# *Travel Information Provision for the traveller in Public Transport. Can it be improved?*

*Master's Thesis*

Final Rapport

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# Preface

After more than ten years of studying civil engineering, this report closes my study career and my period as a student. My study started at the secondary school in Breda, where I first learned the practical part of Civil Engineering. After four years of studying, bricklaying, and designing, I went to a high school in 's-Hertogenbosch were I gained more detailed knowledge about civil engineering. After completing the high school in three years, the area of transportation gained my interest. I wanted to learn more about transportation engineering and therefore I started with the education of transportation engineering at the University of Twente in Enschede. After three years of master courses, I began working on my master's thesis program at InTraffic in Nieuwegein.

This report will describe almost a year of research concerning travel information provision in public transportation. Public transportation always had a positive interest on me and therefore, this research provide me with the opportunity to execute my master's thesis on a subject which really interests me. A lot of people see public transportation as an inferior mode of transportation compared to the car because of i.e. prizes and delays. My vision of public transportation has always been more positive and I find it interesting to look at innovative possibilities to improve the attractiveness and quality of public transport.

I would like to thank everyone who devoted some of their time to participate on my experiment at Intraffic. Furthermore, a thank you goes to all of the interviewees who all helped me a lot in collecting sufficient and usable information about the world of public transportation. Next, I would like to thank my supervisors, Marieke and Jing, from the University of Twente for providing me with the necessary feedback to successfully complete my thesis on an academic level. Two people who helped me a lot during my graduation period, where Gerard and Roelof. From the moment I started at InTraffic, I always had a positive feeling about graduating at InTraffic and both of them provided me with the needed support and feedback.

Although all of those people helped me a lot during my graduation process, there are two people who have always where there for my whole life. Therefore I wish to specially thank both of my parents who always provided me with advice and support regardless I was at secondary school or at the University. Without them, I would never have completed my Master of Civil Engineering.

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Joris Eveleens Maarse

# Abstract

Travel information provision for the traveller in public transport is becoming increasingly more important in today's world. In the last ten to fifteen years, a shift has been noticed from mainly static travel information to dynamic travel information. Personal travel information is rapidly becoming more standard and the possibilities of modern mobile smart phones make travel information more accessible for travellers. Access to improved travel information increases the quality of public transport by decreasing the amount of uncertainty a traveller perceives. The location before and during the journey is an important aspect of the type of travel information a traveller desires. Three types of locations are identified to obtain travel information; home-based location, way-side location and on-board location. The travel information which travellers obtain is depended on the type of travel information media per location and therefore also depends on the source of information. Public transport organizations maintain and operate different types of travel information media per location whereby the travellers are mostly depended on the public transport organizations for travel information provision. Because of the availability of multiple public transport organizations, which provide travel information, the possibility exists that travellers obtain none, false or contradictory travel information which increases the uncertainty of travel information and therefore decreases the quality of public transport.

In the Netherlands, there are multiple public transport organizations active which produce, operate or provide travel information. Travel information systems do have an important influence on the quality of travel information provision for travellers and by looking at the overview of the complete travel information systems in the Netherlands, a good indication of the state of the travel information provision can be obtained. By conducting interviews with travel information experts, information is obtained about the state of the travel information provision. Experts from multiple public transport organizations were interviewed in order to obtain a complete overview of the travel information provision systems. With this information two complete data flow-chart (train and bus/tram) were created to indicate bottlenecks of the Dutch travel information systems. Information from the experts indicates that the travel information system in the Netherlands is reasonably outdated and organizations only seem to have interest in their own individual systems. Therefore it seems that there is no particular organization which takes responsibility for maintaining a complete overview of the total travel information system which has a consequence and instable travel information system. Together with the diffusion of public transport organizations and the public tender of concession areas, travel information provision in the Netherlands for public transport still has lot imperfections to improve which are not only soluble by using technical solutions, but also by improving the organizational structures.

InTraffic has developed a new type of travel information application called Triptipper whereby travellers can obtain personal and actual travel information in just one second. Travellers are provided with travel information based on their final destination. Travellers can input their destination, by postal code, by using numeric keypad, QR-code or OV-chip card. Once the traveller has inputted his or her destination, the Triptipper application provides the traveller with three possible travel advices to continue the journey based on the fastest possible options. Triptipper applications which are located on board of transportation mode provide the traveller with the best possible transfer location to alight. This Triptipper travel information provision systems makes, together with the conventional and mobile smart phone travel information systems, a total of three travel information provision systems. In order to determine the quality of the new Triptipper system, a test is necessary to compare the quality of the three travel information provision systems. Literature has stated that the quality of travel information provision system can be measured by time and effort savings. In order to use these two indicators, an experiment must be applicable to execute including these two indicators. After analyses of several types of experiments, the Serious gaming experiment has been chosen.

The Serious gaming experiment exists of the simulation of a real journey on a physical basis. Participants of the experiment execute a journey in a room with multiple partially closed spaces. These spaces represent a specific location during a journey whereby the available travel information which is provided at the real location is simulated at that particular space. By using six different spaces, a complete journey with public transportation can be simulated whereby the same type and amount of travel information is provided as in the real journey. Computer displays, timetables, public address systems and mobile phones are some of the travel information media which are simulated to replicate a real journey. 18 participants have executed the experiment whereby they make three types of journeys and with the execution of each journey, they use one of the three travel information provision systems. The participants were asked to execute the journey as quickly as possible by obtaining the correct travel information. Information concerning the measurements of time (perceived and actual) and effort where obtained to determine the quality difference between the three travel information provision systems.

Results show that there are not many differences between the three travel information provision systems. Perceived searching time however does show a significant difference with the mobile smart phone information provisions system in favor of the Triptipper system. Results also show that the participants needed more time and effort to obtain their travel information at transfer locations for all systems which is in accordance with literature. Participants do mention that they perceive Triptipper as a usable alternative when obtaining travel information, though they wish they can obtain more information about the complete journey to decrease uncertainty.  It can be assumed that Triptipper does show it has future possibilities to satisfy the desires of travellers in public transport by providing them with personal, reliable and accessible travel information. Recommended improvements to the current design of Triptipper are: providing more information about the remainder of the journey per Triptipper application and provide not only travel information for public transport but also in large public and commercial buildings to really improve actual door to door travel information.

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# 1 Introduction

*Chapter one provides an overview of travel information for public transport in the Netherlands, Subsequently, the problem and the scope of the research is described, followed by the objective and the research questions. The latest part of this chapter describes the methodology used during this research.*

## 1.1. Public transport in the Netherlands

### *1.1.1. Multiple transport organizations*

In transport, private and collective transportation can be distinguished. Collective transportation can be separated into private bus-, taxi-, water taxi- and public transport. Public transport has the highest share of collective transport and is therefore, next to car transport, an important factor for the logistics in the Netherlands. Bus, train, tram and metro belong to the four major transportation modes in the Netherlands, wherein the train mostly covers the long distance transportation and most other transport modes have a more regional or urban function. In the last twenty years, the public transport sector has been privatized wherein initially the government has controlled most of the public transport activities. The government still has a large share in some major transport organizations in order to still have some influence. However the privatization has resulted in multiple organizations, which together manage the majority of the public transport in the Netherlands. In 2007, travellers in public transport consumed 6.4 billion seat miles[1] which forms a percentage of 7.3% of the total transport[2] in the Netherlands and the public transport is being managed by more than twelve large public transport organizations.

### *1.1.2. Public transport as an transport alternative*

The Netherlands forms a small country with a high population density and which has a high road network density. The intensity of the roads is growing which results in traffic jams and which leads to negative effects on the environment and on the economy. For many years organizations and governments are trying to persuade the traveller to make use of public transport rather than of the car (private transportation). From the customer's viewpoint, the quality of public transport is not high enough, which prevents the public transport system from being an attractive alternative to replace travelling by private car (Grotenhuis, Wiegmans & Rietveld, 2006). Therefore the quality of the public transport has to increase in order to attract more travellers to make use of public transport. One of those quality aspects of the public transport is travel information for the traveller.

[1]Unit for the distance an individual traveller covers with an certain transportation mode
[2]Number derived from CBS (Centraal Bureau voor de Statistiek)

## 1.2. Travel information

### *1.2.1. Travel information in the Netherlands*

Travel information is becoming increasingly important these days and travellers are continuously depending on the provided travel information. Reliable and actual travel information will increase the likelihood that travellers reach their destinations on time. Timely arrival of people and goods at their destination mostly results in financial benefits. Nowadays however, getting people and/or goods at their destinations in time can be a huge challenge. Therefore reliability of the predicted travel time becomes more important so that the appropriate action can be taken. This is one of the reasons that the Dutch government has stated in the 'Nota Mobiliteit 2004' that reliability of travel time is as important as providing the actual travel time.

In the last few years travel information in the private transport sector has become an important issue in today's society. The use of in-car navigation devices has therefore grown rapidly to almost 60% of the cars in some European countries. Car navigation systems make it easier for car drivers to determine the shortest route and to receive traffic jam information. This kind of information allows drivers to act according to the provided information by choosing an alternative route if possible.

Road signs though are still an indispensable source of travel information for the driver. Where most road signs display static travel information, dynamic route signs provide the driver with actual travel information. Dynamic road signs and car navigation provide, besides static travel information, also dynamic travel information in such a way that car drivers can make optimal decisions based on the provided information to continue their journey in an ideal way.

### *1.2.2. Travel information in public transport*

While car navigation has been providing actual travel information for more than ten years, actual travel information in public transport has only recently becoming more important in the Netherlands. Large disturbances on the railways during the 2010/2011 winter periods and the increased use of personal mobile communication, has resulted in a high demand for better and reliable travel information. For many years the printed timetables and information that was provided near the tracks or bus stops were the only methods for travellers to obtain travel information. Static, unimodal[3] and impersonal travel information were for many years the only kind of information travelers could obtain. In the last few years there have seen a rapid growth of smart phones with internet connection. This combination provides the traveller with actual and personal travel information and thereby increases the possibility for travellers to collect the necessary travel information.

With the increasing number of options for traveller, there are many media sources where travelers can obtain their travel information. Online travel planners, platform signs, broadcast systems and ceefax are some examples of the possibilities travellers have to collect their necessary travel information. However the possibilities for travellers to consult specific media for travel information depends on their stage of the journey. It used to be standard that at home other media can be consulted to obtain travel information as when a traveller is waiting for his train or bus on a platform. In recent years, this 'hard' separation of location based travel information provision has faded by the arrival of the mobile smart phone with internet. Nowadays it is almost always possible to obtain the same amount of travel information when travellers are at home and when they are travelling if they have the availability of a mobile smart phone with an internet connection.

Travel information is becoming increasingly more important and the need for improved travel information is rising. Travel information provisions for the traveller have undergone substantial changes in the last decade, but current and near future technologies allow improving the quality of the travel information for the traveller in the coming years.

[3] Single mode of transportation (van Dale Dictionary)

## 1.3. Problem definition

### *1.3.1. Travel information distribution*

There are different possibilities for travellers to obtain travel information, but not every travel information provision (TIP) system provides the same information to the travellers. The source of the data differs in dependence from the mode of transport, data detection method, transport organization, etc. Public transport operators produce and/or collect travel information on national, regional and local level. The presence of multiple transport operators has influence on the travel information that is provided to the traveller. A good example is the travel information service on the railways in the Netherlands. It is particular a point of discussion between the two major transport players, NS (Dutch Railway; the mayor train operating company) and ProRail (the company managing the Dutch rail infrastructure). Together they control and operate the major part of the railway network in the Netherlands and they have different systems to provide travel information to the traveller.

### *1.3.2. Multiple players involved in travel information provision*

Besides in the railway network also in the field of bus- and tram transportation, there are multiple players active so that there are automatically multiple players involved in the provision of travel information for the traveller. Whereas ProRail manages the infrastructure of the railways, the infrastructure for bus- and tram transportation is mainly taken care of by the government. Local governments and Rijkswaterstaat partially manage the collection and distribution of travel information for private transportation, but they have also an important role to play in public transport travel information. Given that the infrastructure is an important element in the detecting and conveying of travel information, infrastructure managers have, besides transport operators, an important role to play in travel information provision. Besides the transport operators and the governments, travellers also have influence on the travel information provision. They are the end-users of travel information and therefore have influence on the desired output. Travellers do not only have the option to obtain travel information from the travel media which the government or the transport operators provide, but independent organizations also provide travel information for the traveller. This means that there are multiple players involved in travel information provision who all have a direct or indirect mutual connection. Large travel organizations, like NS, have got multiple divisions concerning travel information for their own. This means that the whole travel information provision system for public transport is made up of dozens of sub-systems to provide the traveller with the travel information.

As many organizations are involved in the passenger transport industry, the complexity of information flows has increased, with a multitude of different (sometimes competing) systems serving different tasks, dealing with different data formats from different sources. The difficulties in obtaining, managing and interpreting data from dispersed sources is a much more formidable challenge than the telecommunications systems used as delivery mechanisms (Lyons & Harman, 2002). Information systems are restricted to one transport operator and are insufficiently standardized. Hence, problems can occur during information exchanges of the concessionaires, integration of information between transporter operators on shared stops is difficult, and aggregation of information on national level is difficult to control. A lot of transport organizations act at their own initiatives which mean that everybody is re-inventing the wheel. Also there is insufficient cooperation between the organizations and there is no communication between multiple initiatives. (Letter: Ministerie van Verkeer en Waterstaat, 2008).

### *1.3.3. Travel information for the traveller*

From the customers 'viewpoint', the quality of public transport is not high enough, which prevents the public transport system form being an attractive alternative to travelling by private car. One of the factors contributing to the quality of public transport is travel information. Information provision on itself does not have the capability to persuade people to switch modes of transport, though in various studies this service has been indicated as important. Hence it can substantially contribute to the overall satisfaction with public transport quality (e.g. Balcombe, Mackett, Paulley, Prestion, Shires, Wardmann, White, 2004; Stradling, Hine, Wardmann., 2000a). For the traveller there are multiple media platforms available to obtain the required travel information, but not all media platforms are being managed by one transport organization. This situation creates the possibility that travellers obtain false or contra dictionary travel information because of the non-synchronized information.

Most travel information that is provided to the traveller is universal and therefore does not provide any personal travel information for the traveller. Consequently the traveller has to filter out his own personal travel information to continue his journey. This process of searching personal information and planning the journey will affect time- and effort savings of the traveller (Stradling et al., 2000b). Developing new TIP systems will therefore have to decrease the amount of time and effort savings to increase the quality of the system in order to provide a higher share of personal travel information. Currently, only devices that are connected to the internet and have personal travel related input options, have the possibility to provide improved personal and more actual travel information. This in particular accounts for home-based personal computers or mobile smart phones. New TIP systems will have to increase the quality of the travel information provision in comparison with the current systems in order to stand out as a new and possibly innovative TIP system.

### *1.3.4. New travel information provision system*

InTraffic B.V. is a joint venture of a software developing company (Humiq) and an engineering company (Movares). The main focus of InTraffic lies in the development of software for ProRail to increase and maintain the quality of the rail infrastructure in the Netherlands. In the end of 2010, Intraffic has started a new innovation division to develop innovative solutions for modern transportation problems. One of the first major ideas that have been developed into a product, is a new travel information provision system for the traveller in public transport. The goal of this new TIP system is to provide the traveller with personal, reliable and clear travel information. In order to determine the usability of this TIP system, a comparison will be made between current TIP systems and the new TIP system. This comparison will be conducted as based on the quality of the TIP systems. Therefore this report will also include the criteria to measure the quality aspects of a TIP system.

## 1.4. Scope of the research

### *1.4.1. Travel information provision chain*

The concept of travel information involves many players and it forms a large field to explore. Therefore the focus of this research will lie on the traveller in public transport in the Netherlands. Only travel information that influences the traveller (directly or indirectly) will be taken into account during this research. Direct travel information which has influence on the traveller exists of travel information that is provided by travel information media, i.e. platforms signs or internet planners. Indirect travel information consists of travel information which is 'developed' in an earlier stage and has no direct connection with the traveller, i.e. planning or delays. Therefore, not only the connection between traveller and travel information provision media will be investigated, but also other systems, from planning till traveller, will be examined. All the links and systems that provide travel information to the traveller form part of the travel information provision chain. This chain will provide the scope for this research.

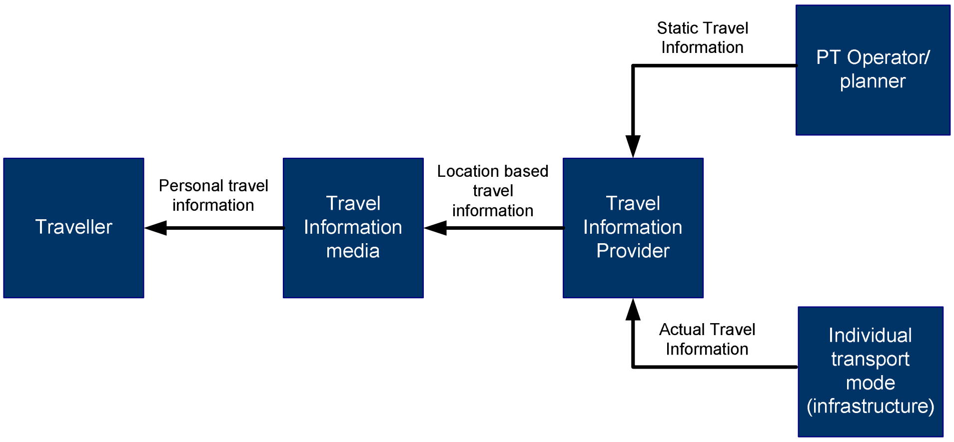



Figure 1: Scope of the research: Travel information provision chain

The theoretical overview of the travel information provision chain will consist of three links which connect different elements of the system (Figure 1) .The first link connects the traveller with the travel information media systems. The second link connects the travel information media with the travel information provider. The last link connects the PT planner or an individual transport mode to the travel information provider.

### *1.4.2. Usability of travel information*

Travel information includes not only the content of information but also the user-interface of information (i.e. the medium, layout and ergonomics) and the composition of the information (Hendriks & Egeter, 2003).  The main focus of this research lies on the usability of the travel information provision for the traveller. The conditions and composition of the information have an effect on the usability of travel information. In order to keep the research within achievable limits, the user-interface will not be included in this research.

### *1.4.3. Travel information provision systems*

For this research, three travel information provision systems are identified. The first one is the standard traditional travel information system with exist among others of track signs, timetables and broadcast systems. In the last decade, obtaining and sending information by mobile telephone has increased rapidly. Today, smart phones with internet connection can provide the traveller with more personal and actual travel information. These possibilities of smart phones create a new type of travel information provision system. Therefore the usage of smart phones with internet connection will be considered as a second travel information provision system. The last and third system is a new travel information provision system called Triptipper and is designed by InTraffic B.V. The characteristics of this new travel information provision system will be explained further in this report.

## 1.5. Objective

The objective of this research is to analyze the usability of travel information services in the area of public transport for the travellers and to give recommendations for improvement by protracting the distribution and quality of travel information systems and evaluating the usability of three travel information provision systems for the travellers. The primary goal is to compare the advantages of the new Triptipper travel information provision system to already existing travel information provision systems.

**Research question:**

*What is the usability of the travel information provision systems for the traveller in public transport and can Triptipper be an added value in comparison with the already existing travel information provision systems?*

**Sub-research questions:**

1. *Which are the quality characteristics of travel information systems in public transport in the Netherlands?*

   Information systems include people, procedures, data, software, and hardware (by degree) that are used to gather and analyze digital information. Specifically computer-based information systems are complementary networks of hardware/software that people and organizations use to collect, filter, process, create, & distribute data. All of these phases will be researched to identify the quality characteristics of the travel information provisions systems. With this information, the current state of the Dutch travel information systems is determined and provides input for answering the following research question.

2. *Where are the bottlenecks located considering the usability of the travel information systems?*

   The important components of the travel information system are investigated. Together with information from travel information expert's important bottlenecks of the Dutch travel information system can be located.

3. *What are the criteria to measure the quality of the travel information provision of travel information provision systems and how can they be implemented during an experiment?*

   There are several methods available to determine the quality of travel information provision systems. Kenyon & Lynons (2003) assume that time and effort savings are two factors to determine the quality of travel information. In order to validate this research, those two factors must be applicable during the chosen experiment. Different options need to be weighed against each other to provide the optimal solution during the chosen experiment to measure the quality of travel information provision systems.

4. *Which possibilities are there to improve the usability of the travel information provision systems?*

   The experiment will produce results for the benefit of the usability of the travel information provision system. Those results will provide possibilities to determine improvements concerning the usability of the travel information provision systems.

## 1.6. Research methodology

The travel information system is a large and complex unit with comprising different elements connected through communication links. Testing the new travel information provision system will have huge affinity with the travel information system because it can be considered as a part of the system. Therefore the research will be split into two parts:

1 Travel information chain: Creating an overview of all of the travel information in public transport in the Netherlands that is needed to provide the traveller with travel information.

2 Experimental study: Designing an experiment whereby a new travel information provision system will be tested in comparison to current travel information provision systems. Results from this experiment will be used to provide recommendations to improve the new travel information system.

### *1.6.1. Interview and data flow-charts*

In order to get an overview of an data flow-chart interviews were held with public transportation experts. The interviewees were selected based on their field of expertise. These fields of expertise ranged from planning to execution of different organizations.  Before the interview, questions were prepared to obtain as much information as possible. These questions were asked face-to-face and also during the interview information was provided, were again new questions can be asked about that information. The gathered information serves as basis for the data flow-charts. By holding interviews different sections of the data flow-charts can be identified until the data flow-charts are complete. Complete versions of the data-flow charts will again be reviewed by the travel information experts. Information during the discussions of the interviews will highlight opportunities and drawbacks of the system and thereby, information concerning possibilities to improve the current travel information system can be obtained.

### *1.6.2. Set-up of the experiment*

The set-up of the experiment will have a large influence on the results. In order to test the the quality of travel information provision system fictional journeys will be created. By creating fictional journeys, the quality of the travel information provision systems can be tested under different circumstances like i.e. delays and locations. During these fictional journeys, information is obtained about the quality of different travel information provision systems. Questionnaires will be held to determine the soft and hard characteristics of the participants in order to indentify any relationships with the results of the fictional journeys.

*1.6.3. Structure of the thesis*

Figure 2 provides an overview of the structure of this thesis. The four research questions are coupled to several phases. These phases are again allocated in the eight chapters of this thesis. This figure therefore provides a clear view of the important subjects of this research and the lay-out of the thesis.

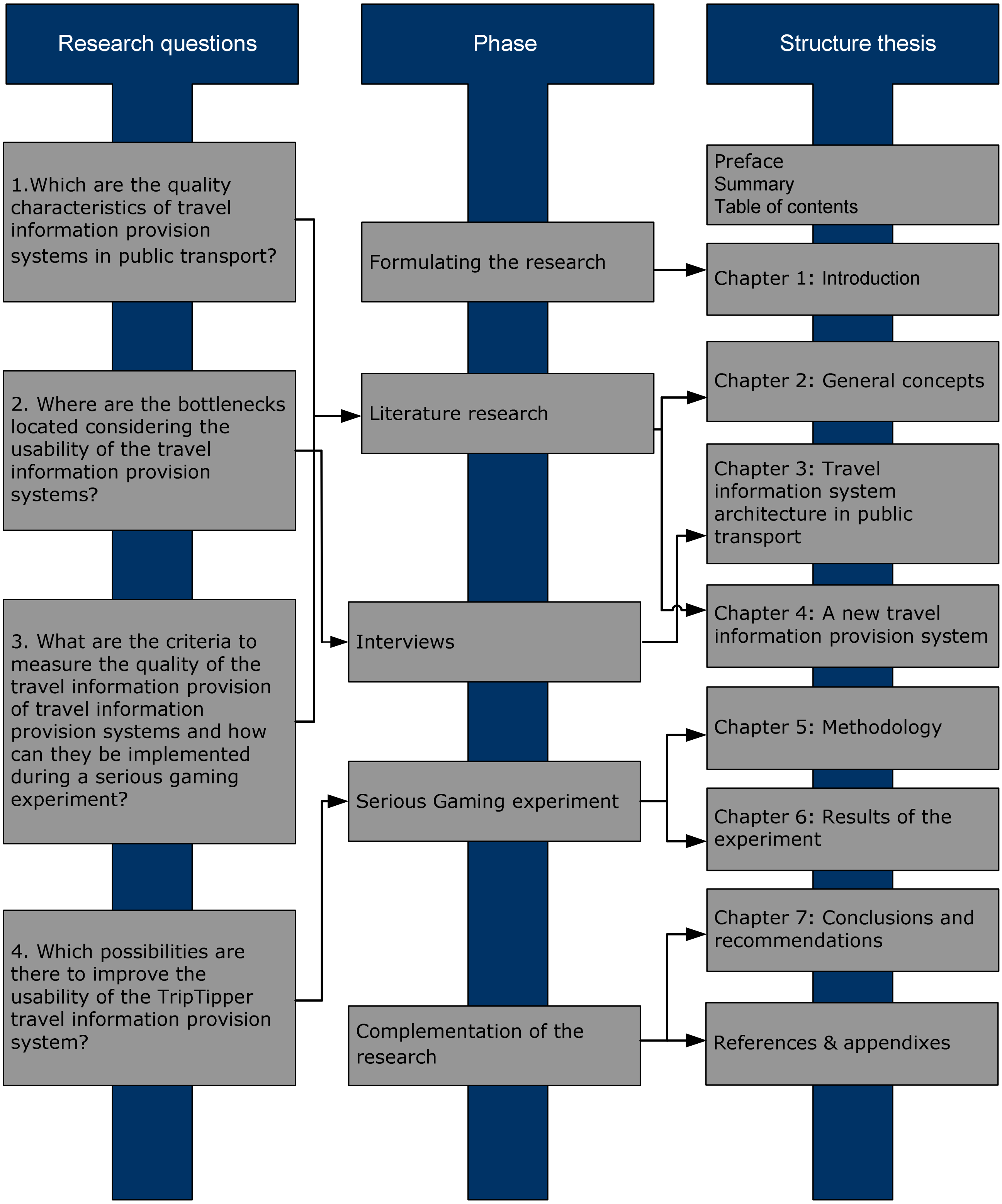



*Figure 2: Structure of the research*

# 2 General concepts

*This chapter describes the aspects of travel information and travel information systems. The main question that is: What is public transport travel information and how is it used? First general information is being discussed and subsequently the concept of travel information will be explained on different aspects. The different types of travel information media are also being discussed and finally the role of the government about travel information will end this chapter.*

## 2.1. General information

### *2.1.1. Definition of information*

Travel information can be seen as a derivative of general information when involved in provision of information concerning travelling. The Business Dictionary (2011) defines information as: *"Raw data that (1) has been verified to be accurate and timely, (2) is specific an organized for a purpose, (3) is presented within a context that gives it meaning and relevance, and which (4) leads to increase in understanding and decrease in uncertainty."* This definition provides the four aspects of information: the right information, the right context, fulfilling a goal and resulting in a decrease in uncertainty or increase in understanding. Providing information has to possess these four aspects.

Wang & Strong (1996) state that the quality of information can be judged on four aspects:

- *Intrinsic: Accuracy, Objectivity, Believability, Reputation*
  This contains the information itself, the accuracy of the information and the reliability.
- *Contextual: Relevancy, Value-added, Timeliness, Completeness, Amount of information*
  The context of the information provides the information which a person wants to know at a certain moment.
- *Representational: Interoperability, Ease of understanding, Concise and Consistent representation.*
  Is the information provided also usable? Can a person understand the information and is it consistent with the other information provided?
- *Accessibility: Accessibility, Access security.*
  Is the information accessible at the right place and right time?

These definitions of general information will also concern travel information and therefore those four quality aspects will be taken along during this research. During this research, the focus will mostly be on the contextual aspect of information. A lot of travel information is available, but providing specific information to the traveller is challenging and difficult. Accessibility of information does also play an important role in travel information provision in order to make travel information easily accessible and available at the most important places. The intrinsic of travel information refers to the source of the information and the trajectory of the information and has a high similarity with the travel information systems architecture. Intrinsic has also affinity with the source and operation of travel information, in order to determine the reliability and the content of the information.

### *2.1.2. Data and information*

During this research, a distinction is made between data and information. Data can be seen as plain facts and therefore are useless on their own. But when these data are interpreted and processed to determine their true meaning, they become useful and they can be regarded as information. Data is the computer's language and information is the human's translation of this language. Looking at travel information, data will be used for information that is being obtained from infrastructure or individual transport modes, like for example the location of a bus. When the data is being managed and distributed at travel information providers, then the term 'information' will be applied.

## 2.2. Travel information system

### *2.2.1. Elements of the public transport information system*

The structure of an information system may be considered to consist of discrete elements among which there are linkages. Each linkage is a connection which realizes the relation between the elements. In a very broad sense, the term 'information system' is frequently used to refer to the interaction between people, algorithmic processes, data and technology. The term is used to refer not only to the information and communication technology (ICT) an organization uses, but also to the way in which people interact with this technology in support of business processes. Part of the difficulty in defining the term 'information system' is due to vagueness in the definition of related terms such as system and information. In general, an information system can be considered as a complex of suitably interfaced basic structures that provide activities from data collections to presentation (Solotruk & Kristofic, 1980). Solutruk & Kristofic (1980) determine the components: 'methods', 'activities', 'technique', 'data' and 'people', that form the basic structure of an information system. The given components can be explained as public transport elements, as applied to the information system of public transport, 'Methods' relates to the organization in which activities take place and information has to be provided. This organization 'sets the rules' and justifies the need for information, and here can be regarded as the public transport organization: the organization in which the information system functions. 'Activities' are the journeys, performed by public transport modes, for which information is needed. 'Technique' represents the way in which travel information is provided, i.e. the information delivery system. Data[4] can be considered as the kind of travel information that should be provided; in this report, the 'data' is restricted to IMTI (Integrated Multimodal Travel Information). And, finally, the component 'people' mainly concerns the customers, but also others actors in the information system (Grotenhuis et al., 2006).

All the five components which are determined by Solostruk & Kristof (1980) can also be projected at the public transport information system in the Netherlands. 'Methods' relates to the public transport organizations and travel information providers. They 'produce' the travel information and determine how, when and where this information reaches the travellers. Public transport organizations and providers can manage multiple elements in a travel information system wherein some of its elements are mutually depending and other elements are not and a integrated information system of elements exists. This means that the overall management of the travel information system may be quite complex and tasks and responsibilities are not always clear. 'Activities' refer to the transport by bus, tram, train and metro vehicles. These vehicles are mostly operated by the public transport organizations and the vehicles produce and provide travel information. Therefore, activities can be seen as an important component in the travel information system. 'Technique' refers to travel information media platforms which provide travel information to the travellers. 'Data' gathering is needed to provide the traveller with the needed information concerning location and time. From the gathered data, travel information will be obtained. Travel information can be considered as the main product of the travel information system and is therefore indispensable. 'People' can be considered as a varying but important component. They present both the travel information managers making

[4] In this report, data can be considered as information because it can be interpreted and processed by almost everyone who comes in contact with the information.

decisions concerning different characteristics of travel information provision such as the distribution of the travel information and the travellers itself. Note that travel information systems are substantially automatic systems and therefore they do not require extensive human interference. However in the case of disturbances, the automatic travel information system will often not operate satisfactorily with the complexity of the disturbances and human interference is required. Furthermore, 'people' also refer to the end users of the travel information system and they are, apart from the public transport organizations themselves, the ones who require travel information most.

## 2.3. Travel information

### *2.3.1. Travel information for the traveller*

Travel information belongs to the quality attribute of 'Communication & Information' which is one of the nine quality attributes of public transport (Vonk, Hulleman, Bodmer, & Berkum, 2009) (Figure 3). Travel information ranges from a basic time schedule to personal real time travel information. It differs in time, place, type and technology. Especially technology has become more interesting in the last years. Providing travel information can have two goals. The first is to make the trip more convenient, by giving information about time, route, connecting services and surrounding areas. The second objective is to stimulate people to use public transport instead of car transport. For that, the information has to make a comparison in quality and speed between car and public transport (Lyons & Harman, 2002; Chorus, 2007)

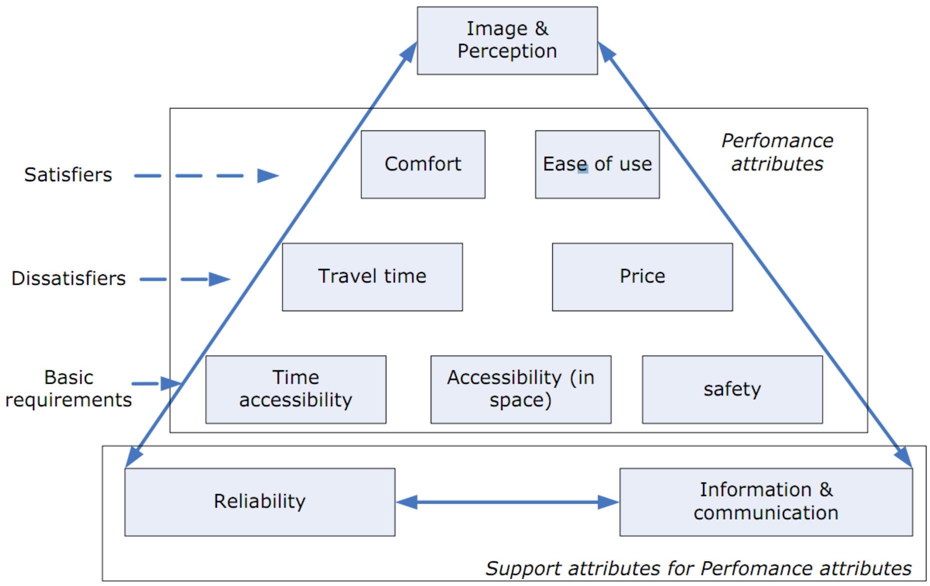



*Figure 3: Principle Public transit quality attributes (Vonk, Huleman, Bodmer, & Berkum, 2009)*

Grotenhuis et al. (2006) state that travel information is one of the factors which contribute to quality of travel information. Travel information can be divided into statistic, dynamic and actual travel information (Hendriks & Egeter, 2003). Though the difference between static and dynamic travel information is quite clear, the difference between dynamic/dynamic- and actual travel information is not. This subject will be discussed in section 2.5.2.

Hulleman, Jems & Spittje (2004) adds two criteria to the criteria provided in the previous section. Primarily the information has to be adjusted to the capabilities of the audience. Secondly, the information has to be adjusted to the needs of the audience (which information a user wants at what place). Lyons & Harman (2002) translated these criteria into specific criteria for travel information: "Travellers want reliable, clearly, unambiguous and comprehensible information that is accessible, complete and consistent, but most of all that is specific for his personal situation."

Travel information helps people to plan and complete their journey (Grotenhuis, Wiegmans & Rietveld, 2005). Travel information involves not only compromising the message, but also the composition of the message and the characteristics of the provision of the information (such as place, medium and layout) (Hendriks & Egeter, 2003). When travelling from origin to destination, people often use more than one mode of public transport. Just as present day car travel information (as provided by navigation systems), public transport travel information must also provide service from door-to-door. The provision of information from door-to-door means that travel information of different transport modes must be available and comparable; this means that integration of multimodal travel information is necessary (Lyon & Herman, 2002)

*2.3.2. The (un)reliability of travel information*

Many public transport travellers depend on the travel information but travellers value and need different information. In terms of regularity of travelling it is found that regular transit users are more sensitive to service reliability and the actual condition of service. Meanwhile irregular commuters tend to be more sensitive to basic information and availability of service (Krizek & El-Geneidy, 2007).

Chorus (2007), states that the media do not primarily report about the fact that a certain train did not run during on a severe winter day, but rather the fact that travellers were not properly informed and were sometimes for hours in a state of uncertainty which created the most indignation. The traveller could not rely on his planned schedule and therefore we speak of travel time variability. This travel time variability creates unpredictability and therefore uncertainty among the travellers. Travellers have difficulty with the uncertainty of their journey. If there is a preferred arrival time (for example, when someone has an important meeting), then the need for travel information becomes very high. And if many routes and transport options are available and when there is a high probability to regret, then the need for travel information is the highest. The combination of a preferred arrival time and uncertainty about the travel time causes travellers building in buffer times. Arrival time sensitive trips and unfamiliarity with the destination induces a higher willingness to acquire information.


Figure 4: The cause of uncertainty by travellers

The value of information increases when information is more reliable, more relevant to the situation and when trips have a high variety in conditions and more travel alternatives are available (Chorus, 2007). Second to this, information is more needed during the start of the journey, due to the bigger availability of travel options (Dziekan, 2008). Figure 5 shows a global display of the combination of the two statements concerning the need for travel information.

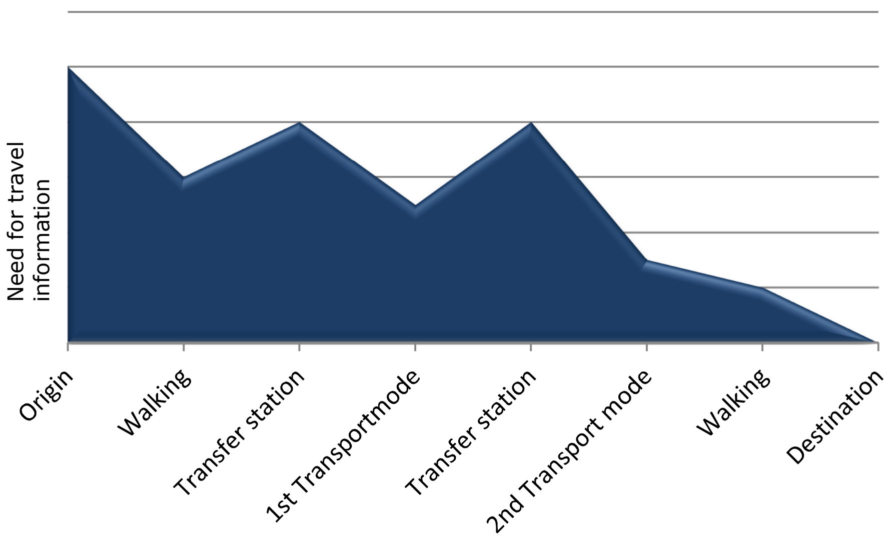



*Figure 5: A global display of the need for travel information during a multimodal journey. Based on Chorus (2007) and Dziekan (2008).*

### *2.3.3. Types of travel information in public transport*

Travel information may comprise multiple types of information. Important types are final destination, time of departure and travel time. Rover (1999) and Graaf & de Hagoort (2000) have researched what type of travel information about their journey travellers value highly:

A. Necessity of reservation in advance;
B. Location of boarding (e.g. bus stop, number of platform), including walking route;
C. Location of transfer (including walking route);
D. Location of alight;
E. Time of boarding;
F. Time of alighting;
G. Accessibility of the vehicle;
H. Safety of the route;
I. Complete logical travel route with map view;
J. Cost of the journey, inclusive discount;
K. Actual deviations in respect to timetables and track alteration;

| Type of journey (time and route) | Type of preferred travel information |
|---|---|
| Daily, fixed route and time | K |
| Regular on fixed route and variable time | E,F,G,K |
| Incidental from A to B | A,B,C,D,E,F,G,H,J,K |
| Incidental (tourist) tour trip | A,B,C,D,E,F,G,H,J,I,K |

*Table 1: Type of preferred travel information by journey type*

## 2.4. Three stages of the journey

When planning and undertaking a trip, travellers have different purposes to fulfill. These purposes are presumed to determine the tasks and decisions and hence the information needs of a traveller can be assigned to three different stages of a journey, roughly in conformity with three location types; pre-trip, wayside, and on-board (Hine and Scott, 2000)

### *2.4.1. Pre-trip stage*

The pre-trip stage is essentially the travel planning step, when the traveller prepares his/her future journey. Most common places are home-based or work/office locations, often the origin of the journey. When planning a journey by public transport, most information must be obtained before starting the journey. This is in contrast to private car transport wherein travel information can be obtained during the journey (Stradling et al, 2000b).

### *2.4.2. Wayside stage*

Most bus stops, train stations and ferry docks can be seen as wayside locations. Among wayside locations, first stop locations and interchanges can be distinguished. At first stop locations, travellers are usually much more familiar with the stop or station than on intermediate stops, leading to different needs for information. Interchanges are perceived as a barrier to using public transport and therefore suitable information is essential in this travel stage to make the journey easier and more convenient (Lyons and Herman, 2002). Wayside travel information is mainly used for travel support than for planning.

### *2.4.3. On-board stage*

On-board information consists of information that is provided within a vehicle, and it is always preceded by pre-trip- and wayside information. There is a distinction between information provision in the pre-transport stage, in the main stage, and in the end-transport stage. It is likely that information needs vary between these modes since the characteristics in each part of the journey differ. Like wayside information on-board information is mainly used for travel support (Grotenhuis et al, 2006).

## 2.5. Travel information media

### *2.5.1. Different travel information media platforms*

Travellers do appreciate to be able to choose from different types of information channels (Granberg & Vesanen-Nikitin, 2003). Those information channels provide different types of information to travel information media. An example of travel information medium is a track sign or a timetable. Some travel information media do provide multiple types of travel information. For instance dynamic bus station displays show departure time, location of boarding and bus line number. In appendix 8, a list of different types of travel information media is provided per stage of the journey.

During the planning process, but also during the journey itself, travellers have different goals they want to realize (Infopolis 2, 1999). These goals determine their decisions and actions and therefore also their need of information. The diversity of travel information channels can be split into official canals provided by transport organizations and by unofficial channels like friends and family. Paulley et al, (2006) states that information given by the official channels is less used and people more rely on own experiences or experiences from family and friends. The degree to which information is used and the perception of the transport mode is updated is dependent to how the traveller perceives the reliability of his known information and the perceived reliability of the new information (Chorus 2007). Therefore a difference can be found in objective and perceived reliability. Official travel information is often highly reliable but is perceived as relative unreliable, whereas unofficial travel information, experience and experience from friends and family, is perceived as highly reliable. Appendix 8 provides an overview of the different aspects of travel information per stage of the journey.

### *2.5.2. Static VS dynamic travel information*

The difference between static and dynamic travel information seems quite clear. Static travel information is travel information which always stays unchanged, whereas dynamic travel information changes during a certain period of time. Hendriks & Egeter (2003) state that travel information can be divided into static, dynamic and actual travel information. Rijkswaterstaat (2009) also agrees with Hendriks & Egeter (2003) stating that there are three types of travel information. They describe the difference between static-, dynamic- and actual travel information. Static travel information provides no information about the current situation and will not be daily updated. It displays the situation confirming the planning but does not take along the current delays. Dynamic travel information is being described as information which accounts of the normal (planned) situation and displays information about e.g. work on the tracks. The refresh rate of the information is not high, because de information only accounts for a longer period of time. Actual travel information presents the information which applies for the consulted time and has a high refresh rate.

Rijkswaterstaat (2009) describes that the main difference between the three types of travel information is dependent on the refresh rate of travel information. Especially the difference between actual and dynamic travel information is highly depended on the factor of time. But actual travel information can be seen as dynamic travel information with a high refreshment rate. Therefore, during this research, two types of travel information will be used; dynamic and static. Actual travel information will be seen as a part of dynamic travel information which has a high refreshment rate.

### *2.5.3. Perception of time*

Where the definition of actual time is quite clear, the definition of perception of time is somewhat more difficult. Time perception, according to Fraisse's conception, is defined as "the attention to, or apprehension of, change through the integration of a series of stimuli and characterized by the ability to conceive of duration, simultaneity, and succession" It implies that time in perception bears no straightforward relationships to physical time (Fraisse 1984). Hence, the subjective duration experienced by a traveller may be different from the objective time passed (Li 2003). Li (2003) has identified four relationships with the perception of time in a urban commute context with public transport. These four relationships are; commute characteristics, journey episodes, travel environment and expectancy.

| Commute characteristics | |
|---|---|
| Commute duration | Commuters will perceive a short duration as being longer, and a long duration shorter (than the objective clock-time) |
| Commute stages | Commuters making a given journey involving more commute stages will perceive the journey time as being longer |
| **Journey episodes** | |
| Ride | Commuters riding on board are likely to perceive a given duration as being the shortest among the journey episodes |
| Wait | Commuters in wait are likely to perceive a given duration as being the longest among the journey episodes |
| Access or transfer | Commuters in access or transfer are likely to perceive a given duration as being shorter than are those in wait, but longer than are those riding on board. |
| **Travel Environment** | |
| Comfort | Commuters will perceive a given duration as being shorter in more comfortable service environment |
| Entertainment | Commuters will perceive a given duration as being shorter in travel environment with amusing entertainment provided |
| **Expectancy** | |
| Commuter expectation | Commuters will perceive a given duration as being longer (or shorter) than it should be, if the duration is longer (or shorter) than once expected duration. |
| Commute reliability | Commuter will perceive a given duration as being longer for a journey of lower commute reliability. |

*Table 2: Four relationships with the perception of time*

Table 2 shows that the perception of time can be dependent on multiple aspects. In the case the duration of time refers to the travel time, while this research focuses on searching time, though it is assumed that searching time has a relationship with travel time. Because of no known literature concerning perceived searching time, the findings of (Li 2003) will provide an insight in the perception of searching time. Looking at journey episodes, it is plausible that during the access or transfer episode the most travellers are searching for travel time, though during other journey episodes the possibility exists that travellers are also searching for travel information. It is therefore difficult to give a statement about the actual valid differences between actual and perceived searching time and which one can be considered as best for evaluating the quality of travel information provision systems.

### *2.5.4. Multimodal travel information*

Multimodal can be described as travel information which provides information on more than one mode of transport within a particular information service. Since many journeys require multiple public transport modes to reach the desired destination, travel information has to cover the travel journey from door to door to assist in diminishing the perception that a journey is difficult or inconvenient. To do so, awareness of the details of travel alternatives for the journey to be undertaken is essential in order to compare various mode options. Thus travel information for multi-mode travel requires the provision of integrated multimodal information services (Lyons & Harman, 2002).

The provision of multimodal travel information at random or selected locations in the public transport network in order to simplify the transfers belongs to the added value of integration. This way it minimalizes the effort for the traveller in collecting information about possible transport modes and it allows the traveller to inform himself about different transport- and route types at the same time (Kenyon & Lyon, 2003).

Multimodal travel information must conform to certain quality conditions in order to be useful for travellers: it must be actual (still valid and relevant), on time (still time left to anticipate), specific for the location where the traveller is at that moment, easy to find, easy to obtain and be reliable (Balcombe et al, 2004; Lyon et al, 2001). Integration also requires coordination of uni-modal sources, like harmonization and standardizing of travel information services (Hine & Scott, 2000; Infopolis 2, 1999, Wardman et al, 2001).

## 2.6. Travellers in public transport

### *2.6.1. Travel behavior*

The main target group of travel information is the traveller using public transport or considering making use of public transport and whose desire for information must be satisfied (Grotenhuis et al, 2005). Distinction can be made between frequent and less frequent travellers (FTA, 2003). A frequent traveller is a traveller who travels regular by public transport and mostly has a fixed route which he knows quite well. A frequent traveller therefore does not need travel information before the start of the journey. A less frequent traveller on the other hand rarely travels by public transport and therefore he has a higher need of information preceding the journey (Infopolis 2, 1999). Also other factors determine the need for information of the traveller, like time of day (ToD), day of the week (DoW), travel time, travel purpose and individual personal characteristics (Balcombe et al, 2004).

Travel behavior of travellers evolves from a habit (Aarts et al, 1997; Thørgesen, 2001; Van Wee and Dijst, 2002). This means that decisions concerning travels mostly are taken without thinking and can be therefore considered an automatism (Aarts et al, 1997; Verplanken et al, 1994). Once when a person has made a choice for a certain mode of transport he will often continue using that mode of transport without considering the alternatives, even when travelling to other destinations. Habitual behavior prevents and decreases stress and makes sure that people use their time and mental energy effectively (Van Wee and Dijst, 2002). It is very difficult to change human behavior (Van Wee and Dijst, 2002). Travel information therefore can only realize a modal shift when there are realistic alternatives for the primary travel choice (Lyon et al, 2001). If public transport wants to be a realistic alternative, it is necessary that the service quality of the travel information system satisfies the needs of the traveller in every way.

### *2.6.2. Hierarchy of needs*

The pyramid of Maslow (1943) is a hierarchical order of needs and it is used in many behavioral studies. Maslow states that that needs are explainable and predictable because needs are hierarchical classified by urgent till least urgent. Van Hagen (1999) has developed an special pyramid of needs based on own research and the pyramid of Maslow (1943)(Figure 6). This pyramid displays the needs of the travellers main activity 'travelling'. The pyramid displays also the dissatisfiërs, which can be seen as absolute basic conditions which have a direct effect on customer satisfaction when there not optimal. Satisfiers can enlarge the customer satisfaction, but will not have negative influence on the customer satisfaction when there not optimal. Travel information belongs mainly to the category of 'ease', which means that travel information is being considered a basic quality aspect during a journey. Unreliable or inadequate travel information will therefore result in a dissatisfied effect on the traveller. Safety and reliability are literal requirements for a traveller when he or she is travelling. If these requirements are not met, then many travellers would not execute a journey.

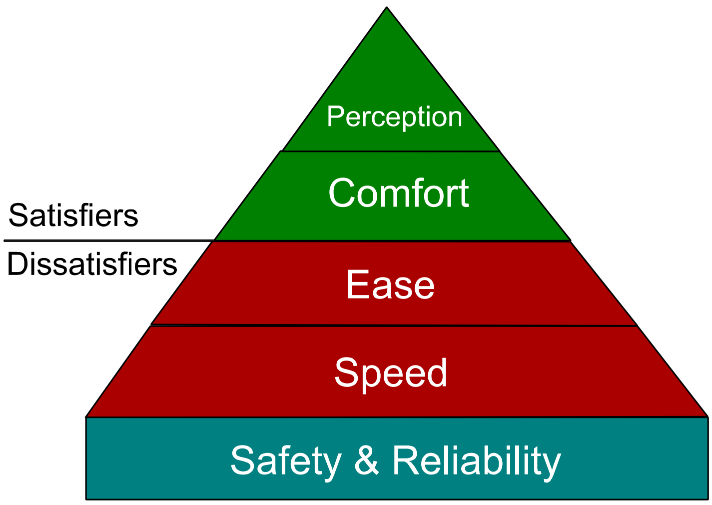



*Figure 6: Pyramid of needs during travelling (Van Hagen 1999; Maslow 1943)*

### *2.6.3. Different type of travellers*

Every area of transportation has its own mix of different types of travellers. Every type has its own needs and expectations concerning the public transport. Travellers can be divided based on criteria such as their travel frequency, travel habit, etc. Many public transport organizations and scientist have executed research concerning different types of travellers. However there is still no universal standard available to describe all travellers in the public transport.

The Dutch Railways (NS) have done their own extensive research concerning the different types of travellers that make use of their product. A lot of research has been directed to the needs of travellers in public transport although most research has been done investigating the 'hard' characteristics of travellers. Hard characteristics are characters that do not include big changes during a certain period of time and which consist of two elements:

- 'Hard' general characteristics based on socio-demographic characteristics like age, gender, and social class, etc.
- 'Hard' domain specific characteristics like travel frequency, map usage, travel purpose, etc.

These characteristics do not always seem to have an explainable value for the behavior of public transport travellers and do not always provide sufficient insight in the needs and wishes that they have during their travel- and transfer process (Hagen, Visser& de Gier, 2005). There are thus more characteristics than only the 'hard' criteria. These are the 'soft' criteria, which give insight at the person and psychology behind the traveller. This missing element must be taken along to get a complete picture of the needs of the traveller.

### *2.6.4. Needscope model*

The NS has chosen a research method by the Needscope model to explain the motivational and inner needs of the traveller. This research has been executed by NS together with the TNS NIPO and the research includes a qualitative and a quantitative element. Needscope is a unique instrument which helps to map the hidden needs and underlying motivations. The instrument was developed in New-Zealand, based on the theory of Jung (1959) about archetypes and was applied at hundreds of companies, especially in the fast moving consumer goods. The model and the used photo sets appear to be highly valid (Wilson & Calder, 2006). Table 3 Shows the travellers characteristics and the area of the Needscope Model.

| | General segmentation | Domain specific segmentation |
|---|---|---|
| Hard characteristics | Socio-demographic<br>Geographic | Travel behavior<br>Map usage<br>Season ticket<br>Private/business |
| Soft characteristics | Psychographic: WIN model | Motivational/inner motives<br>*NEEDSCOPE* |

*Table 3: Travellers characteristics and the area of the Needscope model*

### *2.6.5. Type of travellers*

The Needscope model has resulted in the segmentation of six different types of travellers when looked at their motivations and inner motives (Table 4). Appendix 7 provides more detail about the type of travellers.

| Traveller | Type | Travel behavior | Preparation for journey |
|---|---|---|---|
| ***The Life Enricher*** | Independent.<br>Flexible.<br>Trendy & business like.<br>Young(er).<br>Highly educated. | Makes use of train for work or business.<br>Travels often in rush hour.<br>Uses second class.<br>Likes to work on board. | Prepares just before start of journey<br>Uses internet to obtain travel information |
| ***The Individualist*** | Self-confident<br>Status sensitive<br>Business like<br>Older<br>Mostly not working anymore | Mostly travels for pleasure but sometimes also for work.<br>Prefers first class<br>Likes to work or read in the train | Plans journey in advance<br>Always carries travel information |
| ***The Functional Planner*** | Organized<br>Calm<br>Everything under control<br>Young and working | Travels mainly for business or work.<br>Mostly second class.<br>Works in de train | Knows the way, so little preparation.<br>Only checks for actual travel times. |

| | | | |
|---|---|---|---|
| ***The Certainty Seeker*** | Friendly, open, peaceful, social and involved. Mostly women of all ages | Mainly recreational Small part travels for work Likes to read or look outside the window | Plans the journey carefully and in advance. Always carries travel information and looks for confirmation at the staff. |
| ***The socializer*** | Happy, friendly, positive and spontaneous. Open for contact. Mainly females. | Travels to visit family/friends or to shop. Travels outside the rush hour. Looks out the window or amuses herself with fellow travellers. | Plans the journey in advance with the use of everybody and everything. Always carries travel information. |
| ***The Convenience Seeker*** | Carefree, relaxed, spontaneous, positive. Relative many young as older (+65) people. | Travel to school or uses the train for recreational trips. Listen to music or enjoys himself with fellow travellers. | Plans the journey just before or during the journey itself. Likes to get travel information with ease. |

*Table 4: Different types of travellers with their behaviors*

During this research not only the 'hard' characteristics will be taken in to account, also the soft characteristics with the use of the results of the Needscope research. Yet, some remarks must be made considering the validity for the use of these results for this research. Firstly, the Needscope research was only executed by the NS for the NS. Therefore the scope of the research only encompasses train transportation by NS. This means that those results of the participants are not completely the equivalent, as the present research focuses on the whole area of public transportation and not the train only. Nevertheless, there are many segmentations known for travellers in public transport, but none are so extensively researched as the Needscope model by the NS. Also, looking at the description of the segmented travellers, most of the soft characteristics of the train travellers seem applicable for other public transportation mode travellers. Therefore, the segmentation of the travellers as a result of the Needscope research will be applied for this research.

Another point of discussion concerning the usability of the Needscope research is the applicability of the travellers. The segmented travellers of the Needscope research are journey oriented. This means that the 'soft' travellers characteristics are being based on the type of journey travellers make. A traveller will not act as the same type of traveller each journey he/she makes and therefore the soft characteristics can differ based on type of traveller and the type of journey.

### *2.6.6. The quality of travel information*

Stradling et al, (2000b) and van Wee and Dijst, (2002) have identified two dimensions of public transport quality: time and effort. These factors are also presumed to be applicable to information quality. Kenyon and Lyons (2003) support this by presuming Integrated Multimodal Travel Information (IMTI) to "minimize the effort for the user in acquiring information on mode choice options" and so reduce time and effort costs of searching and using information. Since unimodal information needs are highly dependent on the particular stage of the journey (FTA, 2003; Infopolis 2, 1999), this is also presumed for IMTI requirements and the needs to save time and effort (Grotenhuis et al, 2006).

Time savings can take place in two ways: by way of processing information and during the journey. Chorus et al. (2003) states, that processing information can be distinguished in searching and using information (Figure 7). People have to search and acquire information service and retrieve information from these services. Next, people use travel information by accepting the information and adapting their perception of the route or mode (Grotenhuis et al, 2006).

Effort savings can be classified into three kinds of effort: physical effort; cognitive effort; and affective effort (Stradling et al, 2000b; Stradling, 2002). Physical effort may be expended on a journey in walking, waiting, carrying, escorting and maintaining body posture. Cognitive effort is the mental effort that people use for processing information, e.g. route planning, navigation and error correction. Affective effort is the emotional energy expended on a journey and is caused by dealing with the uncertainty connected with travelling.

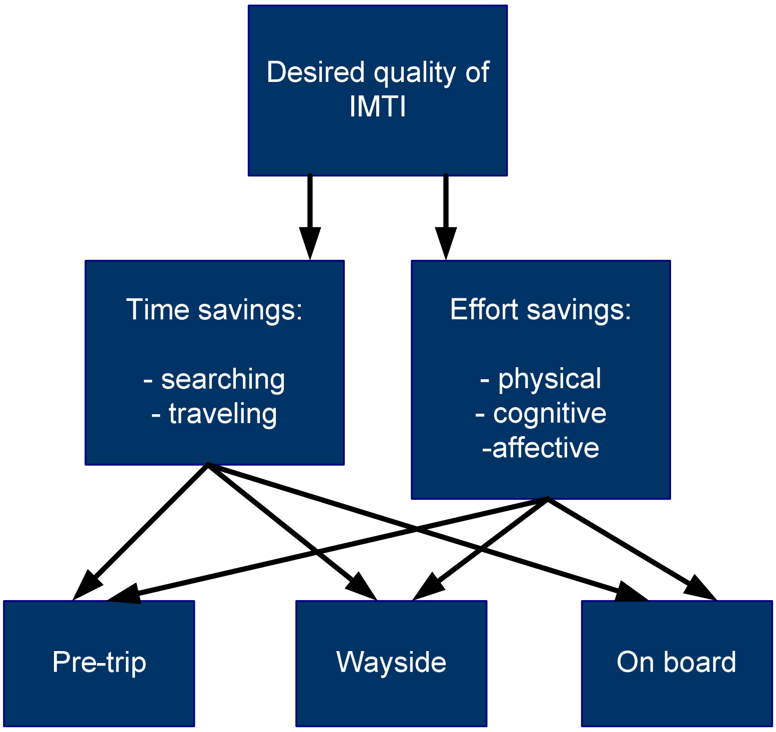



Figure 7: Factors that determine the desired quality of IMTI.
Grotenhuis et al, (2007)

Travellers will be content if time and effort can be saved so their journey can be executed within their personal set of (time and effort) resources (Stradling, 2002). Therefore a travel information service will be satisfying when it contributes to these time and effort savings.

## 2.7. The role of the government in travel information

### *2.7.1. Improved quality and distribution of travel information*

Politics have a large influence on the quality of travel information and therefore also on travel information provision. Like mentioned before, the government has stated in the beginning of 2011 that the NS acquires the responsibility of travel information provision in the whole Netherlands for al train travellers. At the same time, public transport organizations are required to provide actual travel information as of January 2011. Hence, the government has a large role as awarding authority/owner, but also as executive national power.

The Dutch government cooperates with public and private partners in order to create a robust and coherent mobility system and to improve the accessibility. A part of this so called 'mobility approach' is optimal utilization of the networks for car transport and public transport. Optimal travel information can contribute significantly. Herein it is assumed that travellers are capable of making conscious and optimal choices to move from door to door. This asks for information of high quality (actual, reliable and all-covering multimodal) which is available on every moment in time and on every location.

Currently, this information is not yet sufficiently available as in size, timeliness and interoperability. For many years, the uncertainty of the expected travel times is one of the biggest annoyances of travellers because it has a negative influence on an efficient planning and day schedule. The user friendliness of information provisions is also a point of improvement, certainly concerning delays and transfers. In order to decrease the gap between desirable and reality, the government helps running and starting initiatives of other governments and commercial parties to improve their ideas. In addition, there are new initiatives being taken by the government to also improve the quality and distribution of travel information.

The government is responsible for the working of the mobility system in the Netherlands. Good travel information enables the traveller to make conscious choices. Especially concerning travel information, the governments have a requirement creation and framework creation role. This means that governments create minimum conditions, which means that travel information has to meet these conditions. But the realization is a concern of the commercial parties, only if these realizations have negative effects on public interest like traffic safety, livability of accessibility, then the governments will act. In all other cases, the distribution of travel information to travellers will be left to the commercial parties.

### *2.7.2. Private travel information organizations*

Public transport organizations, as executors of a public service, have to cooperate and pay for the supply, actualization and conservation of a travel information system (Artikel 14, Wet personenvervoer 2000[5]). Article 10 of the Besluit personenvervoer 2000 [6] states what the transport organizations have to deliver. Concession granting governments can create conditions and frameworks by making optimal use of the concession. The public transport organizations have together created a travel information group called 9292OV. This is an independent organization which collects, manages and distributes national travel information. (Letter government: Aanpak multimodale reisinformatie, 2009).

9292OV now provides nationwide travel advices. These travel advices are partly based on actual travel information, but do not take actual delays into account. Therefore the government wants a nationwide databank for actual data (NDOV[7]). The goal of this project is to quickly transfer from static to dynamic travel information. But recently there are more commercial parties which are getting involved in the area of collecting, managing and distrusting travel information.

[5]Dutch law of Passenger Transportation of 2000

[6]Dutch Royal Decision of Passenger Transportation 2000

[7]NDOV (Nationale Databank OpenbaarVervoer) Dutch National Databank For Public Transport

# 3 Travel information system architecture in public transport

*This chapter describes the operations of travel information system in public transport and the effect it has on the provided travel information for the traveller. First the different travel information systems will be inventoried by holding interviews. This will create and overview of the travel information systems in the public transport. Then travel information experts will comment of the created overview and provide recommendations for improvement. After this chapter an answer will be provided concerning research question number 2.*

## 3.1. Public travel information systems in The Netherlands

### *3.1.1. Different travel information systems*

Many countries, including the Netherlands, have the disposal of multiple travel modes in public transportation. Train, tram, bus and metro are public transportation modes which are most common in the Netherlands. Operating a travel information provision system for public transport requires are large network of multiple sub-information systems. These different systems will provide different types of information. As discussed in chapter 2, an information system can be considered as a complex of suitably interfaced basic structures that provide activities from data collections to presentation (Solotruk & Kristofic, 1980). This document determines the following components: 'methods', 'activities', 'technique', 'data' and 'people'.

### *3.1.2. 'Methods' in public transport travel information systems*

This refers to the organization in the public transport sector. In the Netherlands there are multiple large organizations involved in the area of public transport. Those organizations can be separated into public transport operators, infrastructure managers and travel information providers. The area of public transport is a divers sector so that the requirements per organization can differ and have effect on the design of a specific travel information system. Travel information systems of public transport organizations focuses on providing travel information to the traveller. Travel information systems or infrastructure managers on the other hand also provide information for the public transport organizations for operational purposes for example. Also the mode of transport and the type of organization determine the lay-out of the desired output of the each travel information system.

### *3.1.3. Activities in public transport travel information systems.*

The activities refer to journeys provided by public transport companies for which information is needed (almost all journeys). Travel information is needed not only for the traveller, but also for the public transport organization itself for operational purposes. Information about vehicle locations, delays, etc. are also valuable for public transport organizations. Travel information systems provide information that is needed to execute the activities of the public transport organizations.

### *3.1.4. Techniques in public transport travel information systems.*

Information systems do not need to use computers, however, modern organizations increasingly rely on information technology as the core of their information systems. Watson

(2007) states that information technology includes hardware, software and telecommunication equipment that is used to capture, process, store and distribute information. The public transport sector makes frequent use of information technology. Especially heavy rail transportation is heavily depended on information technology because of safety issues.

#### *3.1.5. Data in public transport travel information systems.*

Data refers to the travel information in the information systems. Note that data and information are two separate elements, in this research, and the data that is mentioned here also refers to information. The data can be considered as the product of the travel information provision process.

#### *3.1.6. People in public transport travel information systems.*

People include the managers who define the goals of the system and the end-user of the system, the travellers. An important insight here is that individuals involved in the information system come to it with a set of skills, attitudes, interests, biases and personal traits that need to be taken into account. Very often, an information system fails because the users do not have enough skills, or have a negative attitude toward the system (Watson, 2007). Especially in the rail sector, human influence, besides the driver of the vehicle, is very high. Train managers who control the rail-infrastructure partly determine the rail operations and thereby have direct and in-direct influence on the travel information flow. The public address system is also being maintained manually, which means that individual characteristics have influence on the travel information provision for the traveller.

## 3.2. Interviews with public transport organizations

#### *3.2.1. Purpose of the interviews*

Watson (2007), states that information systems consists of social systems and technical systems. This also can be assumed for the Dutch travel information systems. Every public transport organization has its own travel information system. These travel information systems can be considered as a crisscross of elements and links whereby the arrangement of the total travel information leaves much to be desirable. This vague overview of travel information systems creates unnecessary errors, delays and diversions in the travel information flow. Public transport organizations also state that they lose track of the distribution of their own travel information flow. By conducting interviews with several specialists of public transport organizations concerning travel information systems, information will be gathered about the architectural layout of information flows for each information system. With this information, a complete overview can be created (data flow-diagram) whereby possible bottlenecks in the information flow can be located.

#### *3.2.2. Set up of the interviews*

In order to obtain the required information, interviewees are needed which can provide sufficient information about specific sections of the public transport provision system. Literature is also available, though detailed information about travel information systems is not. By using interviews, it is expected that more detailed information can be gathered and that contradictory information can be easily solved. The selection of interviewees is based on their field of knowledge and with enough interviewees the intention was to create a complete overview of the total public transport provision system. With the help of the existing connections of InTraffic, people were contacted who had knowledge about specific parts of the public transport provision system. Organizations which had no known connection with InTraffic, were contacted individually by telephone with the question if they wanted to cooperate. NS and ProRail are the two largest rail organizations, therefore experts from those organizations were contacted. For the bus and tram sector, experts were located at general public transport organizations, i.e. 9292OV and KPVV, this because of the difficulty to contact bus and tram transport organizations. The interviews were held at the preferred location of the interviewee, which was mostly at their own office. The interviews were held on an individual basis and the questions were based on an open interview whereby the interviewees provided answers on the questions. The questions that were asked were based on the expertise of the interviewees. For example, questions about travel information for the bus where asked to travel information experts of bus organizations like GOVI and 9292OV. Every interviewee was asked about his own field of study. A major part of the questions were based on the travel information flow. Those questions referred to the input and output of travel information systems and the purpose of travel information systems. During the interview, the interviewees could respond on the draft versions of the data flow diagrams and implement any changes. When all interviews were held, and a complete version of the data flow diagrams were created, these were sent to the interviews to provide any comment, because it can be expected that contradictory information was provided whereby an iterative process has started, though none contradictory information was found. The following people were interviewed to obtain to create an complete overview of the public transport provision system:

- Mr. R. van den Berg (Operations Manager at GOVI[8])
- Mr. R. van Ee (NS Reizigers)
- Mr. R. van Stralendorff (NS Reizigers)
- Mr. K. Leegwater (System designer ProRail)
- Mr. M. Sloot (Senior Advisor Public Transport KPVV[9])
- Mr. J. Thijmessen (Advisor BISON[10] project)
- Mr. L. Hoogeveen (PRL expert at InTraffic)
- Dr. C. Chorus (Researcher Technical University Delft)
- Mr. M. van den Berg (Operations manager 9292OV)

### *3.2.3. Information flow*

Large public transport providers like NS and Connexxion rely heavily on a reliable and good working information system to obtain, but also, to provide travel information. Therefore a good and clear information flow is a result of a flawless working travel information system which results in better travel information provision. The flow of information can be distinguished as a communication process. During a communication process there are several activities which take place: Shannon & Weaver (1949)

- Coding the information: Information needs to be edited in order to be send. Important aspect of using coded information is that the receiver understands this code.

- Transmitting of the coded information: Transmitting of the coded information can take place by many different methods. For example by means of mechanical vibrations (speak and sound), light signals or electromagnetic radiation (radio).

- Receiving the coded information: To able to receive the information, a special device or element is necessary which is sensitive for vibrations, light signals or electromagnetic radiations.

- Decoding of the received information. The received coded information needs to be decoded in order to use the information.

- Feedback from the receiver to the sender: The first message confirms receipt of the message, the second confirms that the message is understood and the third is the confirmation that the demanded action will be taken.

The information flow in travel information systems also makes use of the process which is describe above. The difference however is that the travel information systems make particularly use of technological systems to transmit information. An example: Computers code the information that is being inputted from other systems or persons. A network which is connected

[8] GrenzelozeOpenbaarVervoerInformatie (organization for integration and provision of multi modal travel information)
[9] Kennis Platform Verkeer&Vervoer ( Dutch knowledge institute traffic and transportation)
[10] Platform that creates, maintains, harmonize and monitoring of information standards which facilitate information exchange in public transportation

with the receiver transmits the information to the receiver in a minute time. The information is being received by another computer which is connected to same network. The computer also decodes the information in such a way that it can be used for its purpose, though the travel information systems make use of different options to transmit and create the travel information, including GPS, FTP[11], HTTP[12] and Email which are some examples of the options that are being used.

## 3.3. Travel information data flow-diagram

### *3.3.1. Set-up of the travel information flow diagram*

In order to create a clear overview of the travel information flow and understand the function of different system elements, several functions are used to provide distinctions in the flow diagram. Information to create the travel information data flow diagrams are mainly obtained from the interviews, though missing information was obtained from literature. The focus on this research lies on the traveller in public transport; therefore the three identified locations from section 2.4 are used.

These three locations automatically determine the type of travel information because of the availability of different travel information provision systems. Further these different travel information provision systems are again managed by different public transport organizations. The difference between those organizations is made clear by using multiple colors to easily identify the organizations. The flow diagram also provides an overview to distinguish between static and dynamic travel information.

### *3.3.2. The data flow diagrams*

There are several public transportation modes in the Netherlands and most of them are also being operated or managed by several organizations. Creating a flow diagram for every public transport mode is an almost impossible task and requires extensive knowledge about internal system and organizational structures. Also the constant changing environment requires continued adjustment of the data flow diagram, whereby it is difficult to provide a constant up-to-date version of all the data flow diagrams.

In order to provide a clear overview with all the basis travel information systems without going in to detail, the focus will lie on two public transport modes which creates two data flow charts:

- Train data flow diagram
- Bus/tram data flow diagram

### *3.3.3. Train data flow diagram*

The train data flow diagram (Figure 8) discloses the information flow of the public transport mode using the railroad infrastructure. As the Dutch Railways (NS) are the major public transport organization concerning train transportation, their travel information system will be used as the primary system in the train transport sector. Together with ProRail (the national infrastructure manager), the NS represents the largest part of the train data flow diagram. It is plausible that smaller public transport organizations in the railroad sector will use similar systems to that of NS/ProRail systems. Appendix 1 provides a more detailed overview of the train data flow-diagram.

[11]File Transfer Protocol (standardization to facilitate exchange between computers

[12]Hypertext Transfer Protocol (communication between web client and web server)

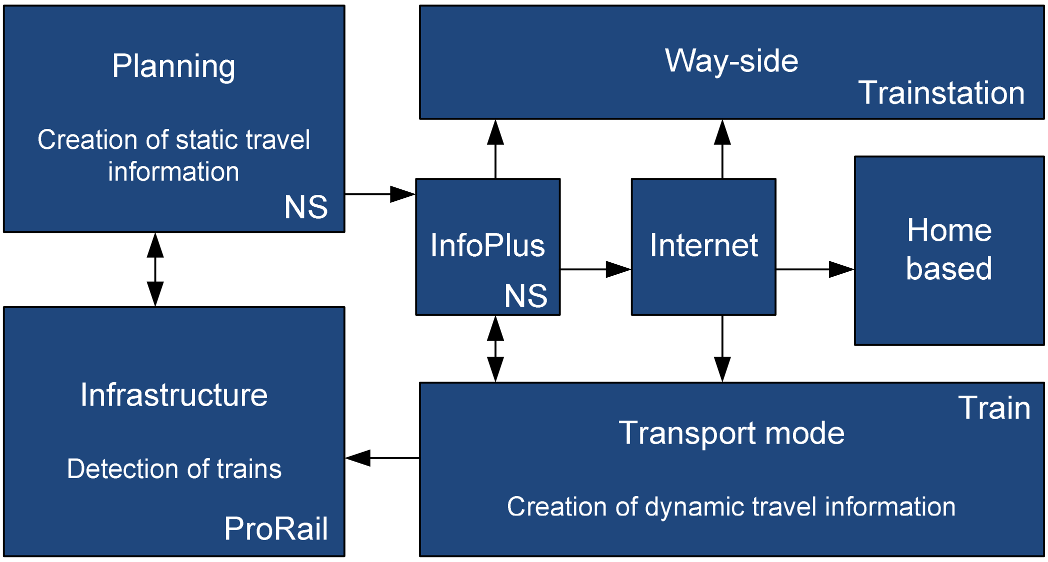



*Figure 8: Global overview of train data flow-diagram*

### *3.3.4. Operation of the train data flow diagram*

Static travel information is created at the planning department of NS, where the Basic Hourly Pattern is created. This pattern contains all train movements in the whole of the Netherlands and can be considered as the main planning attribute for static travel information. The annual and daily plans are derived from the Basic Hourly Pattern. The VKL and PRL systems are operated by ProRail and they control the train movements in the Netherlands by operating the railway infrastructure. These systems compare the actual train movements with the planned movements according to NS' daily planning which is mainly based on the Basic Hourly Pattern. With this information the train and traffic service leaders try to manage the train flow as good as possible in order to prevent any large delays.

VKL and PRL obtain the actual train locations from TROTS. This system tracks the train movements by using train numbers and defining the actual position of the trains. The information from PRL and VKL are distributed to the BEPAC system. This system provides travel information on the train stations. All the tracks signs, public address systems and information desks are being controlled by the BEPAC system managed by ProRail. The NS however has its own system called AR.NU. This system also obtains data from the VKL/PRL systems but it does not distribute it to the train station. AR.NU provides information for travellers when they are in the train or on the internet (NS Travel planner). Also information to the guards is provided by this system. A new travel information system called InfoPlus will replace the current travel information systems in the near future. By analyzing the train data flow diagram a clear distinction can be made between the provision of travel information in the Netherlands; ProRail mainly manages the tracking of the train movements and provides travel information to the traveller on the train stations, whereas NS creates the timetables and provides the traveller with travel information in the train and at home and at their mobile phones through e.g. the internet.

### *3.3.5. Bus/tram data flow diagram*

The bus/tram data flow diagram provides an overview (Figure 9) of all the bus and tram travel information flows in the Netherlands. In appendix 2 there is a more detailed overview to be found. There are many public transport operators operating bus and tram lines. The main focus of this diagram lies on the bus system and not on the tram system. The reason therefore is that the bus TIP system is much larger than the train TIP system and both systems have a major overlap in terms of system architecture. The system architecture of the bus TIP system is more diverse than that of the train TIP system as caused by the high amount of travel information organizations compared to the train TIP system. Hence, this makes it more challenging to create a clear structure for the TIP system.

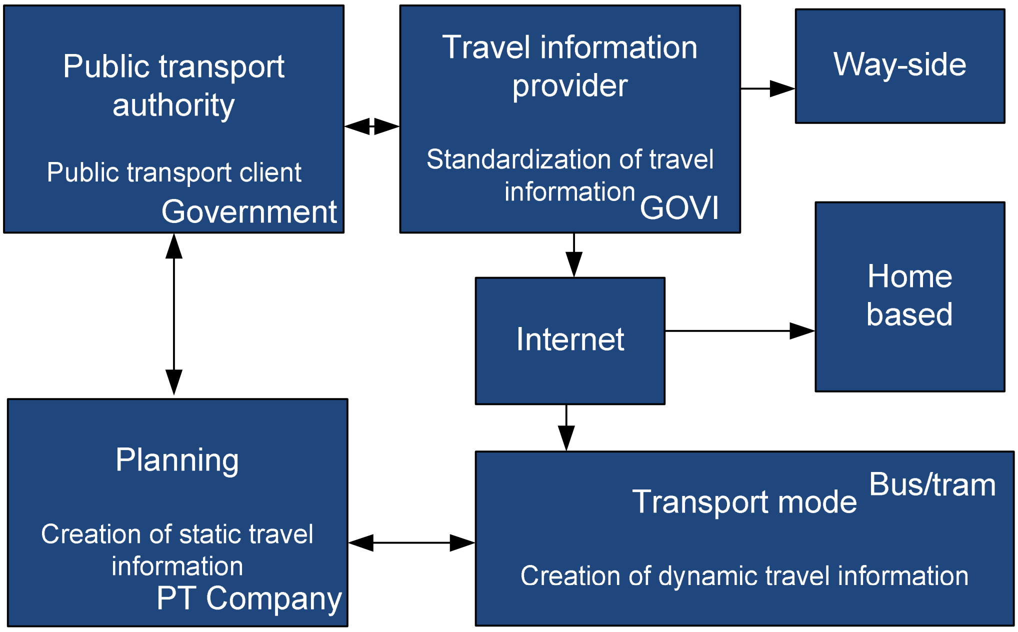



*Figure 9: Global overview of bus/tram data flow diagram*

### *3.3.6. Operation of the bus/tram data flow diagram*

Timetables are created by the planning system of the public transport operator. Dynamic travel information mainly is distributed from the individual transportation mode itself. The bus or tram has an system called Infoxx containing the static travel information for that particular mode of transportation. With the use of an integrated GPS-system, the Infoxx system identifies the current location of the bus or tram. Hence, with the current information, the actual travel time can be calculated. The planning system (EBS Transport Operator) also provides information to the travel information integrators. The travel information integrators gather and standardize different streams and types of travel information and present this usable and standardized information at DRIS-distribution servers or internet route planners i.e. 9292OV and Google Transit. DRIS-distribution servers maintain the quality of the travel information which is presented at the connected DRIS displays. The travel information of the travel information integrators is also sent to the public transport authority. They use mainly the actual information to evaluate the punctuality of the public transport operators. The GIS/KAR system is a system allowing individual transport modes to transfer data on a short distance. Therefore, this system is mainly used to operate traffic lights in order to create a high priority situation.

## 3.4. Results from interviews

### *3.4.1. Current condition of the travel information provision system*

The travel information provision system in public transport in the Netherlands is sometimes described as a tangle of information systems. The multitude of organizations, travel systems, transport modes and operators make it difficult to quickly identify a logical structure. Although the origin of the most systems is relatively old, especially when looking at the train TIP system, the TIP systems still functions properly. However with such an amount of different systems which are sometimes heavily mutually dependent, malfunction of one system often has consequences for the whole TIP system. In January 2011, the government has decided that NS is to become responsible for all of the travel information provision in the railway sector. With a new travel information system, InfoPlus, NS hopes to improve the travel information provision to the traveller. However, in order to obtain all the necessary travel information, NS is also dependent on ProRail, who maintains the infrastructure and has vital information concerning travel information provision. In order to provide high quality travel information, NS has to maintain and preferably improve an extensive relationship with ProRail.

Looking at the bus TIP system, there are more public transport organizations than in the train TIP system which operate that specific sector. The diversity of the public transport organizations and concession areas in the Netherlands creates a cluttered view of the TIP system. However, this diversity does not have a large influence on the quality of travel information provision. Maintaining standardization for travel information supports provides a clear overview of the total system. It is also noticeable that the bus TIP system has an improved technological system against the train TIP system.

*3.4.2. The source of information*

Looking at the public transport system in the Netherlands, a shift can be made between the bus/tram system and the train system. Both systems appear to be rather different looking at the figures in the appendix, although the main difference between the two systems is the location where travel information is created. The main source for creating actual travel information is the determination of the actual position of the individual transport modes and there is where the main difference between these two systems resides. The position of the train is determined by the infrastructure. ProRail detects the position of the train on a certain track section and calculates the difference between the planned and the actual position. The same difference is calculated at the tram and busses, though hereby the location is determined by a individual transport mode. This individual transport mode knows its own planned schedule and calculates its own actual time and transfers it to a travel information provider.

*3.4.3. Provision of travel information to the traveller*

The data flow diagrams provide a interesting overview of the possibilities the traveller has to obtain travel information at the three distinguished locations during the journey. Not all travel information media are available like described in the data flow diagrams, because locations and transport modes can differ from each other. Interesting to see is that travellers at an on-board location have fewer possibilities to obtain actual travel information in comparison with travellers which are home-based or way side based (mobile smart phone not accounted), though this is in concurrence with Chorus (2007) who states that travellers are in need of more travel information during transfers. These transfers take place on way-side locations, however, many travellers want to know if they will arrive on time on their destination. Therefore, travellers are in on-board locations also in need actual travel information. Just the past 5 á 8 years, public transport modes are equipped to provide actual travel information to the traveller, though this is highly depended on the mode of transport and the public transport company. The mobile smart phone is a recent newcomer as travel information media device and can provide the traveller with actual travel information when he or she is in high need of information. The traveller can on almost every place, if internet is available, obtain actual travel information. While public transport organizations are increasing their provision of actual travel information, more travellers have the possibility to obtain travel information by mobile smart phone. The increased amount of media devices which provide travel information to the traveller is a direct result of increased quality of travel information and can therefore be considered as preferable. However, this increased amount of travel provision media can also increase the chance of contradictory travel information for the traveller which again increases the unreliability which is one of the most important quality attributes of public transportation.

# 4 A new travel information provision system called Triptipper

*In this chapter a new travel information provision system for travellers will be proposed. The purpose and design of the new travel information provision system will be explained. Furthermore the functioning of the system will be explained. The main focus on this chapter however lies in explaining the added value of the system in order to determine the quality of the travel information provision system.*

## 4.1. A new way of searching for travel information.

### *4.1.1. Travel information for the traveller*

Today's current travel information provision systems provide the travellers with enormous amounts of information. Especially static travel information can be presented in high amounts to the traveller which creates a low efficiency output. Bus and train timetables can be confusing for people and it can take a lot of time for people to scan and obtain their personal travel information. Therefore, InTraffic has developed a new type of travel information provision system called Triptipper to improve travel information provision to the traveller. In the end 2010, InTraffic started the development of Triptipper and since transformed from an idea to a full grown travel information application. Triptipper has the following objective: 'Providing clear and personal travel information to the traveller in one second.' Travellers will be provided with actual and personal travel information related to their destination. This way, travellers will need less time to gain access to their travel information and to make a decision based on the provided information.

### *4.1.2. What is Triptipper?*

Triptipper is a new travel information system which is developed by InTraffic that proposes one or multiple personal advices to the traveller preceding his journey. The system is not comparable with a multimodal travel planner, as for example the public transport planner from OV9292. The planner of OV9292 proposes an optimal journey (depending on the traveller's requirements) from origin till destination whereas Triptipper only provide travel information for a certain stage of the journey (similar to TomTom). By only providing by stage of the journey, travellers are not provided with information they do not need and therefore need less time to obtain their necessary information.

A Triptipper application provides the optimal travel information at a certain point during the journey for the next possible stage of the journey. This stage can be walking or travelling with a certain mode of public transport. Based on the final destination of the travellers, information to the traveller is provided. The traveller has an item, for example an OV-Chipcard or QR-code, containing the final destination of the journey. With this item the traveller can scan his final destination at a Triptipper application which stands at large PT intersections like for example at train station. The Triptipper application recognizes the final destination of the traveller and immediately (within one second) provides the traveller with a personal travel advice on a display. This travel advice mostly contains several possible ways (tips) for the traveller to continue the journey based on different PT modes. Figure 10 and 11 provide an example of such a travel advice display.

Each tip contains among others, the destination and departure time of the next PT mode, the PT mode and the departure location. Depending on the location of the Triptipper application, other forms of personal travel information than in the latter can be provided, like for example, a map with an optimal walking route or a line overview with current location and transfer location for the on board stage (Figure 12). The traveller can continue the journey by scanning his item at every transfer point with a Triptipper application to arrive at the final destination quickly. Mobile smart phones do also provide the possibility to obtain actual travel information at almost every location, though mobile travel information provision does have some drawbacks. Not at every location GPS and wireless internet are available which makes it difficult to obtain detailed and reliable information. Furthermore, it requires multiple actions for travellers to obtain their travel information on their smart phone which also requires a certain amount of time depending on the familiarity of the user of the smart phone.

## 4.2. Triptipper for the traveller

### *4.2.1. Starting the journey*

Triptipper works on the basis of travelling with a final destination and obtaining new travel information at every transfer point. In order to start travelling, the destination must be known and coupled to a certain item which the traveller carries during the journey. The final destination is being imported by a postal code which can contain four numbers or four numbers and two letters depending on the level of detail of the final destination. A postal code is a number which provides relatively high detailed geographical information in comparison with addresses. By only using a postal codes which contains only four numbers, travellers can quickly and easily input their final destination. This postal code must be transferred from the traveller to a Triptipper application widely available at a train or bus station. A Triptipper application can almost be compared to an OV-chip card terminal, although the OV-chip card terminal only give information about transport costs but does not provides travel information. There are three different possibilities to transfer the final destination (postal code) from the traveller to a Triptipper application:

- By numeric keypad/touch screen
- By QR-code
- By OV-chipcard

### *4.2.2. Input by numeric keypad or touch screen*

Every Triptipper application has the ability to import the final destination manually. This can be done by a numeric keypad or a touch screen (depends on the availability). Travellers do not have to carry an item which contains their final destination, but can just import their destination by using their hands. This option offers the traveller more diversity concerning the final destination and a transfer to another destination can be done quickly by importing a postal code different from the previous postal code.

### *4.2.3. Input by QR-code*

A QR(Quick Response)-code is a code which can be compared with a barcode. Only a barcode stores information in one dimension were a QR-code can store information in two dimensions. By using two-dimensions, more information can be stored than on a regular barcode, QR codes are also often being used to store web pages.

By using the webpage of Triptipper (www.Triptipper.nl), a postal code or a place name can be transferred to a QR-code. The QR-code is shown on the screen and the traveller has the possibility to print out the QR-code. Business cards also have the opportunity to be provided with QR-codes coupled to their destination. This way, visitors don’t have to plan their journey but can rely on the QR-code on the business card to provide the necessary travel information.

Once a traveller has his/her destination on a QR-code, the QR-code must be scanned by the Triptipper application in order to obtain the final destination. Every Triptipper application is equipped with a camera. With this camera, the Triptipper application recognizes the final destination which is contained by the QR-code and provides travel information to the traveller based on the imported destination.

#### *4.2.4. Input by OV-chipcard*

The OV-chipcard was introduced three years ago in 2008 in the Netherlands and it is rapidly becoming the main method for travellers to pay for public transport. The OV-chip card is useable in the whole of the Netherlands and it is operable at almost every public transport mode. Every OV-chip card contains a RFID-chip which is able to save or read information from a certain small distance. On this RFID-chip not only transport costs information is being saved, but third party developers also have the possibility to make use of the RFID-chip and store minor information.

Therefore, the final destination of a journey can be transferred to the RFID-chip in the OV-chip card. This way the OV-chip card can contain the final station and can be used to obtain travel information from the Triptipper application. Information exchange of the OV-chip card is done by using card-readers. These card readers can be connected to a computer or Triptipper application with a USB-connection. This way, travellers can make use of the website of Triptipper to transfer their final destination to the OV-chip card. When a traveller wants to obtain travel information at a Triptipper application, he or she scans the OV-chip card at the card reader. The card reader transfers the final destination from the OV-chip card to the Triptipper application and the travel information for the traveller is being displayed on the basis of the imported information.

## 4.3. Travel information provision

#### *4.3.1. Location based travel information*

Three different stages are identified where travellers can obtain travel information. The pre-trip stage mostly matches the phase when travellers are planning their journey and is mostly at home or at work. Because travellers are most commonly familiar with the personal environment like home work, they do not need travel information for that particular stage of the journey. This is the reason that Triptipper only focuses on providing travel information during the way-side stage and the on-board stage.

#### *4.3.2. Way-side travel information provision*

Travel information during the way-side stage is provided by Triptipper on the basis of three travel advices, whereby the upper advice is considered being the fastest option to travel, the one beneath the second fastest and the lowest advice is the third fastest option. Thus the order of travel advices is based on the fastest option which is based on the moment of requesting the travel information (Figure 10 and 11). Design of the lay-out of the travel advice displays are based on own experiences of the designers and their requirements for personal travel information. It is assumable that during the further development of the Triptipper application, the lay-out of the travel advices will be adjusted, though the ergonomics of the Triptipper application does not belong to the scope of this research.


Figure 10: 3 travel advices


Figure 11: Travel advice for walking to destination

Every travel advice display comprises different types of travel information together creating a travel advice. Those types of travel information are displayed based on a question every traveller asks him- herself, 'where to'? This question can mostly be answered by which particular mode of transport and the location of its departure. Therefore, the travel advice is being split up in two parts. The first part is mostly located on the left-side of the display and identifies the specific travel mode of the traveller. This contains the mode of transportation, final destination of that mode of transportation, line number or type of train and the departure time. The second part contains the location of the departure of the specific mode of transport. This location is indicated with track number and the direction (arrow) of that track based on the current location of the Triptipper application.

Together, this information provides personal travel information obtained within one second, so that the traveller is guided to his destination or another Triptipper application which provides him or her with new travel information. Besides the three travel advices, the current time and imported final destination are also displayed in order to provide a complete overview of the current situation.

### *4.3.3. On board travel information*

On a transport mode, travellers ask themselves other questions concerning the sequel of their journey. They mostly want to know if they will arrive on time and, if necessary, will catch their connecting transport mode. Also, the location of alighting compared to the current location is considered as interesting (Grotenhuis et al. 2006).


Figure 12: Actual position and alighting station

The Triptipper on-board display provides information concerning the current location of the mode of transport with the travel route of that specific transport mode (Figure 12). Stations or bus/tram stops which are located on the travel route are also displayed. The station or bus/tram stop where the traveller should alight is highlighted. This means that the traveller should alight at that location in order to continue his/her fastest option to get to the final destination. After the alighting location, the delayed arrival time is displayed when the vehicle as encountered any delay. This way, travellers are informed about the expected arrival time of their transport mode on their transfer- or final destination. Once at their transfer location, travellers can request new travel information to guide them further on their journey by using a Triptipper applications which are situated at that transfer location.

## 4.4. Triptipper application

### *4.4.1. Advertisement*

Triptipper works on the principle that every Triptipper application at any location has the best available (static) travel information for that location and that every important transfer point in The Netherlands has a Triptipper application. The Triptipper application at every location has its own travel information being maintained by the owner of that application. An owner of an application can be anyone, from a public transport company to a kiosk dealer. A Triptipper application gives increased value to travellers and therefore can be seen as an extra service from the owner. The Triptipper application provides the opportunity for different types of organizations to show advertisements in the media box. This media box can be considered as a kind of wallpaper which constantly shows pictures of own preference to increase advertisement. The media box will contribute to the effect that more private organizations are willing to invest in a Triptipper application and thereby increase the installed base of the Triptipper applications.

### *4.4.2. Postal codes*

The static travel information that is provided to the customer works on the basis of postal codes. Postal codes in the Netherlands contain four numbers and two letters and are therefore easy and quick to import compared to an address with a city name. The whole of the Netherlands is divided into several thousands of postal codes. In combination with the two letters, a very accurate location can be obtained.

### *4.4.3. Working of Triptipper*

Every Triptipper application has its own location and therefore its own postal code. The application is programmed so that every postal code is related to a destination. But the application does not have to obtain every postal code in the Netherlands, only for the ones in the area or with large connecting public transit points. Most of the travellers travel from transfer point to transfer point to complete their journey etc. So at every location of a Triptipper application, only the travel information in the direct area or the large connecting transit points is programmed in the application. This is because people who are travelling outside of the area will mostly use large connecting transits to continue their journey. At that connecting transit point, another Triptipper application will provide the traveller with new (local) travel information. By using this method, the owner of every Triptipper application will provide the necessary travel information for its own application, thereby contributing to a large and complete public transport travel information system when there are thousands of Triptipper applications. Figure 13 provides an example of a journey and how Triptipper works and determines how travel information is calculated and provided to a traveller during a journey from Nieuwegein to Amsterdam. Figure 14 shows the same route, but then only the travel displays the traveller sees.

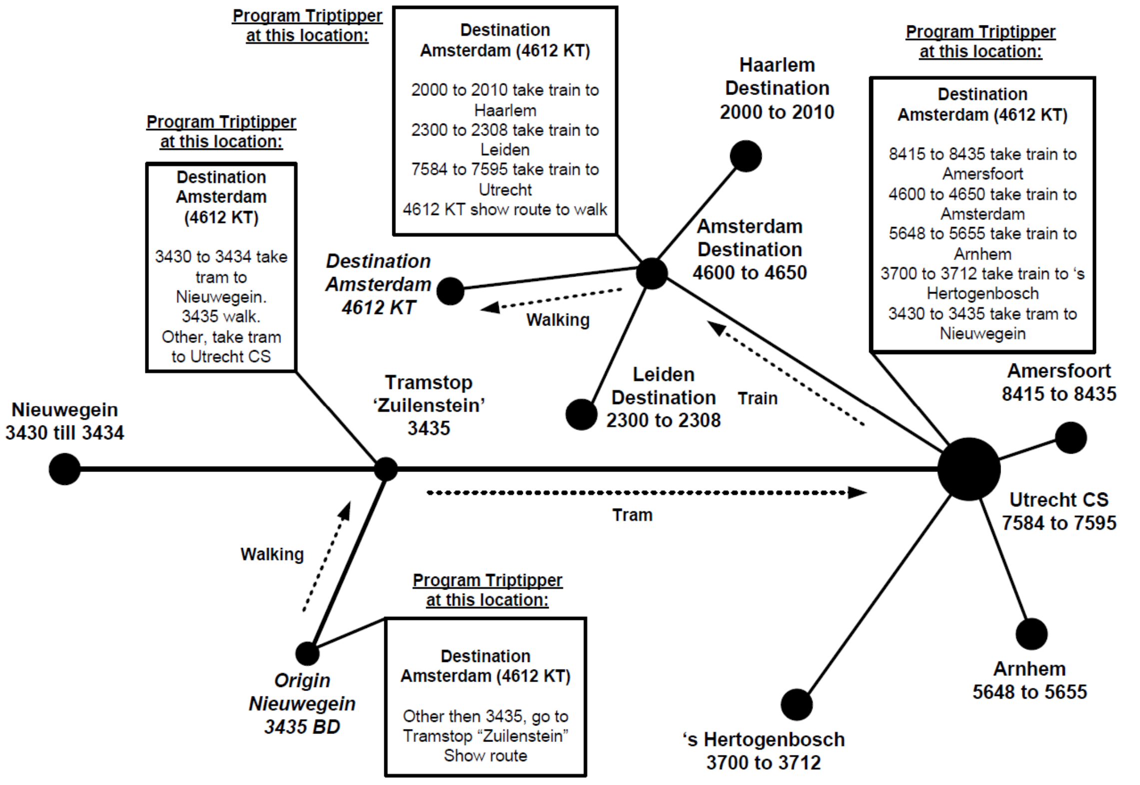



*Figure 13: The working of Triptipper application during a journey from Nieuwegein to Amsterdam*

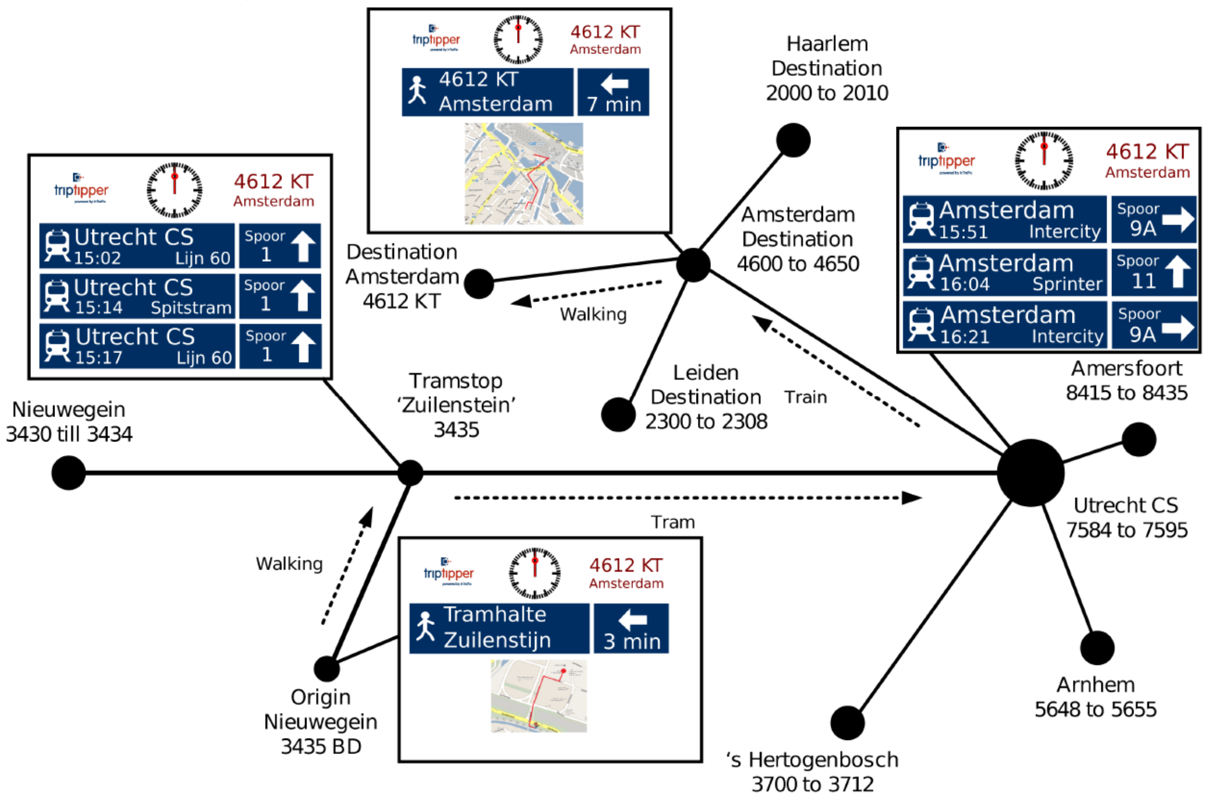



*Figure 14: The travel displays during a journey from Nieuwegein to Amsterdam*

### 4.4.4. In- and output links

The Triptipper application has multiple input and output links in order to provide quick and personal travel information to the traveller in public transport (Figure 15). The main travel information will be provided to the Triptipper application by NDOV (Dutch Databank for Public Transport). However this is a future scenario as the NDOV is not operational at the moment. Therefore, the data will be obtained from the travel information provider 9292OV until the NDOV is operational. NDOV (or 9292OV) will provide static and actual travel information of almost all public transport modes in the Netherlands. An extra connection with VIEW will be made in order to obtain more actual train travel information. VIEW is a system which is maintained by InTraffic and which traces trains on a more detailed level than the current train travel information system. By using this system to update the current travel information, improved travel advices can be provided to the traveller. The local manager of the Triptipper system also has the possibility to provide travel information input. This generally mostly concerns local travel information like travel routes. In appendix 3 an overview is found of the location of the Triptipper application in the travel information architecture.

In order for the traveller to obtain travel information, he or she first has to transfer his travel destination to the destination item (QR-code or OV-chipcard). This can be done by using a PC with an OV-chipcard reader or printer. This item will be used to provide the Triptipper application with the travel destination input. With that information, the Triptipper application will calculate the three quickest possible travel advices and present said travel advices to the traveller.

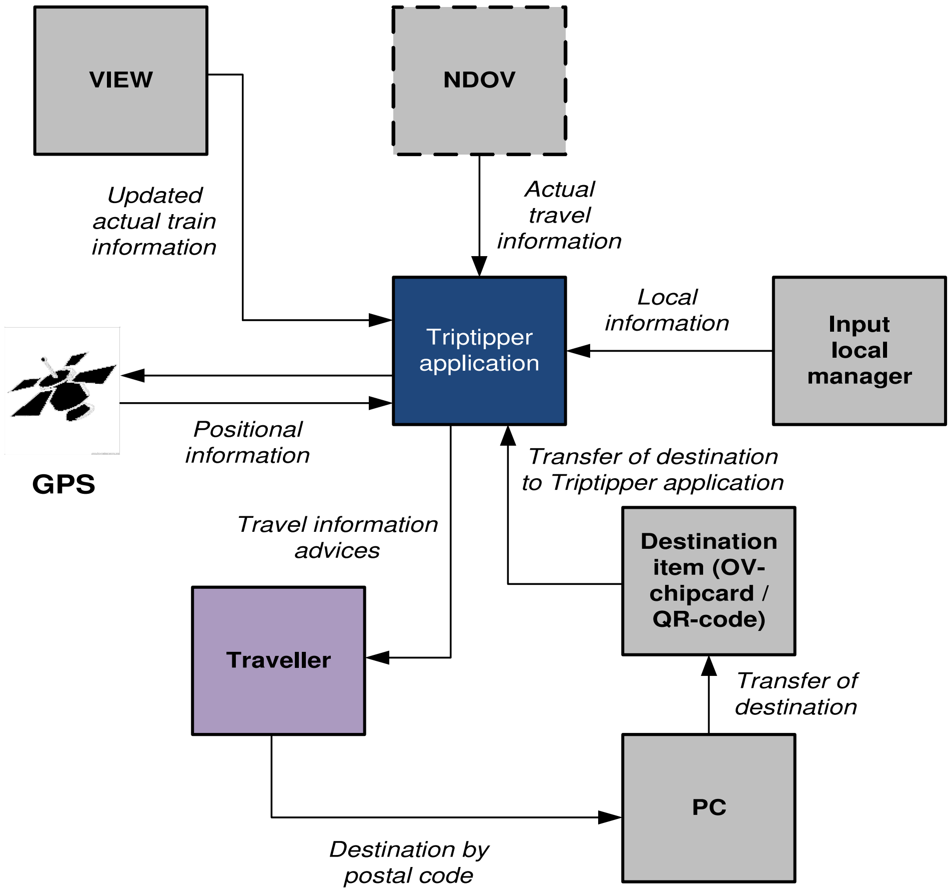



*Figure 15: The in- and output links for a Triptipper application*

# 5 Methodology

*In order to test the quality of travel information provision several methods are available. Most methods are based on a practical approach based on the preference by InTraffic. This chapter describes the methodology that is used during this research. Different methods are explained and underpinned. Most of this chapter is dedicated to the description of the setup of the Serious Gaming experiment. Advantages and disadvantages are being compared to come up with a final set up.*

## 5.1. Methods to test travel information provision systems

Travel information is a reasonably subjective matter. Several factors contribute the way how travellers react on provided travel information. Therefore it is also difficult to test the quality of a travel information provision system on the basis of time and effort as stated by Grotenhuis et al. (2007). However different options are available to test the quality of travel information provision systems, wherein every option has its advantages and disadvantages concerning testing the quality. The following options have been evaluated on applicability and desired output in order to test the quality of a travel information provision system:

- 3D simulation
- Real time at location
- Serious Gaming
- SERVQUEAL method

### *5.1.1. 3D simulation*

3D simulation may refer to 3D computer graphics called 3D modeling in a dimensional surface of an object which is mathematical represented via specialized software. This representation can be displayed as a two-dimensional image in a computer simulation. 3D simulations can also refer to a physical 3D model whereby no software is being used to project the 3D model. Describing a 3D simulation, reference is made to the 3D simulation with 3D computer graphics. When working with an experiment concerning a 3D simulation, it is important to know if an existing 3D simulation model exists which can be used to execute the experiment is available. NS and ProRail have developed a 3D simulation in 2009 of the train station Leiden Centraal with the name: mijnproefstation.nl (my test station). They have made an exact 3D model of the train station Leiden Centraal. Researchers from NS, ProRail and other external companies had the possibility to use the model to perform different types of research. Most research focuses on the station environment concerning light and noise and until now no research concerning travel information provision has been executed.

When there is no 3D model available, there is also the possibility to create a new 3D model, but creating a 3D model requires substantial knowledge of modeling and it would consume much time and many resources. External companies may be asked to create a new 3D model but that would require a financial basis which is not always available.

*5.1.2. Real time at location*

An alternative option is formed by testing the travel information provision in the field. Travellers at stations and in trains and busses can be asked several questions concerning their journey and how they think about the travel information provision. An option is available here to make use of randomly selected people (real travellers) or people selected in advanced and to ask them to execute a pre-routed journey. Time can be measured and questions can be asked by executing an interview or handing out questionnaires. The advantage of this option is that data can be obtained in a real environment. A disadvantage is that the environment cannot be controlled by the researcher and he or she has no control over the provided travel information.

*5.1.3. Serious gaming*

Serious gaming is a type of gaming experiment which is mainly used for government communication, information, education and training. Other names for serious games are social impact games or non-entertainment games. The goal of these games is different from entertainment. Serious gaming is being used to learn or to communicate a message to someone in a fun and safe manner. TNO (Dutch Organization for applied physical research) has defined Serious Gaming by the following requirements:

- A serious game has another purpose than entertainment only
- The game is based on ICT
- The game has a game component

*5.1.4. SERVQUAL method*

The underlying thought of the SERVQUAL method is the assumed difference between the expected service and the perceived service. The expected service is the service that meets the expectations of customers, while the perceived service is the service that people actually experience. The expected service has to be determined to find out which quality level can really satisfy the customers. Distinguishing between expectations of adequate services and expectations of desired services can help to define expected quality (Parasuraman et al., 1993). By determining what travellers expect and what they perceive of travel information, it is possible to determine the quality of travel information provision systems.

*5.1.5. The choice for Serious Gaming*

The four methods described above, all have positive and negative side-effects concerning testing the quality of travel information provision systems for traveller. A clear distinction can be made between the four methods in the content of closed or non-closed environment, whereby both options contain advantages and disadvantages.

The 3D simulation option accounts as a serious option, though at the moment of executing the experiment, the 3D model of the train station of Leiden Centraal is not accessible anymore. Creating a complete new 3D model is not a feasible option concerning the amount of time, skill and finances available. Real-time measurements at public transport locations can deliver a lot of valid information as the experiment is executed in a real environment. The open environment ensures that there is hardly any control on the output of the travel information provision systems, including Triptipper which must be executed in multiple locations if to be operated as a travel information provision system. The SERVQUAL method is based on a theory which looks at the adequate level of information service. This research focuses on the desired level of information service and therefore will not be chosen as a suitable method.

The Serious Gaming method has been considered to be the most useful for executing this experiment. The value of working in a closed environment and the availability of a suitable location were the two main reasons to choose for this option. When using a closed environment, predetermined scenarios can be used to create a controlled environment. Furthermore there is already a location available at InTraffic which can be used to execute the experiment. A disadvantage however is that a closed environment, which is created at InTraffic, cannot completely simulate a real-life public transport environment so that  the chance exists that participants do not react the same as they would have done in a real environment. Although

this disadvantage has to be accounted for, the advantage of creating a closed environment with pre determent scenario's and the availability of a suitable location are prevalent over the disadvantage of a closed-environment.
This experiment will make use of ICT components like computers however the participants will not make active use of these components. The ICT components will only display travel information to the participant and he or she will not be actively involved in any form of input at the ICT components besides providing a destination input at a Triptipper application. Because of this and the fact that experiment has a high 'gaming value', the name 'Serious Gaming' will be used at this experiment.

## 5.2. Three travel information provision systems

### *5.2.1. The Triptipper travel information provision system*

There is a distinction between three locations home based, way-side and on-board locations. A real distinction between types of travel information provision systems is more difficult to make because of the diversity of travel information provision platforms and media, but to test the newly developed Triptipper system it has to be compared with the currently available (conventional) travel information provision systems. Present day's technologies offer a lot of options for the traveller to obtain his or her travel information. Due to the diversity of possibilities to obtain travel information for travellers requires that a distinction will be made between the current travel information provision system and the mobile telephone travel information provision system. The choice for an extra system concerning the mobile phone system is based on the feature that this system can provide personal travel information to the traveller and that he or she always carries it with him/her. Together with the Triptipper system they present the three travel information provision (TIP) systems which will be tested.

### *5.2.2. The conventional travel information provision system*

This travel information provision system comprises almost every possibility for today's traveller to obtain travel information. Every sign or timetable at train and bus stations belongs to the conventional travel information provision system. This also includes the presentation of travel information from the internet at home, at work or in a certain mode of transportation. Table 2 at page 17 provides a good overview of different types of travel information platforms which al belong to the conventional travel information provision system apart from the mobile phone.

### *5.2.3. The mobile phone travel information provision system*

The mobile phone is considered as a separate system because it provides actual and personal travel information to the traveller. Not every mobile smart phone belongs to this category, rather only the ones which have an active internet connection. This internet connection allows the mobile phone to provide the traveller with actual travel information and to increase the value of information significantly. With the use of a mobile telephone with an internet connection, the traveller always has the option to access actual travel information. Most smart telephones are also equipped with GPS, which can determine the location of the mobile phone and thereby also determine the location of the traveller. There are different possibilities to obtain travel information by making use of different applications on the smart phone. Every application providing travel information mostly uses GPS and internet in order to provide actual and personal travel information.

## 5.3. Three travel scenarios

### *5.3.1. Development of the scenario's*

One of the big advantages of using Serious Gaming is that the environment can be controlled so that scenarios can be developed. These scenarios represent different types of journeys by public transport from origin till destination in the Netherlands. The scenarios do not only mutually differ in origin, destination and transport mode but also in terms of the delays which are implemented in some of the scenarios. By implementing delays, the quality of the three travel information provision systems can be assessed more easily because delays are the moment when travellers are in extra need of travel information as mentioned by Chorus (2007). Therefore it is interesting to analyze the differences in travel information the systems provide to the participants and how they will react to the information. Participants will execute all three scenarios with different types of travel information provision systems. By making use of three types of scenarios and travel information provision systems, differences between the qualities of the travel information that the systems provide can be observed.

The scenarios have been developed on the basis of the quickest possible journey. The route choice for this journey is planned by the route planner of the website of 9292OV. This route planner is considered to give the best route advice as it obtains travel information from almost every public transport organization. The planned routes were double checked by other route planners such as Google Transit and the planners from the concerning public transport operators i.e. NS and Connexxion. Participants received information before starting their journey on a printed paper providing the details of the start locations and of the destination locations on the paper of address details. The participants could plan their journey with these details printed on the paper.

### *5.3.2. Scenario 1: 's-Hertogenbosch to Oosterhout (NB)*

The first developed scenario is the journey from 's-Hertogenbosch to Oosterhout (NB) (Table 5). This journey started at a home-based location near the train station of 's-Hertogenbosch. The traveller walked to the train station and continues his or her journey by taking the train to Breda. At Breda the traveller walked from the train station to the bus station and takes the bus to Oosterhout (NB). The traveller alighted at the bus stop 'Mathildastraat' in Oosterhout and continues his/her journey by walking to the Ice parlor 'Via Via'. This scenario does not comprise any delays.

| Location time | Departure time | Origin | | Destination | Arrival time | Transport mode |
|---|---|---|---|---|---|---|
| **14:35** | 15:43 | Havensingel 16 's-Hertogenbosch | | Train station 's-H'bosch | 16:46 | Walking 3 min. |
| **14:45** | 15:49 | Train station 's-H'bosch Track 6 | **15:03** | Train station Breda | 16:20 | Intercity NS to Roosendaal |
| **15:21** | 16:24 | Train station Breda | **15:38** | Mathildastraat Oosterhout NB | 16:49 | Bus 126 Veolia to Geertruidenb. |
| **15:49** | 16:49 | Mathildastraat Oosterhout NB | | De Markt 6 Oosterhout NB | 16:52 | Walking 3 min. |

*Table 5: Detailed description of the journey from 's-Hertogenbosch to Oosterhout*

### *5.3.3. Scenario 2: Amersfoort to Amsterdam*

The second scenario started at a dental practice in Amersfoort. The traveller walked from the dental practice to the train station of Amersfoort. At the train station, the traveller takes the train to Amsterdam Central station. During the train stage, the train gained a delay of +2 minutes. This delay had no effect on the following stage of the journey, because by the arrival of the train delayed by 2 minutes, the traveller will not miss his or her connecting transfer. When the traveller leaves the train station of Amsterdam, he or she walked to the tram station where the tram to Keizersgracht was taken. At the tram stop of Keizersgracht, the traveller alighted and continued his or her journey to the Museum Van Loon, which is the final destination (Table 6).

| Location time | Departure time | Origin | | Destination | Arrival time | Transport mode |
|---|---|---|---|---|---|---|
| **15:50** | 15:54 | Dental practice KoninginWilhelminalaan | | Train station Amersfoort | 15:59 | Walking 5 min. |
| **15:57** | 15:59+3 | Train station A'sfoort Track 7 | **16:06** | Train station Amsterdam Centraal Track 11a | 16:33 +3 | Intercity NS to Enkhuizen |
| | 16:33+3 | Treinstation Amsterdam Centraal | | CS Tram station East side Amsterdam | 16:44 | Walking 8 min. |
| **16:44** | 16:45 | A'dam Tram station E-side | **16:51** | Tram stop Keizersgracht Amsterdam | 16:53 | Tram 25 GVB to Pres. Kennendyl. |
| **16:53** | 16:53 | Tram stop Keizersgracht Amsterdam | | Museum van Loon Keizersgracht 672 Amsterdam | 16:54 | Walking 1 min. |

*Table 6: Detailed description of the journey from Amersfoort to Amsterdam*

### *5.3.4. Scenario 3: Almelo to Hengelo*

The final scenario involves a journey from Almelo to Hengelo (Table 7 and 8). The traveller started at a home-based location in Almelo and walked to the train station in Almelo. At the train station in Almelo, the traveller boarded the local train to Enschede train station. During this stage of the journey, the train encountered a delay of several minutes and it arrived later than planned at the train station in Hengelo. Because of this delay, the traveller was not able to catch the connecting train the train station of Hengelo-Oost. Therefore the traveller took the bus to bus stop 'De Noork' as this is the next quickest possible travel option. At the bus stop 'De Noork', the traveller continued his or her journey by walking to the final destination. The delay at this scenario is very interesting as caused by the multiple options for the traveller when the planned transfer connection is not available anymore.

| Location time | Departure time | Origin | Destination | Arrival time | Transport mode |
|---|---|---|---|---|---|
| **14:55** | 14:58 | Egbert Gorterstraat Almelo | Train station Almelo | 13:59 | Walking 1 min. |
| **14:57** | 14:59 | Train station Almelo Track 2 | Train station Hengelo OV Track 3a | 15:13 +8 | Sprinter to Enschede |
| **-** | 15:16 | Trainstation Hengelo OV Track 3a | Train station Oost Hengelo OV Track 2 | 15:10 | Syntus stop train to Oldenzaal |
| **-** | 15:19 | Train station Oost Hengelo OV Track 2 | Josef Haydenlaan 62 Hengelo OV | 15:25 | Walking 6 min. |

*Table 7: Plannend detailed journey from Almelo to Hengelo*

| Location time | Departure time | Origin | | Destination | Arrival time | Transport mode |
|---|---|---|---|---|---|---|
| **14:55** | 14:58 | Egbert Gorterstraat Almelo | | Train station Almelo | 13:59 | Walking 1 min. |
| **14:57** | 14:59 | Train station Almelo Track 2 | **15:17** | Train station Hengelo OV Track 3a | 15:13 +8 | Sprinter to Enschede |
| **15:22** | 15:33 | Busstation Hengelo OV | **15:36** | Bus stop De Noork Track C2 | 15:38 | Citybus 11 to HasselerEs |
| **15:38** | 15:38 | Bus stop De Noork | | Josef Haydenlaan 62 Hengelo OV | 15:42 | Walking 5 min. |

*Table 8:Actual detailed journey from Almelo to Hengelo*

### *5.3.5. Locations at the scenario's*

In order to replicate the journey's as good as possible, several locations were copied as in the real journey. The locations will have the same media containing travel information as in the real locations. The choice of the locations is based on the most important stages where travellers can access travel information. These locations are separated into home-based, way-side and on-board locations as stated by Hine & Scott (2000) (Table 9).

| Scenario | Location 1 | Location 2 | Location 3 | Location 4 | Location 5 | Location 6 |
|---|---|---|---|---|---|---|
| **1** | At home | Train station 's-H'bosch | In the train to Breda | Bus station Breda | In the bus to Oosterhout | Bus stop Mathildastr. Oosterhout |
| **2** | At work | Train station A'foort | In the train to A'dam | Tram station Amsterdam | In the tram to Keizersgracht | Bus stop Keizersgracht |
| **3** | At home | Train station Almelo | In the train to Hengelo | Bus/train station Hengelo | In the bus to bus stop De Noork | Bus stop De Noork |

*Table 9: Description of locations of the three journeys*

## 5.4. Setup of the experiment

### *5.4.1. Location of the experiment.*

With the development of the scenarios and the segmentation of the three travel information provision systems, the setup of the experiment could be created. The experiment was executed at the 3$^{rd}$ floor of the office building of InTraffic in Nieuwegein. A former software testing room served as the main location for the experiment. This room was separated into five smaller spaces by setting up wall elements. These smaller spaces matched the scenario locations 2 till 6. A separate small room nearby, functions as the location for scenario 1. Appendix 6 provides a complete overview of the setup of the experiment.

### *5.4.2. Possibility to execute the experiment simultaneously*

The setup of the experiment was designed to facilitate multiple participants at one time. Hereby it was possible to obtain more information from multiple participants in the same amount of time. The maximum number of participants is six because of the possibility to facilitate one participant at one of the six locations. Therefore there are six headsets available whereby participants obtain travel information for a specific location. The application to automatically measure the time is also designed to facilitate multiple participants by using unique scanning card per participant.

Although the original intention was to execute the experiment with multiple participants at one time, this intention was not executed. Because of organizational and logistical problems, it was difficult to gather multiple participants at one time. It was also expected that the accompany of multiple participants could create problems because of the availability of the supervisor/researcher. During test experiments with one participant, the supervisor/researcher had varying troubles executing a guaranteed successful experiment based on the type of participant and the attention that this person needed. Therefore, when executing the experiment with multiple participant, it was not guaranteed that the researcher could divided his attention of all of the participants when they are in need of it. Therefore the decision has been made to execute the experiment with only one participant at a time. For future experiments, it is possible to execute the experiment with multiple participants though it is required that there are more than one supervisors are present.

### *5.4.3. Travel information visual media*

At almost every location there are several travel information media platforms available. Multiple computer displays simulated travel information media by displaying pictures or videos of real public transport environments. E.g. during scenario 1 in location 2, computer displays provided pictures of the platform signs of the train station in ‘s-Hertogenbosch at the scenario time. The computer displays replicated six types of information:

- Dynamic track signs at train stations
- DRIS-signs at bus stations
- OBIS-sign in the train
- On-board dynamic route information in the bus
- Video’s replicating location surroundings
- Pictures replicating location surroundings

The order of the type of travel information is divers and it depended on the travel scenario.
The goal of the computer displays was to represent the real-time environment at all of the locations as good as possible. By providing the same types of travel information in the experiment locations as in the real location, the traveller was expected to react in a comparable way as in the real locations. In appendix 11, all the visual travel information

### *5.4.4. Travel information sounds*

Apart from visual travel information media, sound is also an important source of travel information. Participants executed the experiment with the use of a headset. The use of headsets is preferred above the use of sound through speakers. The sound created by the speakers can be heard in the whole room, which is not preferred in view of the possibility that multiple participants perform the experiment simultaneously. Although this experiment was only executed with one participant at one time, the use of a headset was preferred above the use of the use of speakers because of the noise nuisance.

The headset plays the following different types of sounds:

- Environment sounds (train/bus stations sounds etc.)
- Introduction of the scenario and the assignment for the specific location
- Travel information by replicating public address systems
- Pause music

When a participant entered the room, he or she heard the assignment for that specific location. After the assignment instruction a bell is ringed, which indicates that the participant can enter the room and start with the assignment. After the sound of the bell, the environment surrounding sounds will be played. This sound may be temporarily interrupted by the sound of a public address system providing travel information. After the sound of the bell, the participant is allowed two minutes to complete the assignment. When the assignment is finished and the participant leaves the room, pause music is played during one minute. This music indicates that the participant is allowed one minute to fill in the answers on the form and to prepare him- or herself for the next location.

### *5.4.5. Triptipper application*

A Triptipper application is present at every location. This Triptipper application runs on a computer which is specially provided for the application. There are three methods to input the destination to the Triptipper application; therefore keyboard, camera and chip card readers are connected. To create identical situations for inputting information in the Triptipper application, the experiment will only be executed with the QR-code option.

### *5.4.6. Mobile smart phone*

For travelling with the mobile smart phone travel information provision system, a Samsung Galaxy Mini is be used. Participants were not allowed to execute the experiment with their own smart phone. Because smart phones have different control functions, there is a difference between the usability of smart phones of different types and therefore also for the options to obtain travel information. Only one type of smart phone was used to increase the reproducibility of the research. Using one smart phone for all the participants also provides the option to manipulate the usage of the smart phone.

In order to execute a journey as real as possible and to obtain the same amount and type of information as in the real world, two adjustments were be made to the smart phone. First the time was manually adjusted so that it matches the scenario time. This adjustment was executed by the researcher every time the participant changes from location. Secondly, the GPS was adjusted in order to correspond with the location of the scenario. The original GPS in the smart phone only provided the current location of the smart phone which is in Nieuwegein. In order to match the location on the GPS with the scenario location, a software program was installed on the smart phone whereby the GPS-location can be manually faked to a preset location. The preset locations represented the scenario locations and with the software program it was possible to change the locations during the experiment.

Because there are a lot of programs available on the smart phone and they do not all provide the same amount and type of travel information, only two travel information applications were installed on the smart phone. Participants only could make use of these two travel information applications. These two applications are 9292OV and Google Maps. These two applications were selected because these two applications are the most often used travel information applications on mobile smart phones and both applications respond positively on the GPS-fake program. Other applications, like the travel planner from NS, are also popular travel information applications but they do not respond positively to the GPS-fake program, whereby the application is unsuitable for the experiment. The 9292ov application has two main functions, namely the planning of a journey form origin till destination and the obtaining of actual travel information on the basis of the current GPS location. Both functions were used during the experiment. The Google maps application was mainly used to obtain the current position and to display walking routes from current position to the destination. The Google maps applications also makes use of Google Transit to plan public transport journeys, though participants would not make use of that function during the experiment because of the low popularity of this sub application of Google Maps.

### *5.4.7. Technical specifications*

In order to keep all the different visual-, sound- and Triptipper systems working, a main system was developed to operate the experiment. By operating this main system, the researcher controls the scenarios by starting, pausing or stopping the provision of travel information by computer displays, Triptipper applications or sound. The time is measured automatically by the main computer obviating the need for the researcher to measure the time manually.

The main operating computer is connected with ten other subsystems. All of these subsystems launch the application displaying the travel information on the displays, start the Triptipper application and play the selected sound. A User Interface installed on the main operating computer provides the researcher to manually load, start, pause and stop the scenarios. The user interface allows the researcher to change the search time and the order of the sound per location.

## 5.5. Measurements

### *5.5.1. Time measurements*

The quality of travel information provision systems can be measured by time and effort (Grotenhuis et al. 2007). The first variable to be measured is time and at every location the time needed by the participant to obtain the correct travel information following the questions in the assignment will be measured. The time was measured automatically and is stored into a demo Triptipper application. This Triptipper application was made operational primarily to measure the time at the main computer and does not have any relationship with the normal Triptipper applications during the execution with a Triptipper system. The time measurements were performed by making use of a chip card and a card reader. The system started the time automatically when the location scenario is started and it also transferred the start time to the demo Triptipper application. When the participant knows the answers to the questions, he or she leaves the location and manually stopped the time. The participant does this by scanning the chip card by the card reader. The card reader sends the end time to the Triptipper application and calculates the total search time.

Chorus (2003) states that processing information can separated into searching and using information. The setup of the research room does not completely allow to measure the search time, therefore only the processing time will be measured. The search time is also dependent on the distribution of the travel information provision systems at a transfer station or in a public transport vehicle and is therefore difficult to measure. During the experiment, participants needed time to process the information and time to look at the different travel information provision media. This is also referred to as search time, though this search time is only a small fraction of the search time in a real environment. Taking all of this into account the processing time and the search time were taken into the research, but with restrictions that the search time in this research was only a small fraction of the normal search time travellers need to find travel information.

Apart from the exact time measurements, the perceived time of the participants have also be taken into account. At every location, the participants are asked to estimate the time they needed to obtain the travel information. With the official time and the perceived time, information about the difference between the two measurements can be made in related to the three travel information provision systems.

### *5.5.2. Effort measurements*

Effort savings can be classified into three kinds of effort: physical effort; cognitive effort; and affective effort (Stradling et al, 2000b; Stradling, 2002) (Table 10). During the research, all of the three types of effort were measured. The data concerning the effort measurements was obtained by a small questionnaire which was filled in by the participants after the performing of each scenario (Appendix 11). By asking effort related questions per scenario, a comparison was made with the three types of scenario in relation to the different travel information provision systems.

| Type of savings | Time savings | | Effort savings | | |
|---|---|---|---|---|---|
| **Type of time- and effort savings** | Actual time, measured by the system. | Perceived time, written down by the participant self. | Physic al effort | Cognitive effort | Affective effort |
| **Type of Measure ments** | Automatic system with chip card and card reader that measures the time. | At every location, the participant gives answer to the question how long he/she things it took to find the correct travel information. | Questionnaire which will be filled in by the participant after and during the execution of journey. | | |

*Table 10: Type of time and effort savings*

## 5.6. Participants

### *5.6.1. Types of participants*

The participants are an important aspect of the research. The participants assumed the role of traveller during a public transport journey. Initially three types of participants were identified in order to execute the experiment. Those three types are employees from InTraffic, students and public transport experts. With this diversity of participants, also differences between the participants can be taken into account. Originally every group of participants comprises of nine people, which makes 27 participants in total. The choice for nine people is based on the three scenarios and the three travel information provision system. This means that when three participants have executed the experiment, all scenarios have been executed with three different travel information provision systems. In order to increase the validity of the research, nine people per group have been selected so that every scenario is executed three times with one travel information provision system. This means that three people per group execute the same experiment and therefore data between those participants creates a more valid comparison. But due to organizational problems, it was not able to collect nine public transport experts therefore the total amount of participants was set to eighteen.

### *5.6.2. Identification of the traveller*

Travellers are never the same and they react completely different in varying situations. This is not only due to the provided travel information, but it is also dependent on the traveller as a person. Because every traveller is different, is it difficult to provide travellers with all different types of services, including travel information, due to different psychological preferences. For the experiment, the research for the segmentation of six types of travellers in public transport by NS (Appendix 7) is used in a questionnaire. This questionnaire contained 30 statements about travelling in public transport whereby the participant could answer on a range from 1 (completely agree) till 5 (completely disagree). As a result to this questionnaire the participants received a percentage score per one of the six types of travellers.

The six types of travellers identify the soft characteristics of the participants. In order to also know more about the hard characteristics, the questionnaire also contained questions regarding social-demographic preferences. These questions together created a basis allowing identification and possibly segmentation into predetermined groups of the travellers.

## 5.7. Execution of the experiment

### *5.7.1. Preparation before the start of the experiment*

In order to give the participant information about the experiment, he or she received a small presentation about the purpose of the experiment and about the course of the experiment. This presentation took about 10 minutes and afterwards, participants were allowed to ask questions relating to the experiment. After the presentation, the participants had time to get familiar with the mobile smart phone and the Triptipper application. Of the three travel information systems, it is assumed that travellers are familiar with the conventional travel information provision system, though this cannot be expected concerning the mobile smart phone- and Triptipper travel information provision systems. Therefore participants received an explanation about travelling with the use of the mobile smart phone. Participants who are less familiar with the smart phone received more explanation about the use of the smart phone and had more time to get adjusted to the functions of the device. Some participants were also unfamiliar with the operation of Triptipper and therefore also received some explanation about the functions of Triptipper.

### *5.7.2. Main questionnaire*

In order to identify the type of traveller, the participant answered several questions regarding social-demographic and public transport travel related questions. The participants were allowed 15 minutes to complete the questionnaire in a separate room. During that time, the researcher had enough time prepare the experiment including loading the scenario in the system. See appendix 10

### *5.7.3. Distribution of the participants during the experiments.*

When the participants have finished the questionnaire they were ready to start the experiment. It depended on the follow-up number of the participant, which order of scenario was executed. In order to ensure that every scenario was executed with the same number of different travel information provision systems, the following schedule was used (Table 11):

| | Participant | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** |
| **Scenario 1** | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Scenario 2** | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 |
| **Scenario 3** | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 |

*Table 11: Order of execution of experiment by participant*

The numbers related to one of the three travel information provision systems whereby number 1 related to the conventional travel information provision system, number 2 to the mobile smart phone travel information provision system and number 3 relates to the Triptipper travel information provision system. By using this schedule, every travel information provision system was performed the same number of times during every scenario increasing the validity of the research. Every participant executed one scenario with one travel information provision system. This was done because when every participant executed the scenarios with the same travel information provision system, the type of scenario would affect the results concerning the quality of the travel information provision systems.

### *5.7.4. Execution of the experiment – start location*

At the start of the experiment, the participant received a new assignment containing questions to be answered during the performing of the experiment. The experiment started at location 1, the home-based location, where the journey will be planned. The researcher gived a signal that the participant can plan his/her journey and he will record the time. When the participant had obtained all his necessary information he will give a signal to the researcher that he or she is finished whereby the researcher stopped the time.

During the execution of the scenario with the conventional travel information provision system, participants had the ability to make use of the internet and the printer. It is expected that participants will plan their journey online and print the route on paper. For the rest of the journey, participants were allowed to take along this route on paper. When executing the mobile smart phone travel information provision system, participants made use of the supplied mobile smart phone. They had the option to save their planned journey on the mobile phone, so that they can request that information during the remainder of the journey, but participants do not have the option to print out their planned journey on paper. For the Triptipper travel information provision system, participants made use of the website of Triptipper.nl and had the ability to print out the QR-code which was generated on the website. Participants do not had the ability to print out other types of travel information besides the QR-code.

### *5.7.5. Execution of the experiment – location 2 till 6*

Location 2 till 6 represented the locations during the journey apart from the home based location. During this part of the journey, participants executed the experiment with a head set. When starting this part of the experiment, participants put on the headset. They will stand ready before the entrance of the 2nd location with their assignment with them and, depending on the scenario, the mobile smart phone, a QR-code or a travel route on paper. Once the sound is played by the headset, the participant heard the questions regarding the location, which is the same as described on the paper assignment. After the questions, a bell sound indicated that the participant can enter the room. Once in the room, the participants had two minutes of time to obtain their needed information. When the participants assume they had all the required information, they leaved the room and stopped the time by placing a chip card on the card reader. When a participant was in the room for longer than 2 minutes, the sound was stopped, the displays turned black and the time will be stopped automatically. Once, the participants had stopped the time, they had the possibility to answer the questions.

Participants were only allowed to write down the answers to the questions after the time has been stopped. This is because during a real journey, travellers (mostly) don't write down their answers and this writing time will affect the search time per location. A disadvantage of this choice is that participants may had forgotten their answer when writing down their answers. However, during a real journey, travellers could also forget the information they just obtained and therefore, this choice will represent the options which is most related to a real travel information searching situation.

### *5.7.6. Finishing the experiment*

After the participants had completed a journey, they are asked to answer questions relating to the experience of effort perceived during that journey. Those questions provided information to compare the needed effort of travellers during the journey with a certain travel information provision system. After the experiment was completed, the researcher showed the participant how he or she scored concerning the 6 types of travellers based on the first questionnaire the participant answered.

# 6 Results of the experiment

*This chapter presents and describes the most important results obtained during the experiment. Results are obtained by the questionnaires and time measurements to determine the quality of the travel information provision systems. First, results concerning the travellers are provided. Subsequently results concerning time and effort are discussed in relationship with other important variables. These results form the basis for the conclusions in this research.*

## 6.1. Participants

### *6.1.1. Type of travellers (soft characteristics)*

The types of travellers are based on the research of the NS[13]. Those types of travellers all have different behavior and expectations about travel information provision in public transportation. Extensive research of the NS has provided information concerning the types of travellers in the Netherlands. The comparison between the distribution of the type of travellers concerning the participants (N=18) and to the distribution in the Netherlands is interesting. Another comparison is showed between the participants from InTraffic and the students.

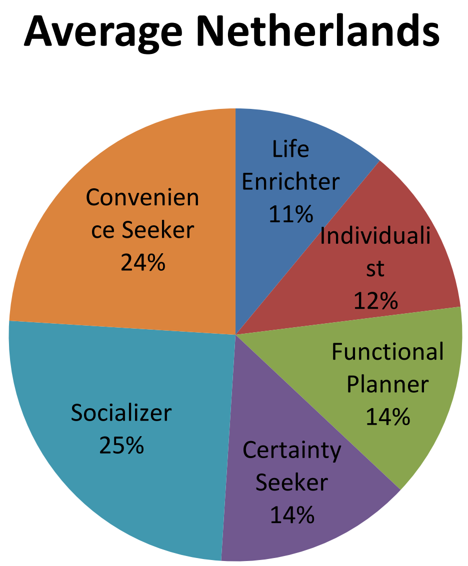



*Figure 16: Distribution of type of travellers in the Netherlands*

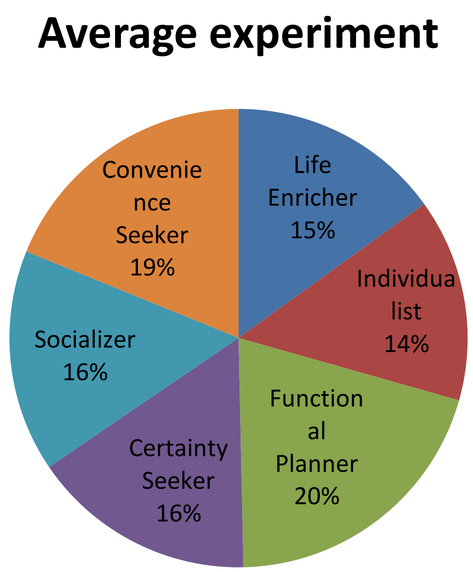



*Figure 17: Distribution of type of travellers during the experiment*

[13] Research by Needscope

Observing the average distribution of travellers in the Netherlands in (Figure 17), both the Convenience Seeker and the Socializer represent almost the half of all travellers. Convenience Seekers and Socializers are mostly more recreational oriented travellers, implying substantial number of travellers are no commuters who often travel with the recurrent pattern concerning origin and destination. The average of the participants of the experiments shows that especially the Convenience Seeker (-5%) and the Socializer (-9%) deviate from the average in the Netherlands. This difference again is leveled by the other four types of travellers

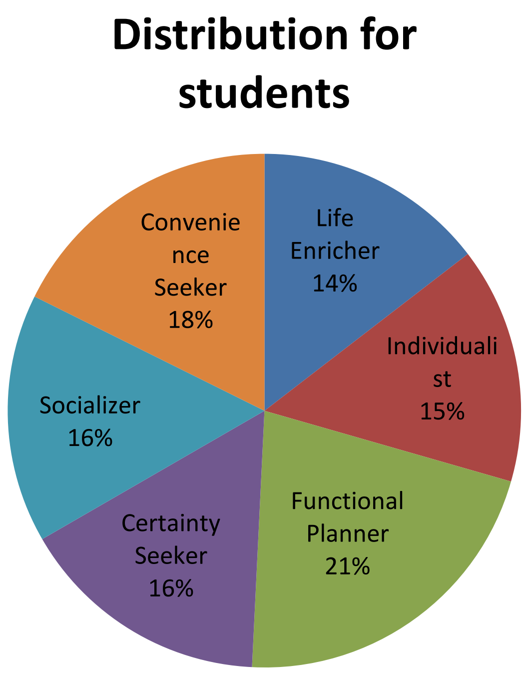



*Figure 19:Distribution of type of travelers by students*

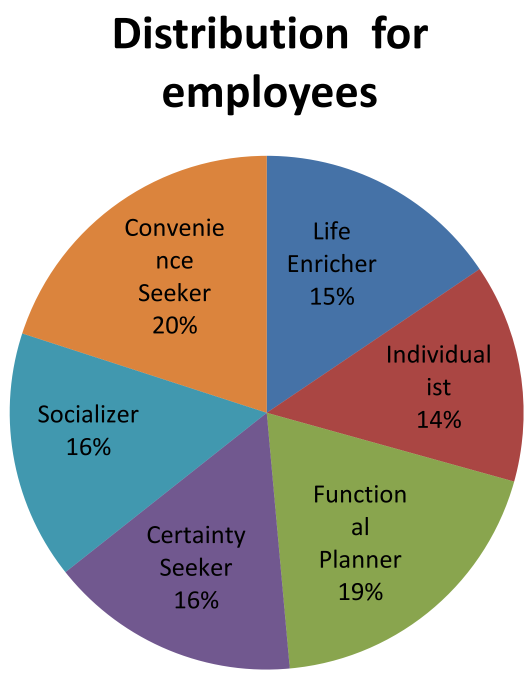



*Figure 18:Distribution of type of travellers by employees*

The overview of the distribution between the students and the employees shows no big difference (figure 18 & 19). The relatively biggest difference can be noticed between the Functional Planner and Convenience Seeker type of travellers. The results show that Functional Planners are 2% more represented by the students than by the employees and this accounts in reverse for the Convenience Seeker whereby the employees have a 2% higher share. This small difference between the groups is remarkable because it is expected that students have a higher share of Convenience Seekers in comparison to the employees. This is even truer as students figure as a role model for the Convenience Seeker type. The same accounts for the Functional Planner, whereby students have a higher share of this type of traveller than the employees. This difference can, however, be explained by the possibility that employees often travel for work with public transport and therefore have no need to plan their journey, which is an important attribute of a Functional Planner, because he or she is familiar with the route.

Table 12 shows that the differences between the averages for the Netherlands and the participants of the experiment are relatively high compared to the differences between students and employees of InTraffic. This, of course, may be a result of the small sample size for this experiment. The Needscope research has made use of +2000 respondents in order to create its own distribution for the type of travellers. Another remark can be made considering the questionnaire for research to identify the type of travellers. The Needscope model makes more use of visual instruments to identify the needs of the traveller. Because of the limited availability of supporting instruments to identify the type of traveller, only a questionnaire was used during this research. Apart from the small sample size, this reason could also have effect on the distribution of the type of travellers. However, the used method for the distribution of the type of travellers will provide enough validity to be taken along in this research.

| Type of traveller | The Netherlands | All participants | | Employees InTraffic | | Students | |
|---|---|---|---|---|---|---|---|
| | | Measure-ments | Δ | Measure-ments | Δ | Measure-ments | Δ |
| **Life Enricher** | 11% | 15% | *-4%* | 14% | -3% | 15% | -4% |
| **Individualist** | 12% | 14% | *-2%* | 15% | *-3%* | 14% | -2% |
| **Functional Planner** | 14% | 20% | *-6%* | 21% | *-7%* | 19% | -5% |
| **Certainty Seeker** | 14% | 16% | *-2%* | 16% | *-2%* | 16% | -2% |
| **Socializer** | 25% | 16% | *+9%* | 16% | *+9%* | 16% | +9% |
| **Convenience Seeker** | 24% | 19% | *+5%* | 18% | *+6%* | 20% | +4% |

*Table 12:Overview of the differences between the participants*

### *6.1.2. Participants hard characteristics*

Travellers own several hard characteristics which have effect on their travel experience. Hard characteristics can be described as characteristics which, in contrast with soft characteristics, will not change quickly over a long period of time. These hard characteristics will have effect on the behavior of the traveller and thereby the need for travel information. The relationship between those hard characteristics and the quality of travel information provision is described in section 6.4.1.

## 6.2. Time results

### *6.2.1. Average searching time per scenario*

Searching time is one of the two variables which determine the quality of travel information provision systems. The searching time of every participant is measured and this provides a good indication of a part of the quality of the three travel information provision systems. The difference between the actual searching time and the perceived travel time by the participants is interesting. The executed scenario during the experiment are not mutually comparable because of different transport modes, locations and delays. In order to determine how much effect the individual scenarios have on the results, the following figure shows the relationship between the scenarios and the actual- and perceived searching time.

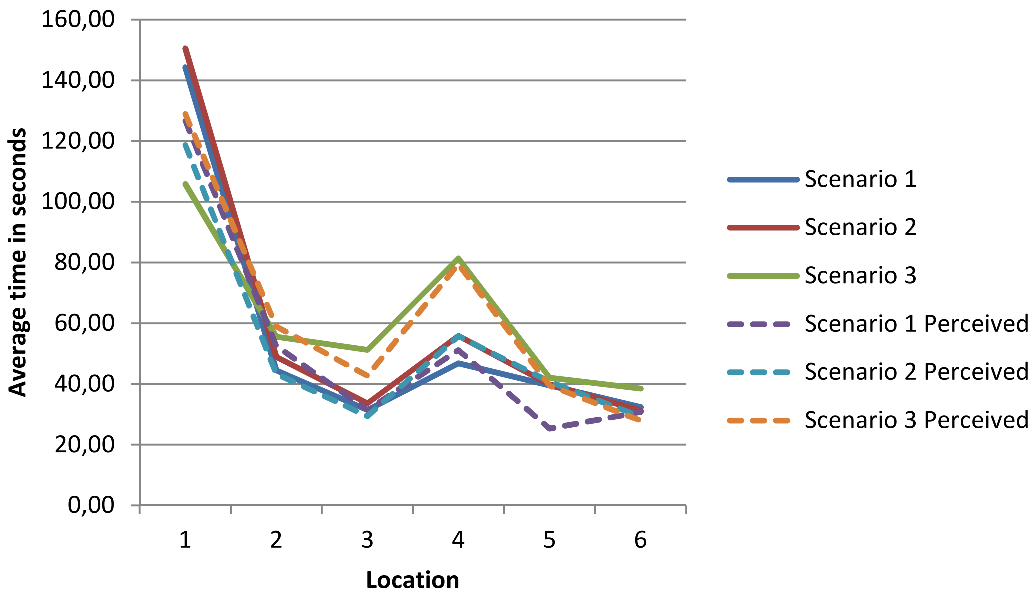



*Figure 20: Average actual and perceived searching time per scenario*

Looking at figure 20, the course of the lines shows that every location clearly discerns it from the other location per scenario. I.e. all scenarios for location 3 show a declining line in comparison to its predecessor, location 2. Location 4 on the other hand has a higher average value for all scenarios in comparison to location 3. This pattern shows that all locations have their own effect on the searching time, independent from the kind of scenario executed.

A clear statement can be made that location 1 has a relatively high actual and perceived searching time. However, location 1 simulates a home-based location, where travellers start with planning their journey. This planning process takes more time than at the other five locations, therefore it cannot be stated that searching time at a home-based location is comparable to searching time at the other locations. However it provides a good indication for the necessary time travellers need to plan their journey. Location 1 has the highest variation when the differences between the scenarios are observed. This can be explained because of the high variation searching time of the travellers. Because the average searching is longer, it can be assumed that the variation will be larger. Furthermore, travellers have different behaviors when planning their journey. Some travellers settle with one quick look at a planned online journey, whereby other travellers seek for more confirmation and also look at other possibilities, to plan their journey besides their primary option.

The most interesting information to be obtained from the graph is that scenario 3 has a higher average searching time in comparison to the other two scenarios. This corresponds with the expectations, because scenario 3 is developed as a more difficult scenario in comparison with scenario 1 and 2. Not only the actual search time, but also the perceived search time is noticeably higher than the other two scenarios. Hence not only actual search time for scenario 3 differs in comparison to the other two scenarios, but travellers also perceive to need more time to complete this scenario. Another noteworthy comment is that scenario 1 and 2 do not differ very much, though a larger difference can be observed at location 4 where scenario 1 has a shorter searching time. This can be explained by the fact that a small delay in scenario 2 at location 3 has effect on the searching time at location 4.

Location 4 has, in comparison to the other locations (2-5) a higher average of searching time. Location 4 is, in all three scenarios, a transfer location where travellers transfer from one transport mode to another. The graph suggests that travellers need more searching time to obtain their required information to continue their journey. Especially when a traveller has encountered a delay during his/her journey, he/she needs more time to obtain their travel information. This corresponds with Chorus (2007) stating that the value of information increases when trips have a high variety in conditions and more travel alternatives are available. Travellers at a transfer point are more in need of travel information, so that the value of travel information rises and it is assumable that the searching time also rises. Location 2 is also a transfer point and this fact corresponds with the argument that travellers at transfer point need more searching time to obtain their travel information.

### *6.2.2. Significant differences between scenarios*

The above section describes the differences between the three scenarios based on the graph displaying the average searching time per one of the 6 locations. The graph gives a good insight in the average actual and perceived searching time per location. Table 13, on the other hand, provides exact information concerning the total search time per scenario. This information provides the basis for the determination of any significant difference between the three scenarios. The data is gathered by assuming the fact that only the data from 6 participants can be compared. 18 participants have each executed three scenarios with three different types of travel information provision systems. Every scenario is equally executed with every TIP-system, which means that 6 participants have executed scenario 1 with the Conventional system, 6 with the Mobile Smart Phone system and 6 with the Triptipper system. This also accounts for the other 2 scenarios, which means that only the data of 6 participants can be used to identify any valid significance between the three scenarios or TIP-systems. Table 13 provides an overview of the mean and standard deviation of the data of 6 participants, which provides information to determine the difference between the three scenarios. Section 6.2.4 discloses details about the differences between the three TIP-systems.

| Conventional | Scenario 1 | | Scenario 2 | | Scenario 3 | |
|---|---|---|---|---|---|---|
| *Total search time (sec.)* | *Actual* | *Perceived* | *Actual* | *Perceived* | *Actual* | *Perceived* |
| Mean | 346 | 415 | 375 | 307 | 418 | 483 |
| Std. deviation | 97 | 62 | 205 | 180 | 41 | 171 |
| Mobile Smart Phone | | | | | | |
| Mean | 355 | 293 | 443 | 426 | 398 | 356 |
| Std. deviation | 202 | 232 | 181 | 116 | 59 | 123 |
| Triptipper | | | | | | |
| Mean | 317 | 199 | 262 | 218 | 308 | 293 |
| Std. deviation | 104 | 97 | 48 | 125 | 123 | 160 |
| Average | | | | | | |
| **Mean** | **339** | **302** | **360** | **317** | **375** | **377** |
| **Std. Deviation** | **134** | **130** | **145** | **140** | **74** | **151** |

*Table 13: Values of the differences in actual and perceived search time per scenario and TIP system provides an overview of the three scenarios for the actual and perceived search time.*

The difference between the actual and the total means do not differ much. Looking at scenario 3, the difference between the actual and the perceived searching time only differs 8 seconds. This small difference can be caused by the delay during the journey of scenario 3, though no valid statement can be made based on this result because other factors can also have effect on the result. Furthermore, the results show a large difference between the actual and perceived standard deviation in scenario 3. This result indicates that participants have a divergent opinion concerning the perceived travel time, which is striking because of the small difference between the mean of the total actual and perceived time. The results also show that the mean of the scenario is increasing in the order from scenario 1 2 and 3. This indicates that the amount of delays during the scenarios does have an effect on the actual and perceived searching time.

A T-test is used to determine the chance of a significant difference in the mean between two scenarios. The T-test is executed with a 95% confidence interval, which means that every chance on a significant difference below a value of 5% is defined as significantly different. There is no significant difference found between the three scenarios.  This means that, based on the results of actual- and perceived search time, no significant differences could be found between the three different scenarios. Therefore it can be assumed that the set-up differences of the scenarios i.e. type, amount of travel information media and the input of delays, has no effect on the search time results. However the influence of the sample size has to be taken into account, which means that this first experiment will have a high probability in lack of statistical power.

### *6.2.3. Average searching time per travel information provision system*

Besides the three types of scenarios, the actual and perceived searching time per travel information provision systems was measured. The following figures shows the average searching time at 6 different locations during a journey with three different TIP systems.

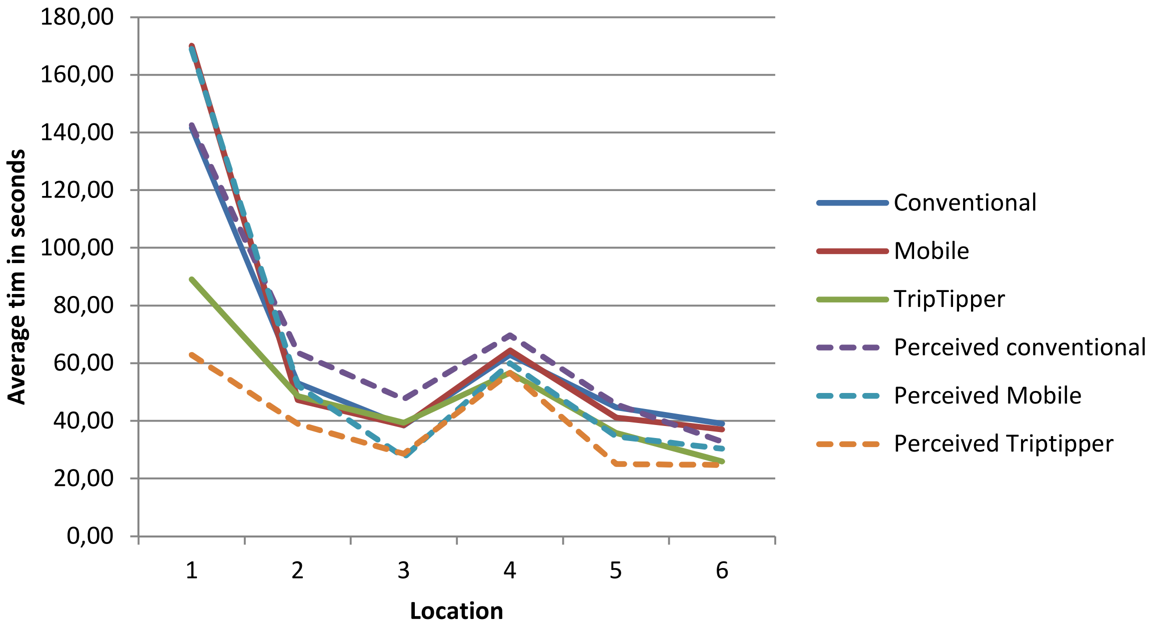



*Figure 21: Average actual and perceived searching time per TIP system*

Noticeable is the overall comparison of this graph with the latter one, Figure 21. Both graphs show increased searching time (actual and perceived) at transfer locations (2 and 4). The most remarkable part, however, is that all three TIP systems have almost have similar measurements and do not deviate from the expected results in comparison to graph. The Triptipper system does show a smaller actual searching time at location 1 compared to the other two TIP systems. This can be explained by the fact that when travellers execute a scenario with Triptipper, they mostly do not plan their journey but only transfer their postal code (destination) in a printed QR-code. Some participants did plan their journey with the help of online route planner, but not many made use of this option. Measurements show that obtaining a printed QR-code does require less time than planning a complete journey. It is plausible that this is one of the major reasons of the low searching time with Triptipper at location 1.

The graph also shows that travellers perceive less searching time when executing their journey with Triptipper. At almost every location the perceived searching time is shorter than the actual searching time, indicating that participants feel like they need less time to acquire their needed travel information in comparison with the other two TIP systems. Especially when looking at the conventional TIP system, it indicates that participants perceive to need more time to obtain their travel information than to the actual searching time.

Looking at the perceived travel time of all the three TIP systems, it is observed that there is a distribution whereby the conventional TIP systems has the highest value, followed by the Mobile Smart Phone TIP system and Triptipper with the lowest value. This distribution could have been caused by the sequence of the experiment. When participants executed the experiment, the first started with the conventional TIP system, followed by the Mobile Smart Phone TIP system and ended with the Triptipper system. By using this order, participants could have gotten more familiar with the experiment during the execution and therefore had less difficulty in using the Triptipper TIP system. It is expected that this learning effect has an influence on the results in favor of the Triptipper system, however due to technical limitations it was not possible (during an ordinary amount of time) to change this setup. During test-runs, the time measurement system of the experiment produced some random errors when the system was just started. Because of the tight schedule to finish the setup of the experiment, it was expected that the problem could only be solved within an unwanted amount of time. Therefore the decision has been made to execute the Triptipper scenario at last of the scenarios because the measurement system is linked to the Triptipper system application whereby chances that errors occurred could be reduced.

### 6.2.4. Significant differences between TIP systems

Table 14 provides the same information as Table 13, though now the total values of the TIP-systems are summed up.

| Scenario 1 | Conventional | | Mobile Smart Phone | | Triptipper | |
|---|---|---|---|---|---|---|
| *Total search time (sec.)* | *Actual* | *Perceived* | *Actual* | *Perceived* | *Actual* | *Perceived* |
| Mean | 346 | 415 | 355 | 293 | 317 | 199 |
| Std. Deviation | 98 | 62 | 202 | 232 | 105 | 97 |
| Scenario 2 | | | | | | |
| Mean | 375 | 307 | 443 | 426 | 262 | 218 |
| Std. Deviation | 204 | 180 | 181 | 116 | 48 | 125 |
| Scenario 3 | | | | | | |
| Mean | 418 | 483 | 398 | 356 | 308 | 293 |
| Std. Deviation | 41 | 171 | 59 | 123 | 123 | 160 |
| Average | | | | | | |
| **Mean** | **380** | **401** | **399** | **358** | **296** | **237** |
| **Std. Deviation** | **114** | **138** | **147** | **157** | **92** | **161** |

*Table 14: Values of the actual and perceived search time per scenario and TIP-system*

Looking at the actual time, results show that the participants do need less searching time when using Triptipper in comparison with the other two TIP-systems. The same accounts for the perceived time, whereby the value of the perceived searching time in comparison with the actual searching time for Triptipper is far less than the Conventional and the Mobile Smart Phone system. This indicates that people think that Triptipper will provide them with travel information quicker, compared with the other TIP-systems. Table 14 also shows a high standard deviation in actual and perceived searching time for the Mobile Smart Phone system. This result can be explained by the fact that some participants had some problems in the use of the mobile smart phone, which result accounted for the high standard variation.

Results show that there is a significant difference in the perceived searching time of scenario 1 between the conventional and the Triptipper system. Looking at the values of Table 14, this indicates that the Triptipper is perceived as significantly better than the conventional system during a journey with no delay during this experiment. At scenario 2, there is also a significant difference between the perceived searching time of the Mobile Smart Phone system and the Triptipper system This result shows that the Triptipper system is perceived as significantly better concerning the searching time during a journey with a small delay in comparison with the Mobile Smart Phone system.

### 6.2.5. Average difference between actual and perceived searching time

Figure 22 and Figure 23 show the difference of the actual and perceived searching time per scenario and per travel information provision system. A positive value indicates that a higher actual searching time is measured in comparison to the perceived searching time. A negative value indicates the opposite.

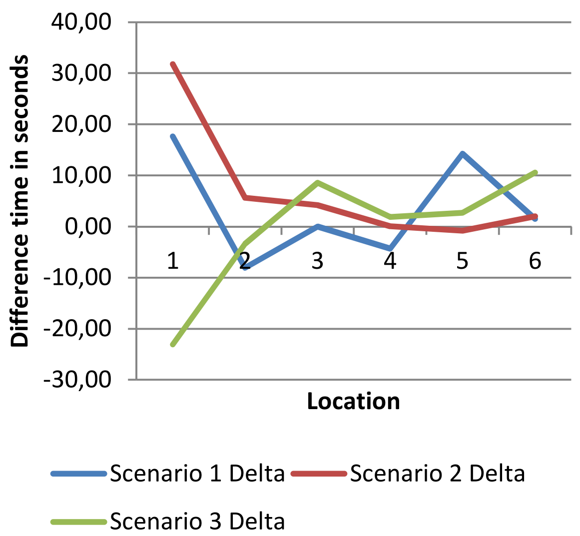



*Figure 22: Difference between actual and perceived searching time per scenarios.*

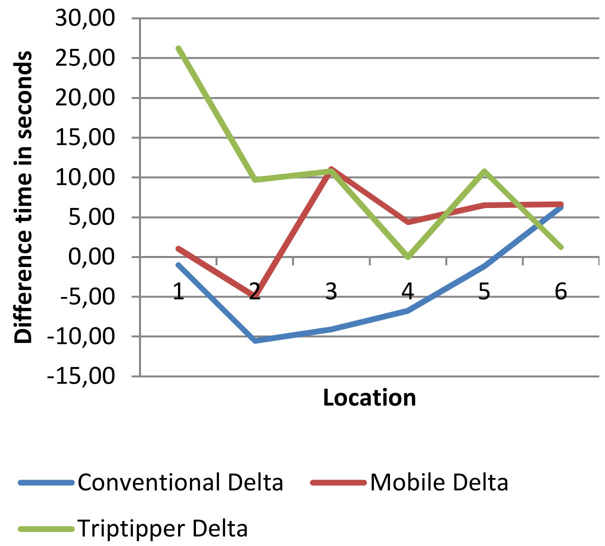



*Figure 23: Difference between actual and perceived searching time per TIP systems.*

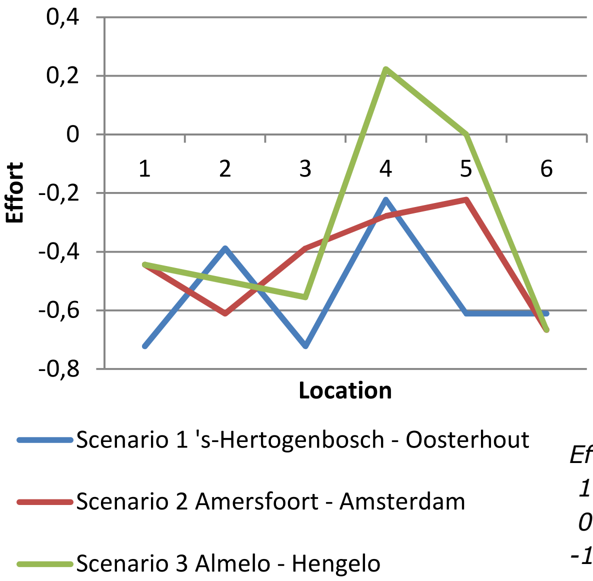
It shows that location 1 has a value more distant from zero than the other 5 locations. This indicates that at location 1, participants perceive the actual searching time more differently compared to the perceived searching time in comparison with the comparable results at other locations. In scenario 1 and 2, participants perceive the searching time significantly shorter than the actual searching time in scenario 3. It is difficult to come up with a solution for this result. The remaining locations do have a low delta which indicates a small difference between the perceived and actual travel time.

Looking at the TIP systems, Triptipper has a high positive delta concerning location 1. This indicates that travellers perceive their searching time shorter than the actual searching time. This effect can be a result of the difference of planning a journey for the Triptipper TIP system and the other two TIP systems explained in the previous section. Furthermore, the conventional TIP system has an average lower delta which indicates that participants perceive their needed searching time higher than the actual searching time. No real explanation can be provided for this result however. Results however show that there is no significant difference between the actual time and the perceived time (Appendix 4)

## 6.3. Effort results and errors

### *6.3.1. Effort during experiment*

During the execution of the experiment, participants were asked what their effort savings where while searching for travel information at a specific location. The participants could answer the question by stating that they used a low, medium or high amount of effort. The average amount of effort of all participants per scenario and per TIP is provided in Figure 24 and Figure 25. The effort range is 1 for difficult, 0 for average and -1 for easy.




*Effort range:*
*1 = difficult*
*0 = average*
*-1 = easy*

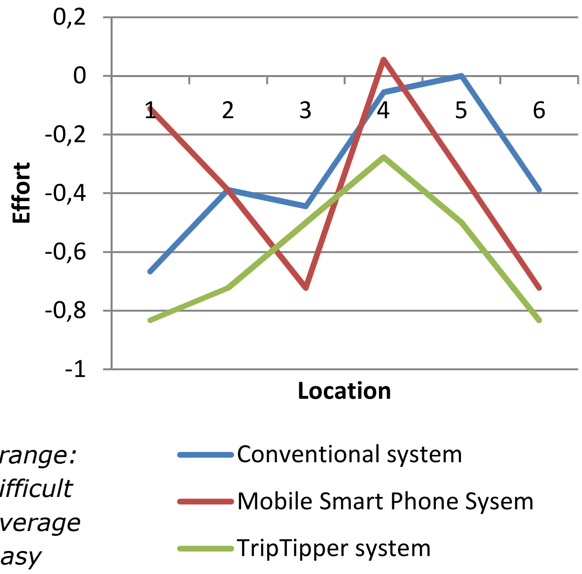



*Figure 24: Average effort per scenario*

*Figure 25: Average effort per TIP system*

The figures show the average amount of effort needed per scenario. The graph indicates that scenario 3 has an average higher amount of needed effort in comparison with the other two scenarios. Likewise the average amount of required searching time and, the average amount of effort is the highest at location 4. This again can be explained by the fact that location 4 is a transfer station whereby travellers have encountered a delay at the previous location and are therefore in need of improved travel information. Not only scenario 3 shows a high amount of effort at location 4, but the other two scenarios also show an increased output of effort at said location. This indicates that travellers do not only need extra searching time at transfer locations compared to other on-board or way-side locations, but also require extra effort to successfully continue their journey. Furthermore, the graph indicates that scenario 1 has an expected pattern complying with the data from the average searching time. Scenario 2 however does not comply with this image and shows an increased amount of effort needed at location 3 and 5, which are both on-board locations. No real explanation can be found for this phenomenon.

| Group participants | Scenario 1 | | | Scenario 2 | | | Scenario 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Conv.** | **Mob.** | **Trip.** | **Conv.** | **Mob.** | **Trip.** | **Conv.** | **Mob.** | **Trip.** |
| *X1* | -6 | -5 | -2 | -4 | -5 | -6 | -1 | -4 | -6 |
| *X2* | -4 | -6 | -1 | -3 | 1 | -3 | 1 | -1 | -5 |
| *X3* | -5 | -4 | -6 | -3 | -4 | -6 | -3 | -6 | -4 |
| *X4* | -1 | -5 | 0 | 3 | 1 | -1 | -3 | 2 | -1 |
| *X5* | 1 | -4 | -6 | -2 | -2 | -3 | 0 | -1 | -1 |
| *X6* | -1 | 1 | -5 | -3 | -1 | -6 | -1 | 3 | -4 |
| *Mean* | **-2,67** | **-3,83** | **-3,33** | **-2,00** | **-1,67** | **-4,17** | **-1,17** | **-1,17** | **-3,50** |
| *Std. Deviation* | **2,73** | **2,48** | **2,66** | **2,53** | **2,5** | **2,14** | **1,60** | **3,43** | **2,07** |

*Table 15: Values of effort per scenario*

Table 15 provides an overview of the effort per participant. Because only per 6 participants a valid comparison can be made between the Tip-system and scenarios, Xi stands for 3 participant which executed the experiment. Observing the table, it shows that the mean for the Triptipper is lower compared to the other two TIP-system at scenario 2 and 3. It can therefore be assumed that the participants who used Triptipper experienced less effort when encountering a delay during his journey. The mobile system has the lowest score when executing scenario 1, therefore it can be assumed that participants who executed a journey without any delay experience the least effort during the journey. The data of Table 14 has also been used to find any significant relationships, though using a 95% conventional interval, no significant results could be obtained (appendix 4).

*6.3.2. Effort after experiment*

After completing every scenario, the participants were asked to fill in questions regarding the effort they experienced. Per scenario, five questions were asked which all together created a total score. This score provides an indication for the needed effort per scenario or travel information provision system. The participants gave a score in a range from 1 (fully disagree) to 5 (fully agree). Per TIP system the score is cumulated up to provide a total overview of the score per TIP system per participant.

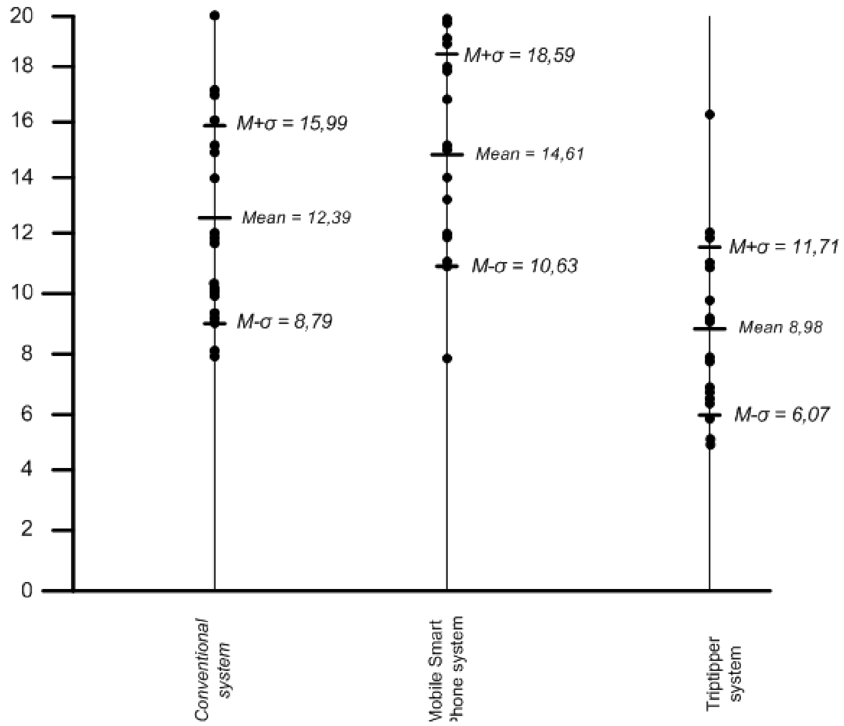



*Figure 26: Cumulated effort after experiment per traveller per TIP system*

Figure 26 shows the total amount of effort per TIP system per participant (a dot is one participant). The graph also provides a good overview of the difference in effort between the TIP systems. The total amount of effort does provide a good indication for the quality of the three different TIP systems, although the distance between the TIP systems itself per participants also provides a indication of the effort of the TIP systems compared. The figure shows that the Triptipper TIP system has an overall lower effort value than to the other two TIP systems. The mobile smart phone system has the highest mean and standard deviations (14.61, 3.6) compared to the conventional system (12.39, 3.98) and the Triptipper system (8.89, 2.82). Using a T-test (see appendix 4) with a 95% confidential interval, a significant difference can be found between the conventional system and the Triptipper system and also between the mobile smart phone system and the Triptipper system. These results indicate that the Triptipper system has a significant better effort score in comparison with the other two TIP-systems.

### 6.3.3. Errors during execution of the experiment.

Participants were asked to execute their journey as quick as possible in combination with a high certainty to find the correct and fastest solutions. False answers were also registered and the results have been taken along in this research. Participants have three possibilities to answer the questions with a correct answer, false answer or no answer. A correct answer will give 0 points, a false answer 2 points and no answer is 1 point. The sum of all points provides a total score per location per scenario or travel information provision system.

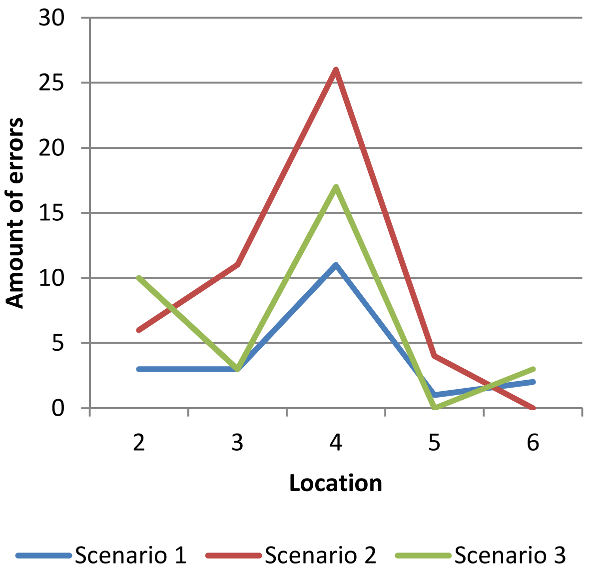



*Figure 28: Cumulated effort per traveller per scenario*

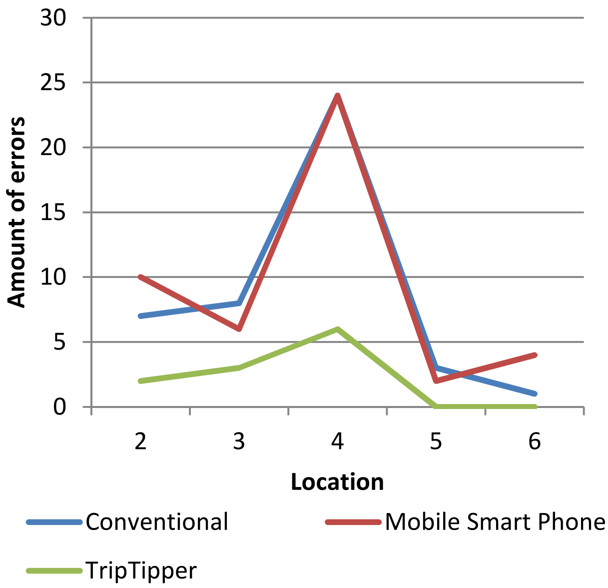



*Figure 27: Cumulated effort per traveller per TIP system*

Observing Figure 27 and Figure 28, it immediately strikes that location 4 contains the most errors. This result is in line with the previous sections showing an increased value of time and effort at the same location. It can be assumed that the delay encountered at location 3 has a direct effect on location 4. Because of the delay, the participants arrive at a later time at location 4, and therefore is their static travel information is not as valuable any more. It is assumable that due to the lack of personal actual travel information, participants make more errors than when they would arrive at location 4 at the planned arrival time.

The graph provides a clear overview of the errors made per scenario and indicates that during the execution of scenario 2, participants make more errors than in the other two scenarios. This is a striking result because it is expected that during scenario 3, which has a higher difficulty level, more errors will be made. This observation assumes that there is no direct correlation between effort and time, because Figure 27 and Figure 28 do indicate there is a consecutive order between the three scenarios. An assumption for the contradictory values indicates that the size of the delays at scenario 2 and 3 does not have a direct effect on the amount of efforts made by the participants. Another possibility for the contradictory result is the availability of travel options at location 4. At scenario 2, participants are asked to continue their journey preferably by tram and during scenario 3, the bus and train are both options. The option for two transport modes assumes that scenario 3 provides a more difficult choice to the participant in comparison with the only possible transport mode of scenario 2. Although the frequency of departing trams from location 4 at scenario 2 is much higher than the frequency of the bus and train of scenario 3. It is applicable that a connecting transfer with a higher frequency will increase the chance of missing the original planned transfer and thereby making an error by not choosing for the quickest possible option. This assumption indicates that not only the size of the delay has effect on amount of errors, but that also the frequency of the connecting transfer modes and therefore indirect the share of possibilities to continue the journey on as quick as possible.

Figure 27 shows a significant difference between the Triptipper TIP system and the other two TIP systems. The Conventional and Mobile Smart Phone TIP system do not show a large difference apart from location 2 and 6. This graph indicates that however that Triptipper provides actual and personal travel information whereby participants make fewer errors in comparison with the other two TIP systems. Hence, at location 5 and 6, no errors were measured during the execution of with the Triptipper TIP system. It can therefore be assumed that the Triptipper TIP system provides travel information whereby travellers make fewer errors compared to the other two TIP systems. No statistical analysis is executed in order to obtain eventual significant relationships because of the validity of the errors. Because not answering with a non-correct answer will not automatically indicates that a traveller will not has chosen the best option. The correct answers are based on the quickest most possible way to execute the journey, but this not means that participants would also experience that as their most optimum journey and make different choices. Statistical differences will therefore not provide any valid results.

## 6.4. Correlation between variables

### *6.4.1. Traveller characteristics*

Traveller characteristics can have an effect on the time and effort savings of the traveller. In this report a distinction is made between soft and hard characteristics, whereby the soft characteristics are based on the Needscope model. Table 16 presents an overview of the correlations of the different characteristics with time and effort indicators. The dependency between two variables is calculated with Pearson's product-moment correlation coefficient for all 18 participants. The closer the correlation value is to -1 or 1, the stronger the correlation between the variables. With a 95% CI, the significance level is calculated on 0,47 for a two-tailed test based on the table in appendix 5.

| Variables | Total actual time | Total perceived time | Total effort during journey | Total effort after journey |
|---|---|---|---|---|
| Gender | -0,14 | -0,06 | -0,15 | -0,42 |
| Age | **0,54** | **0,52** | **0,68** | 0,39 |
| Education | 0,43 | 0,27 | 0,28 | **0,58** |
| Income | 0,46 | 0,41 | **0,64** | 0,37 |
| Driver's license | 0,16 | -0,31 | 0,13 | 0,14 |
| Car ownership | -0,01 | -0,27 | -0,13 | -0,40 |
| Travel product | 0,41 | 0,19 | 0,29 | 0,25 |
| Journey purpose | 0,35 | 0,19 | 0,45 | 0,22 |
| Travel frequency | -0,03 | 0,18 | -0,13 | 0,34 |
| Familiarity of journey | -0,26 | 0,21 | -0,30 | -0,06 |
| Time of travelling (rush hour) | 0,29 | 0,05 | 0,08 | 0,06 |
| Type of traveller | 0,38 | 0,02 | 0,31 | -0,03 |

*Table 16: Correlations for the indicators of the quality of travel information provision systems*

Table 16 indicates that the variable of age has a significant positive correlation with the total actual time, total perceived time and total effort during the journey. These three variables have a high influence of the quality of travel information provision. Based on these results, it can be assumed that age has a significant positive correlation with the quality of travel information provision systems, which means that an increased age will results in reduced time and effort savings for travel information provision systems. Furthermore, a significant correlation (0,58) between education and effort after journey is observed. This indicates that a lower education (lower value stands for a higher education) will result in a higher effort for searching travel information. Income does also have an high correlation (0,64) with the effort experienced during the journey, which indicates that a higher income will result in a higher experienced effort during the journey, though no final conclusions can be made concerning these results. People with a higher income are often older because of a longer career, which means that age does can have an effect, which is also indicated by previous results.

### *6.4.2. Correlation for time and effort per scenario*

Correlations for time and effort are calculated per scenario and travel information provision system. Appendix 5 provides an overview of the results concerning the correlations. The same calculation method to determine any significance is used as in the previous section. The first noticeable point is that all significant correlations are found between the scenarios itself. I.e. a high correlation (0,73) is found between the effort during the journey of scenario 2 and the perceived searching time of scenario 2. This indicates that scenarios are sufficiently mutually dependent and that only inter-correlations can be found between the scenarios. Furthermore is noticeable that all actual times per scenario show a significant correlation with the perceived time and the effort during the journey. This means that, independent of the scenario, there is a high positive correlation between the actual search time with the effort during the journey and the perceived searching time. A high correlation between the actual and perceived time indicates that the participants recognize a difference in the actual searching time. Another noticeable result is the low amount of significant correlation between the familiarity of the journeys with the searching time. Only one significant correlation (-0,49) is found between the familiarity of a scenario and the amount of errors. This significant negative correlation means that an increased familiarity of a scenario, the less errors he or she has made.

### *6.4.3. Correlation for time and effort per TIP-system*

Appendix 5 provides an overview of the correlation for time and effort per TIP-system. The actual search time for the Triptipper system shows a significant positive correlation with the perceived time (0,51) and the effort experienced during (0,55) and (0,66) after the scenario. This means the participants experienced more effort when they need more time to search for their travel information. This significant correlation is also found when looking at the Mobile Smart Phone system. The perceived searching time for the Triptipper system is also highly correlated with the efforts encountered during the journeys. This correlation can be explained by the fact that perceived time is a variable which participants experience just as the effort they encountered. Another noticeable result is the fact that no significant correlation is found between the amount of errors a participant made and the actual or perceived searching time. It can be assumed that a low amount of errors during a scenario results in a low searching time. However, no significant results can be found, which means that the correctness of the journey has no direct effect on the searching time.

### *6.4.4. Effect of familiarity with a mobile smart phone*

Table 17 displays results about the correlation of participants which own a mobile smart phone and the time and effort needed during the scenario with the mobile smart phone. These results are highlighted because it is assumed that participants who own a mobile smart phone and who are therefore familiar with the usage of such a device will encounter less difficulties during the scenario with the mobile smart phone. Results however show that there is a low correlation between the actual searching times, though a significant correlation with the perceived searching time. This indicates that participants who own a mobile smart phone (low value for owning a mobile smart phone) perceive a decreased amount of searching time

| Variable | Correlation |
|---|---|
| **Owns a smart phone** | **1** |
| Actual time | 0,22 |
| Perceived time | **0,47** |
| Effort during journey | 0,38 |
| Effort after journey | 0,04 |

*Table 17: Correlation for participants which own a smart phone*

## 6.5. Participants reflection

### *6.5.1. Input by participants*

In order to not only obtain numerical data about the TIP systems, two open questions were asked to obtain more information:

*I found Triptipper useful because of the following reasons….*
*I have the following recommended improvements for Triptipper…*

The outcome of these questions provides the opportunity to obtain information concerning the usefulness of Triptipper about subjects which were not previously expected.

### *6.5.2. Usefulnes of Triptipper*

This question reflects the experience by the participants travelling with Triptipper. Half of the participants shared the opinion that they found Triptipper useful because of the provision of quick and personal travel information. This result is consistent with the main design principle of Triptipper to provide personal travel information in one second. Several participants refer to a 'TomTom device for Public Transport' and see Triptipper as a new type of personal navigation application. An unexpected often-heard comment was the usefulness of Triptipper at the bus/tram stop location. Participants agree to the fact that they had a positive experience with the quick and easy provision of travel information from bus/tram stop to their final destination. This outcome was not expected in advance, but the time and effort results also indicate that participants experience the travel information provision of Triptipper at location 6 (bus/tram stop) as very handy. Afterwards, it can be concluded that the conventional system does not provide actual and personal travel information for the last transport mode of the journey. Triptipper does provide this type of information and therefore has a head start at this stage of the journey in comparison with the conventional system.

### *6.5.3. Proposed improvements for Triptipper*

By executing three serious gaming scenarios with Triptipper, participants could experience how travelling would feel by using the Triptipper application. Immediately after the participants planned their journey, they commented that they did not know what they could expect during the journey. Though they had travel information concerning their next step, they had no information concerning the route of the journey. Therefore participants do feel that they did not know what to expect during the sequel of the journey. This effect of the unexpected continuation of the journey can create uncertainty by the traveller and therefore increase the amount of effort to complete the journey. Based on this information it can be assumed that extra travel information about the travel route of the journey will increase the amount of desired travel information by the traveller

Several participants also indicated that they found that the time in which their personal travel advice was provided was reasonably short and that they requested the information for the second time because they did not have enough time to obtain all information during the first display of the travel advice. The time during which the information is displayed on the screen is variable. The serious gaming experiment is the first test for the Triptipper application only and this version is still a demo-version. This type of feedback (time of display) however will probably be used for future applications as well  as other ergonomic details during a future update of the system tol increase the usefulness of Triptipper.

## 6.6. Additional findings

### *6.6.1. Limitations of travel information provision.*

Providing actual, reliable and personal travel information is one of the main objectives of every travel information provision system. This provision of travel information is obtained from one or multiple sources and it determines the amount and type of travel information the traveller will be provided with. By making use of this information and the destination input from the traveller, Triptipper provides personal and actual travel information to the traveller. However, the Triptipper application is still dependent on the data it receives from other systems. Thereby, Triptipper can raise the quality of travel information provision by the new way of presenting travel information to the traveller, but cannot completely take responsibility for providing a 'perfect level' of travel information. In order to increase the quality of travel information provision, actual travel information with a high refreshment rate is desirable. In order to obtain such high level of travel information, a good connection with travel information suppliers should applicable and even other options than the conventional possibilities should be considered to constantly obtain a high quality of actual travel information.

### *6.6.2. Serious gaming as experiment to test travel information provision*

The Serious Gaming set-up is created to test the quality of travel information provision systems based on the indicators of time and effort. This type of experiment, developed to test the quality of travel information, can be considered as quite unique considering that this kind of set up has never been used to test this kind of information. Naturally, small changes can be made to this experiment in order to accommodate other types of elements to simulate different aspects of a journey. Options are to add another of type of travel information provision system or add different type of scenarios which simulate other types of journeys.

Serious Gaming does also provide possibilities to test other aspects of travel information. The focus for this experiment lies on travel information provision at typical locations during a journey, but other possibilities are available as well. An example could be to test the ergonomics of the conventional travel information system provided by the NS. It can be expected that the NS and other public transport organizations have done research concerning the ergonomics of the different types of travel information provision platforms in a closed environment during a journey simulation. The question may be posed whether travelling elements do have any effect on travellers during a journey. A Serious Gaming set up has the facilities to test such types of elements when a participant is acting like he is travelling.

Due to the high rate of accessibility of actual travel information by InTraffic, other options are possible to test travel information provision system. A possibility is to change the setup of the Serious Gaming experiment and just focus on one (transfer) location where travellers want to obtain travel information. By providing different types of travel information provision systems which all have different travel information providers, differences and effects on travellers can be measured.

# 7 Conclusion and discussions

*This chapter provides a conclusion about the results that were obtained during the execution of the research. First there is a small recapitulation of the objective of this research and, then a conclusion is given relating to the current state of the travel information architecture in the Netherland and the serious gaming experiment. Some recommendations about improvements for Triptipper will finalize this chapter.*

## 7.1. Introduction

### *7.1.1. Research*

This research is focused on identifying the difference in usability between the quality of three travel information provision systems in public transport for the traveller. Travel information is increasingly becoming important for public transport organizations in view of the improved service they may provide to the traveller. First, in order to determine the state of the travel information provision systems in public transport, research has been carried out by holding interviews with travel information experts concerning the systems architecture. Secondly, the quality of the travel information provision systems is researched by investing time and effort indicators. By executing a Serious Gaming experiment, participants could experience travelling with three different travel information provision systems in a replicated public transport environment.

### *7.1.2. Objective and research questions*

The objective of this research is to analyze the usability of travel information services in the area of public transport for the travellers and to give recommendations for the improvability, by protracting the distribution and quality of travel information systems and evaluating the user usability of three travel information provision systems and in particular the new Triptipper travel information provision system.

In chapter one, the following main research question is defined: *What is the usability of the travel information provision systems for the traveller in public transport and what are future opportunities for Triptipper?*

In order to realize the objective and answer the research questions, the following four sub-research questions are defined:

1. *Which are the quality characteristics of travel information provision systems in public transport?*

2. *Where are the bottlenecks located considering the usability of the travel information provision systems?*

3. *What are the criteria to measure the quality of the travel information provision of travel information provision systems and how can they be implemented during a research experiment?*

4. *Which possibilities are there to improve the usability of the Triptipper travel information provision system?*

## 7.2. Travel information systems architecture

### *7.2.1. The state of the Dutch public transport provision system*

This section answers the first two research questions regarding the quality characteristics and the location of the bottlenecks in the travel information provision systems. Solutruk & Kristofic (1980) determine the components: 'methods', 'activities', 'technique', 'data' and 'people', that form the basic structure of an information system. During the interviews with the travel information experts, the obtained information did not comprise the same, five, components but mainly made a difference between technical and organizational components. If the Dutch travel information provision system for public transport is observed well, it appears that there is a difference in train sector and the tram/bus sector. The rail sector is being operated by two major privatized corporations, while the bus/tram sector is mainly operated by large commercial public transport corporations. Concessions for regional public transport areas mostly refer to bus, tram and regional small railway lines. Commercial public transport corporations always have to operate with the uncertainty that they only can execute their concession area for a certain period of time, which gives them a reluctant attitude to investments in new travel information provision systems. The same accounts for the rail sector wherein the two major rail corporations have struggled to determine the responsible organization for specific parts of travel information provision to the traveller. This, together with aged, outdated and complicated information systems and the difficulty to set up a completely new travel information system creates a negative view of the willingness and possibility of public transport organizations to improve the quality of travel information. Public transport organizations do have knowledge about their own systems which they operate themselves, but they lack knowledge about other direct and indirect travel information systems. This lack of knowledge develops a type of uncertainty and un-willingness by system managers whereby possibilities to improve travel information stays un-noticed. Individual public transport companies have acted to long as they only pay attention to their own needs and only recently are gradually willing to invest and cooperate to improve travel information provision for the traveller.

### *7.2.2. The Dutch government and travel information*

Looking at the travel information provision system of public transport in the Netherlands, one can see that it is difficult to detect a clear structure in the system architecture. Not only because of the presence of multiple public transport organizations and the technical differences between the modes of transportation, but also because of the delayed maintenance of the infrastructure systems. The Dutch government recognizes this problem and it states that action must be taken in order to alleviate these problems.

Travel information systems do not primarily have a focus on the technical possibilities only, but social possibilities are considered as an important factor as well. Therefore organizations can design the most effective technical systems to try to ensure a competent system, the influence of human decision making still determines the total effect of such a system. The Dutch government is trying to create a new databank which collects, maintains and provides travel information to everyone who desires so. By creating such a databank, the Dutch government wants to increase the availability of multimodal travel information to the traveller by creating a link between the already existing NDW[14] and the, yet to be developed, NDOV. The government intends to invest in providing multimodal and personal travel information to the traveller in the coming years.

### *7.2.3. The future of travel information provision for travellers*

The last ten á fifteen years a shift has been observed from more general static travel information to dynamic travel information allowing travellers to obtain more and improved travel information. This also has an influence on the expected amount and quality of travel information of the traveller. I.e. fifteen years ago, most travellers relied mostly on timetables to obtain travel information and they were, generally, satisfied about the provision of travel information. Today (2012), everyone can obtain actual travel information where he or she

[14] NDW = Nationale Databank Wegverkeer (National databank for road traffic)

wants, can plan complete route by using online travellers planners and obtain more actual information. Where fifteen years ago people needed to analyze multiple timetables of different public transport organizations to plan a complete journey, today travellers need far less time to obtain detailed travel information about their journey. With the natural progress of technical developments, travellers expect more and improved travel information and are increasingly willing to spend less time in obtaining travel information. Looking at the future, it is expected that travellers want an increased availability of high quality travel information. Near future travel information will therefore focus more on delivering personal and reliable travel information without less time and effort to require this information. One of such near future travel information provision is integrated travel information in an agenda. People mostly experience travelling as a subordinate aspect of an main purpose. They want to be at a certain point to execute or experience an activity at a certain place and travelling in just the a part of the main purpose. By integrating automatic personal travel advice, based on the planned activity, i.e. in a agenda, travellers do not have to obtain travel information by itself. The agenda software automatically provides the person with the specific public transport travel information for his journey, based on the time and place of the activity he or she planned. In the future, travellers want more and improved personal travel information, though it is assumable that they want to decrease the amount of time and effort to obtain the travel information.

## 7.3. Serious Gaming

### *7.3.1. Applicability of the experiment*

Time and effort savings were indicated as main indicators to test the quality of the travel information provision system, whereby the Serious Gaming setup was used as the executed type of experiment. Based on results and experience, the indicators of time and effort seemed applicable for this type of experiment which provides an answer to research question number 3. With the use of an automatic time measurement system, actual times were accurately measured. Obtaining the perceived time, however, is qua validity more difficult to obtain due to personal characteristics. These personal characteristics do also influence the outcomes of the amount of effort participants perceived during and after the experiment. Therefore, it can be concluded that the measurement indicators of quality of travel information provision are largely based on travellers perception of time and effort. The serious gaming experiment thus seems to more rely on the perception of the participants and therefore, more subjectively based results are obtained. Only the actual time measurements are objective results of the total quality of TIP systems. Therefore the results to test the travel information provision systems are mainly based on subjective results and one can ask if this is applicable for to test such systems. However, travellers have different divergent opinions about TIP systems and thus are heavily based on subjective opinions. Therefore, TIP systems for provision for travellers can be tested by a Serious Gaming experiment, though other types of quality tests of the TIP systems, i.e. accuracy of time provision, can be measured by a more objective experiment.

### *7.3.2. Travellers*

Eighteen participants were invited to participate in the Serious Gaming experiment, wherein nine of those participants where employees of InTraffic and nine where students. A comparison between the distribution of type of travellers between the average in the Netherlands and the average during the experiment shows a difference between the Convenience Seeker and the Socializer. Though results are quite large, using this type of distribution for travellers provides in good view to some of the hidden needs of the traveller. Results show rather small differences between the distribution of students and employees. Although one noticeable remark however concerns these two types of participants. Results show that employees have a higher share of Convenience Seekers compared to the students. This is rather striking because it is expected that students have a higher share of Convenience Seekers, because the type of traveller is modeled after them. These results however can be explained by the small sample size so that for further research, a larger sample size (+/- 384) is preferred. This required sample size is calculated by the following formula:

$$SS = \frac{Z^2 * (p) * (1 - p)}{c^2}$$

Z stands for the confidence level which is chosen at 95% (1.96). P is the percentage of response distribution is 0.5 and the c is the confidence interval which is chosen at 5%. These chosen values together create a preferred sample size of 384 to get the results that reflect the target population (all Dutch residents) as precisely as needed.

### *7.3.3. Difference between scenarios*

Three scenarios were developed to imitate a journey from a home based location to a destination. Time results show that travellers need more time to complete scenario 3 than the other two scenarios. This is in accordance with the set-up of the experiment whereby scenario 3 has a delay to increase the difficulty level of the journey. Furthermore the results show that, travellers need more time at transfer locations to obtain travel information than during an on-board stage. This is in accordance with a theory stating that travellers are in need of more valuable travel information when there are more travel alternatives available at transfer locations. The time results are in accordance with the effort results also showing a higher need of effort during scenario 3 than the other two scenarios. Hence it can be concluded that the setup of different types of scenarios with their own amount of delays has effect on the time and effort travellers need to spend to obtain their travel information.

### *7.3.4. Travel information provision systems*

Looking at the average actual searching time results from the experiment it can be concluded that there is not much difference between the three travel information provision systems, though the perceived searching time does show some significant differences between the Triptipper system with the other two travel information provision systems. When looked at the effort the travellers encountered during the experiment, the Triptipper system shows to have a significant lead in comparison with the two other TIP-systems.

At a home-based location a large difference is noticed between the searching time of Triptipper and the other two TIP systems. This indicates that travellers who plan their journey by Triptipper need less time to plan their journey. However, travellers who use Triptipper actually do not plan their journey but begin their journey without knowledge of the expected travel route if they are unfamiliar with that specific route. It can be questioned if this time benefit of not planning a journey has any consequence during the continuation of the journey regarding the fact of lack of knowledge concerning the travel route. Effort results show almost the same results as the time results concerning the less average amount of effort needed when travelling with Triptipper than with the other two TIP systems.

Looking at the mobile smart phone TIP systems, the results indicate that there is a high variation compared to the other TIP systems. The searching time does not show much difference with the other TIP systems, but effort results do show some large variation. This difference can be explained by the fact that the use of a smart phone to obtain travel information is not obvious for everyone. Apart from the fact the participants had enough time before the experience to get familiar with the smart phone, the usability differs largely per participant. This concerns not only the fact that they are familiar with a smart phone, but also the multiple possibilities of a smart phone itself to obtain travel information explained the high variation.

### *7.3.5. Triptipper*

Regarding the results, the Triptipper TIP system is not regarded to be a system inferior to the other two TIP systems. Especially when looking at the transfer locations, Triptipper even seems to have a lead concerning searching time and effort. Though these positive results seem to show a high quality TIP system, there are some side-effects which should be taken into account. Like mentioned in the previous section, there is no planning phase for the Triptipper. Travellers will need to know the postal code of their destination in order to start travelling and, depends on their preference, link the postal code to a QR-code or OV-chip card. This operation differs from planning a journey like travelling with the conventional or smart phone TIP system. By not planning a journey in advance, travellers have a higher uncertainty concerning the continuation of the journey and therefore can encounter an increase level of stress during the journey despite the high availability of personal travel information provision by multiple Triptipper systems.

The data provides some significant differences between the Triptipper system and the other two TIP-systems. Especially the perceived searching time and the effort during the experiment shows great added value for the quality of the travel information provision. Positive feedback by the participants was also given on the last stage of the journey concerning the Triptipper TIP system. Not only do quantitative results show that Triptipper provides high quality travel information compared to the other two systems, but participants indicate that they were positively surprised by the way of providing the latest travel route from transfer point till final destination by making use of Google Maps.

No data were obtained regarding the different methods of importing final destination postal codes to the Triptipper system by use of numeric keypad, QR-code or OV-chip card. During the experiment, participants made use of the QR-code system and switched to using the keypad when they encountered problems with the QR-system. However participants shared the opinion that they indeed encountered difficulty with the QR-system and switched several times to numerical input by keypad. Therefore the QR-system, with its current options, does not establish itself as a preferred system to transfer information to the Triptipper application. Some modifications are therefore desirable to increase the usability for travellers to obtain travel information. By analyzing the feedback during a demo of the Triptipper application, the OV-chip card seems to be the most favorable system to obtain travel information by the participants.

## 7.4. Recommendations for The Dutch travel information provision systems

### *7.4.1. One travel information organization*

The difficulty in the provision of travel information in the public transport sector resides in the large diffusion of multiple public transport organizations, concession areas, public transport modes and technical possibilities. Creating one ‘umbrella’ organization which has the same tasks as BISON, but rather for all public transportation modes in the Netherlands, will have to possibility to have a more complete overview of all the systems and therefore can more easily spot not only obstacles but also possibilities. This organization should be independent but it should also have some participation from multiple public transport organizations and the government. Public transport organizations can present information about specific public transport modes and governments have information about other aspects i.e. concession demands concerning travel information. Such an organization should have complete vision of travel information provision in public transport in the Netherlands to increase travel information service to the traveller, thereby minimizing effort for the travel information organizations without increasing bureaucratic work for the public transport organizations.

## 7.5. Limitations

### *7.5.1. Time and efforts savings*

Stradling et al. (2000) state that time and effort savings are indicators for the quality of travel information provision systems. However, both these elements do have multiple sub categories. The indicator of time consists of search time and travel time, whereby search time is again separated into two sub-categories. Travel time is a factor which is not taken along during the research because of the predetermined travelling schedule of the scenarios.

Looking at search time, the only factor that is taken along is the ‘scanning’ for the information at the information media. Looking for the travel information media itself, i.e. a train station, is not taken along because of the limited amount of space during the experiment. However, the amount of time needed for travellers to get to a travel information media platform depends on the location and the distribution of the system at the public transport location. If, for example, Triptipper applications are very densely distributed at a transfer location, this will decrease the searching time of travellers to find the Triptipper applications. Because of this high variability and the limited amount of space during the experiment, this part of the indicator is not taken along in the research. Therefore only the searching time at the travel information media itself is taken along in the research and not the whole time indicator.

Effort savings are included in the research by making use of research questions. Five research questions are posed to determine the physical, effective and cognitive effort. These five questions do not provide presumably enough data to take all the three sub categories of effort into account. Due to the scope of the research, not too much detailed data was obtained.

Comparing the objective data (actual time) with subjective data (perceived time) does raises the question regarding the validity concerning the comparison of the two data sets. Results provide however no significant difference between the actual and the perceived searching time, though variances differ a lot when looked the perceived time in comparison with the actual time. Participants also mostly answered in dozens of seconds, which indicates that participants find it more difficult to actually give their perception of search time. Therefore actual time measurements provide an more detailed value for the search time in comparison with the perceived search time. Also regarding the fact that no information could be obtained concerning the value of perceived searching time against actual searching time, the added value of this results is questionable because no real conclusions can be made based on the results.

### *7.5.2. Simulating the availability of travel information*

The Serious Gaming experiment provides a certain environment where different types of travel information media can be simulated. With the use of display, timetables and sound almost every option is available to obtain travel information. However not every option can be simulated. First, a human person, i.e. a guard or a bus driver may also provide travel information to the traveller. It is possible to make use of persons to take on the role of bus driver for example during an experiment, though this requires a lot of man hours apart from the main researcher. Furthermore, a human person providing travel information has more possibilities to provide travel information and also the human character has influence of provision of the travel information which is difficult to simulate. Secondly, the destination displays outside of the transport modes are not simulated. Displays on the outside of busses and trains provide travel information to the traveller and are for some travellers an important source of travel information. Due to the difficulty of simulating actual vehicles in a Serious Gaming set-up, this travel information media will not be taken along in the research.

### *7.5.3. Serious Gaming VS real world*

Serious Gaming is an experiment which simulates the aspect of obtaining travel information during a journey. Participants need to behave like they are travellers on a real journey, though this can be difficult for participants to pretend that they are travellers. The Serious Gaming experiment tries to simulate the real experience of travelling by providing almost the same availability of travel information as in the real world, but nevertheless the experiment is executed in a room in the office building of InTraffic. This difference in environment of the experiment must have had an effect on the usability of the results in real world.

## 7.6. Recommendations for Triptipper

### *7.6.1. Feedback to improve Triptipper*

Triptipper is a newly developed travel information system by InTraffic and mainly designed based on the experience of the developers. By determining the quality of the Triptipper system in comparison with two other TIP systems, advantages and disadvantages could be obtained. The obtained data and the feedback from the participants provides possibilities to recommendations for the further development of the Triptipper system and thereby providing answer to fourth research question.

### *7.6.2. What is Triptipper?*

Triptipper is designed as a new method to provide personal travel information to the traveller in one second. Most other TIP systems are operated by public transport organizations creating travel information themselves or obtaining travel information from other public transport organizations. Triptipper provides travel information to travellers based on existing information and gives travellers a 'tip' to continue their journey on the fastest possible way. It is important to point out the position of Triptipper as a travel information provision system. Does it provide additional information apart from the already provided conventional systems or can travellers completely rely on Triptipper to provide them enough personal and reliable information to escort them to their final destination? Participants of the experiment provide positive feedback concerning the Triptipper application, however they had questions regarding the position of the system in comparison with the other TIP-sytems and they could use Triptipper as a main TIP-system.

### *7.6.3. Reliability of Triptipper travel information*

The data flow-chart shows that there are multiple possibilities to obtain the necessary data to provide travel information to the traveller. Making a grounded consideration to obtain travel information data is very important considering the fact that the provided travel information by Triptipper is only as good as the data that is used. 92929OV, and perhaps in the near future NDOV, will provide travel information data. Using those types of data sources however will facilitate the Triptipper TIP system with the same data as the majority of the travel information systems. Therefore the possibility to provide unique (more actual) travel information than the other conventional systems is difficult. It is important to understand that the traveller mostly does not know where the provided travel information is coming from, so that it is essential that the provide travel information to the traveller is reliable, as otherwise the traveller experiences an higher amount of uncertainty and he or she will no longer trust the provided travel information.

### *7.6.4. Information about the complete journey*

Triptipper's distinction lies in the fact that the most actual personal travel information is provided to the traveller at any given location during the journey. Feedback from the participants shows however, that the traveller has no indication relating to the continuation of his/her journey because of the lack of information. Online route planners provide the traveller with complete travel information from origin till destination, but do mostly not update this travel information during the journey. If Triptipper can also integrate route information about the continuation of the journey into the travel advice, it would provide a major plus to a route planner function and it would expectedly decrease the level of effort.

It is also possible to start at the other and to integrate the Triptipper application in the conventional online route planners i.e. 9292OV or ns.nl. This way, the travellers are immediately provided with a QR-code or the final destination when planning their journey online. This code is transferred to their OV-chip card whereby travellers do not have to make use of the Triptipper website at the start of the journey.

### *7.6.5. More than just public transport*

Results of the Serious gaming experiment already show the high usability of the Triptipper application with the provision of travel information at bus/tram stops to the final destination. This indicates that the strength of Triptipper does not only lie on providing travel information for public transport modes but also during the last stage of the journey often using alternative modes of transport. Providing walking or bicycle routes also belongs to the possibility of Triptipper. The travel information may be provided from door to door, but also even further than that door. Large public buildings often provide a challenge for people not familiar with that building and people have difficulty locating and finding their destination in said building. Triptipper can provide turn by turn information within the building to people who do not know which walking route they need to reach their destination. This option is particularly interesting when looked at large public buildings.

### *7.6.6. Multimodal travel advice*

As mentioned in this report, the Dutch government is willing to invest in multimodal travel information, meaning car and public transportation. By integrating car route information, like for example starting cooperation with TomTom, Triptipper has the possibility to provide multimodal travel information. By providing multimodal travel information, it is expected that more support is provided by governmental organizations and hence increasing the possibility to execute a national Triptipper system in the Netherlands.

## References


Aarts, H., Paulussen, T., & Schaalma, H. (1997). Physical exercise habit: On the conceptualization and formation of habitual health behaviors. *Health Education Research, 12(3), 363-374*

Chorus, C. (2007) Traveler Response to Information. *TRAIL Delft Thesis Series nr. T2007/2*

Chorus, C., Molin, E., van Wee, G., 2003. Influence of a personal intelligent travel assistant (PITA) on a traveller's modal choice behaviour. *Paper Presented at COST-Conference: the User and the Future of ICT, Helsinki.*

Dziekan, K., (2008) Ease-of-Use in Public Transportation - A User Perspective on Information and Orientation Aspects. *Royal Institute of Technology. Doctoral Thesis*

Granberg, M. en I. Vesanen-Nikitin (2003) Improving user-friendliness of information services, *In: Proceedings of the 10th World Congress and Exhibition on Intelligent Transport Systems and Services, November 16-20 2003, Madrid*

Graaf, X., & de Hagoort, M. (2000) Systeem ontwerp Reisinformatie blauwdruk voor een systeem. *Maarsen: Verkeer en Milieu Consultancy*

Grotenhuis, J.W., Wiegmans, B., & Rietveld, P. (2006). The desired quality of integrated multimodal travel information in public transport: Customer needs for time and effort savings. *Transport Policy*

Hagen van, M., & Hulster, G. (2009) Een succesvolle implementatie van belevingsgerichte klantsegmentering voor openbaar vervoer. *Contribution to Railforum colloquium 'Oog voor de reiziger' 11-2009*

Hagen van, M., Visser, J., & Gier de, M. (2005) De psychologie van de treinreiziger. Een verkenning van de behoeften en drijfveren van treinreizigers. *Contribution to colloquium Vervoersplanologisch Speurwerk 2005*

Hendriks, A. en B. Egeter (2003) Visie harmonisatie collectieve reisinformatie openbaar vervoer, *TNO Inro rapport 37, Eindconcept, Delft*

Hine, J., & Scott, J. (2000) Seamless, accessible travel: users' view of the public transport journey and interchange. *Transport Policy 217-226*

Jung, C. (1959) Archetypes and the Collective Unconscious. *Europe, Bollingen Series XX*.

Hulleman, R., Jogems, A., & Spittje, H. (2004) Bewegwijzering op en nabij vervoersknooppunten. *Colloquium Vervoersplanologisch Speurwerk 2004. Zeist.*

INFOPOLIS (1999). Needs of travellers: an analysis based on the study of their tasks and activities.

Kenyon, S., & Lyons, G. (2003) The value of integrated multimodal traveller information and its potential contribution to modal change. *Transportation Research Part F: Traffic Psychology and Behaviour. Volume 6, Issue 1, Pages 1-21*

Krizek, K., & El-Geneidy, A. Segmenting Preferences and Habits of Transit Users and Non-Users. *Journal of Public Transportation, Vol. 10, No. 3, 2007*

Lyons, G., & Harman, R. (2002). The UK public transport industry and provisions of multi-modal traveller information. *International Journal of Transport Management 1 -13*

Ministry of Mobility (2008). Letter: Approach multimodal travel information

Ministry of Mobility (2004). *Nota Mobiliteit 2004*. Den Haag

Ministry of Mobility (2000) Wet personenvervoer 2000 and Besluit personenvervoer 2000

Parasuraman, A., Berry,.L., Zeithaml, .A., 1993. The nature and determinants of customer expectations of service. *Journal of the Academy of Marketing Services 21 (1), 1–12.*

Paulley, N., Balcombe, R., Mackett, R., Preston, J., Wardmann, M., Shires, S., Thitheridge, H., & White, P. (2004) The demand for public transport. *Paper written for presentation at the World Conference on Transport Research, Istanbul, Turkey July 2004*

Rover (1999) Report: Reisinformatie: wensen van reizigers. *Reizigers Vereniging Rover*

Shannon, C. E., & Weaver, W. (1949). The mathematical theory of communication. Urbana, Illinois: University of Illinois Press

Solotruk, M., & Kristofic, M. (1980) Increasing the degree of information system integration and developing an integrated information system. *Information & Management, Vol.3, Issue 5, 207-212*

Stradling, S., 2002. Transport User Needs and Marketing Public Transport. *Transport Research Institute, Napier University.*

Stradling, S., Hine, J., & Wardman, M. (2001) Physical, cognitive and effective effort in travel mode choices. *Transport Research Laboratory*

Vonk, W., Hulleman, R., Bodmer, M., & van Berkum. (2009) InfoRio, focus Group sessions to test potential for a personal real time travel information concept for public transport. *12th WCTR, July 11-15 – Lisbon*

Van Wee, B., (2002) Land use and transport: Research and policy challenges. *Journal of Transport Geography, Volume 10, Issue 4, Pages 259-271*

Wang, Y., & Strong, M. (1996) Beyond accuracy: What Data Quality Means to Data Consumers. *Journal of Management Information Systems; Spring 1996; 12,4 pg.5*

Wilson, A., & Calder, R. (2006). Powerful Brands, learning from the Greeks. *Brandmatters, Esomar, Page 1-16.*

# Appendix