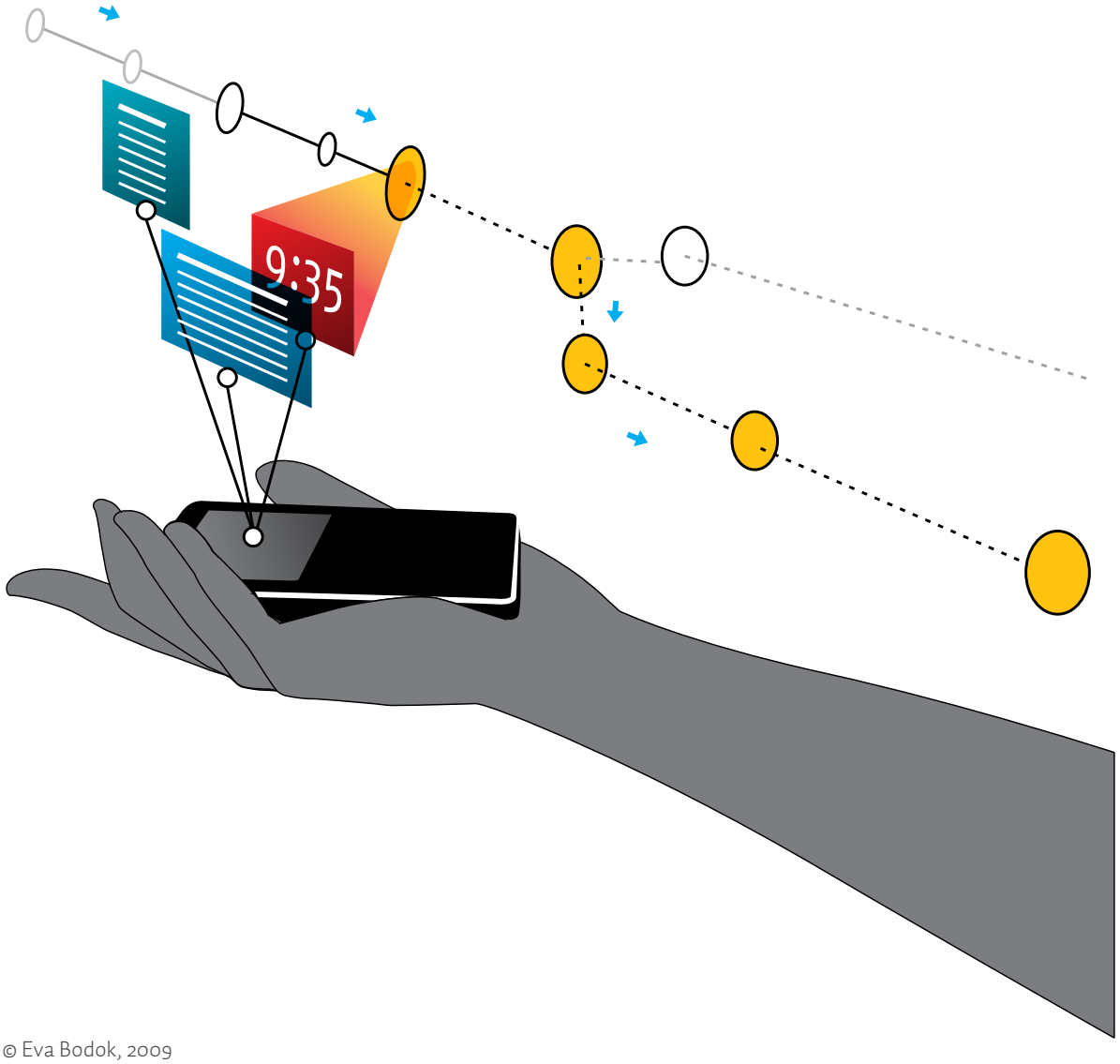
The second measure to improve the reputation of public transport is the improvement of costumer relations. This can be done by giving "pledge to our customers" to current and potential customers outlining a number of benefits of public transport. Listening to riders/non-riders for service improvements via community meetings, and give personnel courses on customer relations. Maintain relationship with current/potential customers.

The last measure to improve the reputation of public transport is by improving relationships with the media. This can be done by:

» Relations need to be developed with news media, to feed them with positive PT news (free publicity).

» Public transport companies should sponsor community events, and provide transport to these events (their form of sponsoring).

» Cooperate with tourist offices for transport to regional areas, tourist areas.



4. Expert Based Evaluation

It is often not practically feasible to implement 10 measures. Only the measures that are believed to be effective and efficient are implemented. It is also a heavy task to quantify the effects of all the measures, which is why the selection of measures is carried out based on a qualitative assessment prior to the quantitative assessment. In the ideal situation, a stated preference survey is performed under the most potential users. This requires significant time temporal and monetary investments to identify these users, to locate them, and to get enough response. This is why the opinion of experts will be sought. Significantly fewer participants are required, which significantly reduces the monetary and temporal pressure. Experts can say something based on their experiences and knowledge, which in most cases is not true for the potential users. The objective of this qualitative assessment is to get an impression of what experts think about the measures that have been designed in chapter 3, if experts of different sectors have the same opinion, and if they can agree with each other on these measures. Agreement amongst experts of the different sectors is important since this indicates a higher feasibility of the measures, but is not top priority in this qualitative evaluation. The ultimate objective is to get a definitive set of measures that have the highest sector-wide support.

In within the available temporal and financial constraint, only experts from the three sectors of public transport are available:

» PT authorities
» Travelers
» Bus operators

Besides this, the opinion of experts at consultancies and educational institutes can also be sought. This means that the expertise of scientists, consultants, passenger representatives, transport experts can be sought.

4.1 Qualitative Evaluation Methods

To be able to perform qualitative analysis of the measures that have been designed, literature research must be carried out on qualitative research methods. The following research methods have been identified as applicable as a result of a short literature research: Depth interviews, focus groups and Delphi methods. Goal of the qualitative evaluation is to determine the applicability of the measures in practice. An assessment of these methods can be found in section I of appendix C.

4.1.1 Selection

There are a number of constraints that have to be taken into consideration for the selection of the expert based evaluation method. First of all, there is a limited time span to perform the research. Secondly, financial resources are limited. Third, the research is classified and a group discussion could compromise this. Fourth, the results of the research must be clearly interpretable. Fifth, the heterogeneity of the participants must be preserved to assure validity of the results.

Table 4.1 summarizes the assessment of the qualitative evaluation method. The table indicates that the Delphi method fits better within the constraints, which is why the Delphi method is selected to quantitatively evaluate the measures.

Table 4.1: Applicability of the evaluation method

Constraint	Time Consuming	Costly	Compromises classified nature	Clear research results	Homogeneity
Depth interview	Yes	Yes	No	Not always	No
Focus group	Yes	No	Yes	No	No
Delphi method	No	No	No	Not always	No

4.2 The Policy Delphi

Out of the three Delphi methods, the policy Delphi has also been chosen since this type of Delphi can be used to establish all the differing positions advocated and the principle pro and con arguments for these positions (Florida International University, 2006). This can later be used to improve the measures and to indicate the best measures. The Policy Delphi contains six phases(Linstone & Turoff, 2002):

» **Formulation of the issue:** What is the issue that really should be under consideration? How should it be stated?

» **Exposing the options:** Given the issue, what are the policy options available?

» **Determining initial positions on the issues:** Which are the ones everyone already agrees upon and which are the unimportant ones to be discarded?

» **Exploring and obtaining the reasons for disagreements:** What underlying assumptions, views or facts are being used by the individuals to support their respective positions?

» **Evaluating the underlying reasons:** How does the group vies the separate arguments used to defend various positions and how do they compare to one another on a relative basis?

» **Reevaluating the options:** Reevaluation is based upon the views of the underlying "evidence" and the assessment of its relevance to each position taken.

This process would require five rounds in a paper-and-pencil Delphi procedure. In practice most Delphis on policy try to maintain a three- or four- round limit by utilizing the following procedures(Linstone & Turoff, 2002):

» The monitor team devoting a considerable amount of time to carefully pre-formulating the obvious issues;

» Seeding the list with an initial range of options but allowing for the respondents to add to the lists;

» Asking for positions on an item and underlying assumptions in the first round.

On the resolutions to a policy issue it is usually necessary to assess both desirability and feasibility. A policy Delphi in general has the following structure(Linstone & Turoff, 2002):

» **Desirability:** Respondents are asked to indicate the desirability of the policy from the perspective of the target group on a four point scale;

» **Feasibility:** Respondents are asked to indicate the practicality of the policy on a four point scale;

» **Importance:** Respondents are asked to rate the importance of the measure for the success of the policy on a four point scale;

» **Confidence:** Respondents are asked to indicate the amount of certainty they have in the effectiveness of the policy on a four point scale.

A more detailed description can be found in section II of appendix C.

4.2.1. Questionnaire Design

The first step in the design of the questionnaire is to determine what the goal is of the questionnaire. The goal of the questionnaire is to get an idea on what the most effective and efficient measures are within the set of measures that has been selected in the previous chapter. The questionnaire will also determine the extent in which the different sectors agree with each other, and what their reaction is when they are presented with the opinion of representatives of other sectors. This leads to the following research question: What are 2 the most effective and efficient measures that can be applied to improve ridership levels among the most potential groups and is there a consensus across different sectors of public transport?

Since this questionnaire is part of a Delphi method, the questionnaire needs to be performed by paper or electronically i.e. there should be no personal interactions when the questionnaires are filled in. The respondents also must be selected carefully based on the following expertise criteria (Skulmoski, Hartman, & Krahn, 2007):

» Knowledge and experience with the issues under investigation;
» Capacity and willingness to participate;
» Sufficient time to participate in the Delphi;
» Effective communication skills.

Since the participants of the Delphi need to be informed, a large amount of background information needs to be supplied. This is why the decision has been made to give standardized background information by phone to prevent different levels of information provision as much as possible. After background information has been provided, the first round questionnaire will be distributed by e-mail. The questionnaire will be carried out digitally in order to minimize turn-around time. Snap survey software has been used to design the user interface. Thus the questionnaire is equal for all the respondents. After this questionnaire has been distributed, the results will be processed and the second round questionnaire will be designed. In this round each sector will be presented with views of the own sector, along the views of the other sectors. This also includes suggestions for improvement of the measures according to the recommendations of the experts. The results of the second round will lead to a selection of the top two measures, which will be used in the quantitative analysis that will quantify the number of travelers that will be generated by each measure. In short, the Delphi procedure will be as follows:

» Decide on sample;
» Provision of background information by e-mail;
» Design and distribution of the first round questionnaire;
» Revision of measures;
» Design and distribution of the second round questionnaires;
» Revision and selection of measures.

4.3 Round 1 Preparations

As mentioned in the previous section, one of the first steps is determining the desired sample population. Each sector must be more or less equally represented in the sample in order to gather as much opposing views as possible. After a selection of participants, background information has been provided to the participants of the Delphi procedure (see appendix C.III-IV). The background information is twofold: background information is provided verbally through telephone conversations and a PDF document will be distributed among the respondents to assist them with filling out the questionnaire. To shorten the length of the questionnaire, measures and categories have been grouped. This resulted in 4 categories and 8 corresponding measures. A pilot test has been carried out to filter out errors in the questionnaire. This resulted in the modification of the confidence criterion into impact; this is easier to interpret for the respondents. The result is the questionnaire that is visible in section V of appendix C.

4.4 Round 1 Results

This section contains the results of the first round of the Delphi procedure. The results will be summarized by category. The response rate is 71%, which is quite high. This was to be expected since personal contact has been established with the respondents prior to issuing the questionnaire. *Table 4.2* shows the number of respondents per sector.

Table 4.2: Round 1 response

Sector	Retrieved number of Respondents	Expected
Transport Authority	3	5
Transport Company	2	3
Travelers' Association	3	4
Consultancy	2	2
Total	10	14

4.4.1 General Results

The rating R of respondent i is calculated as follows (eq.1):

$$R_i = \frac{\alpha_1 \cdot D_i + \alpha_2 \cdot F_i + \alpha_3 \cdot I_i + \alpha_4 \cdot E_i}{0.2 \cdot \sum_{k=1}^{4} \alpha_k}$$

Where:
D is the desirability of a measure by respondent i
F is the feasibility of a measure by respondent i
I is the importance of a measure by respondent i
E is the impact of a measure by respondent i
α_k is the k-th weight coefficient

The rating of a measure is calculated as follows (eq.2):

$$RM = \frac{\sum_{i=1}^{N} R_i}{N}$$

Where:
RM is the rating of a measure
N is the total number of respondents
R is the rating of respondent i.

The rating for each category can be calculated as follows (eq.3):

$$RC = \frac{1}{M - A + 1} \cdot \sum_{j=A}^{M} \frac{\sum_{i=1}^{N} R_{ij}}{N_j}$$

Where:
RC is the rating of the category
A is the number of the first question j within a category
M is the number of the last question j within a category
N is the total number of respondents
R is the rating of respondent i

The above mentioned calculation methods make it possible to compare the ratings of measures to that of categories, and compare the ratings of subsequent rounds. This is possible since all ratings are on a scale between -10 and 10.

The assumption is made that desirability, feasibility, impact, and importance do not have the same weight. The measures should be weighted according to their relative importance. The most important criteria of efficiency are impact and feasibility. Feasibility is related to the effort required to implement the measure while impact is related to the result of the measure. The desirability is a measure of how much travelers want the measure, which also determines how fast the measure will be accepted by the

target group and thus how fast results of the measure can be seen. Importance is a measure of how important the measure is for the PT- sector. This can indicate the level of political resistance that a measure can generate. Thus, effect is the most important criterion, followed by feasibility, desirability and importance. The criteria will be given weights that are proportional to the priority of each criterion. The result can be seen in *Table 4.3*.

Table 4.3: Priority of the criteria and their corresponding weight

Criterion	Priority	Weight α
Desirability	3	2
Feasibility	2	3
Importance	4	1
Effect	1	4

Given the weights in *Table 4.3*, equations 2 and 3 yield *Table 4.4*. Different priorities have also been assigned to the criteria, but these did not yield significant differences i.e. the top ranked measures remain top ranked. If the measures are conditionally ranked e.g. measures must be feasible or have an effect into a certain extent, availability of information and express services remain the top ranked measures. The only way that this changes is by using disproportional weights i.e. zeros or large values.

Table 4.4: Overall rating of categories and measures

Category	Category rating	Measure	Measure rating	Rank
Reliability/ Travel Time	5.9	Transfer Guarantees	5.6	4
		Express services	6.1	2
Information Provision	6.1	Availability of information	6.7	1
		Onboard information	5.6	3
Attractive fares	5.0	Business 2 Business	5.3	6
		Rewarding passengers	4.8	8
Reputation of PT	5.1	Paint Scheme	5.3	5
		Media relations	4.9	7

It is very interesting to know the differences between the different sectors. *Table 4.5* shows the rating of the categories per sector and *Table 4.6* shows the ratings of the measures per sector, compared to the average ratings of the categories and the measures respectively. Chi-square tests have showed significant differences (p=0.95) between the average ratings of categories and the ratings of individual sectors of these categories. Chi-square tests have also showed significant differences (p=0.90) between the average ratings of measures and the ratings of individual sectors of these measures. *Table 4.5* and *Table 4.6* give a comparative overview these ratings.

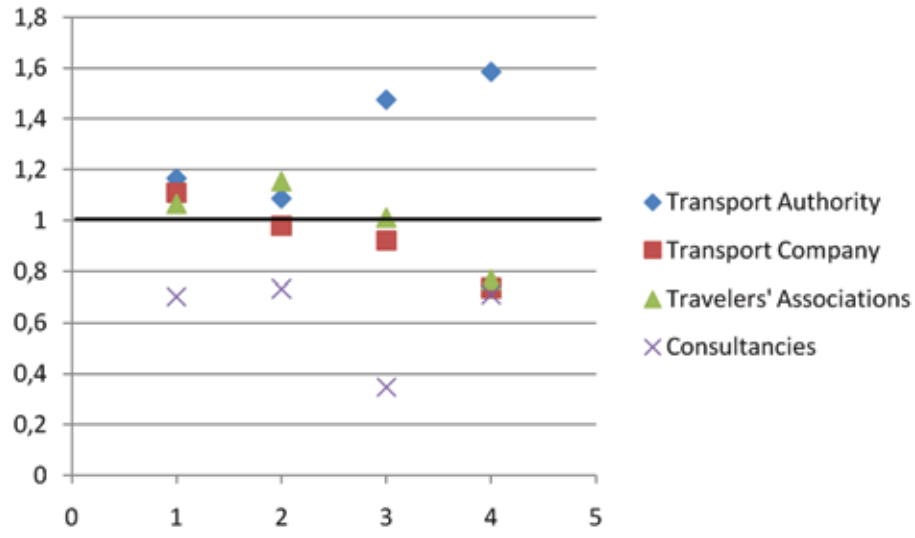
Table 4.5: Overall ratings of categories per sector

Category	Category rating	Transport Authority	Transport Company	Travelers' Associations	Consultancies
1.Reliability/ Travel Time	5.9	6.8	6.5	6.3	4.1
2.Information Provision	6.1	6.7	6.0	7.1	4.5
3.Attractive fares	5.0	7.4	4.6	5.1	1.8
4.Reputation of PT	5.1	8.1	3.8	3.9	3.6

Table 4.6: Overall rating of measures per sector

Measure	Measure rating	Transport Authority	Transport company	Travelers' Associations	Consultancies
1.Transfer Guarantees	5.6	7.3	5.5	4.5	4.8
2.Express services	6.1	6.3	7.5	8.0	3.5
3.Availability of information	6.7	7.0	7.0	8.0	4.8
4.Onboard information	5.6	6.3	5.0	6.2	4.3
5.Business 2 Business	5.3	8.2	7.3	4.0	1.0
6.Rewarding passengers	4.8	6.7	2.0	6.2	2.5
7.Paint Scheme	5.3	8.8	2.5	5.2	3.0
8.Media relations	4.9	7.3	5.0	2.7	4.3

To indicate the polarity of the sectors, the average ratings have been considered as reference values and indices have been calculated for each sector. The results for categories and measures can be seen in *Figure 4.1* and *Figure 4.2* respectively. The numbers on the x-axes of *Figure 4.1* and *Figure 4.2* correspond with the numbers in *Table 4.5* and *Table 4.6* respectively. These figures show that consultancies and transport companies are the more skeptical sectors. The figures also show that as the measures



become more non-traditional, the transport companies and consultancies give lower ratings.

Figure 4.1: Polarity of sectors concerning categories (indices, reference= category average)

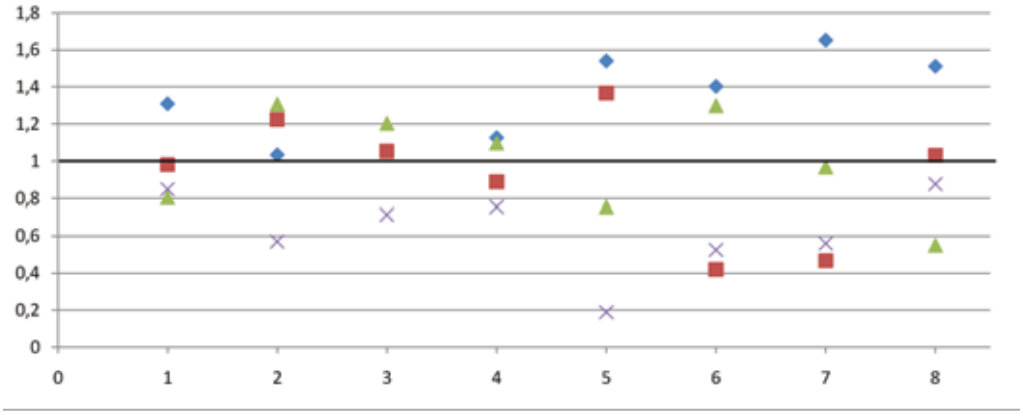


Figure 4.2: Polarity of sectors concerning measures (indices, reference= measure average)

Detailed results about the desirability, feasibility, importance, and impact can be found in section VI of appendix C.

4.5 Round 1 Conclusions

According to the rating of the respondents, availability of information, transfer guarantees and express services are the best 3 measures to be implemented. These measures have especially scored high on their desirability. Traditionally, reliability and speed increasing measures are the types of measures that are taken to increase ridership levels. These measures are also the measures that generated relatively more comments. In recent years, information provision also gained popularity.

The measures that have scored the lowest are rewarding passengers, paint schemes, media relations. These measures can be seen as the measures which are purely related to a more commercial behavior of the public transport sector. It is very interesting to see that transport authorities and travelers' associations give these measures positive ratings on the one hand, and transport companies give these measures a negative rating on importance and desirability. Consultancies do not entirely agree on the feasibility and desirability of the measures, but agree that the public transport sector does not see those types of measures as important. The negative rating by the transport companies may have to do with the fact that they are the ones that should have to do the spending to realize these measures. One transport company commented that the reputation is based on the work you perform, and attractive fares are not fares that cost less but are easy to pay/interpret. Transport authorities appear to be very fond of all measures, and are most fond of paint schemes.

4.6 Round 2

Now the results of round 1 are known, the questionnaire for the second round can be designed. In this questionnaire the respondents of the first round of the Delphi procedure have to see how the other sectors of PT have rated the measures, commented on the measures, and against the ratings of the sector that the respondent belongs to. Each sector assesses the ratings of the other sectors after which they are asked to re-assess the measure. This is repeated until all measures have been reevaluated.

4.7 Round 2 Preparations

The target population of the second round consists of 10 people, since only people that participated in the first round are asked to participate in the consequent rounds in Delphis. However, 13 people will be approached since it is not possible to distinguish people who did fill in the questionnaire from those who did not. One participant withdrew its participation via e-mail which is why the size of the Delphi group has diminished by 1 person. The questionnaire of the second round was given a similar structure as the questionnaire of the first round. In the second round the respondents are given the opportunity to:

» Analyze the results of the first round: Respondents should see their own answers and the answers of the other questionnaire (Linstone & Turoff, 2002). To guarantee the privacy of the respondents, the responses cannot be linked to a person. However, the respondents can be divided into sectors. Since there are at most 3 respondents per sector, the respondent will be able to see the impact of their personal assessment on the assessment of the sector.

» Read and react on the comments on the measures.

» Rate the suggestions that have been provided: To adequately evaluate the suggestions(Linstone & Turoff, 2002), they will be evaluated in the four dimensions that were used to rate the measures in the first round. The scale used in this section is different, since the respondents are asked to indicate the added value. Besides a positive added value and a negative added value, a suggestion can arguably have no added value. This is why a Linkert scale is used in this section.

» To rate the original measures again: Here the respondents are asked to answer the questions that have been provided in the first round again.

This has lead to a questionnaire that has almost twice the length of the questionnaire of the first round. This is a problem, since longer questionnaires take more time to fill out and consequently lead to a decrease in the number of completed questionnaires due to item non-response (Selm & Jankowski, 2006). To keep the questionnaire as short as possible, similar suggestions have been merged, and a small number of suggestions with low probability of acceptance have been excluded. This, however, is a dangerous game according to Lintsone & Turoff (2002) since participants may feel that they are participating in a biased exercise. This is not the case since suggestions of all groups have been presented, and most suggestions that have not been presented were presented as comments. This questionnaire has also been pilot tested prior to deployment and the final version can be found in section VII of appendix C.

4.8 Round 2 Results

This section contains the results of the second round of the Delphi procedure. The results will be summarized by category. The response rate is 46%, which is quite low compared to that of the first round. As was mentioned above, the probability that someone that did not fill in the questionnaire in the first round will fill the questionnaire in the second round is negligible. If the expected number of respondents is used to calculate the response rate instead, the response rate turns out to be 60%. The most important is that each sector is represented. As can be seen in *Table 4.7*, this is the case.

Table 4.7: Round 2 response

Sector	Retrieved	Approached	Expected
Transport Authority	2	4	3
Transport Company	2	3	2
Travelers' Association	1	4	3
Consultancy	1	2	2
Total	6	13	10

4.8.1 General Results

To be able to compare the results of the first round and the second round, along with a comparison between ratings of measures, categories and suggestions, the same methods are applied in this round as were applied in the first round. Thus eq.1 will be used to calculate the rating R of respondent i:

$$R_i = \frac{\alpha_1 \cdot D_i + \alpha_2 \cdot F_i + \alpha_3 \cdot I_i + \alpha_4 \cdot E_i}{0.2 \cdot \sum_{k=1}^{4} \alpha_k}$$

Eq. 2 will be used to calculate the rating of each measure and suggestion:

$$RM = \frac{\sum_{i=1}^{N} R_i}{N}$$

Eq.3 will be used to calculate the rating of each category:

$$RC = \frac{1}{M - A + 1} \cdot \sum_{j=A}^{M} \frac{\sum_{i=1}^{N} R_{ij}}{N_j}$$

This means that the ratings of this round are also on a scale between -10 and 10.

The same weights that were assigned in the first round will also be assigned in the second round. This means that that desirability, feasibility, impact, and importance do not have the same weight. The weights can be seen in *Table 4.3*.

Given the weights in *Table 4.3*, equations 2 and 3 yield *Table 4.8* for the second round. Assigning different priorities to different criteria or conditionally ranking the measures also does not yield a significant difference. As was the case in the first round, the only way that this changes is by using disproportional weights i.e. zeros or large values.

Table 4.8: Overall rating of categories and measures

Category	Category rating	Measure	Measure rating	Rank
Reliability/ Travel Time	6.4	Transfer Guarantees	7.3	1
		Express services	7.1	2
Information Provision	7.0	Availability of information	6.8	4
		Onboard information	6.7	5
Attractive fares	4.3	Business 2 Business	3.1	8
		Rewarding passengers	4.1	6
Reputation of PT	5.6	Paint Scheme	4.0	7
		Media relations	6.9	3

The weights in *Table 4.3* could also be used to calculate the scores of the suggestions using equations 1 and 2. This yields *Table 4.9*, which shows that throughput measures and information at stops are by far the best suggestions of the participants.

Table 4.9: Overall ratings of suggestions

Category	Suggestion	Suggestion rating	Rank
Reliability/ Travel Time	Throughput measures	8.6	1
	Evaluating schedules	4.9	3
	Extra personnel and vehicles	3.8	6
Information Provision	Information at stops	7.4	2
Attractive fares	Simple fares	4.7	5
Reputation of PT	Pro-PT campaign	5.9	4

It is very interesting to know the differences between the different sectors. *Table 4.10* shows the rating of the categories per sector and *Table 4.11* shows the ratings of the measures per sector, compared to the average ratings of the categories and the measures respectively. Chi-square tests have showed significant differences (p=0.90) between the average ratings of categories and the ratings of individual sectors of these categories. Chi-square tests have also showed significant differences (p=0.90) between the average ratings of measures and the ratings of individual sectors of these measures. The same holds for the average ratings of the suggestions of the participants and the ratings per sector. *Table 4.10*,

Table 4.11, and *Table 4.12* give a comparative overview these ratings.

Table 4.10: Overall ratings of categories per sector

Category	Category rating	Transport Authority	Transport Company	Travelers' Associations	Consultancies
1.Reliability/ Travel Time	6.4	7.6	3.9	7.3	6.2
2.Information Provision	7.0	8.2	5.2	8.2	6.7
3.Attractive fares	4.3	7.6	5.3	1.2	0.5
4.Reputation of PT	5.6	7.6	4.4	7.5	6.2

Table 4.11: Overall rating of measures per sector

Measure	Measure rating	Transport Authority	Transport company	Travelers' Associations	Consultancies
1.Transfer Guarantees	7.3	9.0	4.5	6.5	7.0
2.Express services	7.1	8.0	5.8	6.0	5.0
3.Availability of information	6.8	8.5	5.0	8.0	6.0
4.Onboard information	6.7	7.5	5.0	8.0	7.5
5.Business 2 Business	3.1	7.3	5.8	-8.5	1.0
6.Rewarding passengers	4.1	5.5	5.0	6.5	2.0
7.Paint Scheme	4.0	4.3	1.8	6.5	5.5
8.Media relations	6.9	6.5	6.5	8.0	7.5

Table 4.12: Rating of suggestions

Suggestion	Suggestion rating	Transport Authority	Transport company	Travelers' Associations	Consultancies
9.Throughput measures	8.6	9.0	6.8	10.0	10.0
10. Evaluating schedules	4.9	5.8	2.5	10.0	5.0
11. Additional personnel and vehicles	3.8	6.3	-0.3	4.0	4.0
12. Dynamic information at bus stops	7.4	8.5	5.5	8.5	6.5
13. Simple fares	4.7	10.0	5.0	5.0	-1.5
14.Pro-PT campaign	5.9	6.0	5.0	8.0	5.5

To indicate the polarity of the sectors, the average ratings have been considered as reference values and indices have been calculated for each sector. The results for categories, measures and suggestions can be seen in *Figure 4.3*, *Figure 4.4* and *Figure 4.5* respectively. The numbers on the x-axes of *Figure 4.3*, *Figure 4.4* and *Figure 4.5* correspond with the numbers in *Table 4.10* and *Tables 4.11-4.12* respectively. These figures show that consultancies and transport companies are the more skeptical sectors. The figures also show that as the measures become more non-traditional, the transport companies and consultancies give lower ratings.

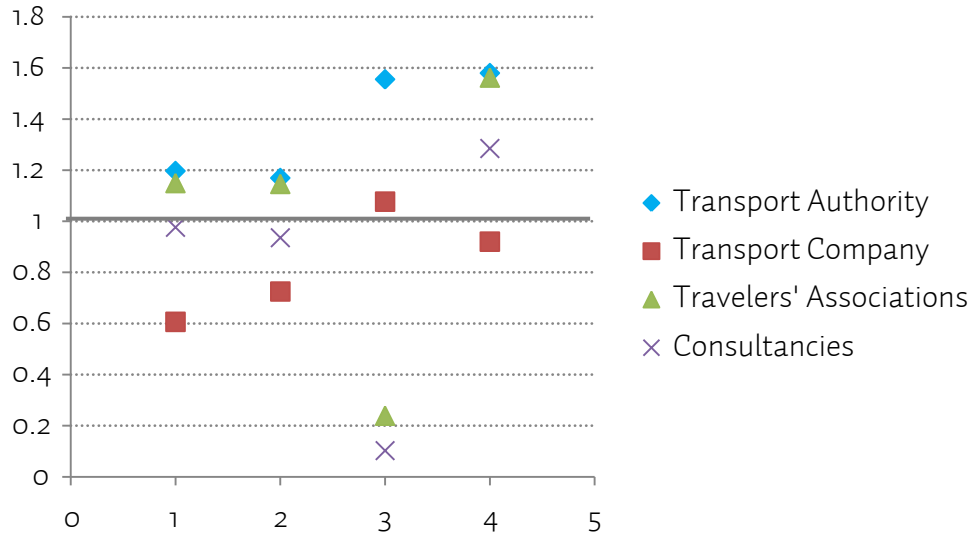


Figure 4.3: Polarity of sectors concerning categories (indices, reference= category average)

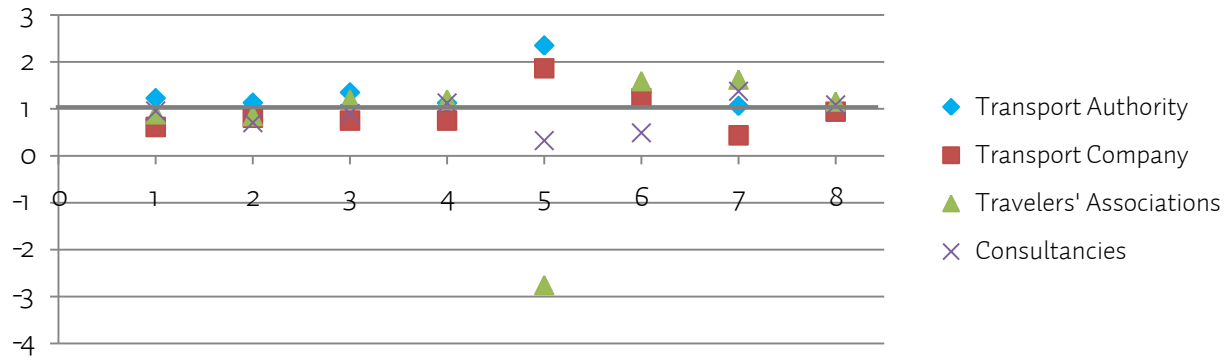


Figure 4.4: Polarity of sectors concerning measures (indices, reference= measure average)

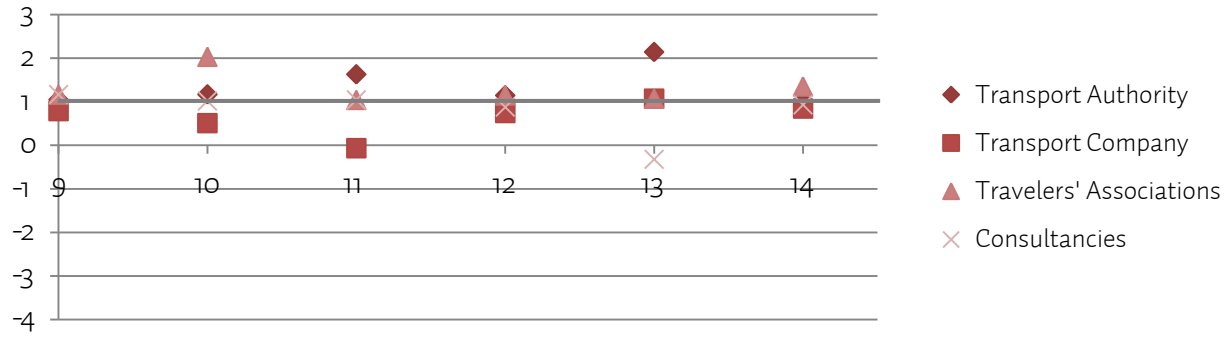


Figure 4.5: Polarity of the sectors concerning suggestions

How the respondents perceived the reliability, feasibility, importance and impact can be seen in detail in section VIII of appendix C.

The consensus can be measured by summing up the absolute differences between the indices and the reference value and dividing this by the total number of ratings. This consensus index (CI) has the following form:

$$CI = \frac{\sum_{n=1}^{Z} |I_n - 1|}{Z}$$

Where:
I is the index n
n is index number
Z is the last index number

There is perfect consensus is CI equals zero. A larger CI indicates a larger value. *Table 4.13* shows the consensus indices for the measures of round 1, round 2 and the suggestions. There is lower consensus in the second round than there was in the first round. On the other hand, the scores for the best measures were higher in the second round than they were in the first round. This means that the average score for the top measures has increased, as did the standard deviation.

Table 4.13: Consensus index

	Round 1 Measures	Round 2 Measures	Suggestions
CI	0.29	0.42	0.33

4.9 Conclusions Delphi Procedure

In general, the transport authorities give the measures a very positive rating; travelers' associations also give the measures a very positive rating but are a bit skeptical; transport companies and consultancies rate the measures slightly positive to slightly negative. *Table 4.14* shows a comparison between the first round results and the results of the second round (they can be compared directly). The results of the second round are significantly different from those of the first round. In the second round the transfer guarantees and express services are the measures with the highest potentials. There is lower consensus among the different parties in the second round than there was in the first round. This could be attributed to the extreme ratings of travelers' associations in the second round and/or less participants in the second round.

Table 4.14: Comparison measure ratings round 1 and 2

Measure	Round 1 rating	Round 1 rank	Round 2 rating	Round 2 rank
1.Transfer Guarantees	5.6	4	7.3	1
2.Express services	6.1	2	7.1	2
3.Availability of information	6.7	1	6.8	4
4.Onboard information	5.6	3	6.7	5
5.Business 2 Business	5.3	6	3.1	8
6.Rewarding passengers	4.8	8	4.1	6
7.Paint Scheme	5.3	5	4.0	7
8.Media relations	4.9	7	6.9	3

Ratings from the second round will be considered since in the second round the respondents have seen the ratings and comments of the other parties in the first round and they have had the opportunity to rate the measures once again with this in their mind. The most effective and efficient measures in this round are transfer guarantees and express services. Along with these two measures, the most effective and efficient suggestion in the category of the best measure will be taken into account when the measure needs to be quantified. Since both measures are in the category of reliability/travel time, the suggestion throughput measures will be included in both the express services and the transfer guarantee measures.

There is consensus among the transport authorities, travelers' associations and consultancies that transfer guarantees are very important. This measure is not that important for transport companies. In general, all the sectors agree that the measure will have a significant positive impact on the number of travelers. The express service measure is of some importance for all sectors, all sectors think that is

somewhat feasible, has some impact and the transport authorities and travelers' associations, transport authorities and transport companies think that the measure is very desirable. Consultancies think that this measure is somewhat desirable.

For what the suggestion throughput measures is concerned, there is consensus among all the sectors that throughput measures are a useful addition for the impact of the measures, importance, and desirability of the measures. Transport authorities and transport companies however are not that sure of the added feasibility of this suggestion.

The Delphi procedure gave interesting insights. Performing this method in a traditional manner can be very time consuming: It requires additional effort from both the participants and the researcher since forms need to be sent by mail between the researcher and the participants. This increases turnaround time and also increases the time required to process the results. Thus the electronic method proved to be very efficient. However, it must be kept in mind that the participants are still experts in their field and are generally quite busy. They must be given at least 3 weeks to fill in the questionnaire, and they must have the opportunity to save the results at one point in time and continue with the results at another time. The experts also need to be convinced that the results of the research are of value for them. Like it is the case with traditional questionnaires, during a Policy Delphi it remains necessary to carefully remind respondents to fill out the questionnaire. The Delphi definitely gives experts the opportunity to reveal their true opinions. These non-politicized opinions cannot always be displayed in consequent rounds without being edited, since this may lead to a shift of attention from the issues at stake to the other participating experts which compromises the effectiveness of the Delphi. Finally, one must keep in mind that to be able to say something scientifically sound about the acceptance of a particular measure by travelers in advance a survey must be conducted under potential travelers.

5. Ridership Impact Assessment

This chapter contains a ridership impact assessment of the measures that have been indicated as the most potential measures by the experts in the previous chapter: Express services, transfer guarantees, and throughput measures. These measures are focused on travel time and reliability, which are the highest needs of the potential groups according to the experts. These measures will be quantified by analyzing the impact on the number of travelers on a specific bus line S in the Netherlands. Due to the confidential nature of the data the exact location of this line cannot be revealed. This bus line is a typical bus line that operates at a frequency of two services per hour in peak hours and one service per hour in peak hours. The bus line is operated between two medium-sized towns called A and J in the Netherlands with a population between 50.000 and 100.000 (see *Figure 5.1*). Thus the goal of this chapter is to get an impression of the percentage of change in the number of travelers that express services, transfer guarantees and throughput measures bring about.

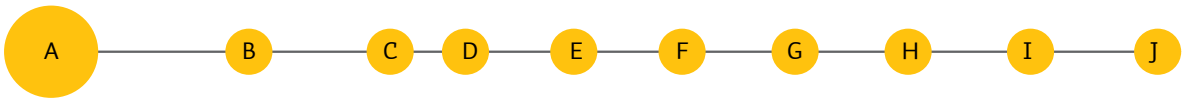


Figure 5.1: Schematic representation of bus line S.

5.1 Quantification Methods

There are several methods available to quantify effects of travel time and reliability. In this research the following will be considered: OV-lite, 4-step model, choice model, TTF model, and the application of travel time elasticities. A brief description of these models follows in the paragraphs below.

The OV-lite model is a model that has been developed by Goudappel Coffeng to assess the impacts of measures on a network level with little computation time. This model is built into the Omnitrans software package and calculates its impacts with travel time and cost elasticities. Components of the model are a PT origin-destination (OD) matrix, generalized costs, and a PT network. The input is a modification in the PT network, while the output is the change in number of travelers. Thus this modal is an uni-modal model, which is why its computation time is lower. The cost of this computation time is the accuracy of the model: this model should not be applied in cases where extreme modal shifts are expected. This model also requires cooperation of other persons which makes it somewhat costly.

The four step model consists of four steps: trip generation, trip distribution, modal split, and route assignment. In the first phase the trips ends are generated i.e. the number of trips from an origin and to a destination are determined. In the second step the trip ends are connected with each other. In the third step the distribution of trips among different modes is computed. The last step is used to assign traffic to the routes. The model is also of an iterative nature since interactions between the different steps are necessary. This model requires large amount of information on a network level, being multi-modal OD-matrices, generalized costs of links. This is why the computation time of this model is quite long, with quite accurate results. The model also requires significant cooperation of other persons which makes it costly.

In choice models the choices of individuals between alternatives are calculated based on the utilities for the individuals. The utility is composed of a number of attributes, their corresponding weights, and an alternative specific constant. The attributes consist of personal attributes e.g. age, gender or social group and alternative specific attributes e.g. time, cost, effort or comfort. The weights of these attributes are calculated by performing a revealed or stated preference survey. The probability of an individual choosing an alternative is derived by entering the utilities in the multinomial logit model (Bie, 2008). Performing a scientifically sound survey takes a considerable amount of time and requires some investments to get a good representation of the target group.

The TTF model computes the share of public transport as a function of the ratio between the generalized travel time of public transport and that of the car (Goeverden & Heuvel, 1993). Thus this model does not take other modes into account. For a detailed description of this model see chapter 2.The model is not suitable for use in cases where the TTF ratio is extremely high or low. In this case the TTF ratio is extremely high. The model is also calibrated on parameters of the year 1993.

The application of travel time elasticity is a method where the travel time gains are calculated in a specific case. These gains are then multiplied by the elasticity to get the change in the number of travelers. The travel time elasticity as calculated by Goudappel Coffeng is -0.5 (Goudappel Coffeng, 2009), which means that 1% decrease in travel time will lead to 0.5% increase in the overall number of travelers. This elasticity has been calculated based on general experiences with travel time gains in The Netherlands, which make the results count as indicative. This is especially true in cases that large modal shifts are expected. The computation time of this method is the lowest of all.

The characteristics of these methods have been summarized in *Table 5.1*.

Table 5.1: Characteristics of quantitative analysis methods

Method	Possibilities	Time consumption	Cost	Data requirements	Other Weaknesses
OV-Lite	Uni-modal, PT OD-matrices, generalized costs, elasticities	High	Medium	High	Intermodal interactions
Choice model	Multi-modal, utility-based, perception	High	High	High	
4-step model	Multi-modal, OD – matrices, generalized costs	Extremely high	High	Extremely high	
TTF model	Uni-modal, perceived travel time	Low	Low	Low	Parameters from 1993, extreme values
Elasticities	Perceived travel time	Low	Low	Low	indicative numbers

Since there are heavy temporal and monetary constraints, the OV-Lite, choice model, and the 4-step model will not be used to quantify the travel time improvements. In this case, the TTF ratio is in this case is extremely high, which makes the TTF model unsuitable for use to quantify the effects in this region. This is why travel time elasticities will be used to give an indication of the changes in number of passengers due to travel time gains.

5.2 Current Situation

The calculation with the travel time elasticity requires the calculation of travel time improvement due to the provision of express services, transfer guaranties, and application of throughput measures. All these measures require information on the current situation. These are the current access times, egress times and bus trip times which together make up the door-to-door time. This means that access, egress, and the bus trip times will have to be calculated for each OD pair. For this purpose a number of OD-matrices is necessary from which can be seen:

how many travelers travel between bus stops that are served by line S;The origins and destinations of access trips per access mode; The origins and destinations of egress trips per egress mode.

Unfortunately, not all this information is available. There is an OD-matrix available that contains trips between bus stops, but no OD-matrices that contain the origins and destinations of access and egress trips per access mode. There is information on:

» the distribution of access and egress modes per bus stop, The origins and destinations of train access and egress trips.

» In the following sections the current durations for the access, egress, bus trips, and door to door trips will be calculated.

5.2.1 Access and Egress Trips

Due to lack of information, the average access and egress trips will be calculated per bus stop. This means that some assumptions need to be made about the duration of walking, cycling, bus, moped, car, and other unknown types of access and egress trips. According to Goudappel Coffeng (2008), bus stops have a service area with a radius of 450 meters for pedestrians and 1100 meters for cyclists. The average walking and cycling speeds are speed 4km/h (Wikipedia, 2009) and 17.5km/h (Wikipedia, 2009) respectively. Pedestrians and cyclists could come from anywhere between the bus stop and the boundary of the service area. The assumption is made that all passengers come from the boundary since routes are not always direct, and they also may have to wait. This yields an access time and egress time of 6.75 minutes for pedestrians and 3.77 minutes for cyclists.

The access time for buses is assumed to be 10 minutes, for the moped and unknown modes 5 minutes, and the car 3 minutes. *Table 5.2* gives an overview of average access and egress times.

Table 5.2: Access and egress times

Mode	Access and egress time (minutes)
Walking	6.75
Cycling	3.77
Moped	5
Bus	10
Car (driver &passenger)	3
Unknown	5

The access and egress train trips are calculated using the trip planner of the Dutch Railways (Dutch Railways, 2009), after which the average access and egress times by train are calculated for each bus stop. The average train access and egress times can be seen in *Table 5.3*.

Table 5.3 : train access and egress times

Bus stop	Access time (minutes)	Egress time (minutes)
A2	47.48	34.50
H3	40.14	120.41

Now that the access and egress times are known for all modes, the average access and egress times can be calculated for each stop:

$$AET = \frac{\beta_1 \cdot Walk + \beta_2 \cdot Cycle + \beta_3 \cdot Train + \beta_4 \cdot Moped + \beta_5 \cdot Bus + \beta_6 \cdot Car + \beta_7 \cdot Unknown}{\Sigma_i \beta_k}$$

Where
AET is the average access or egress time of a bus stop
Walk is the walking access or egress time
Cycle is the cycling access or egress time
Train is the access or egress time by train
Moped is the access or egress time by moped
Bus is the access or egress time by bus
Car is the access or egress time by car
Unknown is the access or egress time by unknown modes
β_k is the number of users per access or egress mode k.

The result is two 1x 89 matrices that contain the average access time AT to bus stop i and the average egress time ET from bus stop j.

5.2.2 Bus Trip

To calculate the bus trip duration, the trip durations between bus stops have been extracted from a bus schedule. This creates a matrix with travel times between bus stops i and j called $BT_{i,j}$.

5.2.3 Door to Door Trip

To calculate the travel times for the door-to-door trips the AT_i, BT_{ij} and ET_j matrices need to be combined, to create the door to door travel time DDT matrix that uses bus stops between i and j. Therefore the algorithm in *Figure 1.3* has been developed. The result is a DDT_{ij} matrix that contains the door to door travel time in the current situation using bus stops i and j. This matrix will be used to calculate the impact of express services and transfer guarantees in the following sections.

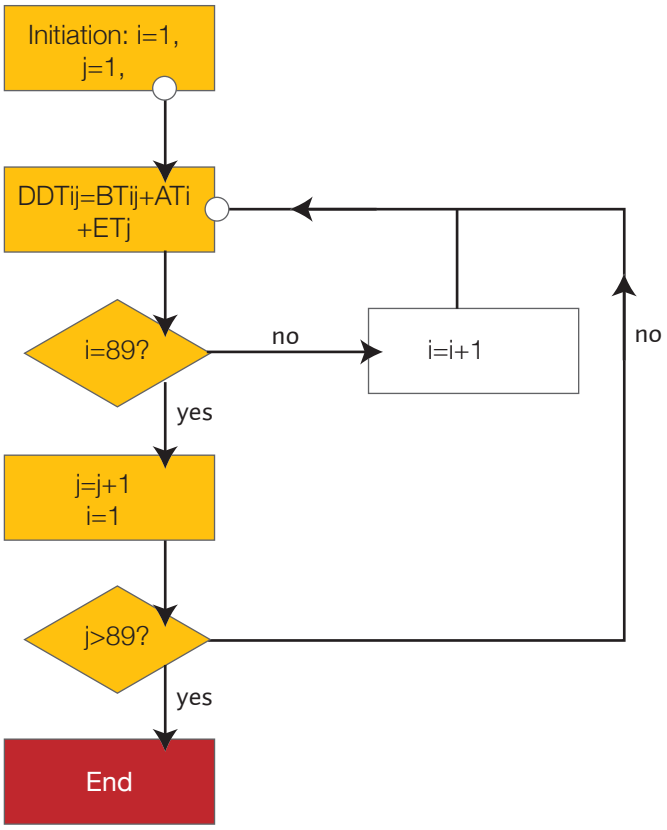


Figure 1.3: Algorithm for calculation of the DDT_{ij} matrix

5.3 Express Services

To calculate the impact of express services, this express service needs to be designed. The express service is based on skipping a number of stops, driving on a different route were possible and installing bicycle facilities. Skipping a number of stops and driving a different route have an impact on the bus trip, this becomes shorter. Skipping a number of stops also has an impact on the access and egress trips, as do installing bicycle facilities. Skipping bus stops makes access and egress trips longer, while installing bicycle facilities makes these trips shorter for the express service bus stops. Thus the next step is the calculation of the impacts on access, egress, and bus trips and consequently on the door-to-door travel time. This door-to-door time will be compared with the door-to-door travel time in the current situation to get the travel time gains per OD-pair. After this the travel time elasticity is applied to get the additional number of passengers per OD pair, summing up these numbers leads to the total increase in the number of passengers brought about by the application of express services in this case.

5.3.1 Design of The Express Service

The design of express services encompasses the selection of stops and the rerouting of the service.

Selection of Stops

The stops are selected by analyzing each town separately. This way each town is served by the express service as is desired by the travelers' associations. The stops are selected if they have a minimum of 25 users per day i.e. at least 25 people access or alight a bus at the stop. This yields the selection that can be seen in the appendix D.

Rerouting

The bus is rerouted at two locations: In town A and in town H. A schematic representation of these rerouting can be seen in *Figure 5.4*.

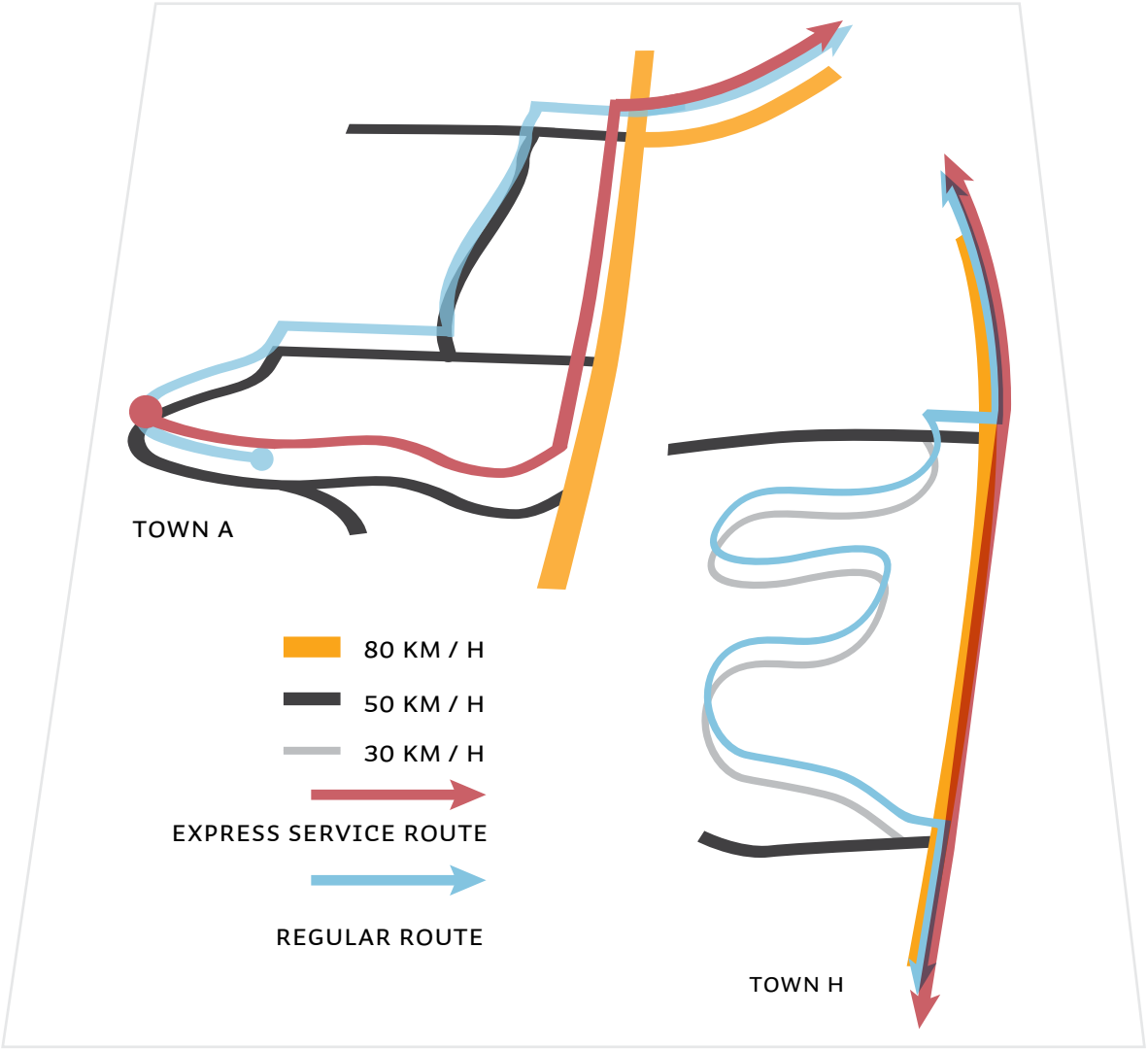


Figure 5.4: Schematic representation of the regular route (blue) and the express service route (Red).

5.3.2 Recalculation of Access and Egress Trip Travel Times

The impact on access and egress trips depends on the skipped stops and of bicycle facilities. This sub-section illustrates how skipped stops affect access and egress trips and outlines how the access and egress trip travel times are recalculated.

Skipped stops within service area of express service

To calculate the impact on the neighboring stops a distance D_i matrix has been created that contains the distance between stop i and $i+1$. The distances have been calculated by using a Google maps based online application (Afstandmeten.nl, n.d.). If a skipped stop is within the service area of an express service stop, the walking trips become cycling trips. This can be done since bicycle facilities have been installed at the express service stop. A skipped stop is entirely within the service are if its 650m from the express service stop. When walking trips become cycling trips, the average access and egress times diminish.

Stops outside service area

For the stops that are not within the service area, the distance to the nearest express service stop is calculated. The service area of a regular service stop is the area within a radius of 450m. At an express service stop this radius is expanded to 1100m. The access and egress times are known for the regular service stop. The assumption is made that the average access and egress speeds remain the same as in the case of the regular stops. The distance increases because they do not give access to an express

service bus. This distance is equal to the distance to the nearest express service stop, which is calculated using the distance matrix. Then the new travel time is calculated for passengers that use the skipped stops by dividing the distance to the nearest express service stop by the average access/egress speed. The average access/egress times of these stops increase as a result.

With these calculations the new access and egress times $\boldsymbol{ATE_i}$ and $\boldsymbol{ETE_j}$ can be calculated. This is done the same way as the original $\boldsymbol{AT_i}$ and matrices have been calculated.

5.3.3 Recalculation of Bus Trip Travel Time

The impact of the bus trip depends on the number of skipped stops, the usage of these stops, and the travel time benefits of the express service route compared to the regular route. This sub-section illustrates how skipped stops affect the bus trip and outlines how the bus trip travel time is recalculated.

Impact of skipped stops

The impact of skipping bus stops on the bus trip can be quantified by calculating the average number of times that a bus should have stopped at skipped bus stop and summing up this average of all the skipped bus stops. The average number of times that a bus stops at a skipped stop is approximated by dividing the total number of daily users by the total number of daily services. Thus this value is the number of times that the bus should have stopped at the skipped bus stops. This yields that the bus stops five times less per trip by skipping these stops. According to Goudappel Coffeng (2008) decelerating, stopping, and accelerating ads one minute of travel time to the duration of the bus trip i.e. five minutes are saved by skipping stops.

Impact of rerouting

The impact of rerouting can be calculated by dividing the old distance by the old speed, the new distance by the new speed, and calculating the difference between the old and new travel time. The speed of a provincial road is higher than a city road, which on its turn is higher than a dwelling road. In the Netherlands, the speed limit of a provincial road is 80km/h, a city road 50km/h, and a dwelling road 30km/h (Wikipedia, 2009). In the town of H the bus can drive on a provincial road instead of a dwelling area road, which gives 5 minutes of travel time gain. A different route in A which uses a provincial road for a longer period of time instead of a city road yields 1 minute of travel time gain. The total travel time gain is equal to 6 minutes.

Skipping bus stops and rerouting shorten the total bus trip by 11 minutes, which means that the bus trip becomes $\frac{11}{86} \cdot 100 = 13\%$ shorter for the average traveler. The bus trip does not become 13% shorter for each traveler, some travelers experience relatively more travel time gains while others experience relatively less travel time gains. In this calculation the average travel time reduction is applied for all travelers. This travel time reduction is applied to the bus trip travel time matrix $\boldsymbol{BT_{ij}}$ giving new bus trip durations, which are stored in the new matrix $\boldsymbol{BTE_{ij}}$.

5.3.4 Recalculation of Door-to-door Travel Times

Now that the $\boldsymbol{ATE_i}$, $\boldsymbol{BTE_{ij}}$ and $\boldsymbol{ETE_j}$ matrices are calculated, the new door to door matrix can be calculated. This is done the same way that was done for the $\boldsymbol{DDT_{ij}}$ matrix of the current situation. The result is stored in the matrix $\boldsymbol{DDTE_{ij}}$.

The gains in number of travelers can be calculated by computing the percentage of difference between $\boldsymbol{DDT_{ij}}$ and $\boldsymbol{DDTE_{ij}}$. This means that the travel time gains are calculated per OD pair. The travel time elasticity is then applied to the travel time gains to get the relative modifications in number of travelers per OD pair. Then the matrix with relative modifications in number of travelers is applied to the $\boldsymbol{T_{ij}}$ matrix to get the absolute change in number of travelers, which is stored in $\boldsymbol{PG_{ij}}$. The total gains are calculated by summing up the gains of all OD pairs $\sum_{j=1}^{89}\sum_{i=1}^{89} \boldsymbol{PG}_{ij}$,which is equal to 32 passengers in the case where only express services are provided all day. However, travelers' associations have indicated that this is not desirable which is why two scenarios will be quantified.

5.3.5 Scenario 1: Express Services in Peak Hours.

In the first scenario only express services are provided in peak hours and only regular services in off peak hours. This gives are 61 express service trips per day and 20 regular service trips. There are currently 1355 passengers per day, which means that providing express services in this scenario will lead to a total of $\frac{61}{81} \cdot 1387 + \frac{20}{81} \cdot 1355 = 1380$ passengers i.e. an increase of 1.8%

5.3.6 Scenario 2: Express Services in Combination with Regular Services in Peak Hours.

In the second scenario express services are provided in peak hours in combination with regular service, and only regular services are provided in off-peak hours. This yields 30 express service trips and 51 regular service trips per day. Providing express services in this scenario leads to a total of $\frac{30}{81} \cdot 1387 + \frac{51}{81} \cdot 1355 = 1367$ passengers thus an increase of 0.9%.

One needs to note that in these calculations all buses are assumed to have the same occupation the whole day. In practice the occupation in peak hours is higher than the occupation in off-peak hours. Data on the occupation throughout an average day is not available, which is why the number of passengers that benefit from the provision of express services is underestimated since the express services are provided in peak hours.

5.4 Transfer Guarantees

Transfer guarantees are primarily focused on increasing the reliability of transfers. These transfer guarantees are conditional: transfer guarantees are only provided in cases that this guarantee does not bring about significantly large delays for the waiting vehicle. This applies to connections between regional buses on the one hand and trains, neighborhood buses and city buses on the other. Intelligent transport systems are used to determine this feasibility of the transfer guarantee. It calculates if the vehicle has arrived at the transfer location, if the passengers have had enough time to transfer, the real-time expected time of arrival of a delayed vehicle, and gives the driver an indication whether he can depart or not. An intelligent transport system that is capable of this is the IVU suite of IVU traffic technologies AG. Thus this measure guarantees transfers by waiting for delayed vehicles. The consequence of not being able to provide the transfer guarantee falls outside the scope of this calculation. Possible options for this are input of additional vehicles and personnel to transport people that have missed their transfer or giving passengers refund. Providing additional vehicles and personnel was not approved by the participants of the qualitative analysis.

The impact of transfer guarantees will be calculated in two scenarios: one scenario where there is 5 minutes of transfer time and another where there is 2 minutes of transfer time. The impact will be calculated for the provision of transfer guarantees between two buses. For each scenario the probabilities of failing and succeeding in making a transfer will be calculated in the current situation, then the probabilities of failing and succeeding a transfer will be calculated when transfer guarantees are provided. After the probabilities have been calculated, the impact of the change in expected travel times will be calculated for the transferring travelers in bus 1 and the waiting passengers in bus 2. These values will be used to calculate the total impacts of transfer guarantees.

5.4.1 Probabilities of Missing a Transfer in Scenario 1

Let A be the event of arriving with the first bus and D be the event of departure of the second bus. The assumption is made that these two events are independent and random. Data on the average delay of arriving vehicles at a transfer location of a city with less than 30,000 inhabitants indicates an average delay in μ_A minutes of 2.4 with the corresponding standard deviation σ_A of in 2.26 minutes. Data on the average delay for departing vehicles of μ_D is 1.8 in minutes and the corresponding standard deviation is σ_D equal to 1.78. These values are based on actual behavior, which means that the waiting that is currently done by bus drivers is included in these values. Let X be the arrival time of vehicle at a scheduled time, and Y be the departure of a second vehicle at a scheduled time. Assuming that the arriving vehicle is scheduled to arrive at time 0, the average arrival time is μ_X equal to $0 + 2.4 = 2.4$with the corresponding standard deviation σ_X of 2.26. The departing vehicle is scheduled to depart at time five since the transfer time is 5 minutes, leading to the average departure time of the second bus stop of and the corresponding standard deviation $\sigma_Y$of 1.78. These two distributions $X \sim N(2.4, 2.26^2)$ and $Y \sim N(6.8, 1.78^2)$can be seen in *Figure 5.5*.

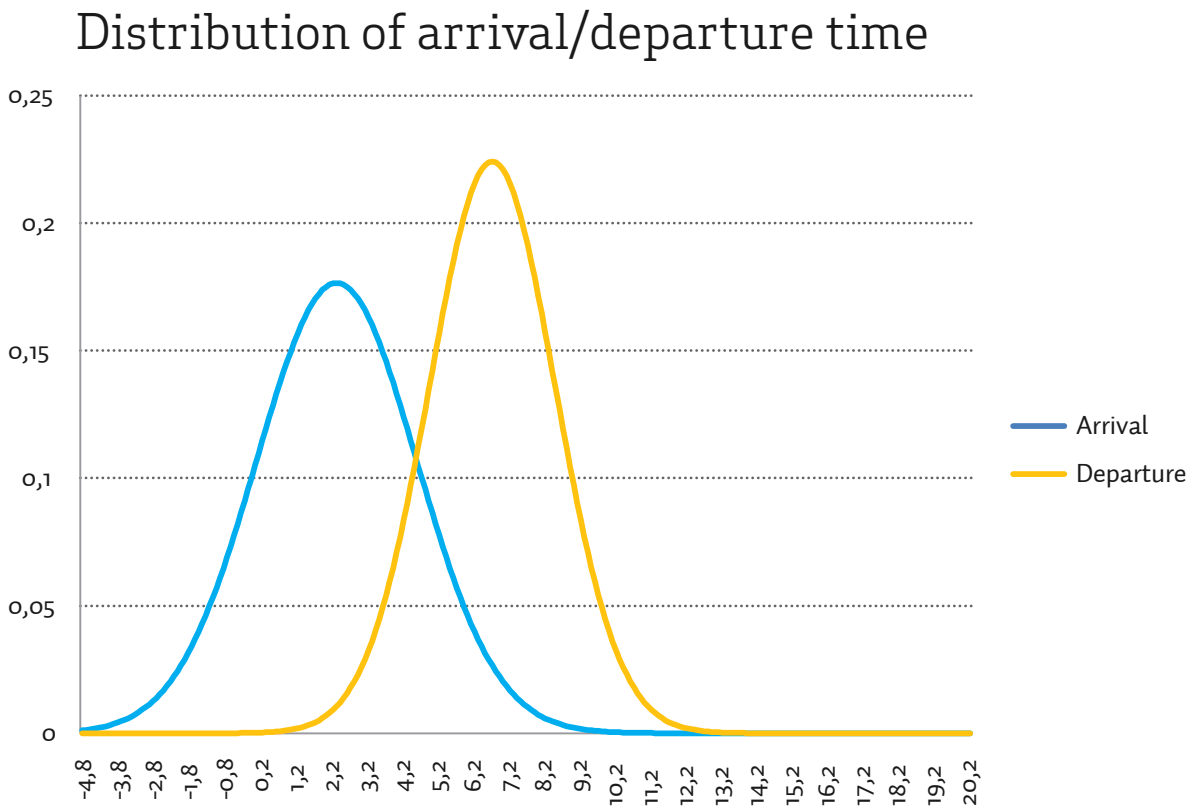


Figure 5.5: Distribution of arrival/departure in scenario 1

The available transfer time is the difference between the departure time of the second vehicle and the arrival time of the first vehicle. The available transfer time is defined as a new variable $\mathbf{z}: Z = Y - X$ Since X and Y are independent random variables, their linear combination is also normally distributed: $Z \sim N(\mu_Y - \mu_X, \sigma_Y^2 + \sigma_X^2)$. This yields $\mu_Z = \mu_Y - \mu_X = 4.4$ and $\sigma_Z = \sqrt{\sigma_Y^2 + \sigma_X^2} = 2.87$. Hence the distribution is $Z \sim N(4.4, 2.87^2)$.

The time that passengers need for a transfer is not equal to the available transfer time. There is also some time necessary for the passengers to physically transfer. This time is estimated to be 1 minute. The probability to miss a transfer can consequently be calculated as $P(Z \leq 1) = 0.12$. The probability of a successful transfer is then $1 - P(Z \leq 1) = 0.88$. The probability of missing a transfer is shaded in *Figure 5.6*

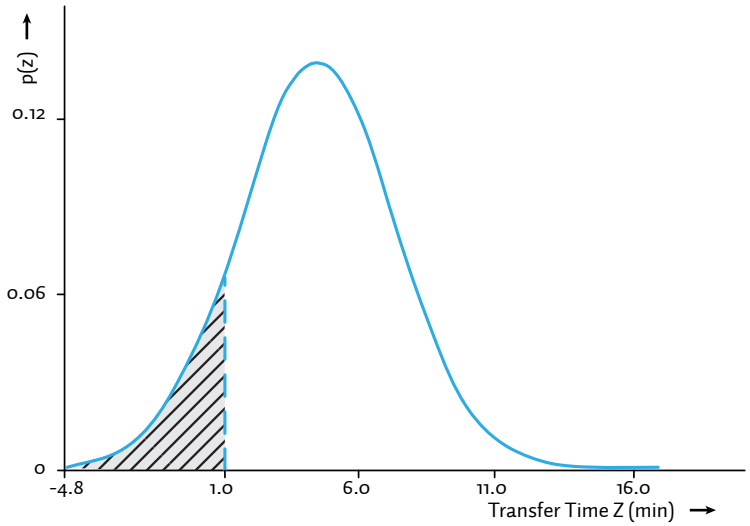


Figure 5.6: Probability of missing a transfer in scenario 1 (shaded area)

The transfer guarantee that is proposed here is a conditional one. These guarantees are only provided if waiting does not bring about a significantly large delay for vehicles. It is impossible to determine exactly in how many percent of cases this would be so without microscopic simulation. This guarantee might even be too complicated to model in case of multi-modal transfers, or in case that multiple transfers need to be made. When the second vehicle needs to arrive at another transfer location, there must not be a significantly large delay due to the provision of transfer guarantees. The assumption is made that the maximum number of minutes that a vehicle can wait while maintaining the feasibility is equal to the transfer time minus 1 minute since passengers must be physically able to make the transfer. This means that in this scenario, transfer guarantees are not provided if the departing vehicle has to wait more than 5-1=4 minutes. Those 4 minutes are considered to be a buffer. If the vehicle departs at transfer location 1 and arrives at transfer location to with no buffer, there is no possibility to provide transfer guarantees in the case of delay between transfer locations 1 and 2 since the practical transfer time becomes too small.

The maximum amount of time a vehicle can wait is equal to 4 minutes. The probability that a passenger misses a transfer when transfer guarantees are provided in the first scenario is equal to $P(Z <- 4) = 0.0018$; the probability that a traveler makes a successful transfer is equal to $1 - P(Z \leq - 4) = 0.9982$. The shaded area in *Figure 5.7* illustrates the probability of missing a transfer.

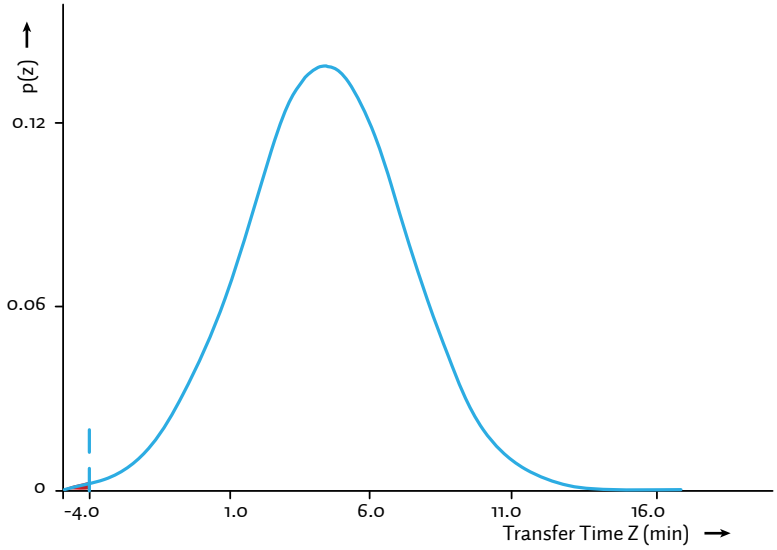


Figure 5.7: Probability of missing a transfer with transfer guarantees (shaded area)

5.4.2 Probabilities of Missing a Transfer in Scenario 2

In the second scenario that will be quantified there are two minutes of scheduled transfer time. Given the distributions for scheduled arrival and departure $A \sim N(2.4, 2.26^2)$ and $D \sim N(1.8, 2.26)^2$ and the distributions for the scheduled arriving vehicle and the scheduled departing vehicle in the second scenario are $X \sim N(2.4, 2.26^2)$ and $Y \sim N(3.8, 1.78^2)$ respectively and can be seen in *Figure 5.8*.

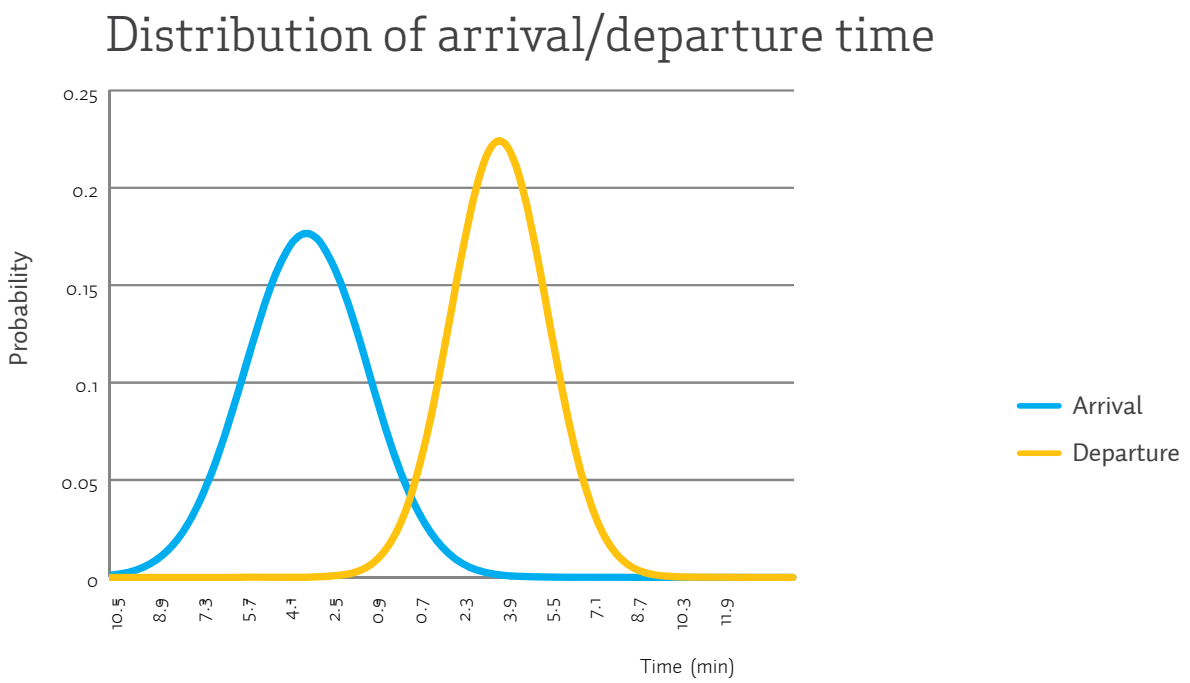


Figure 5.8: Distributions of arrival/departure in scenario 2

The available transfer time is then has a $Z \sim N(1.4, 2.87^2)$ distribution. The time that passengers need for a transfer is not equal to the available transfer time. There is also some time necessary for the passengers to physically transfer. This time is assumed to be the same in this scenario i.e. equal to 1 minute. The probability to miss a transfer can consequently be calculated as $P(Z \leq 1) = 0.44$. The probability of a successful transfer is then $1 - P(Z \leq 1) = 0.56$. The probability of missing a transfer is shaded in *Figure 5.9*.

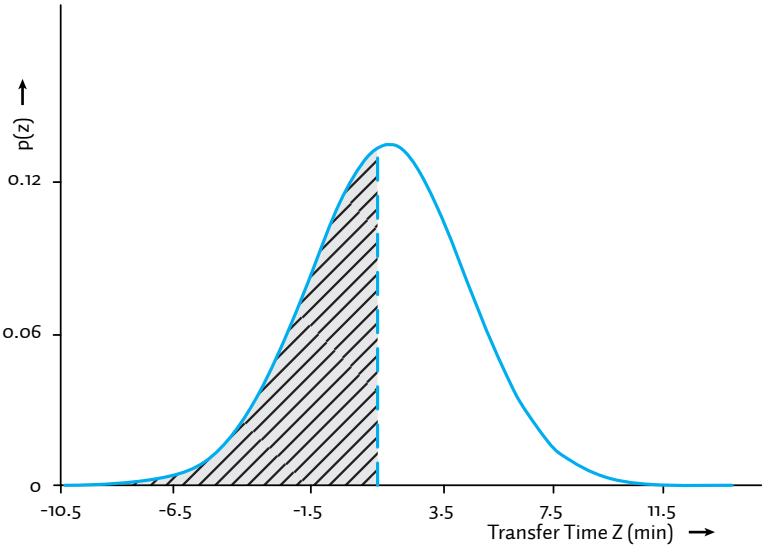


Figure 5.9: Probability of missing a transfer without guarantees in scenario 2

The assumption is made that the maximum number of minutes that a vehicle can wait while maintaining the feasibility is equal to the transfer time minus 1 minute, as has been assumed in scenario 1. This

means that the maximum number of minutes that a vehicle can wait is 1 minute. The probability of missing a transfer when transfer guarantees are provided in the second scenario is $P(Z \leq -1) = 0.20$, and the probability of making a successful transfer is equal to $1 - P(Z \leq -1) = 0.80$.

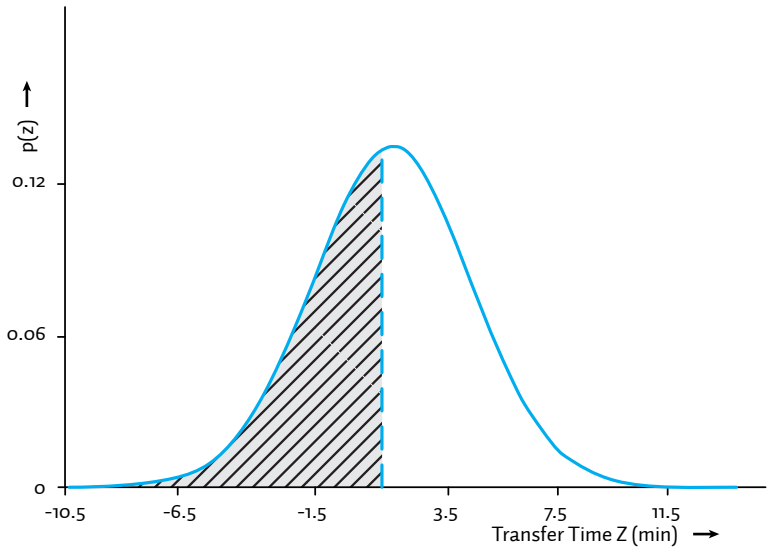


Figure 5.10: Probability of missing a transfer with guarantees in scenario 2

5.4.3 Impacts on Transferring Passengers

The impact of transfer guarantees on the number of travelers is calculated by analyzing the impact of transfer guarantees on each OD pair. First the expected travel times will be calculated for each OD pair. The expected travel time (ETT) can be calculated as follows:

$$ETT = TTM * P_m + TTS * P_s$$

Where
TTM is the travel time when a transfer is missed
TTS is the travel time when e successful transfer has been made
P_s probability of a successful transfer
P_m probability of missing a transfer

The expected travel time is calculated by multiplying each travel time between OD pairs $\boldsymbol{i}$ and $\boldsymbol{j}$ from matrix $\boldsymbol{DDT_{ij}}$ with $\boldsymbol{P_s}$ and adding the consequence of a missed transfer to the travel time of $\boldsymbol{DDT_{ij}}$ and multiplying this number (TTM) with the probability of a missed transfer $\boldsymbol{P_m}$. The consequence of missing a transfer is 30 minutes in peak hours and 60 minutes in off-peak hours. The travel times for peak hours are stored in a matrix called $\boldsymbol{P_{ij}}$ and the travel times for off-peak hours are stored in a matrix called $\boldsymbol{O_{ij}}$. 61 of the trips are made in peak hours, 20 in off-peak hours. To calculate the expected travel times per day the matrices $\boldsymbol{P_{ij}}$ and $\boldsymbol{O_{ij}}$ need to be combined. This is done by multiplying these matrices with the fraction of daily trips that they correspond to and storing them in a new matrix called:$\boldsymbol{D_{ij}}$

$$\boldsymbol{D}_{ij} = \frac{61}{81} \cdot \boldsymbol{P}_{ij} + \frac{20}{81} \cdot \boldsymbol{O}_{ij}$$

A flowchart of this calculation can be seen in *Figure 5.11.*

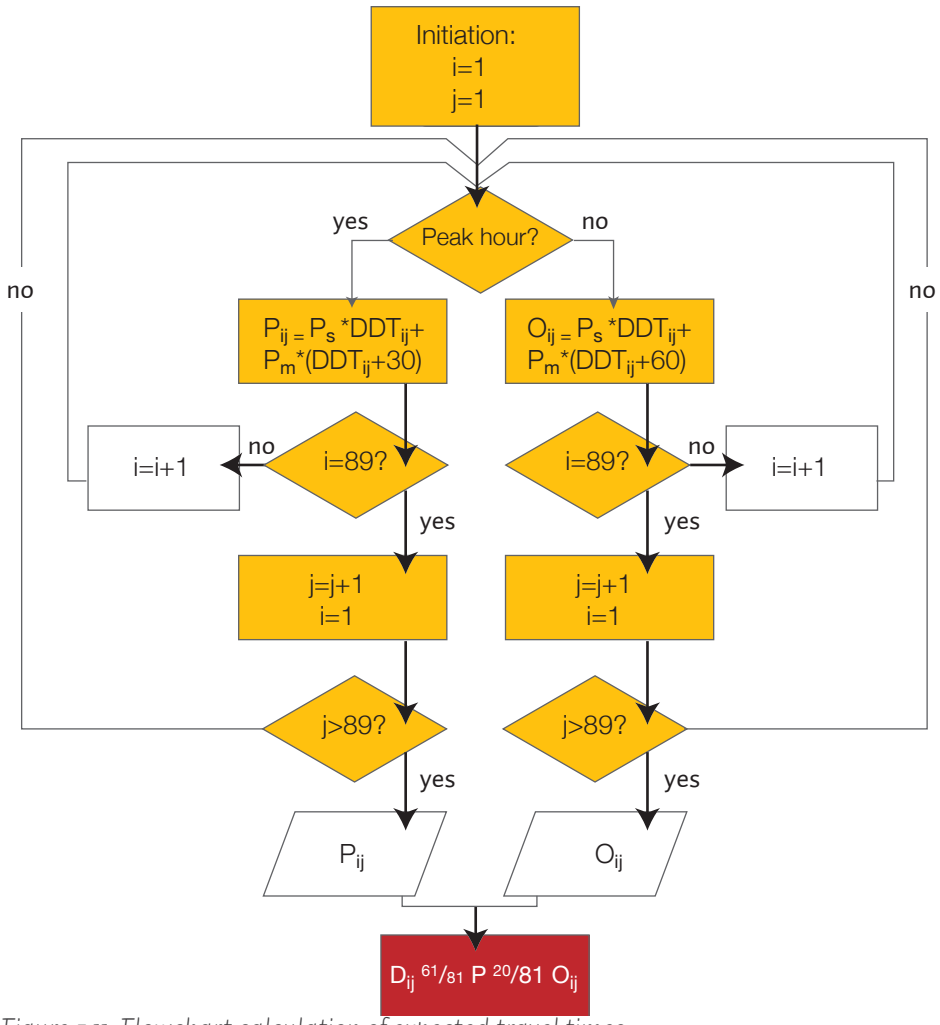


Figure 5.11: Flowchart calculation of expected travel times

$\boldsymbol{D_{ij}}$ is also calculated for the situations where the transfer guarantee is provided, giving the matrix $\boldsymbol{DG_{ij}}$. The ratio between $\boldsymbol{DG_{ij}}$ and $\boldsymbol{D_{ij}}$ is an indication of the relative travel time gains. The elasticity is applied to this ratio to get the relative change in the number of passengers and is stored in a matrix called $\boldsymbol{R_{ij}}$.

To calculate the absolute change in the number of travelers, the number of people that makes transfer needs to be calculated. People that do not make transfers will no benefit from the provision of transfer guarantees. This is done by calculating the number of transfer at the egress side of the bus trip, because the transfer at the access is not the transfer to bus 2. The number of transfers is equal to the number of bus and train passengers that egress. The ratio of passengers that make a transfer is equal to the number of passengers transferring at a bus stop divided by the total number of passengers that egress at a bus stop. These percentages are stored in a 1x89 matrix containing egress transfer trip ratios $\boldsymbol{ETR_j}$. The next step is to create a matrix that contains the number of transferring passengers. This is done as follows:

$$\boldsymbol{TRANS_{ij} = T_{ij} \cdot ETR_j}$$

Where $\boldsymbol{TRANS_{ij}}$ is the matrix that contains the number of transferring passengers per OD-pair ij.

Similar to what has been done in the case of express services, the $\boldsymbol{TRANS_{ij}}$ matrix is multiplied with the $\boldsymbol{R_{ij}}$ matrix to calculate the absolute change in the number of travelers $\boldsymbol{TR_{ij}}$ per OD-pair:

$$\boldsymbol{TR_{ij} = R_{ij} \cdot TRANS_{ij}}$$

Scenario 1: 5 minutes of transfer time

To calculate the impact on the number of travelers, all the values of $\boldsymbol{TR_{ij}}$ need to be summed. $\sum_{j=1}^{89}\sum_{i=1}^{89} \boldsymbol{TR_{ij}}$ is equal to 17 in the first scenario, which is equal to 1.3% increase in the number of travelers.

Scenario 2: 2 minutes of transfer time

Calculating $\sum_{j=1}^{89}\sum_{i=1}^{89} \boldsymbol{TR}_{ij}$ in the second scenario yields 29 in the second scenario, which is equal to 2.1% increase in the number of travelers.

5.4.4 Impact on Waiting Passengers

The passengers in the second bus have to wait when transfer guarantees are provided. This may lead to a decrease in the number of travelers. To calculate the impact on waiting passengers a number of assumptions are made:

» Travelers show identical travel behavior as passengers in the arriving bus i.e. same OD-matrices and travel times.

» The number of passengers is equal to the number of passengers in the first bus i.e. the trip matrix $\boldsymbol{T}_{ij}$ is identical.

» The probability distribution function of Z is assumed to hold for the calculations of waiting passengers.

The expected travel time for waiting passengers (ETT_w) can be calculated as follows:

$$ETT_w = TTG * P_G + TTNG * P_{NG}$$

Where
TTG is the travel time when a transfer guarantee is provided
TTN is the travel time when no transfer guarantee is provided
P_G probability that a transfer guarantee is provided
P_{NG} probability that a transfer guarantee is not provided

The travel time when a transfer guarantee is provided is equal to $\boldsymbol{DDT}_{ij}$ + waiting time, while the travel time when a transfer guarantee is not provided is equal to $\boldsymbol{DDT}_{ij}$. The waiting time in the worst case scenario is equal to 4 minutes in scenario 1, and 1 minute for scenario 2. These values will be used to update the door-to-door travel times for waiting passengers.

Probability that transfer guarantee is provided in scenario 1

The distribution of transfer time in scenario 1 is equal to $Z \sim N(4.4, 2.87^2)$. The probability that a transfer guarantee is provided is equal to $P(Z < 1) - P(Z \leq -4) = 0.12$; the probability that a guarantee is not provided is equal to $1 - P(Z < 1) - P(Z \leq -4) = 0.88$.

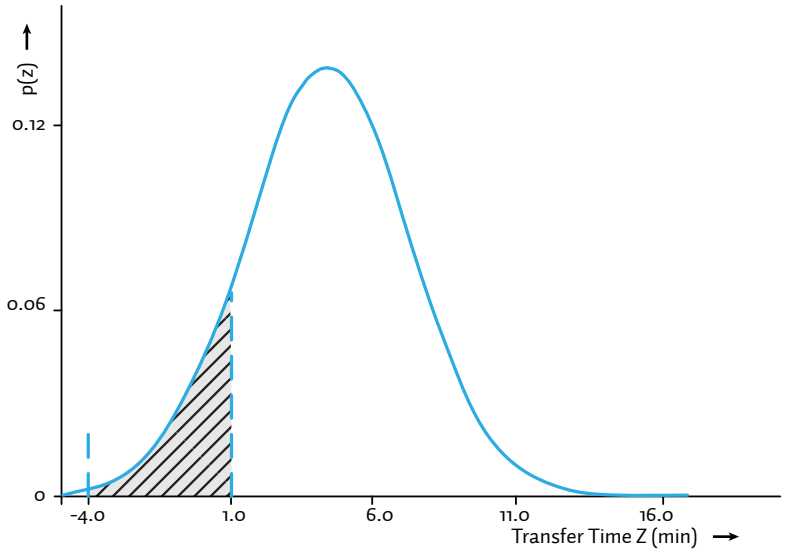


Figure 5.12: probability that a transfer guarantee is provided in scenario 1 (shaded area

Probability that transfer guarantee is provided in scenario 2

The distribution of transfer time in scenario 2 is equal to $Z \sim N(1.4, 2.87^2)$. The probability that a transfer guarantee is provided is equal to $P(Z < 1) - P(Z < -1) = 0.24$; the probability that a guarantee is not provided is equal to $P(Z < 1) - P(Z \leq -1) = 0.76$.

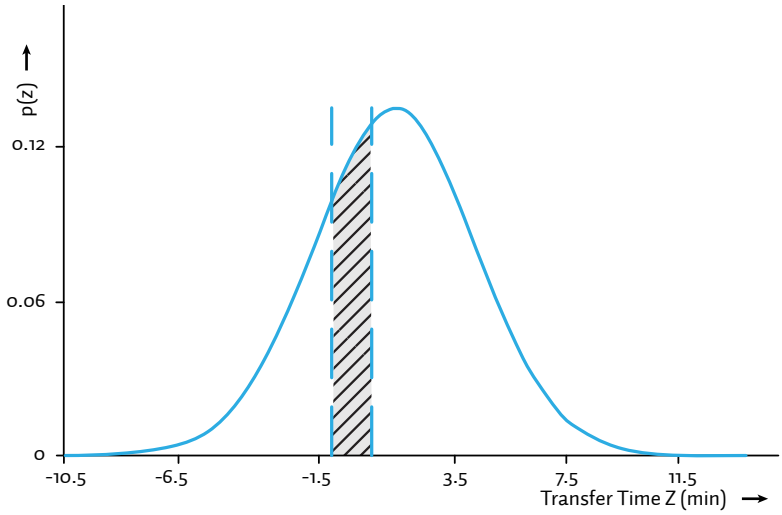


Figure 5.13: Probability that a transfer guarantee is provided in scenario 2 (shaded area).

Impact on waiting passengers in scenario 1

The relative change in travel time has been calculated the same way as has been done for the transferring passengers in section 5.4.3, consequently the relative change in the number of passengers has been calculated the same way as in section 5.4.3 and has been stored in a matrix called $\boldsymbol{RW_{ij}}$. This matrix is multiplied with the trip matrix $\boldsymbol{T_{ij}}$ to obtain the matrix with absolute number of passengers, which is stored in the matrix $\boldsymbol{LP_{ij}}$. To get the total number of passengers that are lost due to waiting the values in $\boldsymbol{LP_{ij}}$ must be summed $\sum_{j=1}^{89}\sum_{i=1}^{89} \boldsymbol{LP}_{ij}$. This yields 0 lost passengers

Impact on waiting passengers in scenario 2

Calculating $\sum_{j=1}^{89}\sum_{i=1}^{89} \boldsymbol{LP}_{ij}$ in the second scenario also yields 0.

5.4.5 Total Impact of Transfer Guarantees

The total impact of transfer guarantees is the sum of the impact on waiting passengers and transferring passengers. The result can be seen in *Table 5.4*.

Table 5.4: Expected impact of the measures on number of travelers

Component	Scenario 1	Scenario 2
Transferring passengers	+1.3%	+2.1%
Waiting passengers	0.0%	0.0%
Total	+1.3%	+2.1%

5.5 Throughput Measures

Throughput measures are measures that are taken to improve throughput at bottlenecks for regional bus lines. These bottlenecks can be caused by a lack of capacity of intersections or road sections, but can also be caused by delay at intersections, without the presence of a lack of capacity. Throughput for these regional bus lines can be improved by constructing bus lanes, or segregated bus ways and by assigning priority at intersection traffic controllers. The benefit of such measures highly depends on the situation: The number of bottlenecks on route and their corresponding severity directly determines the travel time gains for the bus trip. There is no information available on the number of bottlenecks and their severity. This means that general knowledge on the possible effects will be used. According to the

Waaier van Brogt (Goudappel Coffeng, 2009), 10-20% of the scheduled service time can be attributed to scheduled delay time due to intersection traffic controllers and other delay caused by traffic.

It is impossible to eliminate all stoppage time due to traffic lights and other capacity restraints. From past experiences of Goudappel Coffeng it is known that around 30% of this delay can be eliminated by throughput measures (Bureau Goudappel Coffeng (1992);Goudappel Coffeng(2000)) The impacts will be quantified for two scenarios. In the first scenario 10% of the scheduled service time can be attributed to traffic induced delay and in the second scenario 20% of the scheduled service time can be attributed to traffic induced delay. This means that in scenario 1 the scheduled trip time can be reduced by 3% and in the second scenario by 6%.

The increase in number of passengers brought about by the express services and transfer guarantees with the addition of throughput measures depends on whether the groups that are currently attracted by the regional bus line. 70% of the people who currently use the regional bus line have an educational trip purpose. Transfer guarantees and express services can be considered to be measures with a main focus on travel time and reliability. These both these two aspects are very important for people within the CBE user segment. There are also differences within this segment: travel time is more important to business than it is for commuters and pupils/students. When students/pupils are compared with commuter they have less need for better reliability and travel times. Throughput measures are also measures that are considered to be measures of travel time and reliability, so these measures may attract people from the same group. This is why it is not possible to simply add up the effects of the different measures.

The scheduled trip time benefits that are mentioned above apply to the bus trip, not to the door-to-door trip. This is why all values in the matrix $\boldsymbol{BT_{ij}}$ are multiplied with $\left\{1 - \frac{Scheduled\ service\ timegain\ \%}{100}\right\}$ to get a matrix with bus travel times in case throughput measures are applied. As mentioned above this gain is 3% for scenario 1 and 6% for scenario 2. This is stored in a matrix called $\boldsymbol{BTT_{ij}}$. Throughput measures only have an impact on bus trips, which is why the travel times of access and egress trips remain the same as they are in the current situation. The next step is to calculate the new door-to-door travel time, $\boldsymbol{DDTT_{ij}}$. This is done as follows: $\boldsymbol{DDTT_{ij} = BT_{ij} + AT_{ij} + ET_{ij}}$

The ratio's between the $\boldsymbol{DDTT_{ij}}$ and $\boldsymbol{DDT_{ij}}$ are calculated in order to obtain the percentage of change in door to door travel time. The elasticity is applied to these ratios to get the relative change in number of passengers, which is stored in the matrix $\boldsymbol{RT_{ij}}$. Consequently, the $\boldsymbol{RT_{ij}}$ matrix is multiplied to the trip matrix to obtain the absolute change in the number of travelers, which is stored in the matrix $\boldsymbol{TT_{ij}}$. Similar to what has been done for express services and transfer guarantees, the values of the $\boldsymbol{TT_{ij}}$ matrix are summed, giving the total number of passengers.

Impact scenario 1

$\Sigma_{j=1}^{89}\Sigma_{i=1}^{89} \boldsymbol{TT_{ij}}$ in scenario 1 is equal to 0, meaning that throughput measures do not have an impact.

Impact scenario 2

$\Sigma_{j=1}^{89}\Sigma_{i=1}^{89} \boldsymbol{TT_{ij}}$ in scenario 2 is equal to 7, meaning that throughput measures lead to an increase of 1% in the number of travelers.

5.6 Conclusions

In this chapter the effects of express services, transfer guarantees, and throughput measures on the number of travelers has been calculated in a case study. A number of scenarios have been used to calculate the effects of these measures. The calculated impacts of these measures can be seen after a period of time that depends on the applied communication strategies. These impacts are stable if no changes are made to the immediate network of the traveler. The impact of the measures can be seen in *Table 5.5*.

Table 5.5: Expected impact of the measures on number of travelers

Measure	Scenario 1	Scenario 2
Express services	+1.8%	+0.9%
Transfer guarantees	+1.3%	+2.1%
Throughput	+0.0%	+1.0%

The above mentioned impacts have been calculated for a case study. The larger the door-to-door travel time gains, the larger the impact of these measures. This is logical, since these measures have been designed to reduce door-to-door travel time. The regular bus line in this case has an operation frequency of 2 buses per hour in peak hours and 1 bus per hour in off-peak hours. The higher the frequency, the lower the need for transfer guarantees. On the other hand, the need for transfer guarantees increases with decreasing frequencies. The need for transfer guarantees also depends on the distributions of arrival time and departure time of vehicles. If the average arrival time and the standard deviation of this time are large, then transfer guarantees are useful. If the average departure time and the standard deviation of this time are large, than transfer guarantees are useful. Different averages can mean different transfer time. The results are calculated for transfer times of 2 and 5 minutes. The smaller the transfer times, the larger the benefits of the transfer guarantee.

Change in frequencies could have the opposite effect on the need for express services which means that more people would benefit from express services if the frequencies are higher. The benefits from express services also depend on the difference in the use of bus stops. If there is little difference between the usages of distinct bus stops, then the number of bus stops that can be skipped is small, which means that there are small to negligible travel time gains. If there are a lot of unused bus stops there is also little need for express services, since the buses do not stop at the skipped stops. The travel time gains from express services are also small or negligible as a result.

Change in frequency would have no additional impact in this case for throughput measures. The only way that the impact of throughput measures can be increased is by reducing delay that is caused by bottlenecks. If there is not much delay in the area of study, then throughput measures will not have any impact. Hence the impact of throughput measures depends on the composition of the bus trip. The larger the share of traffic induced delay, the larger the impact of throughput measures. One must keep in mind that throughput measures only have an impact on the bus trip.

6. Costs and Benefits Assessment

To determine the added value of the measures, a short cost- benefit analysis will be performed. This cost-benefit analysis will provide an overview of the monetary investments that are necessary to provide express services, transfer guarantees and throughput measures. The current level of service is equal to the level of service in the case that was used for the impact assessment that was performed in chapter 5. The additional *direct* costs and benefits will be calculated in this research. The costs and benefits will be calculated for a single concession period and two consecutive concession periods at price level of the year 2009. First the methodology of this costs and benefits assessment will be explained, after which the current situation is assessed. The output from the quantitative assessment of chapter 5 will be used as input to describe the current situation. Information of the current situation will then be used to calculate the costs and benefits that are involved with providing express services, transfer guarantees, and throughput measures.

6.1 Methodology

This section explains the methodology that is used to calculate the costs and benefits. A concession period typically is equal to 5 years, thus the costs and benefits will be calculated for 5 and 10 consecutive years. This means that a discount rate needs to be applied, in order to calculate the present value of the costs and benefits of future years. This can be calculated as follows:

$$PV = FV \cdot \frac{1}{(1+i)^t}$$

Where:
FV is future value
PV is present value
t is the time in years
i is the discount rate

The rate *i* consists of a risk free discount rate of 2.5% and a project specific risk margin which is 3% in the cases that this risk margin is unknown (Post-Academic Education Foundation, 2009). This gives a total discount rate of 5.5%. How this rate will be applied depends on the type of costs or benefits and when these costs or benefits are made or received. The discount rate is a real value; this means that no inflation needs to be applied (Veen, 2005).

Several types of expenses are necessary in order to make the measures work. The application of the measure brings benefits; the magnitude of these benefits depends on the effectiveness of the measure. These costs and benefits are measure specific. In this research the following costs will be considered:

» **Infrastructure investments:** This is the initial spending that is necessary to bring about the infrastructural changes that are necessary for the operation of the measure.

» **Campaign costs**: Campaign costs are the costs that are necessary for the intended group of travelers to get acquainted with the new service. Three types of campaigns can be distinguished: Promotional campaigns, try-out campaigns, and rewarding campaigns. According to the current experiences of Flow Resulting, a leading public transport marketing firm in The Netherlands, try-out campaigns are more successful. The cost of a campaign for all the bus lines in the Province of Gelderland is equal to €207,000 for a period of 2 months. These campaigns are similar to what is desired in this case study. There are 188 bus lines in Gelderland (WIKIPEDIA, 2009). This brings the average cost of a try out campaign to €1100 per bus line. These costs include

production of tickets and the losses due to free passes. The assumption is made that this campaign needs to be repeated annually. There probably are fixed costs, but the amount of these cost is unknown. Examples of these costs are design costs and transaction costs. Besides that, paint schemes can also be used in order to identify the buses. These costs can be considered to be investment costs. The costs of painting a bus are€15,000 for the Brabant liner, which is an express service in southern Netherlands. There are 8 buses necessary to provide the service of line *S* in the current situation. These 8 buses are only necessary in peak hours. Outside peak ours fewer buses are necessary.

» **Maintenance costs:** These are the costs that are necessary to maintain the additional infrastructure that is required to be able to provide the service.

» **Operating costs**: These are the costs that need to be made due to additional service hours. This is calculated by multiplying the extra hours in a year by the scheduled service hour tariff. The scheduled service hour is an all inclusive tariff: it includes regular personnel, vehicle, fuel, maintenance, ticketing, and marketing costs. These costs may differ in practice due connection constraints.

» **Depreciation cost:** All acquired fixed assets need to be depreciated. The straight-line depreciation method will be used for this purpose. This is calculated as follows:

$$Annual\ Depreciation\ Expense = \frac{Cost\ of\ fixed\ assed - Scrap\ value}{Life\ span\ (years)}$$

» **There are also several types of benefits:**

» Benefits for **new travelers**: These are the benefits of the new travelers, which is the travel time saved

» Benefits for **current travelers:** These are also benefits due to travel time savings of the passengers

» Benefits for the **transport company**: These are the benefits for the transport company due to an increased number of travelers.

The rule of half applies for new travelers, since different travelers perceive the bus as the better option at different instances. Some travelers would use the bus in case of a small improvement, others would ultimately switch in case of a large improvement. The idea behind the rule of half is that the relationship between new users and improvement is linear. This means that the benefits of new travelers are worth half of that of current travelers (Post-Academic Education Foundation, 2009).

Application of discounting:

» **Investment costs** are made in the current year. This means that the discount rate does not have to be applied.

» **Campaigns** are necessary throughout a concession period, since the effects of a campaign will diminish with time and become negligible at a certain point. The discount rate needs to be applied from the beginning of the campaign till the end.

» **Maintenance costs**: The costs need to be made throughout the concession period since the added infrastructure needs to be maintained in order to be operational i.e. the discount rate needs to be applied.

» **Operating costs:** these costs are made if the number of supplied service hours changes throughout the concession period i.e. the discount rate needs to be applied.

Travelers experience the benefits of a shorter time annually. This means that the discount rate needs to be applied to the benefits of the current travelers and the new travelers. However, the benefits of the new travelers cannot be calculated the same way as the benefits for the current travelers.

All calculated monetary values will be rounded off to thousands, negative monetary values are displayed between brackets, and the value costs and benefits equal to zero are indicated with a hyphen.

6.2 Current Situation

The current situation is the scenario where the level of service of the year 2009 is maintained. This section will give an impression of the current number of passengers and the motive distribution among these passengers.

According to the data on of the transport company on this area, there was an average autonomous growth of 2 percent between the years 2000 and 2008 in traffic demand. The assumption will be made that the autonomous growth is equal to 0. This means that the number of additional passengers in the express services, transfer guarantees and throughput measures is systematically underestimated since autonomous growth is excluded. Data on the distribution of motives in the selected case yields the distribution that can be seen in *Table 6.1*.

Table 6.1: Motive distribution in the current situation

Motive	%	#Passengers/day
Commuting	17	231
Education	72	981
Visit	6	77
Shopping	3	36
Recreation	1	14
Other	1	16

The current data available is of a typical working day. To be able to use these numbers in a cost benefit analysis, they need to be converted to annual values. According to the Post Academic Education Foundation (2009), scaling factors need to be applied per motive, since the motive distribution in weekend is different from the motive distribution during weekdays. Educational, business and commuting for example will occur significantly less in weekends. The Post Academic Education Foundation provides scaling factors for commuting, business, freight, and other motives. The assumption is made that education has the same scaling factors as commuting, since like commuting trips educational trips predominantly take place during weekdays. The scaling factors have been applied to the number of passengers, yielding the annual number of passengers (see *Table 6.2*).

Table 6.2: Scaling factor per motive (Post-Academic Education Foundation, 2009)

Motive	Scaling factor	Passengers/year
Commuting	233	53823
Education	233	228573
Business	196	0
Other	384	6144
Visit	384	29568
Shopping	384	13824
Recreation	384	5376
Freight	204	0
Total	N/A	337308

The benefits of the travel in terms of travel time can be determined by using the value of time (V.O.T.) for travelers. The value of time is the opportunity cost of the time that a traveler spends on its journey. Thus the value of time is the amount that a traveler would be willing to pay in order to save time, or the amount they would accept as compensation for lost time. The value of time differs per motive. The assumption is made that the same distribution motive distribution will hold in the case of an increase

in the number of travelers. This is the worst case scenario. The value of time for bus travelers can be seen in *Table 6.3*. The value of time of bus travelers is slightly lower than that of other modes (Post-Academic Education Foundation, 2009). There might be users that have switched from another mode, in the worst case scenario this is not the case. There are also several scenarios for economic development (Dutch: Welvaart en Leefomgeving). The worst case scenario is the regional communities scenario, which is why this scenario will be chosen. This way the benefits of the travelers will not be overestimated. Overestimation of the benefits for the traveler can lead to implementation of a measure that generates losses for the society and/or for individual parties. This is prevented as much as possible by using the worst case scenario.

Table 6.3: V.O.T. of car travelers (Post-Academic Education Foundation, 2009) in Euros per person per hour

Year	Commuting	Business	Other	All
2010	8.29	14.46	5.25	6.16

6.3 Express Services

In this section the costs and benefits will be defined for the express services measure. The costs that will be defined for express services are infrastructural investment costs, campaign costs, maintenance costs and operating costs. The benefits that will be defined are travel time benefits for new travelers and current travelers, and increased ridership revenue. The costs and benefits will be calculated for the two scenarios that have been used in the previous chapter. In scenario 1 only express services are provided in peak hours and in scenario 2 express services are provided in combination with regular services in peak hours.

6.3.1 Costs

Infrastructural investment costs:

In this case bicycle racks will be installed where 4 bicycles can be stored. A top of the line bicycle rack costs€460. The shed that belongs to this rack costs €5,367 including installation. This brings the total costs of bicycle facilities to€5,827 each (Velopa, 2007). Bicycle facilities are required at 31 bus stops, which brings the total infrastructural investments to €180,637 in the year 2007. The average inflation between September 2008 and September 2009 is equal to 1.6% (CBS, 2009). Correcting this amount for inflation yields an amount of €183,527 for 2009.

Campaign costs:

Campaign costs are necessary since users need to know what changes are made to the bus line. When express service buses operate some bus stops are skipped. People who need to take the bus need to know when they can expect the bus on the one hand and on the other they need to the advantages of the express service. Such a campaign is periodically necessary. The tryout campaign costs €1100 per two months that this service is offered. This campaign is held two times per year, which brings the annual costs to €2200.

Paint schemes are also necessary to distinguish the express services from regular services. There are two scenarios of express services. In scenario 1 only express services are offered in peak hours, and in scenario 2 express services are offered in combination with regular services. In the first scenario 10 vehicles are required; in the second scenario 5 vehicles are required. The campaign costs for express services can be seen in *Table 6.4*.

Table 6.4: Express services campaign costs

	Scenario 1	Scenario 2
No. of express service vehicles	10	5
Paint schemes investment	€ 150,000	€ 75,000

	Scenario 1	Scenario 2
Try-out campaign Annual costs	€ 2,200	€ 2,200

Maintenance costs:

The bicycling facilities that will be installed need to be maintained. According to experts of Goudappel Coffeng, these costs are around €2,000 per year.

Operating costs:

The provision of express services leads to a decrease of scheduled service hours. *Table* 6.5 shows the modified scheduled service hours and the monetary consequences. The scheduled service hour tariff is equal to €80, - per hour. The express service is 6 minutes faster than the regular service. A year is assumed to have $\frac{5}{7} \cdot 365 = 261$ working days.

Table 6.5: Operating costs of express services

	Scenario 1	Scenario 2
Number of daily express services	61	30
Daily hours saved	6.1	3
Annual costs	€ (127,000)	€ (63,000)

Depreciation costs:

Depreciation of the cycling facilities needs to take place. According to the municipality of Enschede (2006), the life span of cycling facilities is equal to 15 years. The scrap value of the cycling facilities is equal to €0,-. Application of the above mentioned straight line depreciation formula leads to an annual depreciation cost of €12,235.

6.3.2 Benefits

Benefits for current travelers:

Travelers get benefits by saving travel time. This benefit is determined by calculating the time that each group of traveler saves from the measures in hours for the current travelers and new travelers in both scenarios. The number of hours saved is multiplied by the V.O.T. corresponding to the group of interest (see *Table* 6.3) to obtain the monetary benefits. The result can be seen in *Table* 6.6.

Table 6.6: Annual travel time benefits of current users

	Scenario 1		Scenario 2	
Commuting	3,414 hours	€ 28,000	1,707 hours	€ 14,000
Business	0 hours	€ -	0 hours	€ -
Other	664 hours	€ 3,000	332 hours	€ 2,000
Total	4,078 hours	€ 31,000	2,038 hours	€ 16,000

Benefits for new travelers:

New travelers also save time from this measure. The travel time saved has been calculated the same way as has been done for the current travelers; the only difference is the application of the rule of half for the new travelers. These benefits can be seen in *Table* 6.7.

Table 6.7: Annual benefits for new travelers

	Scenario 1		Scenario 2	
Commuting	61 hours	€ 1,000	15 hours	€ -
Business	0 hours	€ -	0 hours	€ -
Other	12 hours	€ -	3 hours	€ -

	Scenario 1		Scenario 2	
Total	73 hours	€ 1,000	18 hours	€ -
After rule of half	N/A	€ 2,000	N/A	€ -

Increased ridership levels:

Each additional passenger has to pay in order to be able to use the bus. This brings about ridership increase benefits. The annual benefit for the transport company due to increased ridership is equal to€7,000 in scenario 1 and €3,000 in scenario 2.

6.3.3 Costs and Benefits Overview

In this section an overview is provided of the costs and benefits of the express service, along with the net costs benefits for the society. The costs and benefits for the society are not equal to the costs and benefits for the different stakeholder. This is why an overview of the costs and benefits for each stakeholder will be presented as well. *Table 6.8* shows an overview of the costs and benefits after 5 and 10 years for scenarios 1 and 2.

Table 6.8: costs and benefits of express services in euro's x1000

	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Infrastructure investment costs	(184)	(184)	(184)	(184)
Campaign costs: initial investment	(150)	(150)	(75)	(75)
Annual costs	(10)	(17)	(10)	(17)
Annual maintenance costs	(9)	(16)	(9)	(16)
Depreciation costs	(55)	(97)	(55)	(97)
New passenger benefits	2	4	–	–
Current passenger benefits	140	247	66	85
Transport Company ridership benefits	32	56	12	16
Transport company operational benefits*	572	1,010	284	501

* The operational benefits of the transport company are the negative operational costs that have been calculated in section 6.3.1.

Table 6.9 shows an overview of the costs and benefits for scenarios 1 and 2 for express services. These are the costs and benefits for the society. The total costs are equal to all the costs for all parties, the total benefits are equal to all the benefits for all parties, the cost benefit balance is the result of the total benefits minus the total costs, and the benefit cost ratio is the ratio between the total benefits and the total costs.

Table 6.9: Total costs and benefits for express services in euro's x1000 and benefit cost ratios.

	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Total costs	(408)	(464)	(333)	(389)
Total benefits	746	1,317	362	602

	Scenario 1		Scenario 2	
Cost benefit balance	338	853	29	213
Benefit cost ratio	1.8	2.8	1.1	1.5

The costs and benefits are not equally allocated to the 3 stakeholders, the transport company, transport authority and the traveler. *Table 6.10* shows the cost benefit balance after 5 and 10 years for scenarios 1 and 2 for each stakeholder.

Table 6.10: Cost-benefit balance for each stakeholder for express services in euro's x1000

Stakeholder	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Transport Authority	(248)	(297)	(248)	(297)
Travelers	142	251	66	85
Transport Company	444	899	211	425

6.3.4 Conclusions Express Services

The express service measure shows more benefits for the society in the first scenario than in the second scenario. This difference is mainly caused by the operational benefits of the transport company in this scenario. The difference is also caused by the higher benefits for the current passenger, and ridership benefits of the transport company.

The transport company is the one that has the most benefits from the express service measure. This is due to fewer operating hours and increased ridership benefits. The travelers also benefit from this measure. They benefit substantially more in scenario 2 than they do in scenario 1. The measure requires some significant investments from the transport authority. This authority does not receive anything in return for their investments. They do achieve a policy goal of attracting more passengers to this specific bus line. However, the benefits of express services for the travelers do not weight up against the expenses that the transport authority needs to make. A majority of the high expenses of the transport authority are infrastructure investment costs.

6.4 Transfer Guarantees

This section will define the costs and benefits for the provision of transfer guarantees. The costs that will be defined for the transfer guarantees measure consists of infrastructure investments, campaign costs, maintenance costs, and operating costs. The benefits that will e defined are travel time gains, and increased ridership level gains. The costs and benefits will be calculated for the two scenarios that have been used in the previous chapter. In scenario 1 there is a transfer of 5 minutes and in scenario 2 there is a transfer time of 2 minutes.

6.4.1 Costs

Infrastructure investments:

Investment in infrastructure is not necessary since buses in this case are already equipped with a system similar to the IVU suite. The only changes that may need to be made are software changes. These changes are assumed to have€0 additional costs.

Campaign costs:

Campaign costs are necessary since users need to know what changes are made to the bus line. People need to know that conditional transfer guarantees are provided in order for it to have an impact. Try-out campaigns will be used as will be done in the case of express services. Such a campaign is periodically necessary. The tryout campaign costs€1100 per two months that this service is offered. This campaign is held two times per year.

Paint schemes are also necessary to make travelers aware of the provision of the transfer guarantees. There are two scenarios of transfer guarantees. In both scenarios all the vehicles need to get a new paint scheme. This means that 10 buses need to get a new paint scheme. This means that the paint schemes will cost a total of €150,000. All campaign costs are assumed to be covered by the transport company.

Maintenance costs:

There are additional maintenance costs involved for the provision of transfer guarantees, which are related to software maintenance of the IVU suite. The exact cost of maintenance of this type of software is unknown. In this case they are assumed to be equal to€10,000. These maintenance costs are assumed to be covered by the transport company.

Operational costs:

There are no changes in the amount of operational hours provided, so there are no additional operational costs.

6.4.2 Benefits

Benefits for current travelers:

As was the case with express services, travelers get benefits by saving travel time due to the provision of transfer guarantees. This benefit is determined by the time that each group of traveler saves from the measures in hours for the current travelers and new travelers in both scenarios. The number of hours saved is multiplied by the V.O.T. corresponding to the group of interest (see *Table 6.3*) to obtain the monetary benefits. The result can be seen in *Table 6.11*.

Table 6.11: Annual travel time benefits for current users

	Scenario 1		Scenario 2	
Commuting	4,785 hours	€ 40,000	10,073 hours	€ 84,000
Business	0 hours	€ -	0 hours	€ -
Other	930 hours	€ 5,000	1,959 hours	€ 0,000
Total	5,715 hours	€ 45,000	12,032 hours	€ 94,000

Travel time benefits for new travelers:

The travel time saved has been calculated the same way as has been done for the current travelers; the only difference is the application of the rule of half for the new travelers. The annual travel time benefits for new travelers can be seen in *Table 6.12*.

Table 6.12: Annual ravel time benefits for new users

	Scenario 1		Scenario 2	
Commuting	62 hours	€ 1,000	212 hours	€ 2,000
Business	0 hours	€ -	0 hours	€ -
Other	12 hours	€ -	41 hours	€ -
Total	74 hours	€ 1,000	255 hours	€ 2,000
After rule of half	N/A	€ 500	N/A	€ 1,000

Increased ridership levels:

Each additional passenger has to pay in order to be able to use the bus. This brings about ridership increase benefits. The annual benefit that the transport company receives benefits from increased ridership levels due to the provision of transfer guarantees is equal to € 5,000 in scenario 1 and€8,000 in scenario 2.

6.4.3 Cost Benefit Overview

In this section an overview is provided of the costs and benefits of the transfer guarantee, along with the net costs benefits for the society. The costs and benefits for the society are not equal to the costs and benefits for the different stakeholder. This is why an overview of the costs and benefits for each stakeholder will be presented as well. An overview of the costs and benefits for providing transfer guarantees can be seen in *Table 6.13*.

Table 6.13: the costs and benefits for transfer guarantees in euro's x1000

	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Infrastructure investment costs	–	–	–	–
Campaign costs: initial investment	(150)	(150)	(150)	(150)
Annual costs	(10)	(17)	(10)	(17)
Annual maintenance costs	(45)	(80)	(45)	(80)
New passenger benefits	2	4	9	16
Current passenger benefits	203	358	423	748
Transport Company ridership benefits	23	40	36	64

Table 6.14 shows an overview of the total costs and benefits for providing transfer guarantees. The total costs are equal to all the costs for all parties, the total benefits are equal to all the benefits for all parties, the cost benefit balance is the result of the total benefits minus the total costs, and the benefit cost ratio is the ratio between the total benefits and the total costs.

Table 6.14: The total costs and benefits for transfer guarantees in euro's x1000 and benefit cost ratios.

	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Total costs	(205)	(247)	(205)	(247)
Total benefits	228	402	468	828
Cost benefit balance	23	155	263	581
Benefit cost ratio	1.1	1.6	2.3	3.4

As was the case with express services, the costs and benefits are not equally allocated to the 3 main stakeholders. The costs and benefits for the three main stakeholders for the provision of transfer guarantees can be seen in *Table 6.15*.

Table 6.15: Cost-benefit balance for each stakeholder with provision of transfer guarantees in euro's x1000

Stakeholder	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Transport Authority	–	–	–	–
Travelers	205	362	432	764
Transport Company	(182)	(207)	(169)	(183)

6.4.4 Conclusions Transfer Guarantees

The transfer guarantee shows the most benefits to the second scenario. The difference is mainly cause by the substantially higher benefits for the current traveler in the second scenario. The benefits for new travelers and the increased ridership benefits for the transport company also have a small contribution in the difference between the two scenarios.

The traveler is the party that benefits the most from the provision of transfer guarantees. They are the only ones who have direct benefits from this measure. The measure does not have any monetary impacts on the transport authority, while the measure costs the transport company a substantial amount of money for campaigning purposes. In short, the provision of transfer guarantees benefits travelers and helps transport authority to achieve their goal of increase of ridership levels but is not attractive for the transport company.

6.5 Throughput Measures

The monetary impact of throughput measures is very difficult to measure since there is specific information available on the number of traffic intersection controllers that need to be adapted/installed, the number of lanes that need to be constructed and the length of these lanes. This section will only quantify the monetary effects of upgrading intersection traffic controllers. The costs that will be defined for this measure consist of infrastructure investments, campaign costs, maintenance costs, and operating costs. The scenarios of the previous chapter will be used for this purpose. In the first scenario 10% of the scheduled service time can be attributed to traffic induced delay, while in the second scenario 20% of the scheduled service time can be attributed to traffic induced delay.

6.5.1 Costs

Infrastructural investments:

Enabling assignment of priority at intersections costs between €8.000 and €16.000 per intersection traffic controller (Goudappel Coffeng, 2008). The number of intersection controllers that needs to be adapted is unknown. The assumption will be made that each large town has an intersection traffic controller that needs to be adapted. A large town is a town that has more than 10 bus stops. There are 5 large towns, which brings the infrastructural investment costs to a total of €80,000. These costs are assumed to be covered by the transport authority.

Campaign costs:

There are no campaign costs when throughput measures are applied since campaigning is not necessary.

Maintenance costs:

According to experts of Goudappel Coffeng there is no additional maintenance cost involved when existing intersection traffic controllers are adapted.

Operational costs:

Throughput measures have an impact on the number of scheduled service hours. In the first hours the scheduled service hours diminish by 3%, while in the second scenario the scheduled service hours diminish by 6%. The impact of fewer scheduled service hours can be seen in *Table 6.16*. The operational costs are covered by the transport company.

Table 6.16: Operating costs of throughput measures

	Scenario 1	Scenario 2
Number of trips	81	81
Daily hours saved	3.6	7.2

	Scenario 1	Scenario 2
Annual costs	€ (75,000)	€ (150,000)

6.5.2 Benefits

Benefits for current travelers:

As was the case with express services and transfer guarantees, travelers get benefits by saving travel time due to the provision of transfer guarantees. This benefit is determined by the time that each group of traveler saves from the measures in hours for the current travelers and new travelers. This value is multiplied by the V.O.T. corresponding to the group of interest (see *Table 6.3*) to obtain the monetary benefits. The result can be seen in *Table 6.17*.

Table 6.17: Annual travel time benefits for current users

	Scenario 1		Scenario 2	
Commuting	1,499 hours	€ 12,000	2,999 hours	€ 25,000
Business	0 hours	€ -	0 hours	€ -
Other	292 hours	€ 2,000	583 hours	€ 3,000
Total	874 hours	€ 14,000	2,999 hours	€ 28,000

Travel time benefits for new travelers:

The travel time saved has been calculated the same way as has been done for the current travelers; the only difference is the application of the rule of half for the new travelers. The annual travel time benefits for new travelers can be seen in *Table 6.18*.

Table 6.18: Annual ravel time benefits for new users

	Scenario 1		Scenario 2	
Commuting	0 hours	€ -	30 hours	€ -
Business	0 hours	€ -	0 hours	€ -
Other	0 hours	€ -	6 hours	€ -

Each additional passenger has to pay in order to be able to use the bus. This brings about ridership increase benefits. The annual benefit that the transport company receives benefits from increased ridership levels due to throughput measures is equal to €0 in scenario 1 and €4,000 in scenario 2.

6.5.3 Costs and Benefits Overview

In this section an overview is provided of the costs and benefits of the throughput measures, along with the net costs benefits for the society. The costs and benefits for the society are not equal to the costs and benefits for the different stakeholder. This is why an overview of the costs and benefits for each stakeholder will be presented as well. An overview of the costs and benefits for throughput measures can be seen in *Table 6.19*.

Table 6.19: the costs and benefits for throughput measures in euro's x1000

	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Infrastructure investment costs	(80)	(80)	(80)	(80)
Campaign costs: initial investment	–	–	–	–
Annual costs	–	–	–	–
Annual maintenance costs	–	–	–	–

	Scenario 1		Scenario 2	
New passenger benefits	–	–	–	–
Current passenger benefits	63	111	148	223
Transport Company ridership benefits	–	–	–	–
Transport company operational benefits*	338	596	791	1,193

* The operational benefits of the transport company are the negative operational costs that have been calculated in section 6.5.1. *Table 6.20* shows an overview of the total costs and benefits for throughput measures. The total costs are equal to all the costs for all parties, the total benefits are equal to all the benefits for all parties, the cost benefit balance is the result of the total benefits minus the total costs, and the benefit cost ratio is the ratio between the total benefits and the total costs.

Table 6.20: The total costs and benefits for throughput measures in euro's x1000 and benefit cost ratios

	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Total costs	(80)	(80)	(80)	(80)
Total benefits	401	707	959	1,446
Cost benefit balance	321	627	879	1,366
Benefit cost ratio	5.0	8.8	12.0	18.1

As was the case with express services and transfer guarantees, the costs and benefits are not equally allocated to the 3 main stakeholders. The costs and benefits for the three main stakeholders for the implementation of throughput measures can be seen in *Table 6.21*.

Table 6.21: Cost-benefit balance for each stakeholder when implementing throughput measures in euro's x1000

	Scenario 1		Scenario 2	
Stakeholder	After 5 years	After 10 years	After 5 years	After 10 years
Transport Authority	(80)	(80)	(80	(80)
Travelers	63	111	148	223
Transport Company	338	596	811	1,223

6.5.4 Conclusions Throughput Measures

Throughput measures are more beneficial in the second scenario. The difference is caused by an increase of benefits for the current traveler and the transport company. New travelers do not benefit from the provision of throughput measures, because the travel time improvement for new travelers is marginal.

Transport companies travel the most from the provision of throughput measures. Travelers also benefit from throughput measures but their benefits are substantially lower than those of the transport company. Throughput measures only bring about expenses for the transport authority. This does not lead to additional travelers in scenario 1, but it does in scenario 2. The benefits for the current travelers outweigh the expenses of the transport authority.

6.6 Conclusions

In this chapter a short-cost benefit analysis has been performed. The direct costs and benefits for the transport authority, travelers, and the transport company have been calculated for the implementation of express services, transfer guarantees, and throughput measures. The overall results can be seen in *Table 6.22*.

Table 6.22: Cost-benefit balance for the proposed measures in euro's x1000

Measure	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Express services	338	853	29	213
Transfer guarantees	23	155	263	581
Throughput	321	627	879	1,366

The throughput measure is more profitable for the society than the express services and the transfer guarantees. This is because the costs of implementing throughput measures are relatively low. However, this is not the most beneficial measure for the traveler (see *Table 6.23*). The most beneficial measure for the traveler is the transfer guarantee, followed by the express service, and throughput measures. Throughput measures are less beneficial for the traveler since it only improves the bus trip and not the door-to-door trip. This is also the most beneficial measure for the transport authority.

Table 6.23: benefits for travelers in euro's x1000

Measure	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Express services	142	251	66	85
Transfer guarantees	205	362	432	764
Throughput	63	111	148	223

The measures do not bring about direct benefits for the transport authority in any scenario. Only throughput measures do not require an investment by the transport authority. To accurately analyze the costs and benefits of the measures for the transport authority the indirect benefits should be taken into account by looking at the benefits for the traveler. The benefits of the travelers outweigh the costs of the transport authority in the cases of transfer guarantees and throughput measures.

As has been mentioned in chapter 5, all these measures are focused travel time and reliability. The measures may attract people from the same group. This means that the costs and benefits cannot be simply aggregated.

These costs and benefits have been calculated within the framework of a case study. The difference costs in other cases are determined by the local availability of infrastructure and equipment while the benefits determined on the time that the traveler and the transport company save and the consequences of the travel time savings in terms of ridership levels.

7. Conclusions and Recommendations

This chapter will analyze the results of this research by drawing conclusions and giving recommendations for further research.

7.1 Conclusions

In this section conclusions are drawn based on the results of the previous chapters. This is done by summing up the results, by answering the research question and by discussing the results.

7.1.1 Summary of Results

Regional bus lines are facing a decline of ridership both in terms of number of trips as in terms of number of trip kilometers. This is not the case in all regions, but the overall results are negative. These declines are caused by a number of issues of which communication, connection, and availability of good alternatives are the most prominent. The declines are also caused by socio/administrative contexts.

This research has illustrated that the most potential users are working people that do not work at home and pupils/student since they account for more than 80% of the trips made across all modes and they are the groups that are the most sensitive for improvement. The students/pupils represent most of the current users while working people that do not work at home represent most of the potential users. Their greatest needs are better door-to-door travel times, reliability, attractive fares and reputation of public transport.

Based on these needs measures have been designed in the categories of travel time, reliability, information provision, attractive fares, and reputation of public transport:

- Transfer guarantees;
- Express services;
- on-board information;
- Business-to-business strategies;
- New channels of information provision;
- Fare capping systems;
- Loyalty programs;
- Paint schemes;
- Active public relations: free publicity, sponsoring, business to business strategies.

These measures have been qualitatively assessed with the Policy Delphi method which revealed that express services, transfer guarantees and throughput measures are the efficient and effective measures. There is consensus among transport authorities, transport companies, travelers' associations and consultancies that providing transfer guarantees will have a positive impact on the number of travelers, but they do not entirely agree that express services will have a positive impact. These sectors have all indicated that throughput measures are valuable additions to express services and transfer guarantees.

The impact of express services and transfer guarantees have been calculated in a case study where buses operate at a frequency of two buses per hour in peak hours and 1 bus per hour in off-peak hours. The impacts of express services have been calculated for two scenarios: In the first scenario express services are provided in peak hours and in the second scenario express services are provided in peak hours in combination with regular services. Providing express services in the former scenario leads to 1.8% increase in the number of travelers and in the latter scenario to an increase of 0.9%. The impacts of transfer guarantees on the number of travelers have been calculated for two scenarios: where scenario

1 is a situation with two minutes of transfer time and scenario 2 a situation with five minutes of transfer time. Providing transfer guarantees in the first scenario leads to an increase of 1.3% in the number of travelers while providing transfer guarantees in the second scenario leads to 2.1% additional travelers. The impact of throughput measures has also been quantified in two scenarios: in the first scenario 10% of the scheduled service time can be attributed to traffic induced delay, and in the second scenario 20% of the scheduled service time can be attributed to traffic induced delay. Applying throughput measures in the first scenario leads to 0.0% additional travelers, while applying throughput measures in the second scenario leads to 1.0% additional travelers.

The costs and benefits have been calculated using the results of the quantitative analysis. The benefits have been calculated for 5 and 10 years; the overall results can be seen in *Table 7.1*.

Table 7.1: Total benefits-Total costs of the cost-benefit analysis in euro's x1000

Measure	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Express services	338	853	29	213
Transfer guarantees	23	155	263	581
Throughput	321	627	879	1,366

The throughput measure is more beneficial for the society than the express services and the transfer guarantees. However, this is not the most beneficial measure for the currrent and potetntial users The most beneficial measure for the current and potential users is the transfer guarantee, followed by the express service, and throughput measures (see *Table 7.2*).

Table 7.2: benefits for travelers in euro's x1000

Measure	Scenario 1		Scenario 2	
	After 5 years	After 10 years	After 5 years	After 10 years
Express services	142	251	66	85
Transfer guarantees	205	362	432	764
Throughput	63	111	148	223

7.1.2 Answer on Research Question

The main research question has been defined as follows:

"How can the current problems of regional bus trip chains in the Netherlands be addressed efficiently and effectively in order to maintain the current users and attract new users to regional bus lines?

The current problems of the regional bus trip chains can be addressed efficiently and effectively by targeting reliability and door-to-door travel time through the provision of express services and transfer guarantees with the support of throughput measures. Since these measures have been designed based on the needs of current travelers and potential travelers, they will attract new users and also maintain the current users.

7.1.3 Discussion

In this sub-section the applicability of the results is discussed along with the policy Delphi method.

Applicability of the results

The above mentioned results for express services, transfer guarantees, and throughput measures have been calculated for a case. These results must always be interpreted considering of the conditions in the case. There are a number of factors that influence the results. The impact of express services on ridership levels depends on differences in bus stop use, distances between stops, operating frequency, percentage of captives; and that the impacts of transfer guarantees on ridership levels depends on the operating frequency, distribution of time of arrival, and the distribution of time of departure. The impact

of both these measures also depends on the origin-destination relations that are served by the bus line. The impact of throughput measures depends how much of the scheduled service time can be attributed to traffic induced delay, and the boundaries in which throughput measures need to be applied in that specific area. Thus the potentials of these measures depend on the local circumstances.

Reflection on policy Delphi

The Delphi procedure gave interesting insights. Performing this method in a traditional manner can be very time consuming: It requires additional effort from both the participants and the researcher since forms need to be sent by mail between the researcher and the participants. This increases turnaround time and also increases the time required to process the results. Thus the electronic method proved to be very efficient. The respondents were also satisfied with the electronic approach. However, it must be kept in mind that the participants are still experts in their field and are generally quite busy. They must still be given at least three weeks to fill in the questionnaire, and they must have the opportunity to save the results at one point in time and continue with the results at another time. The experts also need to be convinced that the results of the research are of value for them. Like it is the case with traditional questionnaires, during a Policy Delphi it remains necessary to carefully remind respondents to fill out the questionnaire. The Delphi definitely gives experts the opportunity to reveal their true opinions. These non-politicized opinions cannot always be displayed in consequent rounds without being edited, since this may lead to a shift of attention from the issues at stake to the other participating experts which compromises the effectiveness of the Delphi. Finally, one must keep in mind that to be able to say something scientifically sound about the impact of a particular measure on the number of travelers in advance a stated or revealed preference survey must be conducted under potential travelers.

Evaluation of a large number of broad policies and/or measures with the policy Delphi can be quite difficult for the respondents. First of all they need to understand the measure, second the list of issues that need to be evaluated becomes too large and third the respondents agree with a portion of the measure/ policy and disagree with the other portions what makes it difficult for them to say if the measured is desired, is feasible, has a positive impact and is important.

7.2 Recommendations for Further Research

Further research in the field of regional public transport is highly recommended. This research needs to be done on methods to quantify the impact of an integral measure to improve regional public transport. This means that both the impact of improved trip attributes e.g. travel time, travel cost need to be quantified and the impact of how the measure is communicated towards the costumers. Possible methods that can be considered are joint applications of the theory of planned behavior and choice models.

The transfer guarantees that have been proposed are conditional. The inability to facilitate a transfer can have several consequences for the transport company. Some examples are that the transport company gives a fool refund or that it arranges transportation for those who have missed their transfer. Research on the advantages and disadvantages of these options is recommended. Besides this, it is recommended to quantify the impacts of transfer guarantees using microscopic simulation. The waiting of vehicles of one line can have impacts on other lines, and these lines can also have an impact on other lines. Microscopic simulation can give insights of the impacts of transfer guarantees on a network level.

Labeling a bus service as an express service has a psychological impact on travelers, which makes these bus lines more attractive. This is why research on the psychological impacts of express service concepts in regional bus transport is recommended. It is very interesting to analyze the proportions between actual improvement of the service and the impact of the express service.

In this research the impact of the measures on ridership level have been calculated in a case study with multiple scenarios. These measures have proved to be favorable in most of the scenarios that have been used. Prior to the application of these measures in a specific area with different characteristics, the quantification of the impacts on the number of travelers is always recommended.

It is also recommended to perform a detailed cost-benefit analysis to get an overview of the indirect costs and benefits. This gives stakeholders a more accurate view of the costs and benefits that are involved with the implementation of a particular measure.

And last but not least, it is also recommended to design a national tool to evaluate the needs for improvement for both the current users and these needs for the non-users. Output of this tool can be used to evaluate the performance of transport companies and help a lot when attempting to design measures for improvement: It is only through sound evaluation that sound mitigation can be achieved.

References

Afstandmeten.nl. (n.d.). *Afstand meten*. Retrieved December 12, 2009, from Afstand meten: http://www.afstandmeten.nl

Alles over Marktonderzoek.nl. (2009). *Overzicht van de methoden van kwalitatief onderzoek*. Retrieved August 14, 2009, from Alles over marktonderzoek: http://www.allesovermarktonderzoek.nl/Marktonderzoek/Onderzoeksmethoden/Kwalitatieve_onderzoeksmethoden.aspx

Balcombe, R., Macket, R., Paulley, N., Preston, J., Shires, J., Titheridge, H., et al. (2004). *The demand for public transport: a practical guide*. Wokingham: TRL Limited.

Bie, J. (2008, September 19). *Modelling Choice behaviour.* (J. Bie, Performer) Vrijhof V5, Enschede, Overijssel, The Netherlands.

Bureau Goudappel Coffeng. (1992). *Doorstroomingsmaatregelen Oosterhout-Breda*. Deventer: Bureau Goudappel Coffeng.

CBS. (2009, June 29). *CBS Statline*. The Hange, Zuid Holland, The Netherlands.

CBS. (2009, September). *CBS Statline*. Retrieved November 4, 2009, from CBS: http://statline.cbs.nl

CBS. (1998, July 13). *Eén auto op elke drie Nederlanders*. Retrieved May 25, 2009, from CBS: http://www.cbs.nl/nl-NL/menu/themas/inkomen-bestedingen/publicaties/artikelen/archief/1998/1998-0023-wm.htm

Ceder, A. (2007). *Public Transit Planning and Operation*. Burlington: Elsevier Ltd.

Chorus, C. (2007). *Traveller Response to Information*. Delft: TRAIL Research School.

Dutch Railways. (2009, December 11). *Reisplanner*. Retrieved December 11, 2009, from NS Reizigers: http://www.ns.nl/reisplanner-v2/index.shtml?language=nl

Enoch, M., & Potter, S. (2002). Marketing and the British bus industry. *Municipal Engineer* , 49-55.

Florida International University. (2006). *Predictive Analysis: The Delphi Method*. Retrieved August 12, 2009, from Florida International University: http://lacc.fiu.edu/events_outreach/AWC_06/Collier_Gamarra_Handout_02.pdf

Gemeente Enschede. (2006, January 8). Retrieved December 12, 2009, from Enschede: http://www.enschede.nl/appls/stuk/stukken/02755/download.html

Goeverden, C. v., & Heuvel, M. v. (1993). *De verplaatsingstijdfactor in relatie tot de vervoerwijzekeuze*. Delft: Technische Universiteit Delft.

Goudappel Coffeng. (2009, May). *De waaier van Brogt*. Deventer, Overijssel, The Netherlands.

Goudappel Coffeng. (2000). *Ritanalyse Stadsdienst Almelo lijn 21 Windmolenbroek*. Deventer: Goudappel Coffeng.

Goudappel Coffeng. (2008, August 11). *Vragen en aantwoorden in het openbaar vervoer.* Deventer, Overijssel, The Netherlands.

Hagen, M. V. (2004). *Klantwensen bij verplaatsen en verblijven*. Tilburg: PAO.

Heath, Y., & Gifford, R. (2002). Extending the theory of planned behavior: Predicting the use of public transportation. *Journal of applied psychology* , 2154-2189.

IVU Traffic Technologies AG. (2009). *The IVU.suite for Public Transport*. Berlin, Germany.

Kennisinstituut voor Mobiliteitsbeleid. (2009). *Imago en Openbaar Vervoer.* The Hague: Kennisinstituut voor Mobiliteitsbeleid.

Kennisplatform Verkeer en Vervoer. (2006). *De halte als voordeur van het openbaar vervoer.* Rotterdam: Kennisplatform Verkeer en Vervoer.

Kennisplatform Verkeer en Vervoer. (2008). *OV-Klantenbarometer.* Rotterdam: Kennisplatform Verkeer en Vervoer.

Kennisplatform Verkeer en Vervoer. (2008). *OV-Klantenbarometer resultaten 2004-2008.* Rotterdam: Kennisplatform Verkeer en Vervoer.

Knowledge Institute for Mobility policies. (2007). *Beleving and beeldvorming van mobiliteit.* The Hague: Knowledge Institute for Mobility policies.

Koolen, R., & Tertoolen, G. (n.d.). *Back To The Future - Over een toekomst voor het openbaar vervoer.* Retrieved April 21, 2009, from CVS: http://www.cvs-congres.nl/cvspdfdocs/cvs06.28.pdf

Linstone, H. A., & Turoff, M. (2002). *The Delphi Method: Techniques and Applications.* New Jersey: NJIT.

Ministerie van Verkeer en Waterstaat- DGP. (2007). *Eindrapport Landelijke Markt- en Capaciteitsanalyse regionaal OV.* The Hague: Ministerie van Verkeer en Waterstaat.

Ministry of Transport, Public Works, and Water Management. (2009). *Cycling in The Netherlands.* The Hague: Ministry of Transport, Public Works, and Water Management.

Movin'. (2007). *Verkenning markt stads- en streekvervoer.* Capelle aan den IJssel: Ministry of Public Works and Water Management.

NEA. (2008). *Ontwikkeling van het aanbod van OV-diensten.* Zoetermeer: Kennisplatform Verkeer en Vervoer.

OV loket. (2009). *Rapportage OV loket - September 2008 tot en met December 2008.* Amersfoort: Ov loket.

Post-Academic Education Foundation. (2009). *Social Cost-Benefit analysis of infrastructural projects.* The Hague: Ministry of Transport and Public Works.

Rijkswaterstaat Directie Limburg. (1993). *Stimulering fiets in keten fiets-openbaar vervoer.* Maastricht.

Rijkswaterstaat. (2007). *Draagvlakonderzoek 2007.* Rotterdam: RWS-AVV.

Rijkswaterstaat. (2005). *Handboek Segmentatie.* Rotterdam: Adviesdienst Verkeer & Vervoer.

Rijkswaterstaat. (2008). *Mobiliteitsonderzoek Nederland 2007.* The Hague: Ministry of Transport, Public Works, and Water management.

RWS-DVS. (2004). *Mobiliteitsonderzoek Nederland 2004.* The Hague: RWS-DVS.

RWS-DVS. (2008). *Nationale Mobiliteitsmonitor 2008.* The Hague: Stuurgroep Nationale Mobiliteitsmonitor.

Selm, M. v., & Jankowski, N. (2006). Conducting Online Surveys. *Quality & Quantity* , 435-456.

Skulmoski, G. J., Hartman, F., & Krahn, J. (2007). The Delphi Method for Graduate Research. *Journal of Information Technology Education* , 1-21.

Steensel, J. v. (2002). *Een haalbaarheidsstudie naar de ontwikkeling van een individueel vervoersconcept voor het voor- en natransport bij openbaar vervoerssystemen.* Delft: TU Delft.

Stichting OPC. (2009, February 29). *De Ketenmonitor - De kwaliteit van de OV-keten beoordeeld door en voor reizigers.* Utrecht, Provincie Utrecht, The Netherlands.

TAS Passenger Transport Publications. (2007, December 3). *BIM 2007 Editorial.* Retrieved August 5, 2009, from TAS Publications and Events Limited: http://www.taspublications.co.uk/joomla/index.php?option=com_content&task=view&id=41&Itemid=29&limit=1&limitstart=2

UITP. (2004, November). *Why is it essential to develop public transport by low demand?* Brussels, Belgium.

Van Vucht, M., Van Lange, P., & Meertens, R. (1996). Commuting by car or public transportation? A social dilemma analysis of travel mode judgements. *European Journal of Social Psychology* , 373-395.

Veen, A. v. (2005, October 28). *Kosten-baten analyse.* (A. v. Veen, Performer) OH-113, Enschede,

Overijssel, The Netherlands.

Velopa. (2007). *Bestelgids 2007.* Leiderdorp: Velopa B.V.

Wikipedia. (2009, December 3). *Fiets*. Retrieved December 11, 2009, from Wikipedia: http://nl.wikipedia.org/wiki/fiets

WIKIPEDIA. (2009, July 18). *Focus Group*. Retrieved August 17, 2009, from Wikipedia, the free encyclopedia: http://en.wikipedia.org/wiki/Focus_group

Wikipedia. (2009, September 17). *Lopen*. Retrieved December 11, 2009, from Wikipedia: http://nl.wikipedia.org/wiki/Lopen

WIKIPEDIA. (2009, July 29). *Qualitative marketing research*. Retrieved August 17, 2009, from Wikipedia, the free encyclopedia: http://en.wikipedia.org/wiki/Depth_interview

WIKIPEDIA. (2009, November 9). *Stads- en streekvervoer in Gelderland*. Retrieved November 10, 2009, from Wikipedia: http://nl.wikipedia.org/Stads-_en_streekvervoer_in_Gelderland

Wikipedia. (2009, August 9). *Wegen in Nederland*. Retrieved December 12, 2009, from Wikipedia: http://nl.wikipedia.org/wiki/Wegen_in_Nederland

Appendices

A. Appendix Analysis of The Regional Bus Transport System

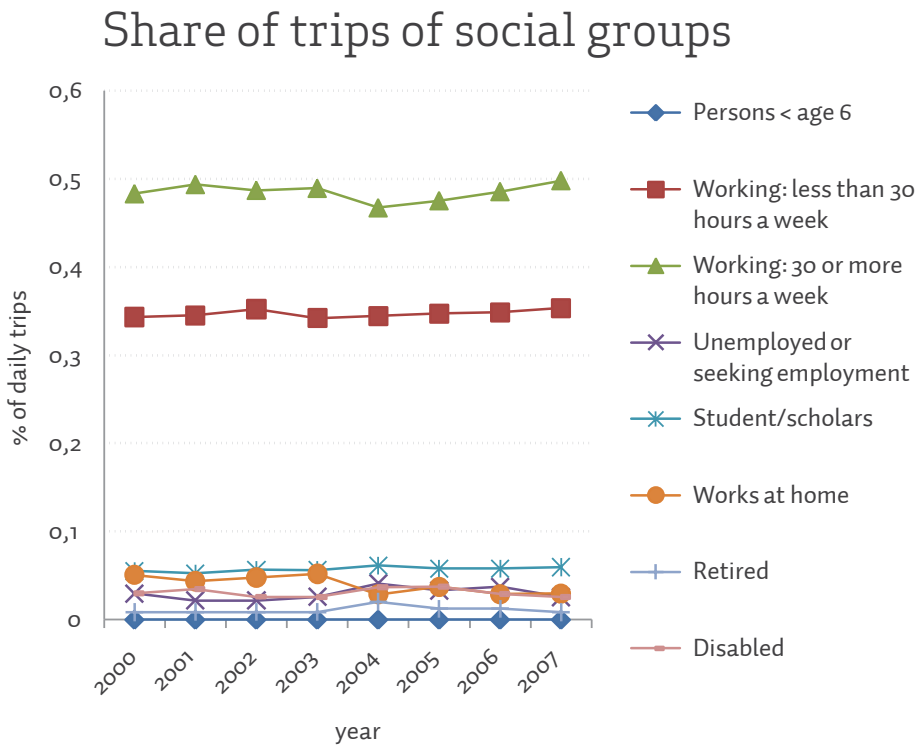


Figure A.1: Share of trips among social groups (CBS, 2009)

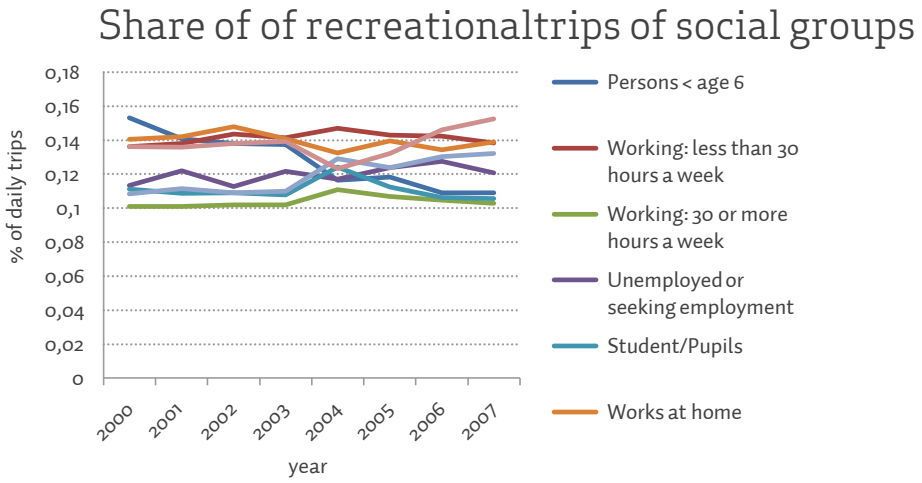


Figure A.2: share of trips of social groups for purpose recreation (CBS, 2009)

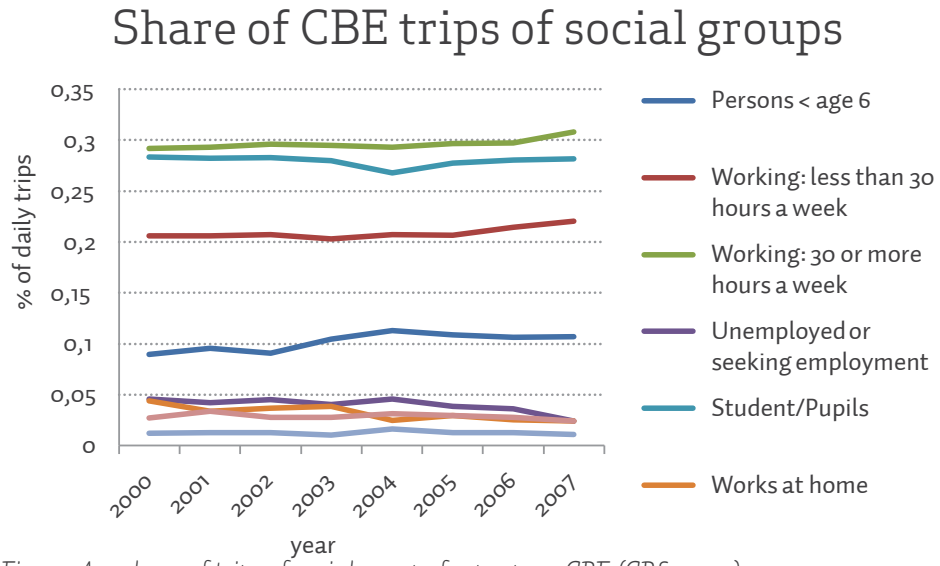


Figure A.3: share of trips of social groups for purpose CBE (CBS, 2009)

B. Appendix The Measures

I. Gross List of Improvement Measures

The lists below summarize the measures that have been designed per category.

Safety:

1. **In buses:** Cameras in buses and projection of CCTV reputations on screen in buses. In the case of emergency the driver can press an emergency button, where authorities will immediately be able to see what is going on in the buses. This security system is linked with an AVL/GPS system, which makes it possible for authorities to direct police officers in the area to the bus.
2. **At bus stops:** Gates at major transfer locations, to prevent that people without a ticket get into transfer locations. The bus stops are equipped with emergency call boxes and cameras to prevent misuse/increased perceived safety, and are facilitated with sensor activated solar power lights. Authorities will immediately be able to see what is going at the location and may also be able to prevent/stop vandalism.
3. **Passenger black list.** The black list is loaded on the OV chip card. Passengers that behave violently will be rejected public transport access. This is only possible in case of personal OV-chip card).

Reliability/travel time:

4. **Transfer Guarantees:** Guaranteed connection between buses and trains. Guaranteed connections between conventional buses and small scale initiatives like the "neighborhood bus" (buurtbus), where the regional bus is the backbone of the system. ITS can be used to indicate the location of the vehicles. Clearance is given to drivers to depart when delays escalate too much.
5. **On time performance:** Provide alternative peek hour routes/express stops, where facilities at these stops are upgraded. This makes it possible to use peak hour routes, also shortening the travel time. Busses will be given priorities conditionally at bus stops to prevent early departure at bus stops. Track performance of drivers/offer incentives for on time performance by use of the IVU or similar system.

6. **More feasible schedules:** Personal feedback from bus drivers about feasibility of schedules, analysis of feasibility of schedules using the IVU or similar system. Design and use of temporary schedules in case of roadwork, and alert passengers via e-mail, SMS about changes in schedule

Information:

7. **Information prior to departure:** First of all, transit operators should develop relationships with realtors in order for them to provide (not upon request but always) their clients with transit information in their soon to be living areas. Besides this, users should be able to seek information by entry of their postal code and or address passengers can see the nearest bus stop location and real-time departure times, along with schedule information. By using teletekst, GIS-based interactive internet applications. Travelers must be actually able to see what is in the vicinity of bus stops, with points of interests highlighted on the maps.
8. **In the bus:** following stop, alternatives, transfer time, departure time, arrival time, news
9. **Mobile guidance:** Mobile access & egress guidance software for telephones that possess a GPS antenna or Mobile access & egress guidance device. This could also be integrated into a multi-platform application that also involves trip planning. After entering OD information, the application will automatically guide you to your final destination. (See DYMOG application (http://www.aida.utwente.nl/education/ITS2-BvdB%26RB-DYMOG.pdf)
10. **Information at the bus stop:** Solar powered real-time information displays at isolated bus stops. Map of the area at a reasonable scale where points of interests in the neighborhood can be seen.

Directness:

11. **Frequent egress trips** to work places, especially where there are flexible jobs (e.g. construction sites), using bicycles, bicycle sheds, and small buses in cases of higher demand.
12. **Demand-responsive systems** (dial a ride/belbus): Including the ability to reserve online and for longer periods up to 3 months in advance. Maximum area of X sq. miles is covered. Ability to pay with the OV chip card and to transfer seamlessly to other forms of public transport.

Attractive fares:

13. **Business-to-business strategies:** The transit company sells discounted tailor made packages to employers, after which employers either provide the employees with the tickets or sell these tickets to these employees.
14. **Recreational packages**: Group discounts for travelling to a recreational facility or integration of a recreational ticket with the OV chip card.
15. **Reward passengers for using PT:** Introduction of a fare capping system and loyalty programs

Comfort:

16. **Waiting areas:** More bus sheds, at least non -metal seating possibilities at bus stops.
17. **Vehicles:** Two-class articulated buses in peak hours, where checking in/out at the first class section doors leads to a higher charge.

Egress trips:

18. **Innovative alternatives:** More Green Wheels like and PT-bike like alternatives available and inclusion of this system in OV-chip card system. Inclusion of the regiotaxi in the OV chip card scheme.
19. **Bicycle sheds at bus stops**.
20. **Guarded bicycle sheds** at isolated stops, where the payment possible via OV-chip card
21. **Mobility management:** transport to business meetings

Activity-service temporal coherence:

22. **Increased frequency**: using lower cost personnel more types of chauffeurs, and shorter routes.
23. **Run ads** that emphasize coherence between bus service and school/working hours

Reputation:

24. **External appearance of buses:** Give the bus a paint scheme that is coherent with the area it is in, give the bus names of community/national heroes, celebrities and involve the community in naming the buses. Buses must also be identified with a green label, indicating the environmental friendliness of the bus vs. the car.
25. **Customer relations improvements:** Give "pledge to our customers" to current and potential customers outlining a number of benefits of public transport. Listening to riders/non-riders for service improvements via community meetings, and give personnel courses on customer relations. Maintain relationship with current/potential customers.
26. **Media relations**: feed media with positive news, sponsoring of community events, cooperate with tourist offices.
27. **Use of OV-chip card for non- PT products**
28. **Cooperation with other transit operators**

II. Rating of Measures

Table A B.1: Rating of Measures

		CBE			Recreation			General	
Category	Measure	Desirability	Importance	Impact	Desirability	Importance	Impact	Feasibility	Total
Safety	1	3	2	2	3	2	2	4	18
	2	2	2	2	2	2	2	2	14
	3	2	1	1	2	1	1	3	11
TT/Reliability	4	4	3	3	3	3	3	2	21
	5	3	3	4	3	2	3	3	21
	6	3	2	4	2	2	3	4	20
Information	7	4	3	3	4	3	3	4	24
	8	4	3	2	4	3	3	4	23
	9	3	2	2	4	3	3	2	19
	10	4	2	3	4	2	3	2	20
Directness	11	3	3	3	1	1	1	2	14
	12	3	4	3	2	2	2	3	19
Attractive fares	13	4	4	4	2	4	4	3	25
	14	1	1	1	3	4	3	3	16
	15	2	3	2	4	4	3	3	21
Comfort	16	3	2	3	4	3	3	2	20
	17	2	3	2	2	2	2	2	15
Egress trips	18	3	4	3	2	3	2	3	20
	19	2	3	2	2	2	2	2	15
	20	2	3	2	2	2	2	1	14
	21	3	2	2	1	1	1	2	12
Activity-Service coherence	22	3	3	3	2	3	2	1	17
	23	2	3	2	2	3	2	2	16
Reputation	24	3	4	3	3	4	3	2	22
	25	3	4	3	4	4	3	2	23
	26	3	4	3	2	3	2	4	21
	27	2	3	3	3	4	2	3	20
	28	2	3	2	3	4	2	3	19

C. Appendix Expert Based Evaluation

I. Assessment of Qualitative Evaluation Methods

Depth interview

A depth interview is a conversation between a trained interviewer and one respondent. These conversations are aimed at revealing the motivations and thoughts on a subject. By using a structured conversation subject list, the user seeks to handle all aspects of the problem (Alles over Marktonderzoek.nl, 2009) (WIKIPEDIA, 2009).

Advantages:

» Possibility to register non-verbal reactions;
» The interviewer can help if the respondent does not understand
» The interviewer can apply the laddering technique to get a hold of motivations, thoughts, and ideas on a subject;
» The interview can take place in a setting where the respondent feels comfortable.

Disadvantages:

» Very time consuming: Separate appointments must be made with each respondent;
» High probability on political answers;
» Expensive;
» Influence of the interviewer is possible;
» There is always the probability that the interviews take place at different locations.

Focus groups

According to this method a group of people is asked about their attitude towards a product, service, concept, idea or packaging. Questions are asked in an interactive group setting where participants are free to talk with other group members. (WIKIPEDIA, 2009).

Advantages:

» Group discussion produces data and insights that would be less accessible without interaction found in a group setting;
» Group members discover a common language to describe similar experiences;
» Focus groups provide an opportunity for disclosure among similar others in a setting where participants are validated;
» Well suited for research on new products.

Disadvantages:

» The researcher has less control;
» Data is tough to analyze because of group interactions
» Moderators need to be highly trained;
» Groups are difficult to get together;
» Observer dependency: the results obtained are influenced by the researcher, raising questions of validity;
» Data is often cherry picked to support a foregone conclusion;
» General conclusions can be drawn that are not valid for all participants.

Delphi method

The Delphi is an iterative process to collect and distill the anonymous judgments of experts using a series of data collection and analysis techniques interspersed with feedback (Skulmoski, Hartman, &

Krahn, 2007). There are three types of Delphis: historical, numeric, and policy. Historical Delphis explain the range of issues that fostered a specific decision or in the identification of the range of possible alternatives that could have been poised against a certain past decision. Policy Delphis define a range of answers or alternatives to a current or anticipated policy problem. The goal of the numeric Delphi is to specify a single or a minimum range of numeric estimates or forecasts on a problem.

Advantages:

Delphis guarantee the anonymity of the experts;

Produce precise documented records;

Disadvantages:

» Time consuming if not performed digitally;

» It may lack the stimulation provided by face-to-face encounters;

» The intermediary or the respondents themselves may misunderstand the brief written inputs of the panel members

» The panel of experts could be to homogeneous or likeminded, producing a skewed dataset;

» The technique's theoretical foundations may be misunderstood by the participants.

A Policy Delphi should be able to serve any one or any combination of the following objectives (Linstone & Turoff, 2002):

» To ensure that all possible options have been put on the table for consideration

» To estimate the impact and consequences of any particular option

» To examine and estimate the acceptability of any particular option.

II. Detailed description of rating criteria

Table C.1: Detailed description of rating criteria

Issue	Answer categories	Interpretation of answer
Desirability	Very Desirable	· Will have a positive effect and little or no negative effec · Extremely beneficial · Justifiable on its own merit
	Desirable	· Will have a positive effect and little or no negative effect · Beneficial · Justifiable as a by-product or in conjunction with other items
	Undesirable	· Will have a negative effect · Harmful · May be justified as only as a by-product of a very desirable item, not justified as a by-product of a desirable item
	Very Undesirable	· Will have a major negative effect · Extremely harmful · Not justifiable

Issue	Answer categories	Interpretation of answer
Feasibility (Practicality)	Definitely Feasible	· No hindrance to implementation · No R& D Required · No political roadblocks · Acceptable to the public
	Possibly Feasible	· Some indication this is implementable · Some R&D still required · Further consideration or preparation to be given to political or public reaction
	Possibly Unfeasible	· Some indication this is unworkable · Significant unanswered questions
	Definitely Unfeasible	· All indications are negative · Unworkable · Cannot be implemented
Importance (Priority or Relevance)	Very Important	· A most relevant point · First order priority · Has direct bearing on major issues · Must be resolved, dealt with, or treated
	Important	· Is relevant to the issue · Second-order priority · Significant impact but not until other items are treated · Does not have to be fully resolved
	Slightly Important	· Insignificantly relevant · Third-order priority · Has little importance · Not a determining factor to major issue
	Unimportant	· No priority · No relevance · No measurable effect · Should be dropped as an item to consider
Confidence	Certain	· Low risk of being wrong · Decision based upon this will not be the wrong because of this "fact" · Most inferences drawn from this will be true
	Reliable	· Some risk of being wrong · Willing to make a decision based on this but recognizing some chance of error · Some incorrect inferences can be drawn
	Risky	· Substantial risk of being wrong · Not willing to make a decision based on this alone · Many incorrect inferences can be drawn
	Unreliable	· Great risk of being wrong · Of no use as a decision basis

III. Telephone conversation information

Objective of research is to seek possibilities to improve regional public transport. The overall performance of regional public transport is negative, which means that a steady decline of passengers is visible. This does not mean that regional public transport is in decline in every region, but it does mean that regional public transport is in decline in some, probably more regions than are facing increase in ridership levels. Regional public transport is considered to be in a negative spiral (as is indicated in Figure 2.12). It starts with a decrease in the number of travelers caused by socio economic developments, leading to a reduction of the number of bus lines, which leads to longer access and egress trips and longer travel times, ultimately strengthening a mode shift i.e. a decrease in the number travelers.

Research has been performed on the causes of these declines, which resulted in the following:

» There is a decline in the number of bus lines;
» The number of bus stops is also in decline;
» The demands of travelers have increased, comparisons to the car are more often made;
» There is poor customer service: poor communication with passengers, poor information provision;
» Bad connections between different forms of public transport and bad connections within 1 form of public transport;
» Travelers experience long unreliable travel times;
» Travelers have inaccurate perceptions of travel times;
» Bad coherence between the activity that needs to be performed and the service provided;
» Unattractive fare structures;
» Bad reputation of PT

Besides the above mentioned problems, the public transport operators tend to be too dependent on declining groups of travelers. The following question quickly arises: What is the most potential group of travelers and what are their demands? The most potential groups of travelers are those with purpose recreation, commuting, business, and education. Travelers with these purposes make more trips and they can be influenced with the least amount of effort. These trips are performed the most (85%) by working people that do not work at home.

Measures have been designed for these groups and a selection of 10 measures has been performed. This lead to a selection of 10 measures belonging to the following aspects: Reliability/travel time, Information, attractive fares, access and egress trips, and reputation. The exact definitions of these aspects are as followed:

» **Reliability/travel time:** Measures concerning reliability/travel time are measures which are design to reduce door-to door travel time and/or increase reliabilities of travel times. Increasing reliability of travel time also reduces the perceived travel times, since travelers take the reliability in travel time into account when they make the decision on how many minutes prior to the scheduled departure they want to be at the departure location. This also means that the perceived transferring or waiting time is significantly reduced, since this is part of the door-to-door travel time.
» **Information:** Measures concerning information are measures designed to inform the passenger better on their door-to-door trip. Thus these measures concentrate on informing passengers on crucial moments when long term decisions are made about the options that PT has to offer, and optimal guidance during the trip until the final destination is reached.

» **Attractive fares:** Measures concerning attractive fares are designed to target groups of travelers with tailor made solutions, in order to at least make traveling with public transport appear more convenient in monetary terms. The public transport sector should behave more commercially to be able to sell "the PT product".

» **Reputation:** Measures concerning reputation are designed to at least minimize negative reputation of potential PT users of (Regional) PT, and if possible turn this negative reputation around into positive reputation. Reputation can be targeted directly by directly applying measures that affect reputation. But the reputation of PT is also affected when passengers see that other aspects are improving, like information provision, attractive fares, and reliable travel times i.e. the reputation of PT is improved when other elements of PT are improved.

IV. PDF Document

Description of used terminology

Measure Categories

Reliability/Travel time

These are measures that are design to minimize the door-to-door travel time and/or to make travel times more reliable. Making travel times more reliable also has an impact on perceived travel times on the long term, since travelers take reliability into account when they are considering the alternative of the bus. This also means that the perceived transfer- and waiting times will decrease, because these are also components of the door-to door travel time.

Information provision

Measures in the category of information provision are measures that are designed to inform passengers better on their door-to-door trip. These measures are focused on increasing the availability of information that guides the traveler during the entire door-to-door trip.

Attractive fares

Measures in the category of attractive fares are designed to offer specific groups of travelers tailor-made solutions. These measures need to transform the PT-sector into a more commercial sector that sells "the PT product".

Reputation of public transport

Measures that are focused on reputation are measures that are designed to improve the reputation of PT.

Rating Criteria

You will be asked to rate the measure using the following criteria:

» Desirability: The extent in which traveler segments are interested in the measure.

» Feasibility: The extent in which the measure implementable.

» Importance: The extent in which the measure is important for the PT-sector

» Impact: The impact that this measure has on the number of travelers.

Guidance table for general assessment

Criterion	Answer categories	Possible interpretations
Desirability	Very Desirable	· Will have a positive effect and little or no negative effect · Extremely beneficial
	Desirable	· Will have a positive effect and little or no negative effect · Beneficial
	Undesirable	· Will have a negative effect · Harmful
	Very Undesirable	· Will have a major negative effect · Extremely harmful
Feasibility (Practicality)	Definitely Feasible	· No hindrance to implementation · No R& D Required
	Possibly Feasible	· Some indication this is implementable · Some R&D still required
	Possibly Unfeasible	· Some indication this is unworkable · Significant unanswered questions
	Definitely Unfeasible	· All indications are negative · Unworkable
Importance (Priority or Relevance)	Very Important	· A most relevant point · First order priority
	Important	· Is relevant to the issue\ · Second-order priority
	Unimportant	· Insignificantly relevant · Third-order priority
	Very unimportant	· No priority · No relevance
Impact	Strong increase	· High probability of extreme positive impact
	Some increase	· High probability of positive impact
	Some decrease	· High probability of negative impact
	Strong decrease	· High probability of extreme negative impact

V. Round 1 Questionnaire

Introduction

The goal of this research is to get an impression on what needs to be done according to experts to increase ridership levels. You will be asked to rate 8 measures on desirability, feasibility, importance and impact. These measures are grouped in the 4 categories that have been mentioned during the telephone conversation.

1. Reliability/ Travel Time
2. Information Provision
3. Attractive fares
4. Reputation of PT

In order to achieve reliable results, you are kindly requested not to distribute this questionnaire. Your answers will be treated with confidentiality; respondents cannot be identified by us.

This research is performed for Goudappel Coffeng and the University of Twente as a part of a master thesis.

Instruction

Click on the 'Next' button to start the questionnaire. You can navigate to the next pages of this questionnaire with the same button.

To go to a 'previous' page, click on the 'previous' button.

Click on the 'submit' button after completion to send the answers.

Only 1 option can be selected at each question.

Goudappel Coffeng
Consultants on traffic and transport

UNIVERSITY OF TWENTE.

Organization Type

Before discussing the measures, you will be asked to indicate the type of organization you work for.

What kind of organization do you work for?

a Transport Authority

b Public transport company

c Travelers' association

d Consultancy

Reliability/Travel Time

The measures in this category are focused on increasing the reliability of travel times and minimizing travel times.

Measure1: Transfer guarantees

Transfer guarantees are offered at transfer locations if offering this guarantee does not bring about a significantly large delay for the waiting vehicle. Thus this transfer guarantee is conditional: One vehicle waits for another for a maximum number of minutes. This transfer guarantee applies to connections between regional busses on one hand and trains, neighborhood buses and city buses on the other. Regional bus lines operate more often at lower frequencies, which means that missing a transfer has a higher consequence: The traveler has to wait a lot before another vehicle arrives. Advanced systems are used to determine whether vehicles should wait at a transfer location; if the vehicles have arrived at the transfer location; if the passengers have enough time to transfer; and if waiting for the eventually delayed vehicles has consequences for the feasibility of the operating schedule.

A1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

A2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

A3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

A4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Reliability/Travel Time

Measure 2: Faster service

One offers only fast services in peak hours or fast services in combination with regular regional services. The fast services only serve important bus stops. These stops are upgraded in terms of bicycle facilities, which means that decent (possibly guarded) bicycle sheds need to be available. PT bikes can be offered at some locations. The OV chip card can be used as payment method for the PT bikes. The presence of bicycle facilities increases the service area of a bus stop, which is crucial for regional bus lines since access and egress distances are relatively larger for these types of bus lines. Since fewer bus stops are served, trip times are reduced and become more robust.

B1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

B2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

B3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

B4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Suggestions Reliability/ Travel Times

S1. Do you have suggestions to improve the measures in the Reliability/Travel time category or other ideas to reduce travel times or make travel times more reliable? Please enter your suggestions in the box below.

Information Provision

The measures in this category are focused on information provision, more particular on information prior to departure and information in the bus.

Measure 1: Availability of information

Travelers need to have the opportunity to seek PT information trough all channels. This means that real-time and planned departure times need to be available through:

» Cellular phones: Nowadays applications can be downloaded on cellular phones. This means that transit operators (or other parties) can offer software that can help the traveler prior and during their trip. GPS-equipped devices can also benefit from a PT navigation system. This system guides the traveler during the access trip, transfers, bus trip, and egress trips. This navigation is important in unknown areas.

» Telephone line: passenger need to be able to call and receive travel information.

» Internet: Interactive GIS-based applications can be used to give the traveler a clear overview of the alternatives.

» Television: Tele text can be used to provide real-time information on alternatives in the vicinity of the traveler. Increasing use of digital television, other options become available like MHEG-4 and DVB-MHP, which offer more interactive possibilities than teletext.

C1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

C2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

C3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

C4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Information Provision

Measure 2: Information in the bus

Real-time information is offered in the bus about the current trip and the transfer possibilities. Information about the current trip needs to contain information about the following bus stops, the estimated time of arrival, and when one needs to off-board the bus to reach points-of-interests. Finally, actual news needs to be provided on the on-board screens.

D1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

D2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

D3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

D4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Suggestions Information Provision

S2. Do you have suggestions to improve the measures in the information provision category or other ideas to improve information provision? Please enter your suggestions in the box below.

Attractive Fares

The measures in this category are focused on attractive fares, by applying business-to-business strategies and rewarding the passenger for using PT.

Measure 1: Business-to-business strategies

Transport operators offer tailor-made discount packages to employers, after which employers provide or sell these packages to their employees. Transport operators can also offer tailor-made discount packages to event organizers. This can be integrated soccer tickets.

E1. What do you think about the desirability of this measure? Is it:

a Very desirable
b Desirable
c Undesirable
d Very undesirable

E2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible
b Possibly feasible
c Possibly unfeasible
d Absolutely unfeasible

E3. What do you think about the importance of this measure? Is it:

a Very important
b Important
c Unimportant
d Very unimportant

E4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase
b Some increase
c Some decrease
d Strong decrease

Attractive Fares

Measure 2: Rewarding passengers

There are several ways to reward passengers for their use of PT. First, a fare capping system can be introduced. This means that the passenger pays for a maximum number of trips or that the passenger pays a maximum fare time interval. Secondly, loyalty programs can be used where the passenger is rewarded points for travelling with PT. These points can also be used to purchase products outside the PT sector.

F1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

F2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

F3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

F4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Suggestions Attractive Fares

S3. If you have suggestions to improve measures in the attractive fares category or other ideas to make fares more attractive? Please enter your suggestions in the box below.

Reputation of Public Transport

The measures in this category are focused on improving the reputation of public transport.

Measure 1: Paint schemes of buses

The external appearance of buses can be made attractive by giving the buses a paint scheme that is coherent with the area in which the buses operate. The buses can also be given names of community hero's, national heroes or celebrities. Buses also need to be labeled as a green transportation mode, where the environmental advantages of the bus against that of the car is made clear. The environment is becoming increasingly important for the society and this opportunity needs to be grasped.

G1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

G2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

G3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

G4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Reputation of Public Transport

Measure 2: media relations

Relations with the media need to be developed and maintained intensively. Negative news ends up easily in the media; positive news however does not reach the media by itself that often. One needs to use free publicity as much as possible. This can be done by sponsoring events in a community or offering service to community events. Transport operators can also work with tourist offices to promote the use of regional bus lines to recreational areas.

H1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

H2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

H3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

H4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Suggestions Reputation of Public Transport

S4.Do you have suggestions to improve the measures in the reputation of public transport category or other ideas to improve the reputation of public transport? Please submit your suggestions in the box below.

Wrap up

These were all the questions. Thank you very much for the cooperation. Your answers will be processed and you can expect the questions of the second round shortly.

V. Round 1 Detailed results

Category 1: Reliability/ Travel time

Figure C.1 and Figure C.2show the assessment of the transfer guarantees and express services respectively.

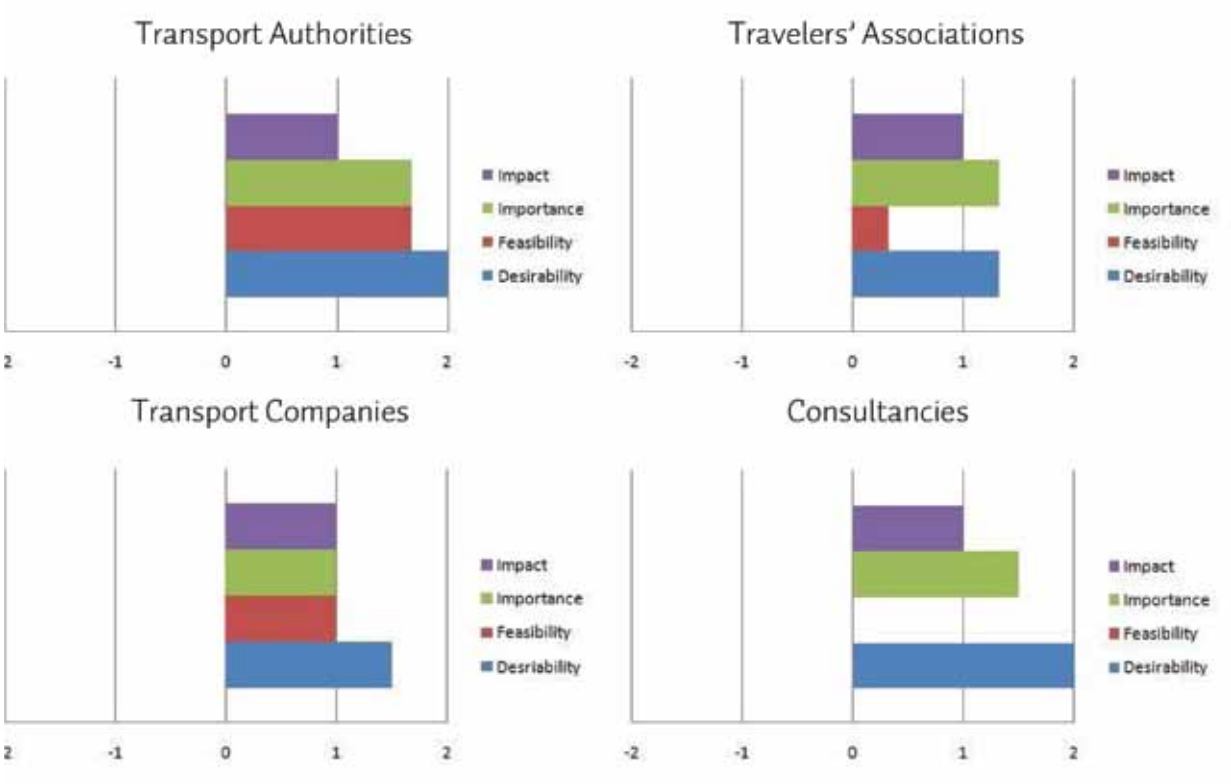


Figure C.1: Transfer Guarantees

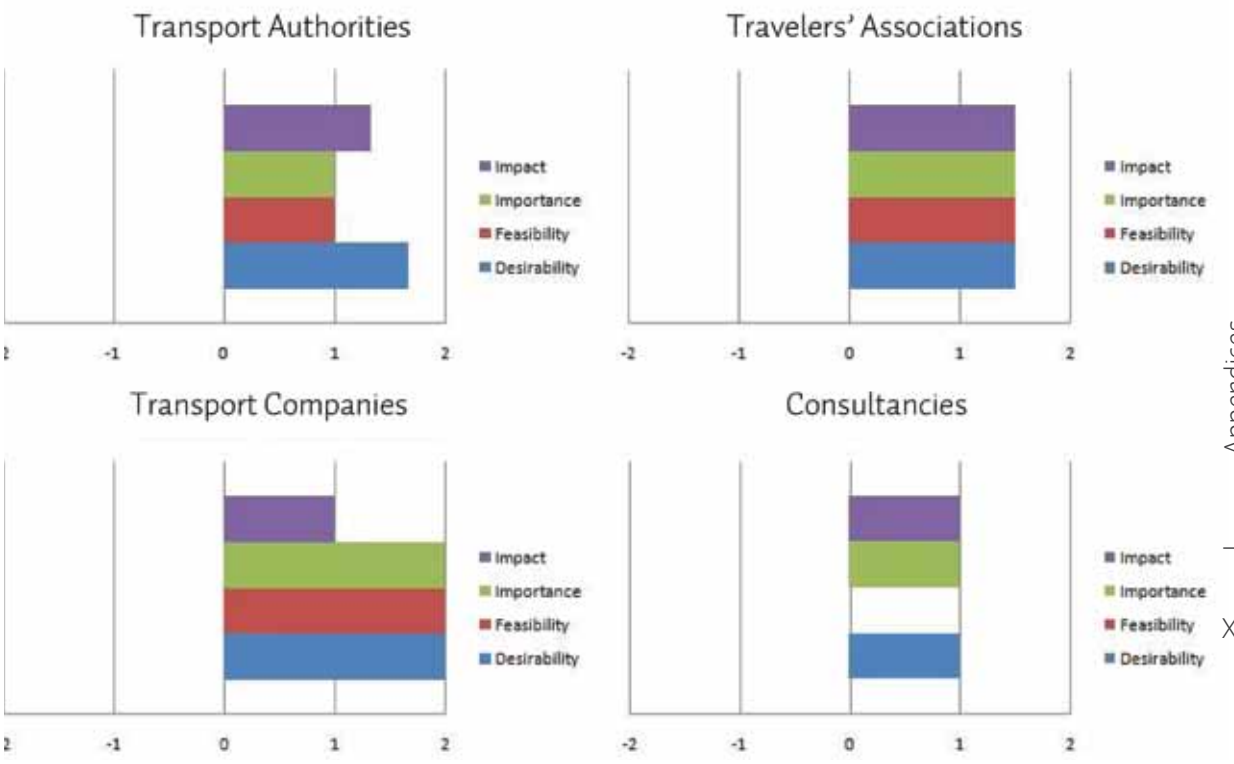


Figure C.2: Express services

Category 2: Information provision

Figure C.3 and Figure C.4 show the assessment of the transfer guarantees and express services measures respectively.

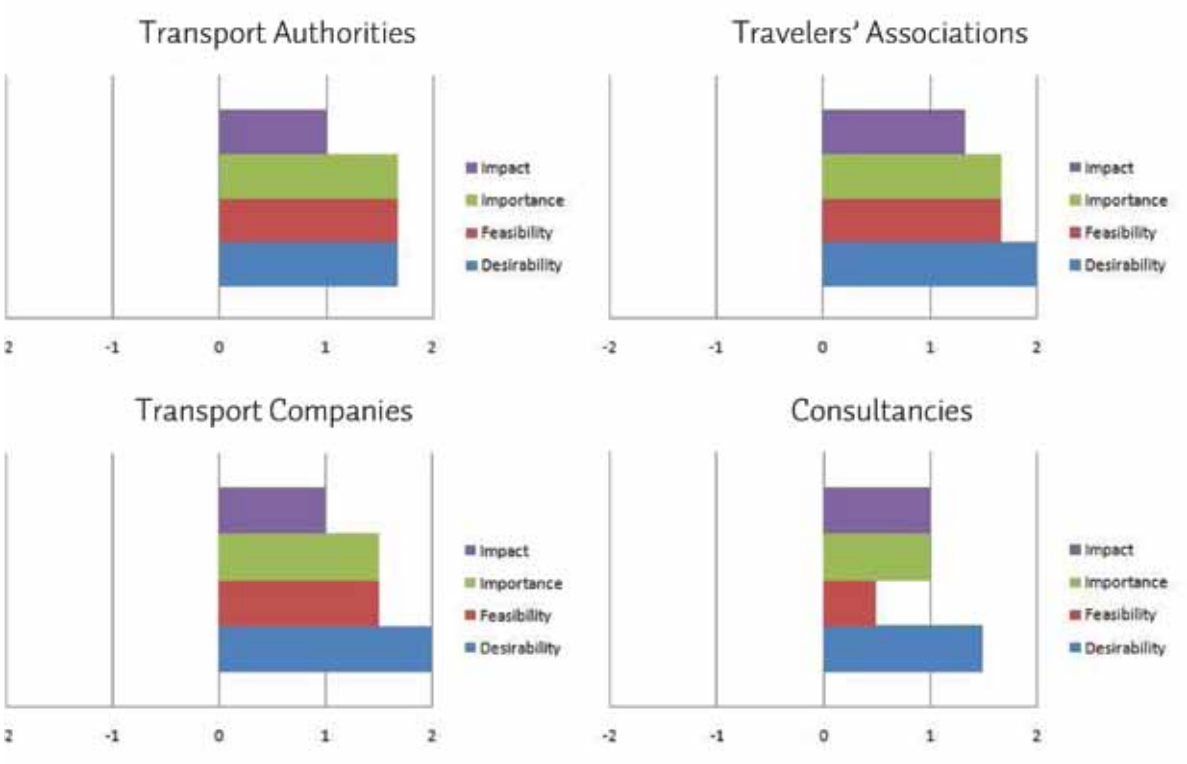


Figure C.3: Availability of information

Figure C.4: Onboard Information

Category 3: Attractive Fares

Figure C.5 and Figure C.6 show the assessment of the business-to-business strategies and rewarding passengers measures respectively.

Figure C.5: Business-to-Business strategies

Figure C.6: Rewarding passengers

VI. Round 2 questionnaire

Introduction

This questionnaire is divided into sections that correspond with the measure categories, as was the case with the questionnaire of the first round. Each category is divided into a number of components. First you will be able to see how the other sectors within public transport have rated the measures that have been presented in the first round. A description of the measure is given after which the ratings will be presented in a figure. Respondents have given comments on the measures in the first round or have given measures on the way things work in the public transport sector. A selection of these comments is presented as the second component with the ability to react on these comments. During the first round you and other respondents have given suggestions to improve the presented measures and have also suggested new measures. In the third component these suggestions are presented and you are given the opportunity to rate these suggestions based on the same criteria that have been used in the first round: desirability, feasibility, importance and impact. The last component involves the reevaluation of the original measures.

In order to achieve reliable results, you are kindly requested not to distribute this questionnaire. Your answers will be treated with confidentiality; respondents cannot be identified by us.

This research is performed for Goudappel Coffeng and the University of Twente as a part of a master thesis.

Instruction

Click on the 'Next' button to start the questionnaire. You can navigate to the next pages of this questionnaire with the same button.

To go to a 'previous' page, click on the 'previous' button.

Click on the 'submit' button after completion to send the answers.

Only 1 option can be selected at each question.

Goudappel Coffeng
Consultants on traffic and transport

UNIVERSITY OF TWENTE.

Organization Type

Before discussing the measures and suggestions, you will be asked to indicate the type of organization you work for.

What kind of organization do you work for?

a Transport Authority

b Public transport company

c Travelers' association

d Consultancy

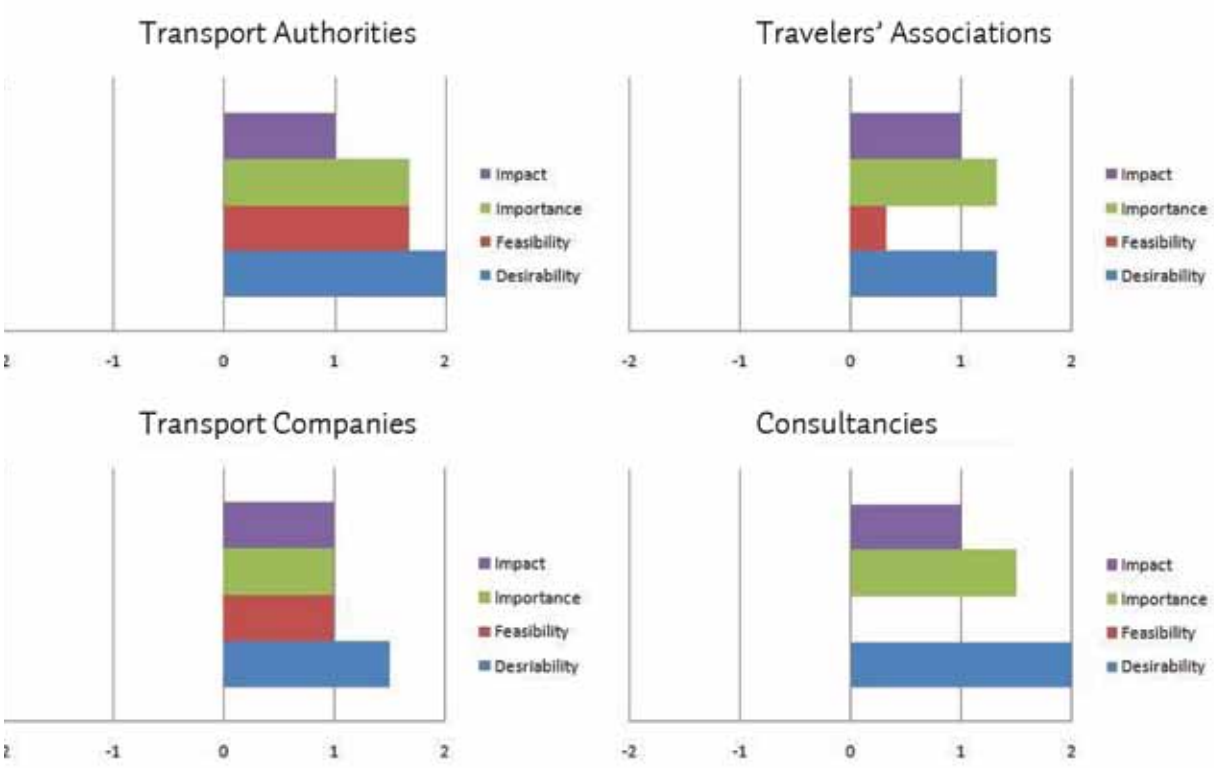
Reliability/Travel Time

Assessment Round 1

The measures in this category are focused on increasing the reliability of travel times and minimizing travel times.

Measure1: Transfer guarantees

Transfer guarantees are offered at transfer locations if offering this guarantee does not bring about a significantly large delay for the waiting vehicle. Thus this transfer guarantee is conditional: One vehicle waits for another for a maximum number of minutes. This transfer guarantee applies to connections between regional busses on one hand and trains, neighborhood buses and city buses on the other. Regional bus lines operate more often at lower frequencies, which means that missing a transfer has a higher consequence: The traveler has to wait a lot before another vehicle arrives. Advanced systems are used to determine whether vehicles should wait at a transfer location; if the vehicles have arrived at the transfer location; if the passengers have enough time to transfer; and if waiting for the eventually delayed vehicles has consequences for the feasibility of the operating schedule.



Comment

Consultancies: Road operators need to be reminded of the necessity of traffic intersection controllers that can be influenced by buses. Now that the largest municipalities are no longer transport authorities, these systems are not being implemented with the necessary urgency.

Reliability/Travel Time

Measure 2: Express services

One offers only fast services in peak hours or fast services in combination with regular regional services. The fast services only serve important bus stops. These stops are upgraded in terms of bicycle facilities, which means that decent (possibly guarded) bicycle sheds need to be available. PT bikes can be offered at some locations. The OV chip card can be used as payment method for the PT bikes. The presence of bicycle facilities increases the service area of a bus stop, which is crucial for regional bus lines since access and egress distances are relatively larger for these types of bus lines. Since fewer bus stops are served, trip times are reduced and become more robust.

Comment

Travelers' Associations: A combination of express and regular services is desired in most cases. The sole provision of express services is undesirable, because the access- and egress distances become too large and makes PT inaccessible for too much people i.e. unusable.

Reliability/Travel Time

Reaction

Do you have a reaction on the ratings and/or the comments in the category reliability/travel time? If you do, please place your reaction in the box below.

Reliability/Travel Time

Suggestions

During the first round the transport companies, travelers' associations and consultancies have suggested a number of improvements for the measures in this category. You are now offered the opportunity to rate some of these measures.

Suggestion1: Throughput measures

Transport companies, travelers' associations and transport authorities have suggested including flow improvement measures when realizing express services. This means using traffic intersection controllers to give buses priorities at intersections and constructing more segregated bus lanes. These measures need to be implemented on road sections that are subject to congestion based on carefully defined criteria.

SB1.What do you think about the added value of this suggestion concerning the desirability of the measures in the category reliability/travel time? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SB2. What do you think about the added value of this suggestion concerning the feasibility of the measures in the category reliability/travel time? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SB3. What do you think about the added value of this suggestion concerning the importance of the measures in the category reliability/travel time? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SB4. What do you think about the added value of this suggestion concerning the impact of the measures in the category reliability/travel time? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SB5. Do you have any comments on this suggestion? If you do, please place them in the box below.

Sugestion2: Evaluating Schedules

Transport authorities and travelers' associations suggest assessing the practical feasibility of schedules. Schedules need to be Specific, Measurable, Achievable, Realistic, Time-bound (SMART) and need to be evaluated in advanced.

SB11. What do you think about the added value of this suggestion concerning the desirability of the measures in the category reliability/travel time? Does it have a:

a Very positive added value
b Somewhat positive added value
c No added value
d Somewhat negative added value
e Very negative added value.

SB12. What do you think about the added value of this suggestion concerning the feasibility of the measures in the category reliability/travel time? Does it have a:

a Very positive added value
b Somewhat positive added value
c No added value
d Somewhat negative added value
e Very negative added value.

SB13.What do you think about the added value of this suggestion concerning the importance of the measures in the category reliability/travel time? Does it have a:

a Very positive added value
b Somewhat positive added value
c No added value
d Somewhat negative added value
e Very negative added value.

SB14. What do you think about the added value of this suggestion concerning the impact of the measures in the category reliability/travel time? Does it have a:

a Very positive added value
b Somewhat positive added value
c No added value
d Somewhat negative added value
e Very negative added value.

SB15.Do you have any comments on this suggestion? If you do, please place them in the box below.

Suggestion 3: Additional Personnel and Equipment

With respect to the measure transfer guarantees transport companies have suggested additional personnel and equipment in cases of major disturbances. These can be deployed in case of these major disturbances.

SB16. What do you think about the added value of this suggestion concerning the desirability of the measures in the category reliability/travel time? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SB17. What do you think about the added value of this suggestion concerning the feasibility of the measures in the category reliability/travel time? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SB18. What do you think about the added value of this suggestion concerning the importance of the measures in the category reliability/travel time? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SB19. What do you think about the added value of this suggestion concerning the impact of the measures in the category reliability/travel time? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SB20. Do you have any comments on this suggestion? If you do, please place them in the box below.

Reliability/Travel Time

Assessment round 2

Measure 1: Transfer guarantee

RA1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

RA2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

RA3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

RA4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Reliability/Travel time

Measure 2: Express services

RB1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

RB2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

RB3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

RB4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Information provision

Assessment round1

The measures in this category are focused on information provision, more particular on information prior to departure and information in the bus.

Measure 1: Availability of information

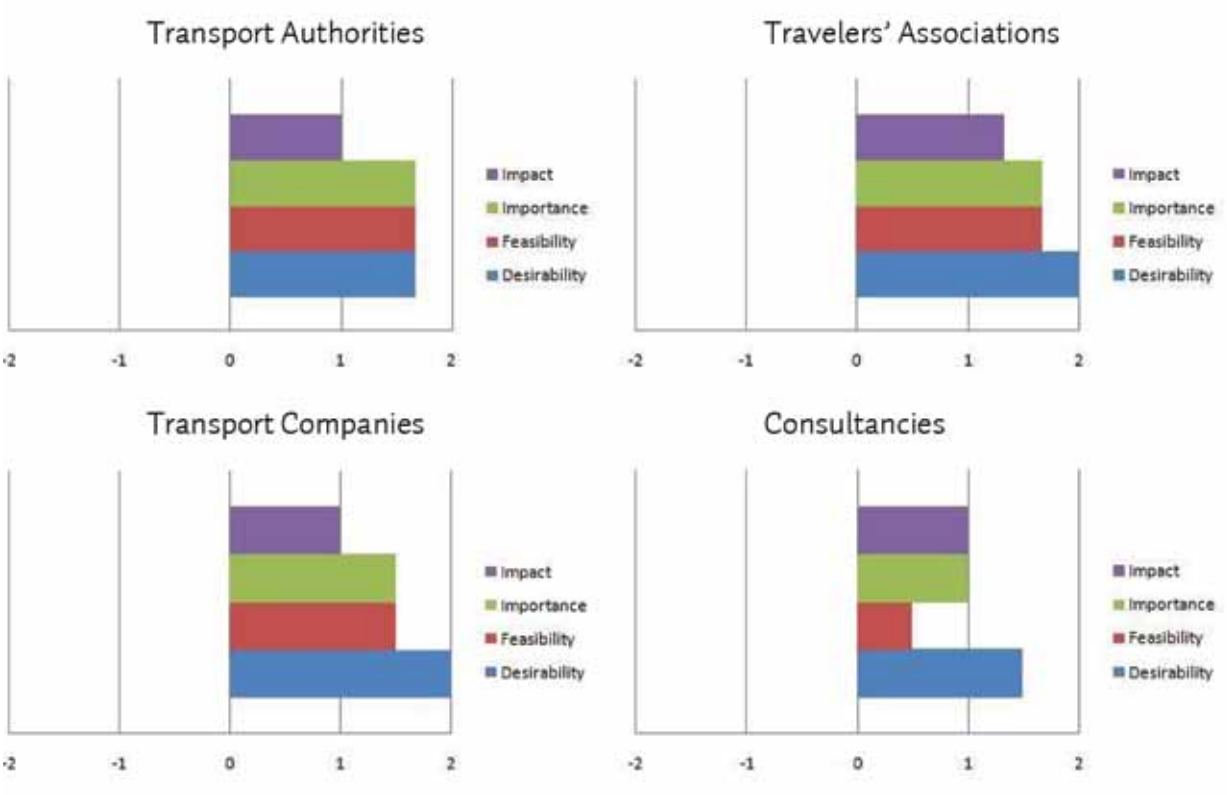
Travelers need to have the opportunity to seek PT information trough all channels. This means that real-time and planned departure times need to be available through:

» Cellular phones: Nowadays applications can be downloaded on cellular phones. This means that transit operators (or other parties) can offer software that can help the traveler prior and during their trip. GPS-equipped devices can also benefit from a PT navigation system. This system guides the traveler during the access trip, transfers, bus trip, and egress trips. This navigation is important in unknown areas.

» Telephone line: passenger need to be able to call and receive travel information.

» Internet: Interactive GIS-based applications can be used to give the traveler a clear overview of the alternatives.

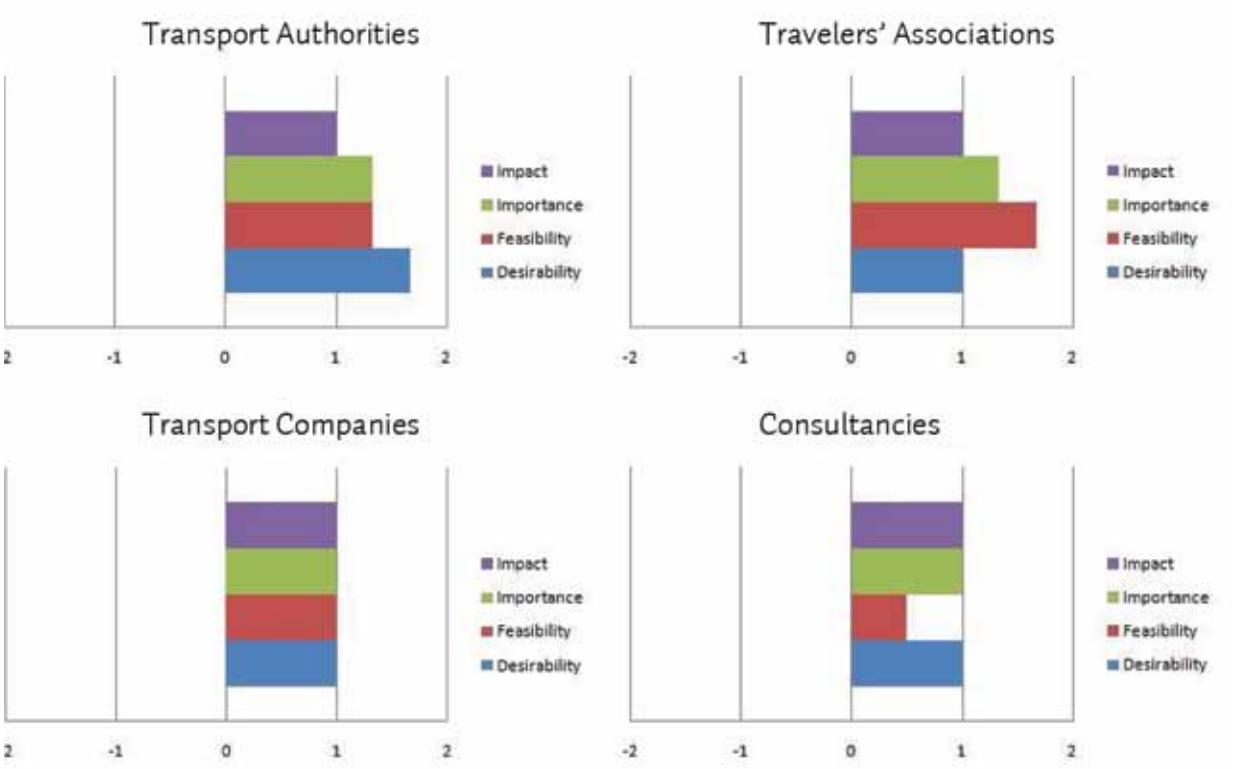
» Television: Tele text can be used to provide real-time information on alternatives in the vicinity of the traveler. Increasing use of digital television, other options become available like MHEG-4 and DVB-MHP, which offer more interactive possibilities than teletext.



Information Provision

Measure 2: Information in the bus

Real-time information is offered in the bus about the current trip and the transfer possibilities. Information about the current trip needs to contain information about the following bus stops, the estimated time of arrival, and when one needs to off-board the bus to reach points-of-interests. Finally, actual news needs to be provided on the on-board screens.



Comment

Consultancies: The current modern standard (automatic stop announcement in buses and dynamic departure times at frequently used stops) are a good start. It is better to perfect this technology prior to the deployment of new systems that do not work accurately.

Travelers' Associations: the improvement of the current static information at nodes can lead to significant results.

Information Provision

Reaction

Do you have a reaction on the ratings and/or the comments in the category information provision? If you do, please place your reaction in the box below

Information Provision

Suggestions

During the first round travelers' associations and transport authorities have given a number of suggestions to improve the measures in this category. You are now offered the opportunity to assess these measures.

Suggestion 1: Dynamic information at bus stops

Travelers' associations and transport authorities suggest installing advanced traveler information systems (ATIS) at all bus stops as an improvement for the measure availability of information. The traveler is offered real-time information on the arrival times of vehicles.

SI1. What do you think about the added value of this suggestion concerning the desirability of the measures in the category information provision? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value

SI2. What do you think about the added value of this suggestion concerning the feasibility of the measures in the category information provision? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SI3. What do you think about the added value of this suggestion concerning the importance of the measures in the category information provision? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SI4. What do you think about the added value of this suggestion concerning the impact of the measures in the category information provision? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SI5. Do you have any comments on this suggestion? If you do, please place them in the box below.

Information Provision

Assessment round 2

Measure 1: Availability of information

RC1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

RC2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

RC3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

RC4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Information Provision

Measure 2: information in the bus

RD1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

RD2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

RD3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

RD4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

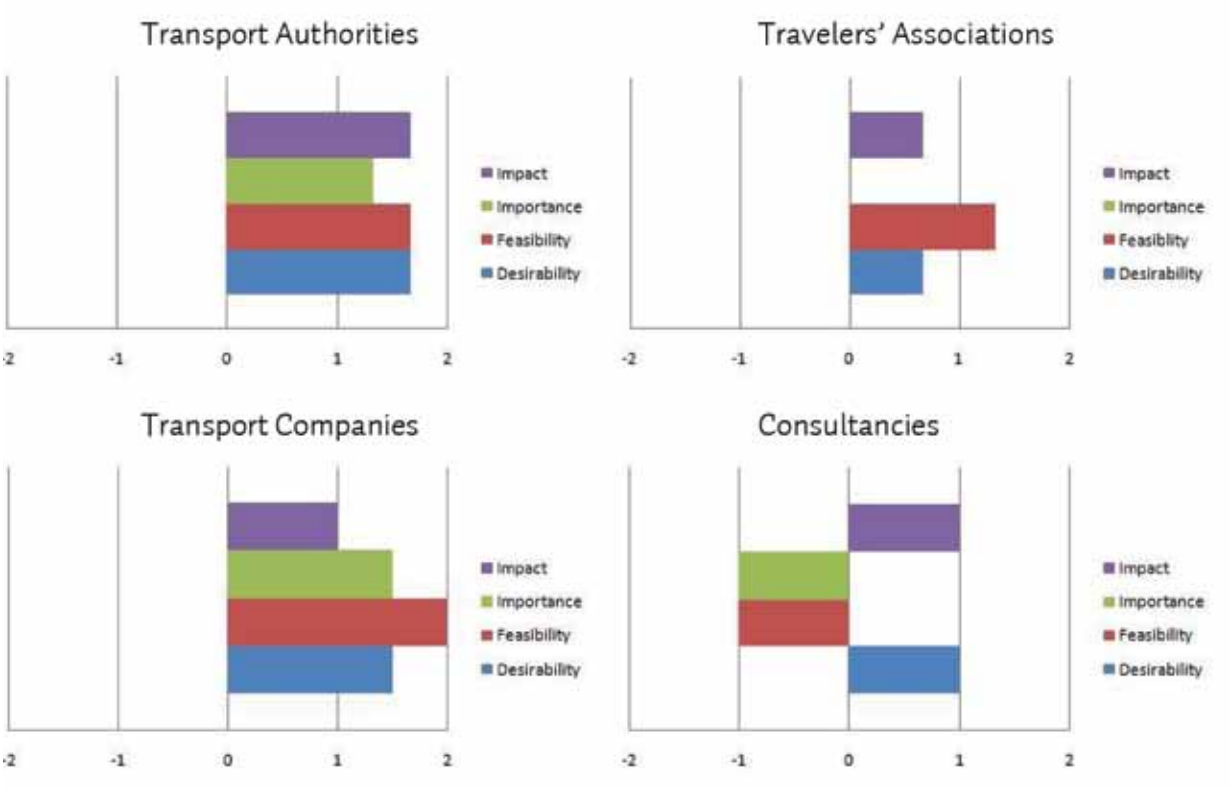
Attractive Fares

Assessment round1

The measures in this category are focused on attractive fares, by applying business-to-business strategies and rewarding the passenger for using PT.

Measure 1: Business-to-business strategies

Transport operators offer tailor-made discount packages to employers, after which employers provide or sell these packages to their employees. Transport operators can also offer tailor-made discount packages to event organizers. This can be integrated soccer tickets.



Comment

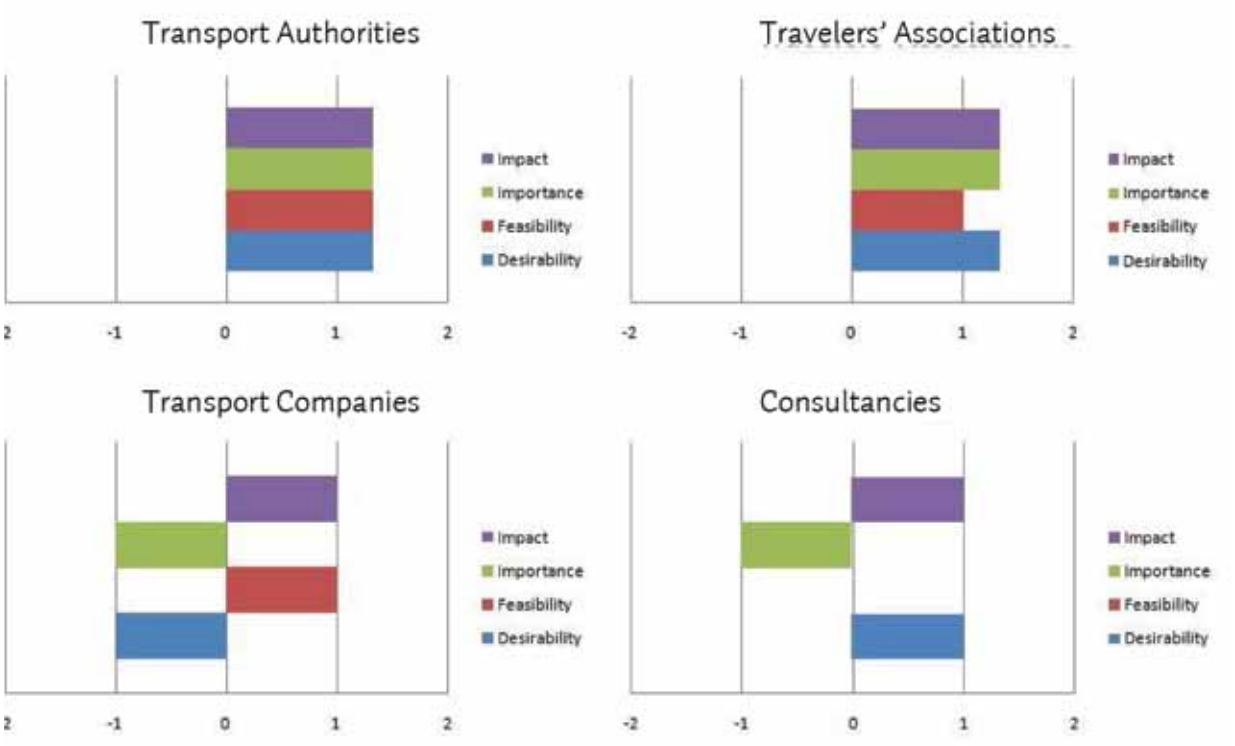
Consultancies: A forest of discount fares has negligible effects. Most travelers barely know what their trip costs with the OV chip card (the same is true for the strip card moreover)

Travelers' associations: It is good if event travelers can use PT for free, but these travelers cannot be bound.

Attractive Fares

Measure 2: Rewarding passengers

There are several ways to reward passengers for their use of PT. First, a fare capping system can be introduced. This means that the passenger pays for a maximum number of trips or that the passenger pays a maximum fare time interval. Secondly, loyalty programs can be used where the passenger is rewarded points for travelling with PT. These points can also be used to purchase products outside the PT sector.



Attractive Fares

Reaction

Do you have a reaction on the ratings and/or the comments in the category information provision? If you do, please place your reaction in the box below

Attractive Fares

Suggestions

During the first round transport authorities, travelers' associations, transport companies and consultancies have given two suggestions to improve the measures in this category. You are now offered the opportunity to rate one of these suggestions.

Suggestion: Easy rates

Transport companies, transport authorities, travelers' associations and consultancies suggest easy rates. The success of these rates can be largely attributed to easy paying than to affordability. Examples are €1,- and €2,- tickets. These easy rates need to be pretested with the target group prior to implementation. Besides this, travelers do not have to be bothered by differences between concessions.

SA1. What do you think about the added value of this suggestion concerning the desirability of the measures in the category attractive fares? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value

SA2. What do you think about the added value of this suggestion concerning the feasibility of the measures in the category attractive fares? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SA3. What do you think about the added value of this suggestion concerning the importance of the measures in the category attractive fares? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

Very negative added value.

SA4. What do you think about the added value of this suggestion concerning the impact of the measures in the category attractive fares? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SA5. Do you have any comments on this suggestion? If you do, please place them in the box below.

Attractive Fares

Assessment round2

Measure 1: Business-to-business strategies

RE1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

RE2 What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

RE3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

RE4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Attractive Fares

Measure 2: Rewarding passengers

RF1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

RF2.What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

RF3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

RF4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

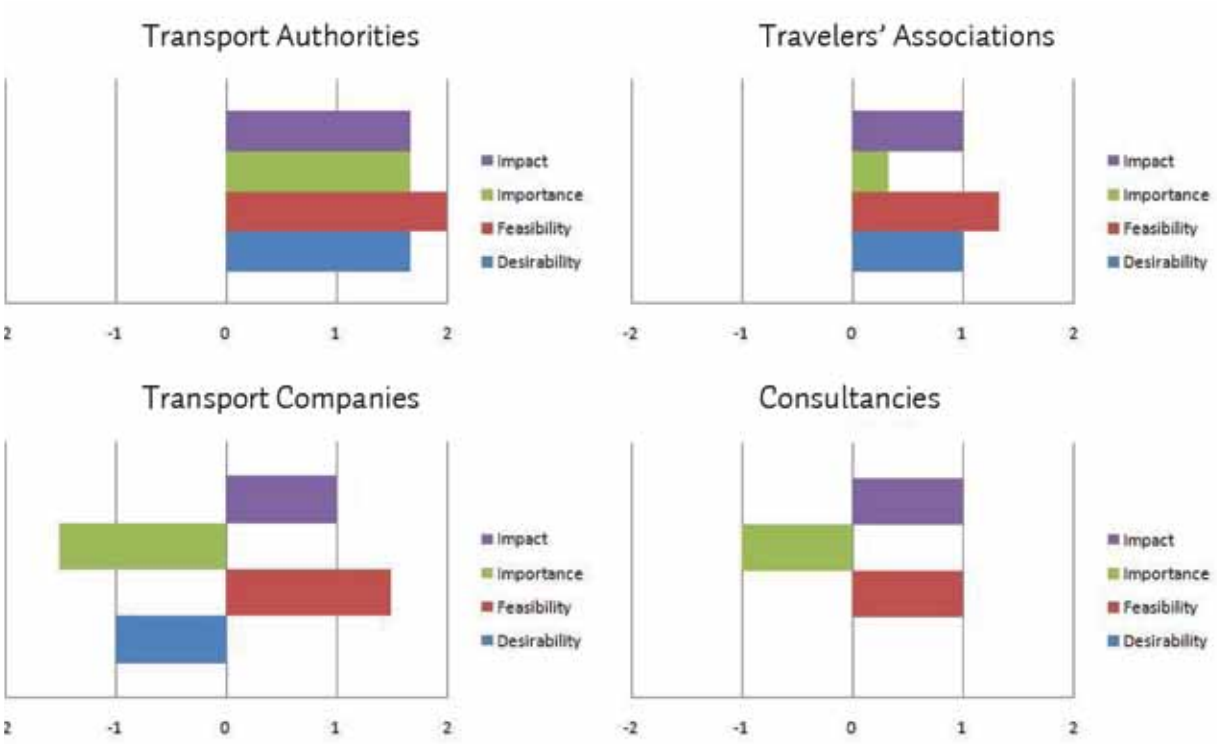
Reputation of public transport

Assessment round 1

The measures in this category are focused on improving the reputation of public transport.

Measure 1: Paint schemes

The external appearance of buses can be made attractive by giving the buses a paint scheme that is coherent with the area in which the buses operate. The buses can also be given names of community hero's, national heroes or celebrities. Buses also need to be labeled as a green transportation mode, where the environmental advantages of the bus against that of the car is made clear. The environment is becoming increasingly important for the society and this opportunity needs to be grasped.



Comment

Consultancies: The sector has to emphasize les show unsafe PT is. This does generate money from the government for that many series of safety projects and helps the management to score with the personnel, the board, and the Union, but it is fatal for the reputation of PT.

Transport companies: Reputation means that transport companies only need to focus on their core business and be good doing it.

Reputation of public transport

Measure 2: Media relations

Relations with the media need to be developed and maintained intensively. Negative news ends up easily in the media; positive news however does not reach the media by itself that often. One needs to use free publicity as much as possible. This can be done by sponsoring events in a community or offering service to community events. Transport operators can also work with tourist offices to promote the use of regional bus lines to recreational areas.

Reputation of public transport

Reaction

Do you have a reaction on the ratings and/or the comments in the category information provision? If you do, please place your reaction in the box below

Reputation of Public Transport

Suggestions

During the first round transport companies, travelers' associations and transport companies have suggested a number of improvements in the category reputation of public transport. You are now offered the opportunity to rate one of these suggestions.

Suggestion: Pro-PT campaign

Travelers' associations suggest a consistent pro- PT marketing campaign entailing informational campaigns that illustrate what the PT-network has to offer, that confirm the choice of PT users and that allow people to experience public transport free of charge or against a reduced fare. Besides this one needs to publish the campaigns and make clear how the government and the private sector are working on improvements in the future.

SM1. What do you think about the added value of this suggestion concerning the desirability of the measures in the category image of public transport? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value

SM2. What do you think about the added value of this suggestion concerning the feasibility of the measures in the category reputation of public transport? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SM3.What do you think about the added value of this suggestion concerning the importance of the measures in the category reputation of public transport? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SM4.What do you think about the added value of this suggestion concerning the impact of the measures in the category reputation of public transport? Does it have a:

a Very positive added value

b Somewhat positive added value

c No added value

d Somewhat negative added value

e Very negative added value.

SM5. Do you have any comments on this suggestion? If you do, please place them in the box below.

Reputation of public transport

Assessment round 2

Measure 1: paint scheme of buses

RG1. What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

RG2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

RG3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

RG4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Reputation of Public Transport

Measure 2: media relations

RH1.What do you think about the desirability of this measure? Is it:

a Very desirable

b Desirable

c Undesirable

d Very undesirable

RH2. What do you think about the feasibility of this measure? Is it:

a Absolutely feasible

b Possibly feasible

c Possibly unfeasible

d Absolutely unfeasible

RH3. What do you think about the importance of this measure? Is it:

a Very important

b Important

c Unimportant

d Very unimportant

RH4. What kind of impact do you think that this measure has on ridership levels?

a Strong increase

b Some increase

c Some decrease

d Strong decrease

Wrap up

These were all the questions. Thank you very much for your cooperation, he answers will be processed.
If you wish to receive the results of the Delphi research, please let us know via an e-mail to Ray Bodok.

VII. Round 2 Detailed Results

Category 1: Reliability/ Travel time

Figure C.6- Figure C.10 show the assessment of the suggestions and measures in the category reliability/Travel time.

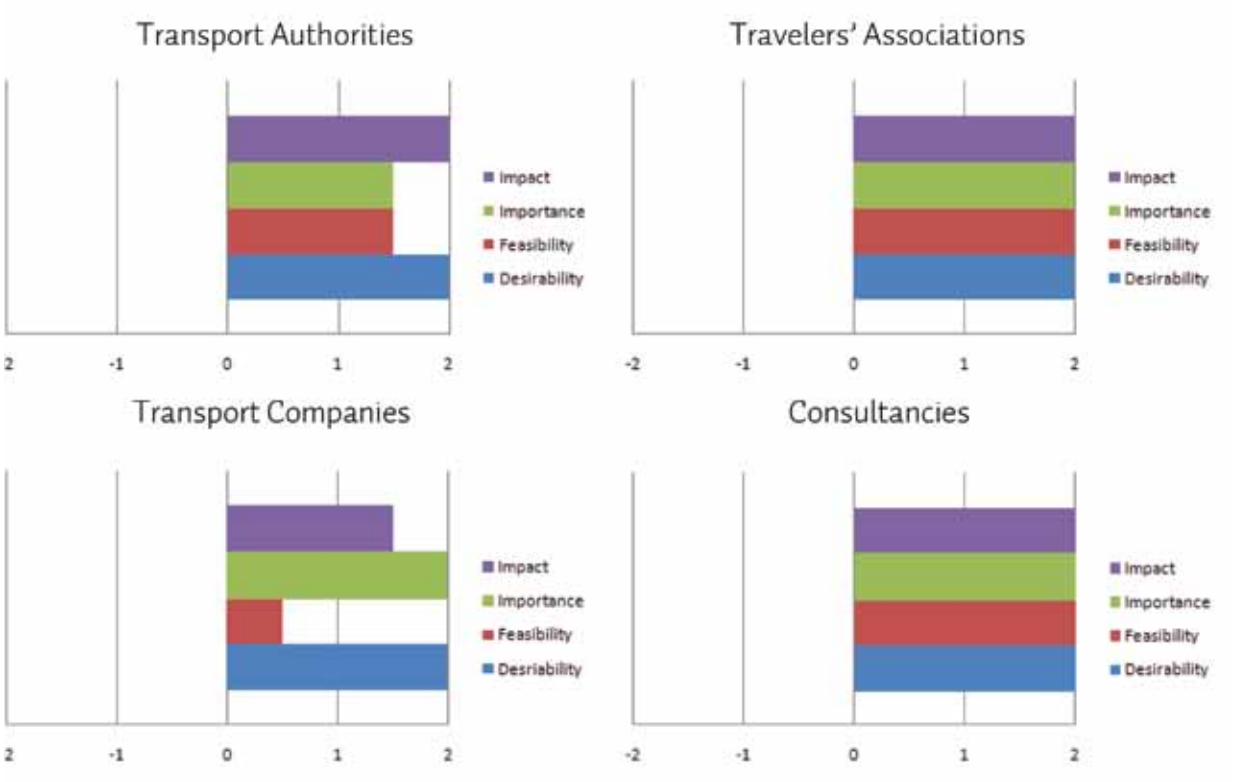


Figure C.7: throughput measures

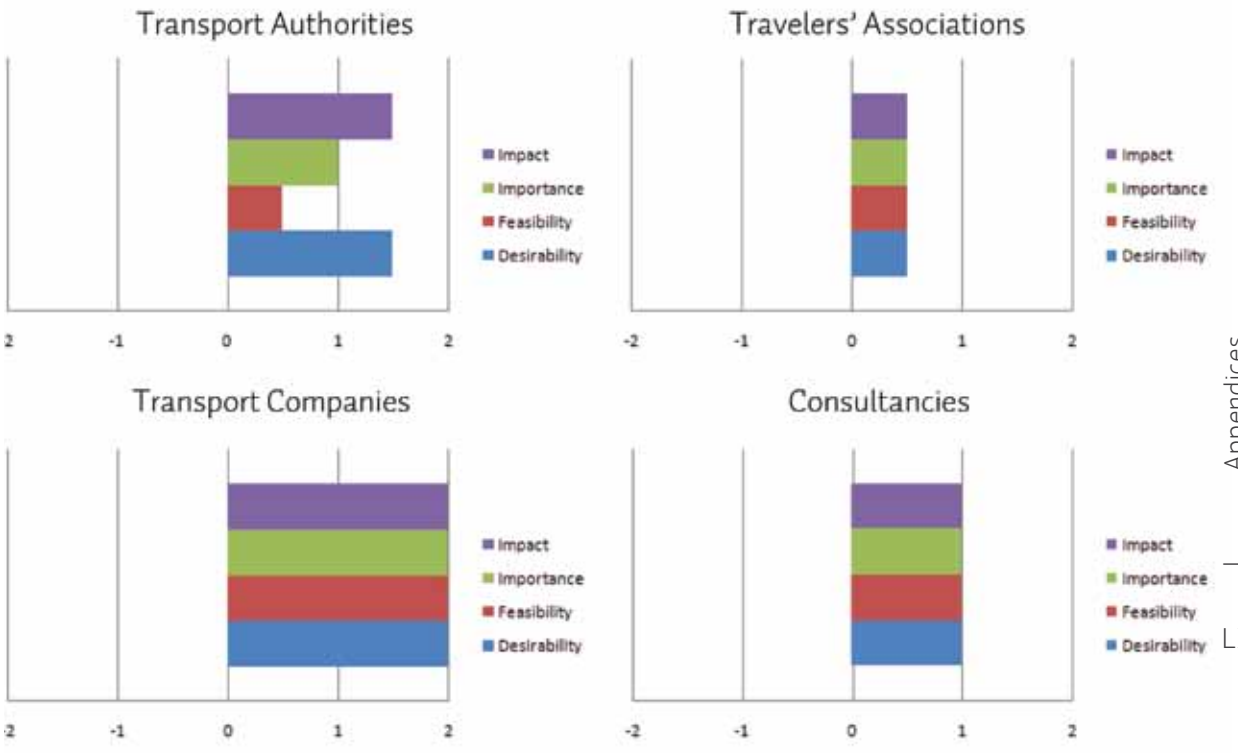


Figure C.8: evaluating schedules

Figure C.9: additional personnel and vehicles

Figure C.10: Transfer Guarantees

Figure C.11: Express services

Category 2: Information provision

Figure C.11- Figure C.14 show the assessment of the suggestions and measures in the category information provision.

Figure C.12: Dynamic information at stops

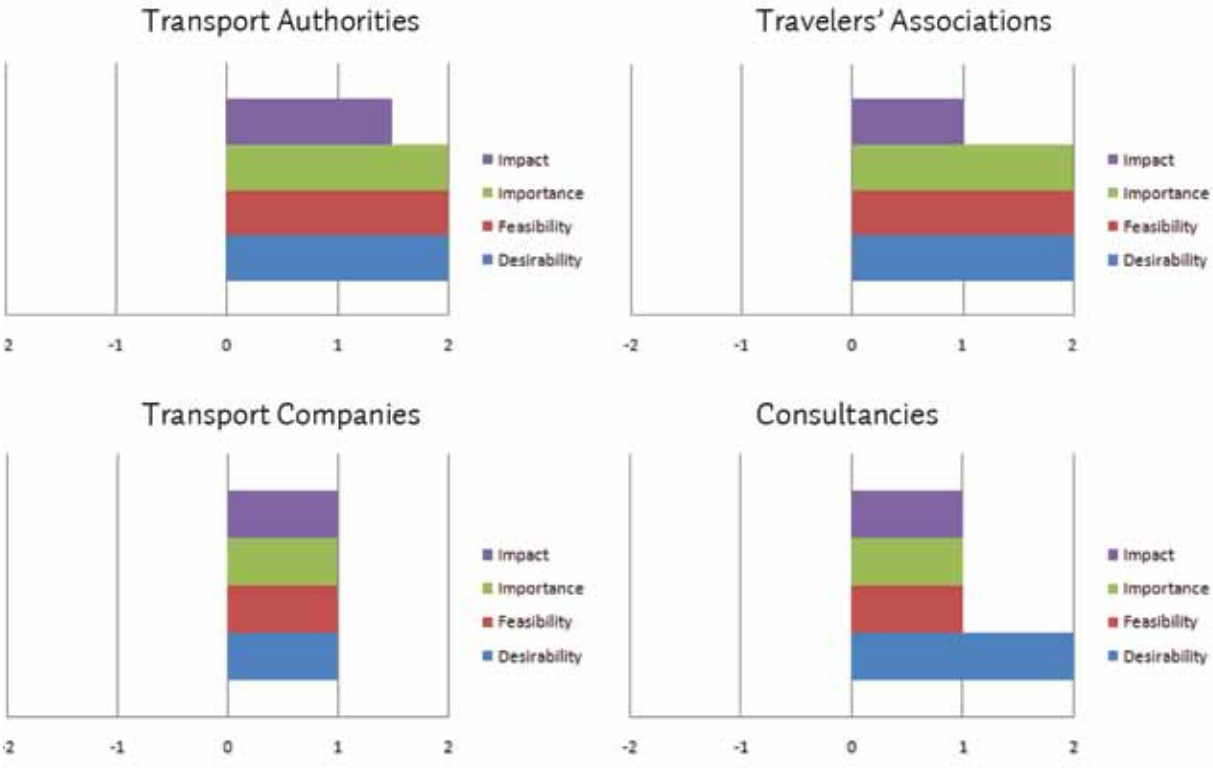


Figure C.13: Availability of information

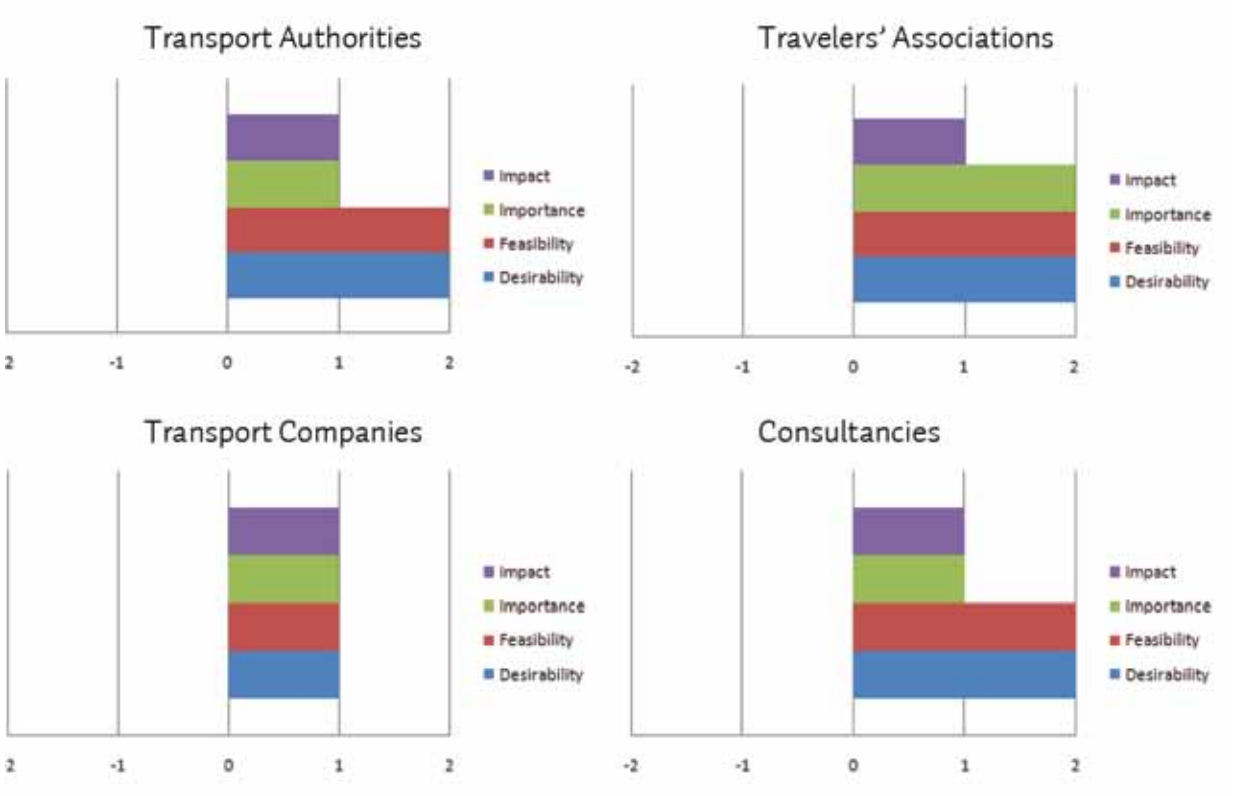


Figure C.14: Onboard Information

Category 3: Attractive Fares

Figure C.14-Figure C.17 show the assessment of the suggestion and measures in the attractive fares category.

Figure C.15: Easy fares

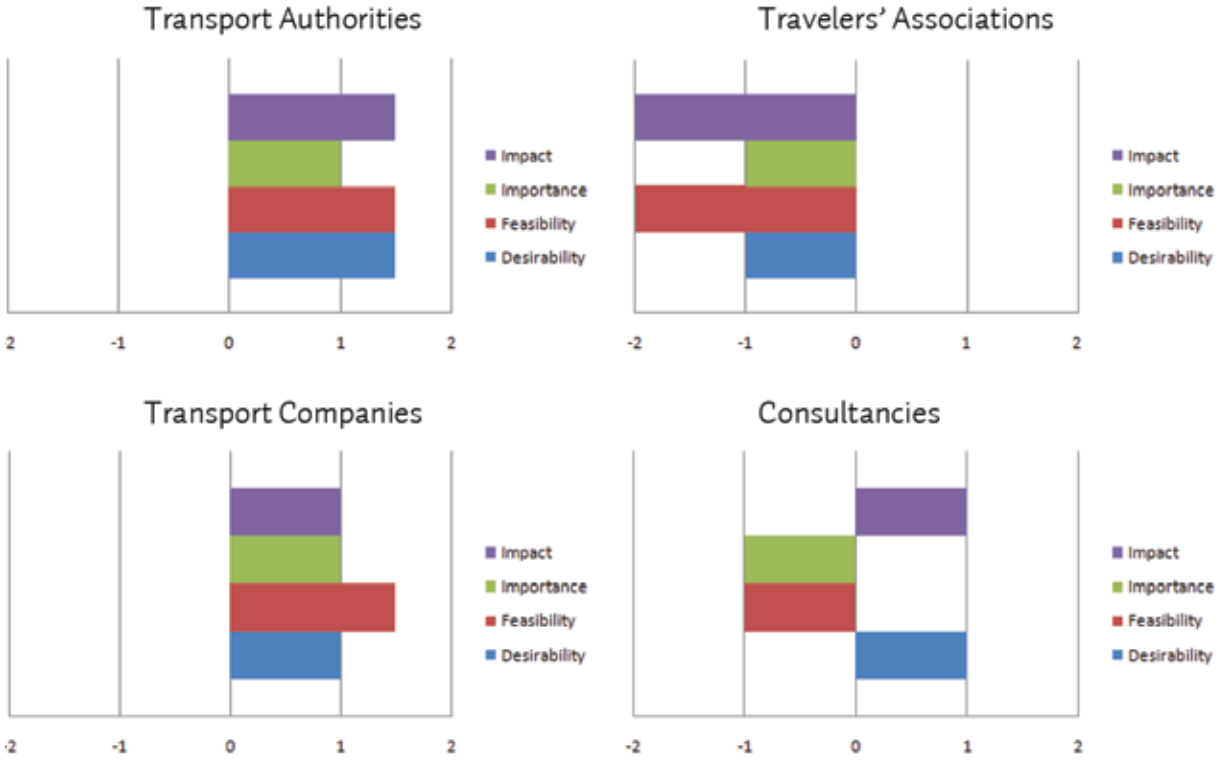


Figure C.16: Business-to-Business strategies

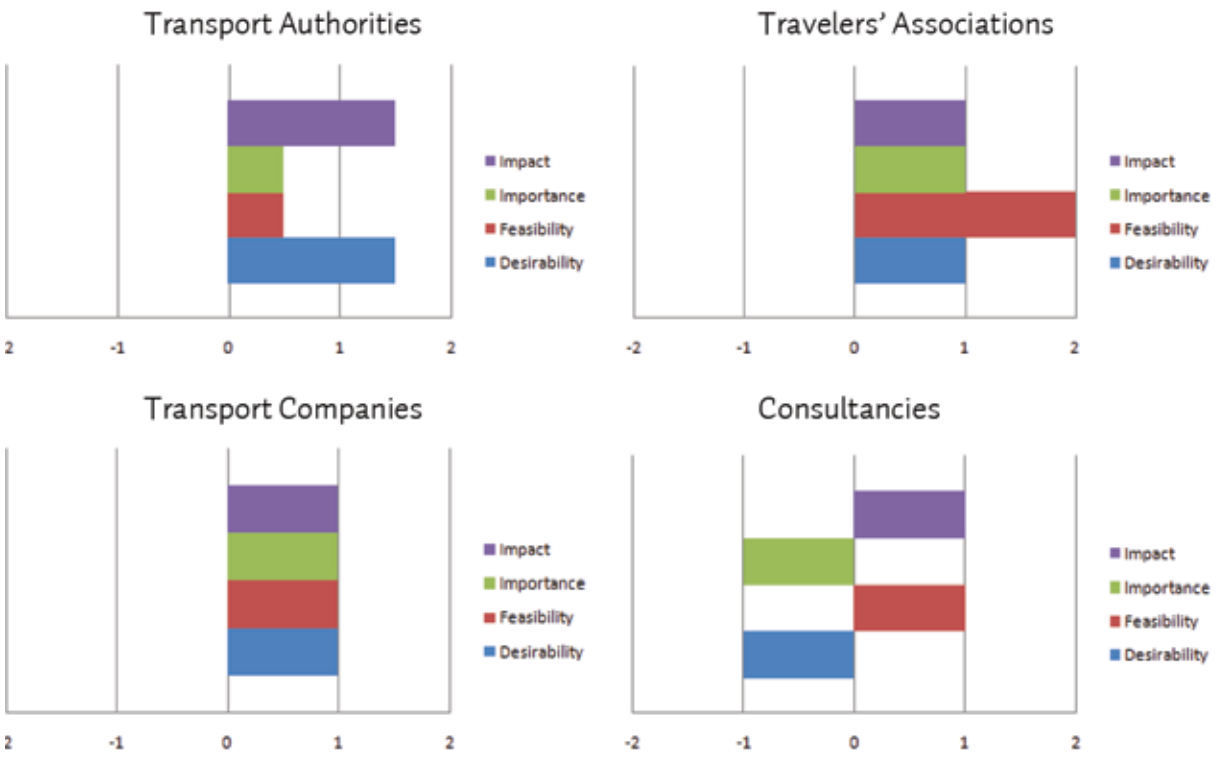


Figure C.17: Rewarding passengers

Category 4: Image of Public Transport

Figure C.17-Figure C.20 show the assessment of the suggestion and measures in the reputation of public transport category.

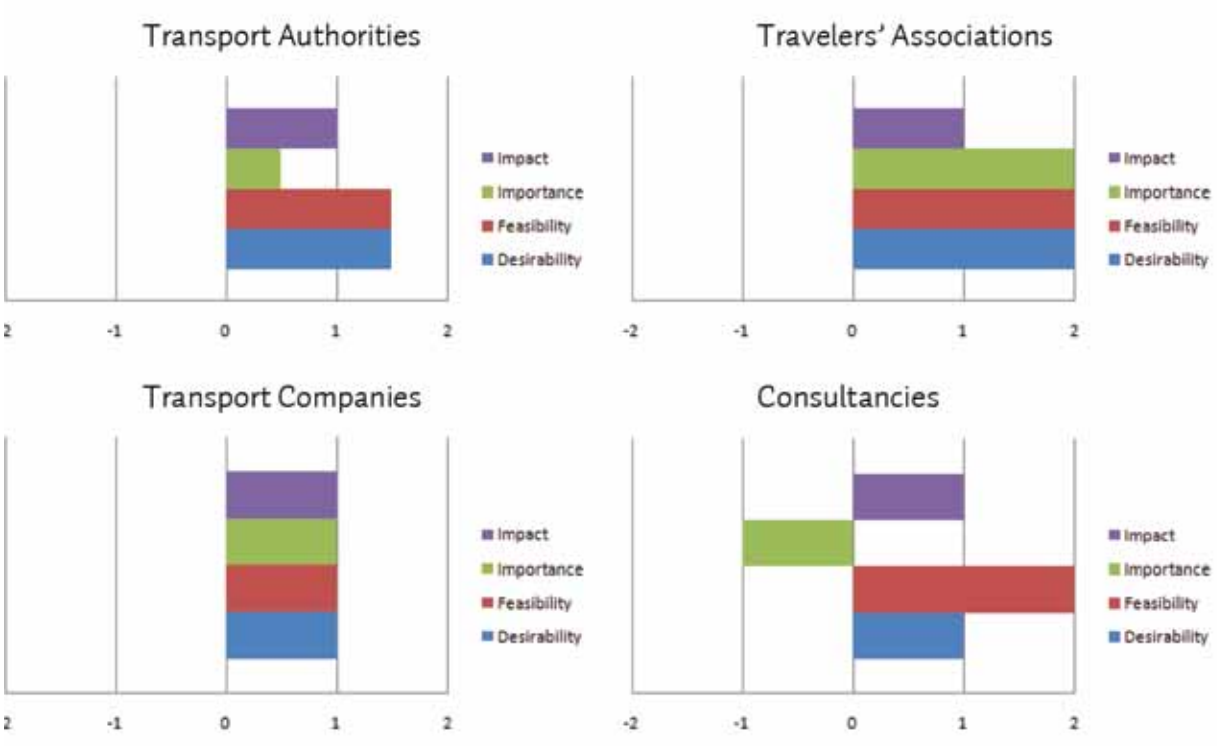


Figure C.18: Pro PT campaign

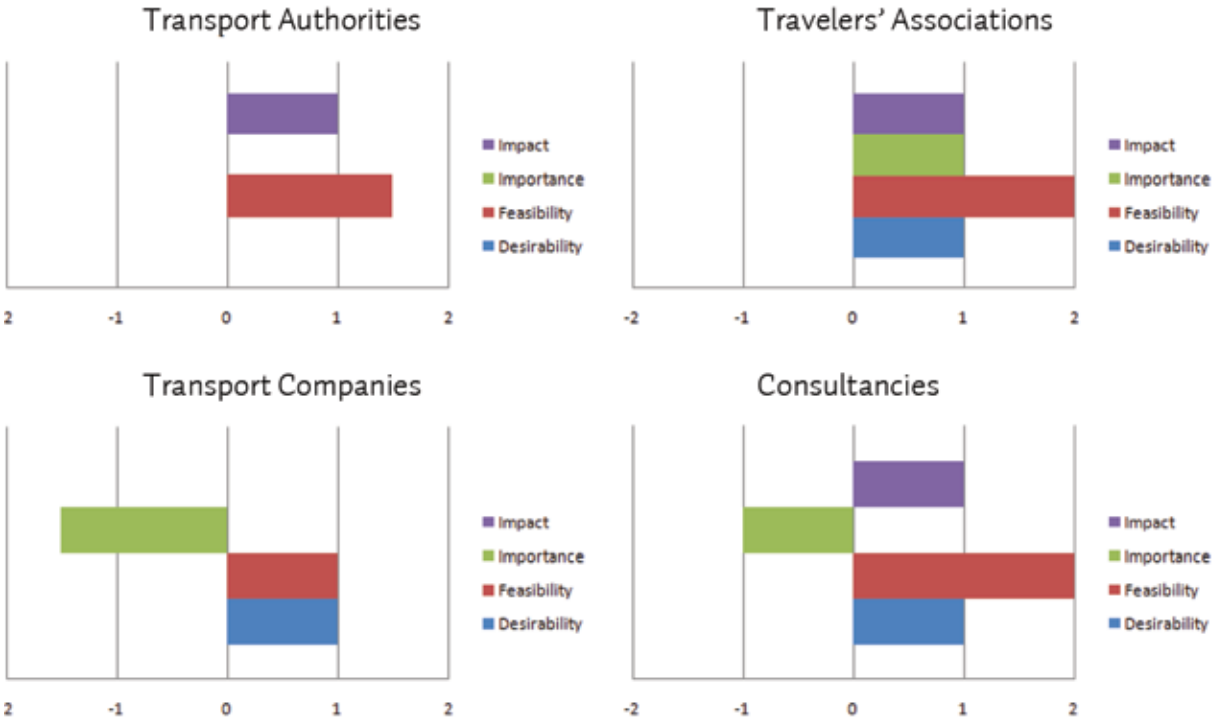


Figure C.19: Paint Schemes

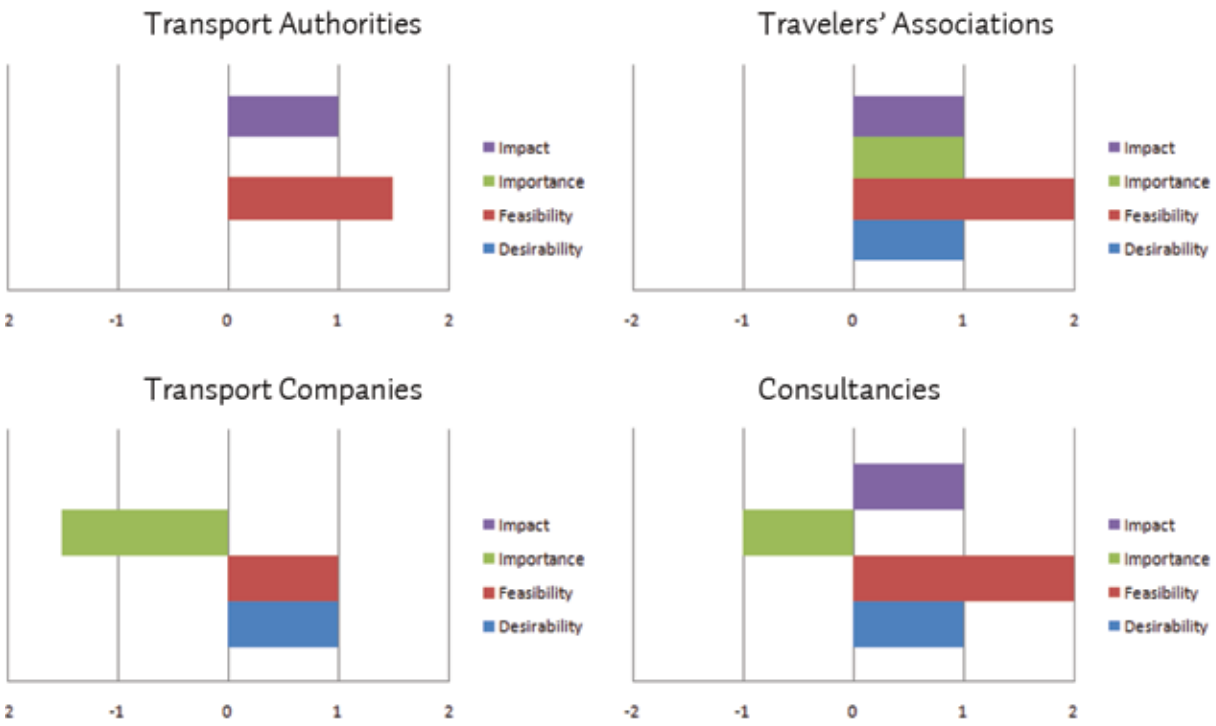


Figure C.20: media relations

D. Appendix Quantitative Analysis

Table D.2: Bus Stops per Symbolic Town

Town	Stop name
A	A_1
	A_2
	A_3
B	B_1
	B_2
	B_3
	B_4
C	C_1
D	D_1
E	E_1
	E_2
	E_3
	E_4
	E_5
	E_6
	E_7
F	F_1
	F_2
	F_3
	F_4
	F_5
G	G_1
	G_2
H	H_1
	H_2
I	I_1
	I_2
	I_3
	I_4
J	J_1
	J_2

Layout by Eva Bodok