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Automated Transport in Urban Areas

Conditions for Success for the development of CTS

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PREFACE

This report is the result of the master thesis project from the section Transport Policy and Logistics’ Organization at the Faculty of Technology, Policy and Management of the University of Technology, Delft. The research has been performed at TNO Environment and Geosciences, Business Unit Mobility and Logistics. TNO stands for the “Netherlands Organization for Applied Scientific Research TNO”.

The report handles about the development of Cybernetic Transport Systems in urban areas. Cybernetic Transport Systems (CTS) are a form of automated transport systems. The report focuses on identifying a possible service for CTS and on possibilities for a municipality to develop CTS.

The reader who is interested in the development of CTS can find the background of the development in chapter three. The reader who is interested in the theory behind service networks and transportation demand in urban areas can read chapter four. Chapter five applies this theory in order to design a service network for traffic flows and travelers in urban areas. When one is interested in the development of transport systems in general and the contribution to this development of a municipality can read chapter six. The reader interested in the results of the research will find these in chapter seven. Finally chapter eight will give conclusions, recommendations and a short reflection on the path of the research.

The research has been supervised by a committee composed of several members from the TU Delft and one member from TNO:

- Prof. Dr. G.P. van Wee - TU Delft - Technology, Policy and Management
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I like to thank my committee for their contribution to the project. Especially John Baggen and Marten Janse, the daily supervisors; John for the weekly debates we had about the subject. These were helpful and pleasant; Marten for his knowledge about and his unabated enthusiasm for the development of these systems. His ideas have often been an eye opener. I like to give a special thanks to Professor Van Wee for he has been able to describe sharply the implications of the subject that I have found on my way during the research and to give useful comment to challenge them. I have been glad that I could work at TNO. An acknowledge research institute where I could perform my research without many conditions.

With this report my study in Delft comes to an end. Studying has been interesting, informative and fun. So has been the performance of this research.

Emmylou Aben

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EXECUTIVE SUMMARY

Background

Ever since 1800 the mobility market has constantly been growing. Expectations are that this will continue for a long time. The growth of the mobility market is a result of the developments in the transportation market of the past decades. These developments made travelling faster, cheaper and more comfortable. These same developments allow more people to travel over greater distances. However, the increasing possibilities to travel also have a downside. Traffic produces negative side-effects such as accessibility problems, parking problems, emission of hazardous gasses and noise nuisance. This is why it is expected that in the near future a new dilemma will appear: the growing demand of transport cannot be met without violating the quality of the environment. This dilemma will present itself at every governmental level. Dealing with this dilemma can be done in several ways. The Dutch government states that mobility is allowed (“Mobiliteit mag”) in Nota Mobiliteit. Measures to deal with this dilemma focus therefore on reducing the negative aspects of transportation. This way of dealing with the dilemma refers to the development of sustainable mobility. This thesis uses the following definition of sustainable mobility: “To diminish the negative effects of traffic, while keeping the accessibility of the transportation means at the same level for the current and the coming generation.”

The development of sustainable mobility is divided into three areas: Economics, Environmental and Social. Possibilities to realise sustainable mobility will influence all of these three areas.

TNO expects automated transport to be one of the solutions which can contribute to sustainable mobility. That is why they perform research to develop automated systems. This research focuses on the development of Cybernetic Transport Systems. The features and functionalities are described in the box below. (McDonald et.al., 2002)
Cybercars are road vehicles with fully automated driving capabilities. A fleet of such vehicles forms a transportation system, for passengers or goods, on a network of roads with on-demand and door-to-door capability. The fleet of cars is under control of a central management system in order to meet particular demands in a particular environment. At the initial stages, cybercars are designed for short trips at low speed in an urban environment or in private grounds.

In the long term, cybercars could also run autonomously at high speed on dedicated tracks. With the development of the cybercar infrastructures, private cars with fully autonomous driving capabilities could also be allowed on these infrastructures while maintaining their manual mode on standard roads.

Cybercars are members of the general family of people movers and close to PRT (Personal Rapid Transit) but they offer the advantage of being able to run on any ground infrastructure which means they are cheaper and more flexible.

**Problem analyses**

The development of automated transport systems, and thus CTS, are mostly technology driven. Experiments in this field are done in niches of the transport market. The goal of the development of these automated transport systems is to integrate in into the existing transport system and with doing so to contribute to the development of sustainable mobility. Not only technical demands have to be met to accomplish this integration, with social issues has to be dealt as well. Because the development of CTS mainly took place in the niche of the transport market, not much is known of the use CTS in urban area’s, nor about the demands the transportation systems has on the organizational setting. This leads to the following problem definition

At this moment there is too little insight in the possible contribution of a service of CTS to the current services of the transport system in urban areas and in the role of the municipality in the development of CTS in urban areas.

**Goal and research plan**

The following goal has been designed to contribute to the identified problem definition.

Define conditions for success and failure for the development of CTS in urban areas, by identifying and analyzing the contribution of a service by CTS to the transport services in urban areas and by identifying and analyzing the possibilities of a municipality to the development of a new transport system

In order to reach this goal the research is split in three parts that are described below.

- A description of the background of the development of automated transport systems and specifically the development of CTS
- Analyzing which service CTS can provide in an urban area and how it can contribute to the current transport services
- Analyzing the development of new transport systems and the role that a municipality can take in this development

The result of these two analyses will lead to conditions for success and failures that can be used in the further development of CTS.
Scope of the project

Because the development of CTS is complex and CTS is related to many other disciplines, the following delineations have been made:

- CTS is one of many ways to develop sustainable mobility. Other means to develop sustainable mobility are not considered in this thesis. CTS will not be compared to other automated transport systems.
- The contribution of CTS to the existing transport system will be limited to the contribution on the transport market. The physical system of a network in an urban area is not designed. The service CTS has to provide in this thesis is a public transport service.
- This thesis is also aimed at describing the possibilities a municipality has to develop CTS. The thesis is not aimed at choice the municipality has to make between different transport systems when developing the transport system.
- The choice of the consumer to use the provided service, will define the rate of success of the system. The wishes of the consumer come from existing results of user-research projects. Besides that the wishes will be represented by a municipality that is responsible for public services.

The development of CTS

The development takes place in several European research projects. These projects focus on the technical possibilities and system functionalities. The development of CTS has several advantages and disadvantages. An operational advantage is the decrease of labor costs, since there is no driver necessary anymore. Automated systems will become more reliable when the experiences with these systems increase. This will lower the costs as well. This advantage makes that the frequency of a service by CTS can be adjusted to the demand and that it is possible to provide (semi-)individual transport, if the capacity of the infrastructure is sufficient. It is expected that CTS can deliver a profitable service in ten years. Disadvantages of the development of CTS are the complexity of its realization, since dedicated infrastructure is necessary due to the inability of CTS to mingle with other traffic. Realizing infrastructure can be a problem, since the construction of infrastructure is expensive; the success of the system uncertain and the available space in urban areas is scarce. The costs of the development of CTS can be higher then calculated, due to the uncertain risks and the fact that systems have not proven themselves in a professional environment yet. Finally the use of CTS results in an extra transfer. This can be a drawback in the usage of the system. However, this depends on the willingness to transfer of the traveler.

It is expected that CTS can contribute to sustainable mobility. Especially in relation to emissions, since the drive of the cybercars is electric in stead of with a combustion engine. Next to this, shorter waiting times and an on demand service with little detour can deliver a decent social performance, but the car still scores very high on social indicators too. The innovative character of CTS can realize an economic pulls.

In this research, CTS is a starting point, it creates a framework for the development of new forms of transport in urban areas. Furthermore, it gives a framework to define a services that need to be executed by CTS and for the role a municipality can take in the development. The research will not make a consideration in the development of CTS compared to other systems, or about the performance of CTS against other systems, conventional or automated.
A service by CTS

The transportation market in the transport system consists of transportation demand – travelers that want to go from A to B – and the transportation supply – the service that can transport travelers from A to B. It appears that CTS can perform a service in areas where the activity level is high and where travelers arrive spread in space and / or time – this means that there is a constant demand for traffic, but with hardly any high peaks. It seems difficult to design a network service for CTS with an all over service, since dedicated infrastructure is necessary. Since CTS is able to perform an on demand and individual service and it is able to find a direct route over a line or small network from origin to destination. There is no need for the cybercar to stop at every halt and the cybercar can choose the shortest route to a next stop. This can shorten the travel time as well as the waiting time. This service can be designed for different traffic flows in urban areas: all inner urban traffic, suburban-center linkage, traffic that comes from outside the city and wants to go to the center (focal traffic I) and traffic that comes from the suburbs and wants to go the centre. (focal traffic II).

The identified flows need to be build of travelers that have at least commuting or shopping as their traffic purposes, to make sure that the offered service can be used efficiently. Whether travelers can use CTS depends on their quality demands. CTS can live up to the demands on quality and comfort. Whether CTS can live up to the travelers’ demands on price is uncertain.

Examples of a service of CTS on short term can be: a feeder for a transport system on a higher scale – metro, tram, regional buses – or unlocking a center from central spaces at the borders. Municipalities see the same possibilities. On longer term, CTS can mingle with other traffic that is prepared with automated driving features, such as ADA. The car takes over the driving tasks. Due to this development it could become easier to free infrastructure for these target groups, since the market share of automated transport increases. When more infrastructures come available the serving area of CTS can be elaborated. Municipalities and regional authorities agree with these possibilities – especially in line with the expected cost advantages compared to the operational costs of an automated transport system. The labor costs of the exploitation of a bus service are 60% of the operational costs (Van Goeverde r et.al., 1998). The labor costs of CTS will be lower, since there is no driver on the cybercar. However, the investments costs are higher. First, financial resources should be made available to gain on the operational advantages for costs.

The development of automated transport systems
Next to the operational development of CTS, development track of a transport system in general is important as well to gain insight in the expectations for the future. At the moment CTS is in the pioneering stage, which is characterized by: lack of standardization, realizing many pilot projects, the development of comparable systems and the diffuse spread of knowledge. Several features are important for CTS to make it to the stage of rapid growth. First, the technology needs to be geared to users demands. This is possible when the demands of the user are taken into account in the current development of CTS and in the executed pilot projects. Second the growth of the system can increase when it can use available infrastructure. To make this happen, infrastructure should be made available for CTS. It is hard to free infrastructure in dense urban areas. Solutions are available, for example the use of available, connecting pieces of infrastructure that are not yet used for conventional traffic. Third standard production process of cybercars and the operational services need to be developed, to make the system available for a larger group of users. CTS should be developed more often to be able to design a standard. No standardization has taken place in the development of cybercars, because possible, likely services need to be adjusted to the wishes of the operator and the user. The step of CTS to the next stage is not impossible but up until now very uncertain.

The development of new transport systems can be seen as a transition. This is a change in which the direction is clear, but the final destination is not. At the moment several governments try to steer a transition to sustainable mobility. The role of the municipality in the development of sustainable mobility appears late in the process, due to her dependencies on financial resources and legislation. However, the municipality is very important in the development towards sustainable mobility: the negative effects of traffic are clearly visible in urban areas. Because of this, the municipality is one of the problem owners. This role increases and strengthens her role in the process.

The role of a municipality in the development process of CTS

Municipalities have no decision power anymore in the development and design of public transport in her areas. Regional authorities (WGR+ regions) are responsible for the development of public transport in urban areas and in spatial planning, due to the Joint Regulations Act. Governors of a municipality take place in the daily board of the regional government and can therefore decide about the decisions in this field.

Municipalities take often an important role in the development of CTS. She can be initiator of a project to develop new transport systems. There are several motives to initiate a project. A problem perception of a government is very important. Next to this the improvement of the image of the city can play an important second role in this initiative. Sustainable mobility is rarely a motive to realize automated transport.

Due to its problem perception and with this the commitment to a project, it can also play role as process manager, facilitator and designer of the agenda. Knowledge and experiences with a system are very important for a municipality to gain trust and insight in the possibilities of the system. Next to this the public support for the development is important. An influential governor, for example an alderman, can fulfill an important role to create public support.

A WGR+ region needs to grant tenders for public transport. The WGR+ region depends for financial resources on higher governments – the BDU-gelden. (Broad Purpose Payments). The economical feasibility of a tender is important to grant a concession to
an operator. Since the risks for CTS are high and since the system has not proven itself professionally, the economical feasibility is uncertain. Due to this reasons, WGR+ regions are hardly initiator of the development of new transport systems.

Because of the financial consideration, new systems will probable not be realized on a large scale with a standard tendering procedure. Financial resources for the development can be found in project programs of governments, in funds and in subsidies. These resources are often bond to specific demands, which makes the search for decent resources more difficult.

**Conditions for success in the development of CTS**

Several features which are important for the development of CTS can be identified. These can be split to organizational, technical and a combination of these features. A problem perception with CTS as a part of the solution is essential for the success of a project. Furthermore, combining technical and organizational possibilities is necessary to make a suitable design for CTS to contribute to the current situation. Moreover, the commitment of parties to the project, regardless of the length and the complexity of the process is necessary to gain success.

**Conclusions and recommendations**

CTS is able to perform a service that can deliver a contribution to the services of the current transport system. This service is not bond to niches. With the introduction of CTS, the whole lay out of the transport system can be revised to make a more efficient design. This design will be based on the functionalities of available transport systems, conventional as well as automated. On long term the service network for CTS can be expanded. This depends on the choices that are made along the development process of CTS. On short term, CTS has to prove itself in a professional application. This brings along uncertainties that decrease the chances for success.

The development of new transport systems needs to be stimulated. Possibilities need to be initiated to free financial resources for further development of CTS. Next to this the financial resources should be less bond to specific demands.

Municipalities fulfill an important role in the development of CTS. CTS will not be realized in urban areas without their initiatives and commitment to the process. However, a municipality is not able to realize a system on its own. Its dependencies are too large to do this. It often seems that the choice for a municipality for a new system is technology driven. This is due to the fact that knowledge about a new transport system is gained accidentally by contact of a supplier or developer of these systems. An extensive decision support system should be designed to focus the consideration for the use of a system on the functionalities of a system. Such a decision support system can combine the content of the development (systems and their functionalities) with the possibilities to design a process. The identified conditions for success can be used to fill this system, if they are specified. Furthermore, gaining information of cooperative projects in which many participants of different disciplines are involved can create insight in the process of the development. The decision support system can be designed by a knowledge institute and can be made available by knowledge platforms.

A project will never succeed when travelers do not make use of it. Further development of CTS should therefore be aimed at serving the traveler. The performed analysis can be used to find traveler groups and traffic flows for which CTS can be suitable.
The defined conditions for failure or success of a project are no guarantee for success. Each development knows its own environment and involved parties. Therefore it is not possible to design an action plan for a successful realization of CTS. The conditions are useful in the development of CTS, since they can prevent pitfalls and make sure that chances are taken.
UITGEBREIDE SAMENVATTING

Achtergrond

Sinds 1800 heeft er een constante mobiliteitsgroei plaatsgevonden. De verwachting is dat deze groei blijft voortduren. Deze groei vindt plaats als gevolg van de ontwikkelingen in de transportmarkt waardoor reizen de afgelopen decennia sneller, goedkoper en comfortabelere is geworden. Door deze ontwikkelingen kunnen meer mensen reizen en worden de afgelegde afstanden langer. De groeiende vervoersmogelijkheden brengen niet alleen voordelen met zich mee. Verkeer brengt ook negatieve effecten teweeg. Dit zijn onder meer congestie, bereikbaarheidsproblemen, parkeerproblemen, emissies van schadelijke stoffen en geluidsoverlast. De verwachting is dat zich in de toekomst een dilemma zal voordoen waarbij de groeiende vraag naar vervoer niet meer is te combineren met de eisen die gesteld worden aan de kwaliteit van de leefomgeving. Dit dilemma wordt geconstateerd op alle overheidsniveaus. Omgaan met dit dilemma kan op verschillende manieren. In de Nota Mobiliteit stelt de Nederlandse overheid dat “Mobiliteit mag”. Oplossingsrichtingen om dit dilemma aan te pakken worden daarom gericht op het tegen gaan van de negatieve effecten van vervoer. Deze oplossingsrichtingen worden ook wel aangeduid als het ontwikkelen van duurzame mobiliteit. In dit onderzoek is duurzame mobiliteit als volgt gedefinieerd: “Het verminderen van de negatieve effecten van verkeer, terwijl de toegankelijkheid van transport voor de huidige en komende generatie gelijk blijft”.

De ontwikkeling van duurzame mobiliteit is onderverdeeld naar drie velden, te weten: Economie, Milieu en Maatschappij. (Economy, Environmental and Social). Maatregelen om duurzame mobiliteit te realiseren, zijn van invloed op elk van deze terreinen.

TNO verwacht dat automatisch vervoer een van de mogelijkheden is die bijdraagt aan de ontwikkeling van duurzame mobiliteit en doet om deze reden onderzoek naar de ontwikkeling van deze systemen. In dit onderzoek is voornamelijk aandacht besteed aan de ontwikkeling van Cybernetic Transport Systems (CTS). De kenmerken en functionaliteiten worden beschreven in de volgende box. (vertaald uit het Engels van McDonald et.al., 2002)
 Cyrercars zijn volledig automatische wegvoertuigen. Dit betekent onder andere dat geen chauffeur op het voertuig aanwezig hoeft te zijn om het voertuig te besturen. Een wagenpark van deze voertuigen vormt een transportsysteem voor personen of goederen over een netwerk van wegen. Dit systeem heeft de mogelijkheid om een vraaggestuurd dienst en dienst van deur-tot-deur te leveren. Het wagenpark wordt aangestuurd door een centraal management systeem. Zo kan het systeem specifieke eisen verzorgen in een bepaalde omgeving. In eerste instantie zijn cyercars ontworpen voor het afleggen van korte afstanden op een lage snelheid in stedelijk gebied of op private terreinen.


Cyercars maken deel uit van de algemene familie van people movers en lijken op PRT (Personal Rapid Transit). Het voordeel van Cyercars is dat ze gebruik kunnen maken van elke weginfrastructuur. Hierdoor zijn ze goedkoper en flexibeler.

Probleemanalyse

Ontwikkelingen op het gebied van automatisch vervoer en daarmee ook CTS zijn tot nog toe veelal technologie gestuurd en experimenten worden uitgevoerd in niches van de transportmarkt. Het doel van de ontwikkeling is om de systemen te integreren in de bestaande transportmarkt, om zo bij te dragen aan de ontwikkeling van duurzame mobiliteit. Voor integratie in de transportmarkt zijn niet alleen de technische wensen en mogelijkheden belangrijk, maar ook de maatschappelijke. De ontwikkeling van CTS heeft veelal plaats gevonden in de niche van de transport markt in gerichte proefprojecten. Daarom is er weinig bekend over de dienst van CTS in stedelijk gebied en over de organisatorische vormgeving van de inrichting van het gebied. De problemestelling luidt hierom als volgt.

Er is te weinig inzicht in de mogelijke bijdrage van een dienst door CTS aan de diensten die het huidige stedelijke transpotsysteem biedt en in de rol van de gemeente in de ontwikkeling van CTS in haar gebied.

Doelstelling en onderzoeksonpzet

Om bij te dragen aan de oplossing van de geïdentificeerde probleemstelling is de volgende doelstelling ontworpen:

Definieer succesfactoren en faalfactoren voor de ontwikkeling van CTS in stedelijk gebied, door het analyseren van de bijdrage van CTS aan de bestaande stedelijke transportmogelijkheden en het analyseren van de mogelijkheden van een gemeente om een nieuw transportsysteem te ontwikkelen.
Om deze doelstelling te halen is een onderzoek opgezet dat bestaat uit drie delen, te weten:

- Inzicht geven in de ontwikkeling van CTS door de beschrijving van de achtergrond van haar ontwikkeling en de beschrijving van het systeem
- Het analyseren van diensten die CTS kan uitvoeren in stedelijk gebied
- Het analyseren van mogelijkheden voor een gemeente om CTS te ontwikkelen

Uit deze analyses kunnen succes- en faalkenmerken geïdentificeerd en geformuleerd worden voor de verdere ontwikkeling.

Afbakening

Aangezien de ontwikkeling van CTS complex is en veel raakvlakken heeft met andere disciplines zijn de volgende afbakeningen gemaakt.

- CTS is een van de mogelijkheden om duurzame mobiliteit te ontwikkelen. Andere mogelijkheden om duurzame mobiliteit te realiseren, worden buiten beschouwing gelaten. Er wordt geen uitspraak gedaan over de kansen van CTS ten opzicht van andere automatische vervoersystemen.
- De bijdrage van CTS aan het bestaande transporex systeem zal zich alleen richten op de mogelijkheden die CTS kan bieden op de vervoersmarkt. De verkeerskundige inpassing valt buiten het bereik van dit project. Daarnaast is de dienst gericht op het aanbieden van openbaar vervoer.
- Dit onderzoek richt zich op de mogelijkheden die een gemeente heeft om CTS te ontwikkelen. Het richt zich niet op de keuze die een gemeente maakt voor het ontwikkelen van een nieuw transport systeem.
- De keuze van een consument om gebruik te maken van een bepaalde dienst, bepaalt uiteindelijk het succes van een systeem. De wens van de consument wordt in dit onderzoek meegenomen door gebruik te maken van uitgevoerde gebruikersonderzoeken en wordt verder vertegenwoordigd door de gemeente, die verantwoordelijk is voor de publieke diensten.

De ontwikkeling van CTS

CTS wordt ontwikkeld in een aantal Europese onderzoeksprojecten. Hierin worden de technische mogelijkheden en systeemfunctionaliteiten onderzocht en ontwikkeld. De ontwikkeling van CTS heeft een aantal voor- en nadelen. Operationeel gezien heeft CTS het voordeel dat de arbeidskosten flink verlagen, aangezien er geen chauffeur meer nodig is. Door de stijgende ervaring met automatisering zullen automatisch systemen betrouwbaarder worden, waardoor ook deze kosten kunnen dalen. Dit kostenvoordeel zorgt dat de frequentie van een dienst door CTS aangepast kan worden op de vraag en dat (semi-) individueel vervoer kan plaatsvinden, mits de infrastructurele capaciteit dit toelaat. Deze kenmerken zorgen ervoor dat betaalbare vraaggestuurde diensten geleverd kunnen worden. De verwachting is dat CTS over een exploitatietermijn van tien jaar rendabel kan zijn. (Filippi, 2004)

Nadelen zijn dat realisatie van CTS erg complex is, omdat voor de verdere ontwikkeling eigen infrastructuur nodig is, aangezien CTS niet kan mengen met ander verkeer. De realisatie van infrastructuur kan een probleem geven, aangezien het aanleggen van infrastructuur kostbaar is, het succes van het systeem onbekend en omdat ruimte om infrastructuur aan te leggen schaars is. Aangezien de risico’s onzeker zijn en de
systemen zich nog niet in een professionele toepassing hebben bewezen, kunnen de kosten hoog uitvallen. Tot slot levert het gebruik van CTS vaak een extra overstap op. Dit kan een nadeel zijn in het gebruik, afhankelijk van de reizigerswaardering van die overstap.

De verwachting bestaat dat CTS kan bijdragen aan duurzame mobiliteit. Met name op het gebied van uitstootgassen, aangezien de voertuigen elektrisch worden aangedreven in plaats van met een verbrandingsmotor. Daarnaast kunnen de korte wachttijden en directe service voor een goede sociale prestatie, al blijkt dat de auto nog altijd het beste scoort op sociale indicatoren. Het innovatieve karakter van CTS kan zorgen voor een puls voor de economische ontwikkeling.

Dit onderzoek gebruikt CTS als uitgangspunt, het geeft een kader voor de ontwikkeling van nieuwe vormen van mobiliteit in stedelijk gebied, voor de diensten die uitgevoerd kunnen worden door CTS en voor de rol die een gemeente heeft in de ontwikkeling van het nieuwe CTS systeem. Het doet geen uitspraken over de keuze tussen het specifieke CTS systeem of een vergelijkbaar systeem, of over de prestaties van het systeem ten opzichte van bestaande systemen of nieuwe, vergelijkbare systemen.

**Een dienst door CTS**

De vervoersmarkt in het transport systeem bestaat uit de vervoersvraag, reizigers die van A naar B willen, en uit het verkeersaanbod, de dienst die de reiziger van A naar B kan brengen. Het blijkt dat CTS een dienst kan uitvoeren in gebieden waar het activiteiten niveau hoog is en waar de reizigers gespreid over tijd en/of plaats aankomen – dit houdt in dat er een constante vraag is naar vervoer zonder extreme piekmomenten. Aangezien CTS eigen infrastructuur nodig heeft, lijkt een netwerkvariant waarin kris kras vervoer uitgevoerd kan worden moeilijk te realiseren. Omdat CTS wel een vraaggestuurde dienst kan uitvoeren, kan een rechtstreekse verbinding gelegd worden over lijinfrastructuur of een beperkt netwerk. Hierbij hoeft het wagentje niet op elke halte te stoppen en kan het de kortste route kiezen naar een volgende halte om zo de reistijd en de wachttijd te verkorten. Deze dienst kan ingericht worden voor verschillende verkeersstroomen in stedelijk gebied: voor verkeer in het centrum, voor verkeer tussen het centrum en de centrumring, voor verkeer dat van buiten de stad komt en naar het centrum gaat en voor verkeer dat vanuit de buitenwijken naar het centrum gaat.

De geïdentificeerde stromen dienen tenminste gevormd te worden door reizigers met een woon-werk motief en/of winkel motief, om ervoor te zorgen dat de dienst die CTS aanbiedt ook daadwerkelijk efficiënt gebruikt kan worden. Of reizigers gebruik willen maken van CTS hangt af van de kwaliteitseisen die zij stellen. CTS kan voldoen aan de reizigers die eisen stellen aan reistijd en comfort. Op het gebied van prijs is de prestatie van CTS nog onzeker.

Voorbeelden van diensten op korte termijn kunnen zijn: het verzorgen van voor- en natransport van een vervoerssysteem op een hoger schaal niveau waarin grotere verkeersstromen verwerkt worden – metro, tram, regionale bus - of het ontsluiten van een centrum vanaf centrale plekken aan de buitenrand. Gemeente onderschrijven deze mogelijkheden. Op lange termijn is het mogelijk voor CTS om te mengen met ander verkeer (uitgerust met bijvoorbeeld automated driver assistance features, waarbij de bestuurderstaken van een chauffeur worden overgenomen). Hierdoor kan het makkelijker worden om infrastructuur vrij te maken voor deze groepen, aangezien het
Aantal gebruikers stijgt. Als er meer infrastructuur vrij komt voor CTS, is het mogelijk om het infrastructuur netwerk uit te breiden. Gemeenten en regionale autoriteiten onderschrijven deze mogelijkheden – zeker gezien de verwachte voordelen van de operationele kosten die een automatisch vervoersysteem met zich meebrengt in vergelijking tot de operationele kosten van een conventioneel vervoersysteem. De arbeidskosten van de exploitatie van een busdienst zijn 60% van de totale operationele kosten van deze dienst. (Van Goeverden et.al., 2000) De arbeidskosten voor de exploitatie van een dienst door CTS zullen lager uitvallen door het ontbreken van een chauffeur op het voertuig, maar de investeringskosten zijn hoger. Om de voordelen van CTS te gelde te maken, zal echter eerst financiering vrijgemaakt moeten worden om het systeem in de praktijk te testen. Dit maakt de ontwikkeling van CTS kostbaar.

**De ontwikkeling van transport systemen**

![Diagram](image)

Voor een succesvolle ontwikkeling van CTS is naast de technische en functionele mogelijkheden van CTS ook het ontwikkeltraject van een nieuw transport systeem in het algemeen van belang. CTS bevindt zich op dit moment in de "pioneering" fase die gekenmerkt wordt door: het gebrek aan standaardisatie, het uitvoeren van veel proefprojecten, de ontwikkeling van veel (deels) vergelijkbare systemen en de diffuse spreiding van kennis. Om CTS de stap te laten maken naar een volgende fase (de fase van ‘snelle groei’) is een aantal factoren van belang. Ten eerste zal de technologie ingericht moeten worden naar de eisen van de gebruiker. Dit is mogelijk indien de eisen van de gebruiker worden meegenomen in de huidige ontwikkelingen die CTS doormaakt en in de proefprojecten die uitgevoerd worden. Ten tweede kan de groei van het systeem versnellen als het gebruik kan maken van aanwezige infrastructuur. Om dit te realiseren zal weginfrastructuur vrijgemaakt moeten worden voor CTS. Dit is in sterk stedelijk gebied moeilijk te realiseren, maar er zijn vaak wel oplossingen voor handen, bijvoorbeeld aanwezige verbindingse stukken infrastructuur die nu niet gebruikt worden voor conventioneel vervoer. Tot slot zullen het productieproces en de operationele diensten ontwikkeld moeten worden, zodat het systeem toegankelijk wordt gemaakt voor een grote groep gebruikers. Aangezien er nog geen standaardisatie heeft plaats gevonden in de ontwikkeling van cybercars en omdat de mogelijke diensten nog verder uitgewerkt moeten worden naar de wensen van de operator en gebruiker, zal CTS vaker gerealiseerd moeten worden om een standaard te kunnen ontwerpen en daarmee door te kunnen groeien naar de volgende fase. De groei van CTS naar een volgende fase is niet onmogelijk, maar nog wel onzeker.
De ontwikkeling van nieuwe transportsystemen wordt vaak gezien als een transitie. Dit is een verandering waarvan de richting vaststaat, maar waarvan het eindresultaat niet op voorhand te voorspellen is. Op dit moment wordt door verschillende overheden geprobeerd om een transitie naar duurzame mobiliteit te bewerkstelligen. De rol van gemeenten in de ontwikkeling naar duurzame mobiliteit komt pas laat in het proces naar voren, vanwege haar afhankelijkheden in wetgeving en financiële middelen. De gemeente is wel een belangrijke acteur in de ontwikkeling: in stedelijk gebied zijn de negatieve effecten van verkeer erg duidelijk en direct zichtbaar. Hierdoor is de gemeente een van de probleemeigenaren, wat haar rol in het proces vergroot en versterkt.

**De rol van de gemeente in de ontwikkeling van CTS**

Gemeenten hebben geen directe zeggenschap meer over de ontwikkeling en inrichting van openbaar vervoer in haar gebied. Regionale autoriteiten (WGR-plus regio’s) zijn in het kader van de Wet Gemeenschappelijke Regelingen Plus (WGR-plus) verantwoordelijk voor onder meer de ontwikkeling van openbaar vervoer in stedelijk gebied en de ruimtelijke ordening. Bestuurders van gemeenten hebben zitting in het dagelijkse bestuur van deze regionale overheden en daarmee zeggenschap in de besluiten op dit gebied.

Gemeenten spelen in de ontwikkeling van nieuwe vervoerssystemen, CTS in dit geval, wel een belangrijke rol. Zo is ze regelmatig initiator van een project voor nieuwe vervoerssystemen. Er zijn verschillende motieven om een project te initiëren, veelal speelt een probleempercectie van een gemeente een rol in dit initiatief. Verder speelt het verbeteren van het imago van de stad een belangrijke bijrol in de keuze voor de ontwikkeling van nieuwe systemen. Duurzame mobiliteit is op dit moment zelden een motief om automatisch vervoer te realiseren, het kan wel een katalysator zijn voor de verdere ontwikkeling. Vanwege de probleempercectie bij gemeenten, en daarmee de commitment aan het project kunnen gemeenten naast de rol van initiator ook een goede procesmanager zijn, de rol van facilitator en agendavormer. Kennis en ervaring met een systeem is voor gemeenten belangrijk om vertrouwen en inzicht te krijgen van de mogelijkheden van een systeem. Daarnaast is het vinden van draagvlak voor de ontwikkeling van een nieuw systeem belangrijk. Hier kan een invloedrijke bestuurder, bijvoorbeeld een wethouder een belangrijke rol vervullen.

Een WGR-plus regio heeft de taak om concessies te verlenen voor de ontwikkeling van openbaar vervoer. Hierbij is ze afhankelijk van financiële middelen toegekend door hogere overheden, de Brede Doeluitkering (BDU-gelden). Het toekennen van een concessie aan een vervoerder gebeurt veelal door een economische afweging tussen de verschillende offertes. Aangezien CTS zich nog niet bewezen heeft in een professionele toepassing, zijn de risico’s en daarmee de kosten vaak hoger dan van conventioneel vervoer. WGR-plus regio’s zijn hierdoor zelden initiatiefnemer voor nieuwe transportsystemen.

Door deze financiële afweging zullen nieuwe systemen voorlopig niet grootschalig gerealiseerd worden via een standaard concessieverlening. Financiële middelen kunnen gevonden worden in Project programma’s van overheden, fondsen en subsidies. Deze middelen zijn vaak gebonden aan strikte eisen. Dit bemoeielt het vinden van geschikte middelen.
Succesfactoren voor de ontwikkeling van CTS

Er is een aantal factoren te identificeren, dat van belang zijn voor een succesvolle ontwikkeling van CTS. Deze kunnen onderverdeeld worden naar organisatorische factoren, technische factoren en een combinatie van deze factoren. Een probleemperceptie waarbij CTS een (deel) van de oplossing kan vormen is essentieel voor het slagen van een project. De combinatie van de technische mogelijkheden met de organisatorische mogelijkheden is essentieel om tot CTS in te richten voor de praktijk. Verder is het commitment van de betrokken partijen aan het proces noodzakelijk voor de realisatie, ongeacht de lengte van het project en de complexiteit.

Conclusies en aanbevelingen

CTS kan een dienst uitvoeren die bijdraagt aan het functioneren van het huidige transportsysteem. Deze dienst hoeft niet beperkt te blijven tot niches. Met de komst van CTS kan het ontwerp van het hele transportsysteem herzien worden, waardoor er een betere invulling aangegeven kan worden, gebaseerd op de functionaliteiten van de verschillende transportsystemen, zowel automatische als conventionele. Daarnaast kan CTS op lange termijn wellicht een dienst aanbieden in een uitgebreider netwerk.

Afhankelijk van de keuzes die gedurende het ontwikkelproces van CTS gemaakt worden zal deze mogelijkheid al dan niet daadwerkelijk gerealiseerd kunnen worden. CTS moet zich op moment echter nog bewijzen in een professionele toepassing. Dit brengt een aantal onzekerheden met zich mee waardoor de kansen voor realisatie verminderen. De ontwikkeling van nieuwe transportsystemen moet dan ook gestimuleerd worden, er moeten mogelijkheden geïnitieerd worden om middelen vrij te maken voor een verdere ontwikkeling en het toekennen van middelen moet minder gebonden zijn aan stricte eisen.

Gemeenten vervullen een belangrijke rol in de ontwikkeling van CTS, zonder hun initiatieven en betrokkenheid aan projecten zal CTS niet gerealiseerd worden in stedelijk gebied. Echter, alleen kan een gemeente een nieuw transportsysteem ook niet realiseren. Daarvoor zijn haar afhankelijkheden van andere overheden te groot.

Het lijkt erop dat de keuze van gemeenten voor een nieuw systeem vaak nog technologie gestuurd is. Dit valt te verklaren doordat de kennis van een nieuw transport systeem vaak per toeval wordt opgedaan door het contact met een leverancier of ontwikkelaar. Om de afweging voor het gebruik van een systeem beter gericht te laten zijn op de functionaliteiten van een systeem zou een uitgebreid beslissings ondersteunend systeem ontworpen kunnen worden, waarin de inhoudelijk kan van de ontwikkeling (systemen en hun functionaliteiten) worden gecombineerd met mogelijkheden voor de inrichting van het proces. De gedefinieerde voorwaarden voor succes van een project uit dit onderzoek opgenomen kunnen worden, mits ze geoperationeerd worden. Verder kan het vergaren van informatie van coöperatieve projecten waarbij veel partijen betrokken zijn van verschillende disciplines inzicht geven in het proces verloop van een ontwikkelproject. Dit systeem kan ontworpen worden door een onderzoeksinstituut en tot beschikking gesteld worden door een kennisplatform of een partij die overheden nu al ondersteunt bij het ontwikkelen van nieuwe projecten. (bijvoorbeeld het KPVV).

Een project nooit zal slagen als de reiziger er geen gebruik van wil maken. De verdere ontwikkeling van projecten met CTS zullen dan hun nadruk moeten hebben op het op het bedienen van de reiziger. Het ontwikkelde overzicht van reizigers en reizigersstromen die bediend kunnen worden kan hiervoor gebruikt worden.
gedefinieerde voorwaarden voor succes of falen van een project zijn geen garantie voor succes. Elke ontwikkeling kent zijn eigen omgeving en betrokken partijen. Daarom kan er geen stappenplan ontworpen worden voor een succesvolle realisatie van CTS. De voorwaarden kunnen echter wel meegenomen worden in de ontwikkeling om valkuilen te voorkomen en verwachte kansen te benutten.
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1. INTRODUCTION

The subject of this research is the development of automated transport in urban areas. Since this is a very broad topic, the background of the research is described in paragraph 1.1, followed by the problem analysis (paragraph 1.2). In addition, the design of the research and structure of the report are explained (paragraph 1.3 and 1.4).

1.1. BACKGROUND

Since the beginning of the last century, a constant growth of transportation can be noticed, in traveled kilometers as well as in the transported number of people and goods. There are three main and constant reasons for this growth (Filarski, 2004). Transport has continuously become cheaper (price), faster (time) and more comfortable (comfort). More people are able to travel, because traveling has become cheaper, and people can travel further in the same time range, because the travel speed of means of transport has increased. Since people tend to spend an equal amount of money and time on transport (the BREVER-wet, Hupkes, 1977) the distances that people travel become larger. The behavior of passengers with respect to their choice of transport mode has been constant. They have based their choices on the factors speed, status, comfort, the option to travel independently, personal security and travel costs (Filarski, 2004).

Many technological transitions have taken place in the past century in the field of transportation; the stage-coach and the steam railway were introduced after the tow barge. Followed by the establishing of the bicycle and car in the transportation market. In the last half of the twentieth century, transport by airplane became more popular and railways underwent a large development. Due to these developments traveling became easier, faster and cheaper. Therefore, it is no longer a privilege for the rich. The ability to travel gives people many possibilities.

However, traveling has not only brought along advantages. The negative effects of transport are becoming a global and a local problem. Globally, because of emissions that are produced directly (by cars with a combustion engine) or indirectly (to generate electricity at large power plants for cars with electric engines); and locally, because of local emissions, noise nuisance, external safety (www.vrom.nl). The effects of transport can be seen in several fields, such as the effects on the environment and air quality, on accessibility of urban areas, on spatial planning policies and on the economic development. These effects are clearly visible in urban areas. The effects become negative, when requirements in the several policy fields can no longer be met due to the growth of transportation.

It is expected that transportation growth will continue, which has two consequences. In the first place, the economic development and the growth of mobility require expansion of existing transport facilities. In the second place, the expansion of transport facilities faces increasing problems due to environmental limitations and high investment costs. (Filarski, 2004)

Several parties see the dilemma between growth of the demand for transportation and the demand for the quality of the environment. Sustainable mobility is seen as one of the possibilities to challenge this dilemma. Sustainable mobility, in the largest sense, means keeping transport possible for all people while its negative effects are diminished.
This premise follows out of several definitions for sustainable mobility, which can be read in appendix I. Governments, businesses, knowledge institutes and consultants on every level are developing and introducing sustainable possibilities for mobility. Just like TNO, the research and knowledge institute where this research is executed.

There are many options for sustainable mobility. One way to realize sustainable mobility is to develop new, sustainable means of transport. TNO is involved in the development of a Cybernetic Transport System (CTS) and expects that this system can contribute to sustainable mobility in urban areas. CTS is an automated transport system with Cybercars. Cybercars are road vehicles with fully automated driving capabilities. A fleet of these cars forms a CTS. This research focuses on CTS. It is assumed that the development of CTS contributes to the development of sustainable mobility. A lot of research has been done for the technical development of CTS and its accompanying functionalities. However, to be able to implement a new transport system in urban areas, many under exposed issues on the demand side of the transport market still need further research.

### 1.2. Problem Analysis

The development and introduction of many innovative technologies in the transport market is mainly technology driven. However, the purpose of the development of cybernetic transport systems is to contribute to the mobility of people in urban areas and to contribute to a sustainable society. Therefore, not only the technical possibilities are important in the development, the societal needs are important as well.

This research focuses on the development of CTS in urban areas. There are several reasons for this choice:

- A city is often an origin and/or a destination of a trip, because of its economic attractiveness and the possibilities for leisure/shopping activities. Therefore traffic, but also its negative impacts concentrate in urban areas.
- Many people live and work in urban areas. They are all affected by the negative impacts traffic brings about.
- Anticipation at the expected regulation from the European Union to design a framework for the transition to sustainable mobility for cities with over 100,000 inhabitants.
- The technical possibilities of CTS and the accompanying system functionalities make a transportation service in urban areas possible on short term.

Apart from these reasons, the limitation to urban areas also defines an organizational and geographical scope.

Many aspects of the development of CTS have already been examined; the necessary legislation that has to be designed is identified as well as further technical developments, the short term technical possibilities and the accompanying system functionalities are known and tested in several pilots (Hylckama Vlieg, 2003). However, these pilots all stay in so-called niche solutions. Niches can be seen as small elements in the transport systems where the influences of the introduction and implementation are not too risky. For example: automatic cars at funfairs, the disclosure of a city via dedicated infrastructure or on parking lots. In the Netherlands, a concept of CTS is implemented at Business Park Rivium in Capelle aan den IJssel and at a parking lot at Amsterdam Airport Schiphol.
The goal of the development of CTS –according to the developing parties- is not to stay in niche solutions, but to contribute to the development of sustainable mobility in urban areas. Therefore, research should be done on how CTS can be integrated in the current transport system to contribute to the existing travel patterns. Furthermore, there is a lack of knowledge about the way CTS can be developed in urban areas – the parties that are involved in this development, their responsibilities and possibilities. Therefore research should be done on the development of CTS in a municipality as well.

**Problem owner**

If CTS is to be developed in urban areas several stakeholders and shareholders can be identified. The consumer who has demands on price, time and comfort; the operator of transport who wants to make a good deal with the authorities; the supply industry that wants to stay in competition with other operators, but also has to keep up with legislation on sustainability and the demands of the consumer; and authorities who have a public duty to make transportation possible for everybody, who have to design and execute the regulations on sustainability and who have a large influence in steering the organization of public transport.

Because of the approach of this research – the lack of knowledge in the development of CTS in urban areas - the municipality is the problem owner. Albeit the regional authorities carry the responsibility for the developments in the field of transportation, the municipality does play an important role. It influences the policies of regional authorities, because its alderman takes an important role in the administrative body of a regional authority and because it has a lot of knowledge about and is very familiar with the problems and possibilities in their own geographical area – after all she deals with it on a daily basis.

It is presumed that the municipality represents consumers, since consumers can choose the governing body and have a say in the approval of designed plans and policies in the field of public transport and spatial planning. The municipality depends largely on other parties. Next to the dependency of the regional authorities for the defined policy, tender procedure and resources, the municipality depends on national and international authorities as well for resources as for regulation.

**Problem definition**

This research focuses on the development of CTS in urban areas. This has two reasons. First, there is a lot of unclearness about the contribution that CTS can have to the service of the current transport system. Second, there is a lack of knowledge about the role that municipality can take in the development of CTS. Therefore problem definition in this research is defined as follows:

> At this moment there is too little insight in the possible contribution of a service of CTS to the current services of the transport system in urban areas and in the role of the municipality in the development of CTS in urban areas

The following paragraph shows the design of the research in order to contribute to solving the identified problem.
1.3. **Design of the Research**

The research is designed to reach the goal, which is defined as follows.

**Define conditions for success and failure for the development of CTS in urban areas, by identifying and analyzing the contribution of a service by CTS to the transport services in urban areas and by identifying and analyzing the possibilities of a municipality to the development of a new transport system.**

**Parts of the research**

In order to reach this goal the research is split in three parts that are described below.

- A description of the background of the development of automated transport systems and specifically the development of CTS

This description is given to create insight in the environment and context in which the development of CTS takes place as well as in the development of CTS itself.

- Analyzing which service CTS can provide in an urban area and how it can contribute to the current transport services

This analysis is performed to determine whether a service by CTS can have a contribution to the current transport market and what this contribution can be. The results of this analysis can be used to generate successes and failures when CTS is integrated in a service network of the existing urban transport system.

- Analyzing the development of new transport systems and the role that a municipality can take in this development

This analysis is executed to determine the development phase in which CTS can be found at the moment and the roles a municipality can take in this phase to develop CTS. Based on this analysis can be determined what possibilities a municipality has to develop a new transport system in her area.

Finally, the second and third part leads to conditions for success and failure to develop CTS in urban areas.

Conclusions and recommendations are formulated in the final chapter.

**Research Questions**

In order to carry out the steps, several research questions have to be answered. These questions are defined below. The methods to answer the questions can be found in chapter two.

**Part 1**

- What is the background of the development of Cybernetic Transport Systems?
- What is a Cybernetic Transport System?
Part 2

- What can a service of CTS look like, based on the characteristics of a service network and the service characteristics of CTS?
- What transportation demand can be answered by a service of CTS, based on transportation demand in urban areas?
- What can a service of CTS look like to serve transportation demand in urban areas?

Part 3

- What does the development of new transport systems look like?
- What are the roles and possibilities of the municipalities in the development of transport systems?

Methods to answer these questions are described in chapter 2.

Scope of the project

Several assumptions and delineations are made to perform the research.

The basis of this research is the premise that CTS contributes to sustainability in urban areas. There are many more possibilities that can contribute to sustainability. These other possibilities are not taken into account in this research, since this research is not aimed at judging the contribution to sustainability of the different system, but focuses on the development of a new system in urban areas. CTS is just the framework to create insight in the possibilities for the development.

The contribution of CTS to sustainable mobility will be explained to give insight in the background of the development of CTS. It is not used to derive conditions for success and failure for the development of CTS.

Furthermore, this research is aimed at determining the contribution of CTS to the transport possibilities in urban areas. This service will be described by using the features of a service network. The physical system of a network in an urban area is not designed. Although an overview of the physical demands for the realization of a system will be described.

Furthermore, the third part of this thesis is aimed at the possibilities of a municipality in the development of CTS of urban areas. Several delineations are made in this part. The dependencies of a municipality on other governmental institutions are shortly described as well as the cooperation with and dependencies on other parties as private developers and operators. The possibilities and roles of other parties than the municipality in the process of development of a new transport system in urban areas are kept outside the scope of this research, because the research is aimed at the possibilities to realize a new transport system in urban areas and not at the development of urban transport systems in general. Next to this, this research is not aimed at determining whether a municipality should or should not develop CTS – it is only aimed at showing the possibilities of a municipality when they decide to develop CTS or another new transport system.

The municipality is an important player in the development of a new transport system. However, eventually new means of transport have to be accepted by the passenger. In this research, it is assumed that the municipality takes the interest of the consumer into account. Furthermore, the wishes of the consumer are taken into account in the
The development of the service, based on several user needs analyses. The importance of the consumer for a successful development of CTS is very clearly stated by Cosgrove: “When the future is on trial the ultimate judge always will be the consumer.”

It is presumed that CTS is a system that performs passenger transport in a public application. Private applications are possible and can be found in for example theme parks or company transportation for personnel. These applications are kept outside this research.

The design of the research process is drawn in the Figure 1-1.

**Figure 1-1 Design of the research**

**Planning the research**

Creating insight in the development process that CTS has gone through has been very important, because a lot of research has been done in this field. Therefore, a large literature study has been performed to describe this development. The second step gained insight in the contribution that CTS can have to the existing services of a transport system. It has been necessary to perceive this insight first, because a municipality cannot determine which roles she can take in a development process as she is not familiar with the content of it. Only after this analysis has been performed the role of the municipality can be described. A lot of information of this role was derived from interviews. The interviews took place in a very late stage of the research, because insight in the different developments of automated transport systems and in the position of a municipality in the development of public transport has been necessary to derive useful information from the respondents. The total research has taken 7 months.

**1.4. Structure of the Report**

The following chapter will describe the approach of the research. Chapter three explains the first part of the research; the context of the research and will give the reader insight in the existing developments in the field of sustainable mobility, automated transport and CTS. Chapter four and five elaborate the second part of the research. Chapter four will describe the theory about the design of a service network and about traffic flows and transportation demand. Finally a short description about the behavior of the traveler will be given. Chapter five will combine the theory of chapter four with the characteristics of CTS and the actual transportation demand in urban areas. This chapter will be concluded with a possible service for CTS. The third part of the thesis starts with chapter six. This
chapter will describe the current development stage of CTS and how CTS can make it to a next phase. The second part of this chapter elaborates on the possibilities of the municipality in the development of CTS. Finally, chapter seven will present the conditions for success and failure of the development of CTS in urban areas based on its likely services and on the possibilities for a municipality to develop CTS. Conclusions about this research and recommendations for further research will be given in chapter eight. The research will conclude with a reflection.

At the end of every chapter the results, the answers to the relevant research questions, can be found as well as short conclusions about that chapter.
2. RESEARCH APPROACH

Several methods and techniques have been used to carry out the different steps. The first paragraph explains the methods that have been used to gather data. The second paragraph explains the techniques that have been used to perform the analysis. Finally, the purpose and structure of the interviews is presented.

2.1. METHODS AND TECHNIQUES

This paragraph describes the methods and techniques that have been used to answer the questions. First the methods for data gathering will be explained. Second, the techniques to structure information and results are presented.

2.1.1. Used Methods for Data Gathering

Two methods have been used to gather data – literature and interviews.

Literature studies

A literature study is major part of this research. In the first step literature has been used to derive information to about context of the development of CTS and about the development of CTS itself. Literature has been very useful to get insight in the many experiences and studies that have been carried out and their results.

In the second step, literature has been used to get insight in the theory of designing a service network and to get insight in the theory about traffic flows in urban areas. These theories have been used to describe possible services of CTS in urban areas.

For the third part literature has been used to get insight in the development of transport systems in the past. Second, literature has been used to get insight in the existing ideas about the roles and possibilities of a municipality in the development of new transport systems. Literature has been useful, because the possibilities of a municipality and the development of a new transport system are not fixed. To get insight in the range of possibilities, information has to be derived about experiences in the past.

Statistical Data

Data about the transport flows that actually occur in urban areas has been derived from the “Statistics Netherlands” (“Centraal Bureau voor de Statistiek”). This data is used in the second step of the research to determine the actual flows that can be served by CTS.

Interviews

Interviews have been held to derive information from municipalities about their choices for a certain transport system and about their perceptions, possibilities and roles in the development of new transport systems in their urban area. Information about experiences in practice is necessary to get insight in the role a municipality can take in the development process.
Interviews are a useful method to derive this information, because:

- the development of an automated transport system for urban areas is custom made
- the development of automated transport systems is complex: many actors are involved and the performance of the system is unknown for many people
- the process of the development differs per municipality
- the reasons for the success or failure of a project differs per municipality

Because of these reasons, open interviews have been held. Open interviews give the possibility to get specified information about the course of a process and the reason for a certain decision. The intent of the interviews is the same, in order to acquire information that is useful for the different parts of the research.

The approach of the interviews, the purpose and the choice for the respondents is defined in paragraph 2.2.

### 2.1.2. Used Techniques

This paragraph presents the techniques that have been used to structure the data (causal relation diagrams, scorecard) and an overview of the presentation of the results of the analyses, based on Van der Panne, 2003.

**Causal Model**

When studying a system, like a transport system, it is useful to distinguish different factors that constitute and influence the system in order to get insight into the effects that a new transport system has on its environment. A technique that can be helpful in visualizing the effects of a new transport system is a causal relation diagram.

The purpose of a causal model is to make the factors in a system explicit as well as factors that influence a system. The relations between the factors show the effect of the alteration of one factor on the other factors. In this research the diagram is used as a tool to give a better insight in the impacts of the realization of CTS in urban areas and to give better insight in the effects of transportation demand in urban areas. (Chapter three) The Figure 2-1 shows the lay out of a causal model.

![Figure 2-1 Causal model](image)

The main function of this modal is to identify and visualize the relations between factors in a system. The factors of a system are drawn in ovals and the relations are drawn with arrows. An arrow is labeled with a symbol: `+`, `-` or `?`. A `+` shows that factor B will diminish when factor A diminishes or that factor B will increase when factor A increases. A `-` shows that factor B will increase when factor A decreases or that factor B will decrease when factor A increases. A `?` shows the effect of factor A on B is unknown.
This is often the case with non-scalable factors. These factors should be avoided as much as possible, because they make the relations unclear.

**Score card**

A ‘score card’ is based on an ‘effect table’ (‘effectentabel’ in Dutch). It is a method to compare different alternatives. This table is meant to present the different alternatives in such a way that the possibility to compare the alternatives on different criteria is improved and not to draw a conclusion about an alternative. The ‘score card’ is a useful method when only qualitative data can be gathered. The hierarchy is indicated graphically with colors and not with firm quantifications. The graphical value of a criterion for a certain alternative is more important than the quantity for the alternative for the comparison.

An example of a scorecard looks as follows.

<table>
<thead>
<tr>
<th>Criterion 1</th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative n</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>0</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Criterion 2</td>
<td>0,5</td>
<td>0,4</td>
<td>0,3</td>
</tr>
<tr>
<td>Criterion n</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Figure 2-2 The design of a scorecard**

In this research the scorecard is used to give insight in the possible contribution of urban transportation modes to sustainability. (Chapter 3) The method is not used and not meant to make a solid consideration for transportation modes based on their contribution to sustainability.

**A framework to derive conditions for success and failure of a development**

There are several ways to derive conditions for success and failure of a development. Van der Panne (2003) designed a framework to derive these conditions for innovations. Van Wee et. al. (2004) applied this method to derive conditions for success and failure for innovations in transport systems. Since the development of CTS can be seen as an innovation, this framework is useful to structure the results of the different analyses.

The framework consists of critical features which form conditions for success or failure of innovations. It structures the features in four. The first two groups determine the technological viability. The last two groups determine the commercial viability of an innovation.

These factors are (Van der Panne, 2003):

- **firm related factors** – firm culture, experience, R&D team, strategy towards innovation, organizational structure, R&D intensive
- **project related factors** – complementarities, management style, top management support
- **product related factors** – relative price, relative quality, innovativeness, technologically advanced
- **market related factors** – concentration of target market, timing market introduction, competitive pressure, marketing
Figure 2-3 shows the design of the framework.

Figure 2-3 Critical factors for successful innovations (based on Van der Panne, 2003)

In this research the framework is used to determine conditions for success and failure for the development of CTS. In this research is spoken about successes and failures of the development of CTS. The correct description should be of course conditions for success and failure of a development, since the success (or failure) is determined by reaching a certain goal; for example the realization of an adequate CTS.

Successes – as they are used in this research - are features in the organizational development of CTS as well as the technical/ system development of CTS that can stimulate or even accelerate the development and actual realization of CTS. Failures – as they are used in this research - are features in the development of CTS that can prevent or delay the further development or realization of CTS.

The factors that determine the technological viability are derived from the analysis of the possibilities of the municipality (Chapter 6). Therefore, in this research organizational viability is a better term than technological viability. The factors that determine the commercial viability are derived from the analysis of possible services of CTS in urban areas (Chapter 5). The successes and failures that can be derived from identified factors are presented in chapter 7.

A lot of information to fill in the framework has been derived from interviews. The approach of the interviews is described in the following paragraph.

2.2. THE APPROACH OF THE INTERVIEWS

Within the framework of this research interviews are held to obtain information about the process of the development of automated transport systems in urban areas – and when available, the development of CTS. The interviews focus on the possibilities of a municipality and on the choices for a certain system.

First an interview is held with ANT – a Dutch traffic and transport consultant with a lot of experience in the field of automated transport in urban areas. This interview is aimed at exploring the initiatives that have taken place in the development of these systems in urban areas.

Second, interviews are held with municipalities to get insight in the development of automated transport systems in their areas. Interviewed municipalities need to have experiences with the development of an automated form of transport. This does not necessarily have to be CTS. The role a municipality took in the development is more
important than the system she had developed - this role does not per se depend on the specifications of the system. Furthermore municipalities that have experienced with other systems can point out why they have chosen for this system and not for another one.

Finally, interviews are held with WGR-plus regions in order to verify the data derived from the interviews with municipalities, and to get insight in the position and the role of these in the development of new transport systems in urban areas. WGR-plus regions are regional authorities that are among others responsible for the development of public transport in urban areas. WGR stands for “Wet Gemeenschappelijke Regelingen” (in Dutch) in which these authorities and their responsibilities are described. A more extensive explanation can be found in chapter 6.

The reports of the conversations can be found in appendix VIII.

**Choice for the municipalities**

This choice has been based on the availability of municipalities and on criteria to derive the necessary information for the research.

**Available municipalities**

Many municipalities have researched the possibilities of a new form of transport in their areas. The information about municipalities that have experiences in the development of urban transport systems is not registered. The sources to find municipalities are very diffuse. They differ from organizations that provide subsidies to accidental conversations with people at a municipality. The main source for municipalities in this research has been the interview with ANT. They performed many researches in municipalities to see whether automated transport can be suitable in an area and in which form. The obtained list was as follows. Almelo, Beverwijk, Capelle aan den IJssel, Den Haag, Eindhoven and Utrecht. Furthermore, during the research it appeared that the municipality of Rotterdam has been very active in researching possibilities for sustainable transport. Delft and Amsterdam are exploring possibilities for automated transport as well.

Not all municipalities have been interviewed. A very important criterion to select municipalities was the progress in the development. Amsterdam and Delft have not yet been developing a new form of transport for their area. The project in Beverwijk stopped very sudden, when another form of subsidy became available and automated transport was not yet feasible anymore. Therefore, not enough information can be gathered from this municipalities.

**Information from the interviews**

Several criteria were designed in order to determine whether the necessary information would be gathered by interviewing the remaining municipalities. The criteria are as follows.

1. All municipalities have to be familiar with automated transport for people and need to have done some research in this field for their own municipality.

This criterion is chosen, because municipalities need to have experience in the possibilities and development of automated transport in urban areas.

2. At least one of the municipalities has a likely application for CTS at her disposal. These applications are identified in the enquiry of Cyber Move (see chapter 4).
This criterion is used to get insight in the link between likely applications for CTS and the choice for a municipality for a certain system at this application.

3. At least one of the municipalities has an extensive public transport system with trams and metros.
4. At least one of the municipality does not have an extensive public transport system with trams and metro’s

These criteria come forth out of the service characteristics of a system; what service does an automated system have to provide in the existing transport system?

5. At least one of them has to grant concessions themselves.
6. At least one of the municipalities does not grant concessions themselves.

These last two criteria come forth out of the responsibility for the public transport system; is there a difference between the consideration for an automated transport system when a municipality depends or depends not on a regional authority?

All criteria are covered in the interviewed municipalities. This is shown in the table below.

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almelo</td>
<td>1, 4, 6</td>
</tr>
<tr>
<td>Capelle aan den IJssel</td>
<td>1, 2, 3, 6</td>
</tr>
<tr>
<td>Den Haag</td>
<td>1, 2, 3, 6</td>
</tr>
<tr>
<td>Eindhoven</td>
<td>1, 2, 4, 5 (temporary)</td>
</tr>
<tr>
<td>Leeuwarden</td>
<td>1, 2, 4, 6</td>
</tr>
<tr>
<td>Rotterdam</td>
<td>1, 2, 3, 6</td>
</tr>
</tbody>
</table>

Four interviews were with (senior) advisors of municipality that have been or are closely involved in the development of automated transportation in their municipality. Next to these interviews one telephonic conversation has been held with an advisor for Traffic and Transportation of the municipality of Leeuwarden. In this conversation not all the topics were covered. The information that has been derived from the conversation is used in the research. Therefore an overview of this conversation is given in the appendix as well. Furthermore a summary of the process of a project in Eindhoven is given. An article has been used to make this summary. An interview was not possible, because nobody has been working at the municipality of Eindhoven who was closely involved in the process. The information from this article is used and has, in this research, the same status as an interview, because the article gives a structured overview of the process around the development of automated transport in this city and the roles of the municipality in the process.

**Purpose and topics of the interviews with municipalities**

The purpose of the interview is twofold. The first purpose is to determine how a new automated transport system can be fitted in the existing transport system. The second purpose is to get insight in the role of a municipality in the development of an automated transport system in urban areas and the accompanying successes and failures, possibilities and risks.
The topics that have been covered are:

- The chosen system and its expected functionalities
- The expected passenger flows
- The reason to choose for a certain system
- The role of the municipality in the development of the automated transport system
- The involved policy departments in the development
- The other parties involved in the development
- The motives to develop an automated transport system
- Chances for success and failure of a project

**Purpose and topics of the interviews with WGR-plus regions**

The purpose of these interviews is to get insight in the roles and perceptions of an WGR-plus region about the development of automated transport systems in urban areas. Furthermore the interviews will be used to compare the information derived from interviews with the municipalities with the information of the WGR+ regions.

The topics that will be discussed are:

- the tasks of a WGR+ region
- the way regions fill in this task
- the role of the region in the development and studies to automated transport in urban areas
- the transport problems in urban areas
- the views, perceptions and policies towards the development of new forms of transport
- the parties involved in the process of development of new urban transport systems and the responsibilities of these parties – especially the municipalities

The respondents were from the “Stadsregio Rotterdam” and from “Stadsgewest Haaglanden”. They have been chosen, because they have been involved in the development of a new transport system in Capelle aan den Ijssel and in The Hague.

### 2.3. Introduction to the next chapter

This chapter has given insight in the techniques and methods to perform the research. The application of the techniques can be found along the report.

The first identified research step is discussed in the following chapter. It will give insight in the background of the research and the development of CTS in order to draw the environment in which this research has taken place.
3. THE BACKGROUND OF THE DEVELOPMENT OF CTS

This chapter forms the first part of the research. An important motive to develop CTS is the development of sustainable mobility. Automated transport systems are seen as possibilities to contribute to sustainable mobility and a CTS is a specific type of an automated transport system. This chapter is used to give an elaborated description of the background of the development of CTS.

Figure 3-1 Step one of the research elaborated in this chapter

The first paragraph will give an introduction to sustainable mobility. In paragraph 3.2 developments in the field of automated vehicles are elaborated. Paragraph 3.3 zooms in on the development of Cybernetic Transport Systems (CTS). Finally, in paragraph 3.4 answers to the research questions will be drawn.

3.1. SUSTAINABLE MOBILITY

This paragraph describes the term sustainable mobility. As Figure 3-1 points out the development of CTS comes forth out of the development of sustainable mobility. Therefore a short introduction to sustainable mobility will be presented in this paragraph. Paragraph 3.1.1 explains definitions for sustainable mobility and which description for sustainable mobility is used in this thesis. The second paragraph is pointed at sustainable mobility in urban areas. The third subsection gives an overview of indicators that can be used to measure the contribution of transport systems to sustainable mobility.

3.1.1. Definitions of sustainable mobility

Sustainable mobility is becoming a term which is used by a lot of authorities, companies and people in general. However, no fixed definition can be found. The development of sustainable mobility comes partly forth out of the dilemma between the growth of transportation and transportation demand and the demands on the quality of the environment. So, at first will be explained what is meant with the term sustainable mobility, sustainability and mobility in the context of this research.
Mobility

Mobility is described in many definitions. These definitions can be subdivided in two groups. One group is only aimed at “the ability to move” and the other group takes the performance of transportation into account: “the movement of people and goods”. In this report mobility will be used in the meaning of “the movement of people and goods”. Mobility is an enabling mode to perform activities in different places (Wee, 2002). It influences the life of people and it allows them to work, relax and enjoy [leisure] activities in different places. Therefore also government policies are aimed at controlling mobility in stead of reducing mobility (Department of Transportation, Public Works and Water Management et al., 2004).

Sustainability

The most common definition used for sustainability comes from the World Commission on Environment and Development Committee (1987) and is defined as: “Meeting the needs of the present generation without compromising the ability of future generations to meet their own needs”. This is a very broad definition. Sustainability is specified and more explicit in several ways by groups that have to work with it.

A way to specify sustainability is to subdivide it in different parts. Three different ways of subdivision are often used. One division is that sustainability has to contribute to people, planet and profit. (www.dubo-centrum.nl) A second subdivision is in economic sustainability, social sustainability and environmental sustainability (www.worldbank.org). Both descriptions point out that sustainability influences the whole state and not just one part of it. The influences of the aspect of sustainable development are often presented in a triangle: a change in one the three parts of the society has its influence on the other parts.

Figure 3-2 The sustainable triangle (www.worldbank.org; March 31, 2005)

This holds also for changes with regard to mobility. Mobility influences and is influenced by all the three boxes. For example: gas to drive a car is extracted from the environment, the ability to drive a car extends the social life and the activities performed in a social life influence the economy. When the economy is running well, it gives the possibility to keep up a social life and visit social activities; traveling to visit activities influences the environment.

In summary sustainability has to include the whole state and can not be restricted to just one part, such as the environment. The same holds for the realization of sustainable mobility.
**Sustainable mobility**

Many definitions of sustainable mobility can be found. Sustainable mobility can be interpreted in a broad or narrow view. When it is interpreted in a narrow view, sustainable mobility is aimed at exorcizing negative effects of traffic.

On the other hand sustainable mobility can be placed in a broader view, for example when it is placed in the light of the Brundtland definition of sustainability. This definition also stands for meeting the needs of the present generation. Several definitions are aimed at this broader prospect of sustainable mobility. The definitions – see appendix I – all focus on the combination of the reduction of negative effects and the ability to travel.

**Sustainable mobility in this research**

Because mobility has a big influence on the whole society, this research will take mobility as a necessary and a desirable aspect of life. Therefore it does not seem possible to approach sustainable mobility from a narrow point of view. In order to reach sustainable mobility and to meet the needs of the present and next generation other possibilities of transportation have to be researched.

Therefore, in this research, sustainable mobility will be defined as follows. To reach sustainability and, more specified sustainable mobility, the future generation has to be able to meet their needs, while the needs of the present generation are met as well. This means that the negative effects of mobility have to be diminished, while accessibility of transport for the present and coming generation remains the same.

### 3.1.2. Sustainable mobility in urban areas

Mobility and its effects are not restricted to one certain area. Many trips overlap one or more villages, cities etcetera. This research only considers on mobility in urban areas for several reasons. These have been described in chapter 1. From these reasons can be derived that the negative effect of transport are clearly visible in urban areas when sustainable mobility is interpret in its broad meaning.

In urban areas it is very hard to realize sustainable mobility from the narrow point of view. Traffic in urban areas is necessary for several different actors: inhabitants and visitors do not want to be limited in their possibilities to go to work, home or to undertake leisure activities; companies want to welcome or visit customers and employees have to go to their work. A lot of people will be affected in a negative way when sustainable mobility is realized in a narrow way. Several municipalities define sustainability comprehensively and struggle with the trade-offs between economic, social and environmental sustainability. (Martens et.al, 2002)

Many trips in urban areas are performed by car (www.cbs.nl) and over 50% of the trips covers a distance shorter than 7,5 km. (Ministry of Transport, Public Works and Watermanagement, 2002). This is an important source of the negative effects of transport.

CTS is a mean of transport that perhaps can contribute to the development of sustainable mobility in urban areas. The contribution of CTS to sustainable mobility in urban areas will be analyzed in paragraph 3.3. First sustainable mobility indicators are identified to be able to analyze this contribution.
3.1.3. **Sustainable mobility indicators**

Sustainability is a very broad defined field. In order to design policy regarding sustainable mobility, it is necessary to formulate goals, ways to reach these goals and indicators to specialize these goals. Birgitte Bryld (1997) designed with the Commission on Sustainable Development (CSD) a working list of indicators of sustainable development. These are subdivided in Social, Economic and Environmental indicators. Appendix II gives an overview of the identified groups of indicators by the Commission that have the closest relation to mobility. In this research the indicators are used to create insight in the qualitative performance of transport in urban areas (paragraph 3.3.4). The category of indicators which have been identified by this commission and that are related to mobility are pointed out below.

**Social indicators**

The social group of indicators that have the closest relation with mobility are the promoting sustainable humans settlement development.

**Economic indicators**

The economic group of indicators that have the closest relation with sustainable mobility are indicators related to changing consumption patterns and transfer of environmentally sound technology cooperation and capacity building.

**Environmental indicators**

The environmental group of indicators that has the closest relation with sustainable mobility is: protection of the atmosphere.

The subdivision of this groups to indicators can be found in appendix II as well. A lot of developments for sustainable mobility focuses on automated transport. This will be elaborated in the following paragraph.

3.2. **DEVELOPMENTS IN THE FIELD OF AUTOMATED VEHICLES**

For ages people have been searching for ways to reduce the negative impacts of traffic. There are several ways to reduce these negative impacts. They can be classified in five categories of measures. Several types of instruments can be identified to perform these measures (Blok, P.M. en G.P. van Wee (1994). The development of automated transport falls insight the category of technical/ technology and can be seen as an infrastructural instrument.

Automated vehicles can be seen as a form of sustainable transportation. Initially they belong to the last category. They are aimed at diminishing the negative effects of traffic in populated areas. With the development of sustainable sources automated vehicles will not only be sustainable in local areas but also world wide. When they drive on fuel cells, their electric battery does not have to be loaded by burning fossil fuels.

Mainly there are two types of automated vehicles: Fully Automated Vehicles (FAV) and Advanced Driver Assistance (ADA) also known as Automated Vehicle Guidance (AVG) or Advanced Driver Assistance Systems (ADAS).
Advanced Driver Assistance

ADA is aimed at developing a smart car in order to improve the vehicle driving performance by automation of vehicle driving tasks and eventually making the driver superfluous. ADA offers important advantages for road transportation: more control on speed and position of vehicles on the road is important to establish more homogeneous traffic streams and to reduce the number of accidents. Moreover, this could lead to a reduction of energy use and emission of environmentally harmful gasses. Finally a part of or even all vehicle driving tasks are supported and/or executed automatically by AVG. Hence, vehicle driving could become more comfortable and more convenient as compared to today’s manual driving. (Marchau, 2002)

Fully Automated Vehicles

FAV is aimed at developing new vehicles that can drive autonomously. They are also called automated people movers. They can be split up in (de Bruijn, 2002):

- monorail systems
- cable systems
- automatic light rails
- electronic systems

Joint feature of these systems is that there is no need for a driver. But they also differ in several things, such as: energy supply, level crossing, lane infrastructure, stops, capacity and heights of the construction (de Waal, 2003). The electronic systems do not depend on physical guidance, except for asphalt. Various people mover systems have been developed under several names: RUF, ULTra, Serpentine and Cybernetic Transport Systems (CTS). Sometimes they are also gathered under the name: Rapid Transport Systems. A comprehensive overview of people movers, their similarities and their differences is made by de Waal (2003).

Integration of ADA and FAV

In several long term views of the development of automated transport systems the integration of electric automated systems and ADA is suggested. Both system should be able to make use of the same dedicated network.

This research is aimed at the development of automated transport systems, specifically the development of CTS. The next paragraph will explain the past developments and characteristics of this system.

3.3. CYBERNETIC TRANSPORT SYSTEMS

From the many automated systems that have been developed, CTS is the chosen subject in this research.

First an explanation on CTS will be presented. Second the position of CTS in this thesis is elaborated (paragraph 3.3.2). Paragraph 3.3.3 describes advantages and disadvantages of CTS. The implementation of a new transport system has several impacts on the urban environment. These will be considered in paragraph 3.3.4. Paragraph 3.3.5 describes the experiences in the development of CTS.
3.3.1. **What is a Cybernetic Transport System?**

This paragraph first gives the description of CTS according to the projects Cybercars and Cyber Move. Second, it presents the expected developments on the supply side of CTS that have been defined in the technical roadmap for the development of peoplemovers. (Hylckama Vlieg et al., 2003)

The description of CTS is given in the following box. (MacDonald et al., 2000)

Cybercars are road vehicles with fully automated driving capabilities. A fleet of such vehicles forms a transportation system, for passengers or goods, on a network of roads with on-demand and door-to-door capability. The fleet of cars is under control of a central management system in order to meet particular demands in a particular environment. At the initial stages, cybercars are designed for short trips at low speed in an urban environment or in private grounds.

In the long term, cybercars could also run autonomously at high speed on dedicated tracks. With the development of the cybercar infrastructures, private cars with fully autonomous driving capabilities could also be allowed on these infrastructures while maintaining their manual mode on standard roads.

Cybercars are members of the general family of people movers and close to PRT (Personal Rapid Transit) but they offer the advantage of being able to run on any ground infrastructure which means they are cheaper and more flexible.

This description is drawn from a technology driven field of vision. The framework that is used to describe the technical development of CTS is the technical roadmap that is designed on behalf of Connekt. (Van Hylckama Vlieg et al., 2003). This can be found in appendix III.

The developments which can be derived from the roadmap are the developments of the technology, the system functions and the legislation. Since this thesis is focused on the demand side of the development of CTS, it is assumed that the described features are feasible. The developments shown on the roadmap (Hylckama Vlieg, 2003) are explained below.

**Technical development**

There are four main technical development tracks according to the roadmap. These are: energy, obstacle detection, navigation and command and control. In this research it is assumed that the technical development can be feasible. However, it should be noticed that the development of innovations is often an uncertain process and it is not certain whether an innovation will eventually be introduced to the market. Therefore the technical development is not static.

**Development of system functions**

In the coming years, cybercars cannot mix with other road users. The development is aimed at providing a reliable and comfortable system on a dedicated track. It is necessary to find places where a dedicated track can be made available to realize development projects. Creating new infrastructure for developing projects increases the costs and the barriers to realize CTS.
The navigation and communication control can only steer <25 vehicles over a length of 3-5 kilometer. At Rivium a second generation of CTS will be realized. This means that the track is expanded in length and in complexity. The cars will pass a level crossing with barriers for the sake of safety. This track will be opened in the summer of 2005.

This level crossing is a step towards the next developments that are described on the roadmap. In ten years –according to the roadmap- the cars still drive on dedicated track, but they are mixing with target groups. The track is also extended to a network and is longer. The capacity of one car diminishes and the number of cars increases, so the service can be more flexible and individual.

Eventually, it should be possible for cybercars to drive on shared infrastructure and to mix with other road users. The length of the track stays the same, but the commercial speed increases to 15 kilometers per hour (Filippi et al. 2004).

Development of legislation

A lot has to be done on the development of the legislation and certification of automated vehicles. The next step on the roadmap is the development of a legislative framework, and then national legislation has to be formulated. International coordination has to take place next to the formulation of national legislation. It is stated by Van Wees (2004) that national governments should point out their policy about ADAS at the international agenda. Since CTS is developed in an international context it is important to get these legislative issues on the international agenda too. It is also necessary to provide safety standards for ADAS. Van Wees (2004) finds it important that the European Commission hurries with the drawing of principals for the safe design of ADAS. Such principals can help parties – producers, member states and test agencies- involved as long as specific safety regulations is lacking. So, since automated traffic is mainly developed in an international context it seems that the international coordination can be placed earlier.

These are the main expected possible developments on the supply side of people movers. However, as stated before, these possibilities do not necessarily have to be realized and are not static. They can be adjusted –in compliance with the possibilities- to wishes and demands from other participants in the development of this system and of course to the wishes of the user.

The following paragraph explains the purpose and position of CTS in this research.

3.3.2. The position and purpose of CTS in the research

This paragraph explains why CTS is used in this research, what the purpose is of CTS in this research and what the position is of CTS in this research and in the development of sustainable mobility.

This research is aimed at CTS, because of several reasons. At TNO it is believed that CTS has a large potential in becoming a mature transport system, because it contributes to a sustainable urban area; it has similarities to current urban road transport: it drives on asphalt, although that is a separate lane and on rubber tiers. Furthermore it can be developed parallel to features of ADA, and eventually both systems can run parallel in the same area.

In this research one system is chosen to be able to describe a possible service for an automated transport system in urban areas. Insight in a possible system is necessary to be able to imagine which impacts a new system can have and what the role of the
municipality in the development of a system, when she wants to realize one. Perceptions, initiatives and motives of participants in the development of a new urban mean of transport can not be described when the purpose and possibilities of such a system is not known.

So, the development and features of CTS form the framework for the research, but CTS does not have to be the best solution and is not the only solution to reach sustainable mobility. This research is not aimed at finding the best solution for the sketched dilemma in urban areas, but is aimed at the roles of the municipality in the development of CTS and what a municipality can learn from these processes in the past. Next to this the system is used to describe possible services with automated transport. These services are not totally bound to CTS but can be designed for automated transport with different design characteristics as well.

3.3.3. **Advantages and disadvantages of CTS**

This paragraph is about the advantages and disadvantages of CTS. Insight in these aspects is important for the consideration whether or not to implement CTS.

**Advantages of CTS**

The advantages CTS brings along can be split to financial advantages, operational advantages and sustainable advantages.

**Financial advantages**

Based on Filippi (2004) the following financial results can be presented for CTS. These results are perceived from the evaluation of the different sites with a CTS service that have been explored in the program CyberMove. An overview of the sites that have been realized can be found in appendix VI.

<table>
<thead>
<tr>
<th>Costs</th>
<th>System</th>
<th>CTS</th>
<th>Tram</th>
<th>Bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment costs (Meuro/km)</td>
<td>0,5 - 4</td>
<td>11</td>
<td>0,5</td>
<td></td>
</tr>
<tr>
<td>Operate a network (E/veh*km)</td>
<td>0,5 - 3,17</td>
<td>1,50 (CVOV, 2005)</td>
<td>2,8 - 3,5</td>
<td></td>
</tr>
</tbody>
</table>

The infrastructural investments are not taken into account, since it is not necessary to create new infrastructure, when it is possible to free existing infrastructure of other traffic and make it suitable for CTS. This should be possible with realizations of CTS on, when CTS focuses on covering short distances. The difference in investment costs of CTS depend mainly on the demand the system has to serve and the level of service. The operational costs differ as well, due to the distance the service covers, it can be presumed that the operational cost decrease, if the distance increases. The same reason holds for the differences in costs for operating a bus. CTS becomes competitive against the buses when a high number of vehicle*kilometers re supplied. The evaluation also shows that CTS can be financially profitable. Eight sites that have been explored do not need do not need to be subsidized in order to be financially neutral. Two of these sites are even able to return their investments in ten years. (Filippi, 2004) The costs for a passenger depend on whether or not a service will be subsidized.
These results show that CTS can be financially feasible. However, since the development of CTS is still in its pioneering stages (chapter 6) no firm conclusions can be drawn on the financial performance. It can be expected that the low labor costs due to the automated character, make the system in a professional implementation very attractive; especially when the network of CTS is increased. However, on short term development costs that will be necessary can diminish the positive financial prospects.

**Operational advantages**

Many operational advantages come forth out of the cost advantages CTS has. CTS has an important difference with conventional public road transport. Its service can be more frequent and flexible, since cybercars have no driver. In the design of a bus service is the relation between the service and its costs very important, due to the high labor costs. (60% of the total exploitation, Van Goeverden et.al, 2000). The labor costs diminish by the automation of a transport system (CVOV, 2005). Therefore, designing a service for CTS can be pointed to the travelers’ demands.

The flexibility also provides possibilities for the capacity. Because CTS does not necessarily depend on a schedule, the capacity can be more easily adjusted to the demand. When the demand is low, the number of cars that are used can be low, when the demand is high, the number of cars can be increased.

**Sustainable advantages**

It is expected that cybercars bring along several sustainable advantages. Based on the identified characteristics of CTS, the following indicators that can describe the contribution to sustainability have been identified:

- **Environmental contribution**
  - protection of the atmosphere (locally in the beginning)
  - reducing congestion

- **Social contribution**
  - serving more persons in a shorter time interval
  - less motorized traffic in urban areas
  - service more aimed at the customer
  - promoting sustainable human settlement development

- **Economic contribution**
  - diminishing of labor costs
  - better accessibility of urban areas due to flexible service possibilities
  - innovation impulse
  - transfer of environmentally sound technology cooperation and capacity building

**Disadvantages of CTS**

An important condition for the real technological development is the ability to test the system and its new possibilities. There is a constant need to run (pilot)-projects to test and develop CTS further. This makes the realization of CTS complex, because on short term this system is not able to mix with other traffic and therefore needs a dedicated lane. However, this slow and interactive development track also offers possibilities. Not only the technology can learn from and adjust to the experiences in the several projects,
also the wishes and the additions of other participants can be taken into account along the process. This can result in a CTS that will be accepted by more participants.

On short term it is necessary to free infrastructure for CTS. This can be a problem, since infrastructure is scarce in urban areas. New means of transport develop themselves easier when they make use of existing infrastructure (Filarski, 2004). This is only possible, when infrastructure is made available or on longer term when CTS should be able to mix with dual mode systems. However, this long term possibility cannot show its advantages when CTS cannot be further tested on short term.

Another disadvantage is that CTS does not contribute to the reduction of emissions of Greenhouse gases (GHG) on short term, it provides only a local ecological surplus in the near future. This is because the electronic battery of a vehicle needs to be (re-)loaded. The loading of the battery can not yet be done in a sustainable way en masse, which means that fossil fuels still need to be burned. Greenhouse gases still emerge by generating energy in this way.

### 3.3.4. Impacts of CTS

A new transport system has a lot of impacts on several fields. This paragraph reflects the impacts of the realization of CTS in urban areas. First, the influence of CTS and other transport systems on the existing infrastructure and transport demand is described. Second, the effects of transport demand on fields of sustainability are described. Third the effects of CTS on sustainability are compared to the effects of conventional transportation modes on sustainability.

**Influence of CTS on the physical infrastructure**

A causal relation diagram has been used to get insight in the factors that are related to transport demand and the necessary infrastructure. The results are discussed below. The diagram can be found in appendix IV.

Transport systems in urban areas always need infrastructure – for driving, picking up passengers and parking. Infrastructure in urban areas is scarce. In each spatial design of a city has to be reckoned with infrastructure for transport. This kind of infrastructure is essential for people to reach their home and activities areas (shopping areas, work, visiting etcetera) – so it is essential to answer transportation demand. A consideration about the use of available space for different purposes has to be made for every adjustment. Not all available spaces are suitable for more than one function. Transportation demand is based on the available functions in a certain area. Therefore one has to reckon with the transport demand to reach a certain area when the transport infrastructure is designed. Congestion will arise when the capacity of the transport infrastructure is not sufficient.

It is also important to reckon with the means of transportation that are used to reach a certain area. Not every mean of transport uses the same infrastructure. Therefore a consideration is needed between the kind of infrastructures that have to be realized and the necessary capacity. Since space is scarce, the development of transport infrastructure and the transportation demand has to be combined.

CTS needs dedicated infrastructure in the initial stages of the development. Therefore the consideration between the development of this system and availability of infrastructure or the possibilities to free or create infrastructure is very important.
Besides the impacts of transport systems on infrastructure and spatial development, the transport demand in urban areas and its effects are important as well for the functioning of a transport system.

**The effects of transportation demand in urban areas**

The diagram that has been used to determine these effects can be found in appendix IV as well. Transportation demand influences and is influenced by aspects out of every field of sustainable development. Economic activities attract transport and therefore influence transport demand. The accessibility of areas increases the establishment of economic activities. Furthermore, the development of transportation demand influences the environment (emission, noise nuisance, congestion). Finally, the availability of transport possibilities makes transport accessible for more people. This influences the economic development (people can go to work or shopping) and the environment. These influences show that every field of sustainability influences transport demand or is influenced by transport demand. Therefore one can steer at the several fields of sustainability to influence transport demand or one can steer transport demand to influence sustainable development.

**A scorecard for the sustainability of conventional transport modes and CTS**

A score card is drawn to compare the performance of different means of urban transport on criteria that can be used to define sustainable mobility. A part of the criteria (the italic ones) comes forth out of the sustainable indicators that are identified by Bryld. The categories of indicators that have been identified are described in paragraph 3.1.3. The specifications of these categories can be found in appendix II. The indicators in this scorecard are the ones that influence mobility. The other part of the criteria has been identified on the basis of the sustainable performance of CTS. This has been described in paragraph 3.3.3.

The urban means of transport that have been taken into account are: car/ motor, public road and rail transport (PT road/ rail) and CTS. The group car/motor contains personal car and motor transport as well as mopeds. Freight transport has not been taken into account, since this table is meant to give an overview of the contribution to urban passenger transportation. The group public rail transport contains information about trams and metros. The group public road transport contains buses. It is assumed that public rail transport and CTS have no local emissions, because of their propulsion - electric. It is assumed car/motor and public road transport have local emissions, because of their propulsion – combustion engine. Table 3-2 shows the scorecard.
### Table 3-2 Effects of different motorized transport systems in urban areas

<table>
<thead>
<tr>
<th>Criteria</th>
<th>CTS</th>
<th>PT rail</th>
<th>PT road</th>
<th>Car / motor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economical indicators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>capital goods</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>used fossil fuel energy reserves</td>
<td>--</td>
<td>-</td>
<td>-</td>
<td>--</td>
</tr>
<tr>
<td>environmentally sound capital goods</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>accessibility</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>impact on infrastructure</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Environmental indicators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>emissions of greenhouse gasses (CO₂, CH₄, N₂O g/pkm)</td>
<td>0,03</td>
<td>0,89</td>
<td>1,3</td>
<td></td>
</tr>
<tr>
<td>emissions of sulfur oxides (SOₓ g/pkm)</td>
<td>?</td>
<td>3*10⁻⁶</td>
<td>5,9*10⁻⁶</td>
<td></td>
</tr>
<tr>
<td>emissions of nitrogen oxides (NOₓ g/pkm)</td>
<td>0,25</td>
<td>1,12</td>
<td>0,65</td>
<td></td>
</tr>
<tr>
<td>ambient concentrations of pollutants in urban areas</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>overall results on emissions</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>congestion</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>noise nuisance</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Social indicators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time preliminary and after transport</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>--*</td>
</tr>
<tr>
<td>frequency of service</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>++</td>
</tr>
<tr>
<td>total waiting time trip</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>--*</td>
</tr>
<tr>
<td>number of modal shifts</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>--*</td>
</tr>
<tr>
<td>infrastructure expenditure per capita</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>length of trips</td>
<td>--</td>
<td>-</td>
<td>-</td>
<td>++*</td>
</tr>
</tbody>
</table>

**Legenda**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>++</td>
<td>Largest, highest</td>
</tr>
<tr>
<td>+</td>
<td>Large, high</td>
</tr>
<tr>
<td>0</td>
<td>Average</td>
</tr>
<tr>
<td>-</td>
<td>Small, low</td>
</tr>
<tr>
<td>--</td>
<td>Smallest, lowest</td>
</tr>
</tbody>
</table>

**Explanation of the table**

The table is build up out of colors as well as symbols. The symbols represent the performance of a mean of transportation on a certain criteria. For example: the symbol for the number of modal shifts is for CTS "++". The colors show the result of the performance compared to the performances of the other alternatives: "++" means that the number of modal shifts for people that use CTS increase. "+" means that the number of modal shifts of people that use public rail transport and public road transport increases less than the number of modal shifts of people that use CTS. "—" shows that the modal shift of people that use a car have even less modal shifts. Their performance is best compared to the other means of transport.
Consideration of assigning the values

This part considers the performance of the several means of transport in urban areas on the different criteria. It was only possible to gather quantitative results for the performance of the different means of transport on emissions. The other results could only be presented qualitative. This is mainly, because no specific sites have been taken into account. General information with equal units appeared not available.

The quantitative data for cars/motor and public road and rail transport comes from the RIVM. (http://www.rivm.nl, 19 April 2005). The quantitative data for CTS comes from the Final Evaluation Report (Filippi, 2004). The average performance of CTS has been taken, since a minimum and a maximum amount of emissions of CTS can be found. The data is presented in grams/passenger kilometer. To determine the amount of emissions per passenger kilometer, the total amount of emissions is divided by the total number of passenger kilometers in 2003 (www.cbs.nl) of the relevant mean of transport.

Capital goods

All goods contribute to capital development. CTS scores best on this criterion, because it is a new, innovative mean of transport. The development of this mean of transport brings in more capital than the conventional means of transport, because of its contribution to the knowledge economy.

Proven fossil fuel energy reserves

All means of transport perform badly on this criterion. CTS and car/motor perform worse than public transport for road and rail, because they transport fewer people per energy unit.

Environmentally sound capital goods

Since CTS and public rail transport have no local emissions they perform better on this criterion than the public road transport and car/motor.

Impact on the infrastructure

The impact on the infrastructure is high for all means of transport. Since CTS and public rail transport often need dedicated infrastructure, they perform worse than public road transport and cars. These forms of transport can mix with other means. Buses perform better than cars, since they can transport more passengers on a smaller surface.

Emissions of greenhouse gasses

Data of the RIVM (2005) shows that cars and the conventional means of transport emit more greenhouse gases per passenger kilometer than CTS (Filippi, 2004) does.

Emissions of sulfur oxide

The public means of transport score better on this criterion than the car/motor does (RIVM, 2005). No information can be found on the emissions of sulfur for CTS.
Emissions of nitrogen oxides

Again, CTS has the lowest emissions. In this case, the emissions of public transport per passenger kilometer are higher than the emissions of a car per passenger kilometer (RIVM, 2005).

Ambient concentrations of pollutants in urban areas

Since CTS and PT rail have no local emissions, they score better on this criterion than public road transport and cars/ motors.

Congestion

Since CTS and public rail transport use their own infrastructure they contribute less to the congestion on roads. They contribute to congestion when road infrastructure has to decline to get free infrastructure for CTS or rail transport.

Noise nuisance

Rail transport performs worst on this criterion because of its wheels, infrastructure and traction. Public road transport and car/ motor perform better, since they have rubber tiers. These make less noise than tiers of steal. However, these modes perform worse than CTS, since they have a combustion engine. CTS is provided with an electric engine. This engine produces less noise compared to a combustion engine.

Time preliminary and after transport

The car/ motor is the most flexible mode that can provide trips from door to door. They score best on this criterion, since there is no preliminary or after transport necessary. CTS scores a bit worse, since it is not yet possible to perform a door-to-door service. It is better than public rail or road transport since it is among others aimed at providing this form of transport for larger systems.

Frequency of the service

The car/ motor scores best, because it is always at once disposal. CTS scores better than public transport modes on this criterion, because CTS can provide a more frequent service due to its operational and financial advantages.

Total waiting time per trip

The waiting time for a trip by car/ motor is the shortest, because this mean is always at once disposal. The waiting time for CTS is less than the waiting time for the other public means of transport, because CTS can provide a service with a higher frequency. Waiting times for conventional traffic is not available, since this depends on the design of the service network.

Number of modal shifts

The car/ motor scores best since this mean of transport can perform a door-to-door service. The other public transport modes score better than CTS, since they cover a larger area. The chance that a modal shift is not necessary is higher than with CTS.
Infrastructure expenditure per capita
Public road transport uses least infrastructure, since it can share its infrastructure with other modes and it transports more people on a smaller surface. Car/motor and public rail transport score equal, since the car uses a lot of infrastructure for its vehicle per capita, but it can share the infrastructure with other means. Public rail transport uses less infrastructure per capita when the maximum capacity is used, but since it cannot always share its infrastructure with other means of transport the expenditure increases. CTS scores worse, because it needs its own infrastructure on short term and it provides a more individual service than conventional public transport.

Length of trips
The car scores best, since the length of the trip can be as long or short as the driver wants it to be. The public means of transport score equal, since they both cover a larger area than CTS, but mostly a smaller area than the car/motor.

Conclusions on the scorecard
The result of the scorecard looks good for CTS. Based on this quantitative overview CTS could contribute to sustainable mobility. Furthermore it shows that the car scores very well on social indicators. The two conventional public transport modes perform average. A main advantage is that they are able to process a large amount of travelers at once. This table cannot be used to give firm judgments about the contribution to sustainability; it just gives an overview of the expected qualitative contribution. To make a better consideration of the sustainable contribution of CTS further quantification is necessary as well as more information about the intended design of CTS.

3.3.5. Experiences in the development of CTS
This paragraph describes the experiences and the developments that have taken place for CTS in practice.

For many years people have been working on the development of several kinds of automated vehicles, single as well as dual mode. Systems are for example the Group Rapid Transport system in Morgantown (1970), Cabintaxi in Germany (1980), ULTra in England (tests 2003). A lot of investigation on CTS is done in the projects Cybercars and Cybermove. Several national and international consortia have been working at the development of CTS. In the projects CyberCars and CyberMove the desired possibilities and necessary developments of CTS are examined. Both projects Cybercars and CyberMove are embedded in and funded through European Programs. The CyberCars project is funded through the IST-Program (Information Society Technology) and started in August 2001. The CyberMove project is funded through the EESD-Program (Energy, Environment and Sustainable Development) and started in December 2001. Both projects are funded for three years. (M. McDonald, T. Vöge 2002) The partners of CyberCars and CyberMove can be found in appendix V.

CTS have been tested in several places in Europe. In appendix VI a presentation of the several sites can be found. Figure 3-3 shows the sites that have been realized.
At all these sites CTS is used as a niche solution for local problems or in local opportunities to test CTS. It has not been integrated in the transport system. In appendix VII an comprehensive explanation is given over the technology of CTS and the completion in practice by the university of Washington.

Next to the expectations of the developing in the projects Cybercars/CyberMove, the World Business Council for Sustainable Development sees CTS as one of the possibilities towards sustainable mobility as well, although the council recognizes the difficulties of the implementation as well. This council has executed an extensive survey (WBCSD, 2004) to possibilities for sustainable mobility. Since this Council consists of large players on the automotive market, this can increase the possibilities for CTS to undergo a succesfull development.

The experiences in the development of CTS have not only focused on the development of the technical possibilities. The user-needs have been taken into account in CyberCars (MacDonald et.al, 2002) as well as in CyberMove (Janse etal., 2003).

The analysis of MacDonald et.al. (2002) has shown that services on long term a solution between a taxi and a mini-shuttle. On short term, the results for the system were that CTS was perceived as being only suitable for very short distances on a dedicated lane or elevated infrastructure to prevent mixing with car traffic and pedestrians. CTS has to provide a high level of flexibility, to be able to adapt to changing patterns of demand. High service frequency or on-demand operation is important. The system has to be fine-tuned in terms of short waiting times, short distances between stops and careful network design. The participants expressed skeptics on the possibility of CTS to find its place in the 'private car society'. Dedicated infrastructure (by new infrastructure or making current infrastructure available for CTS) is necessary to avoid the same
congestion problems as with cars. Furthermore, the system has to prove to be safer than manual means of transport. The confidence in the system can increase when more people become familiar with the system.

Decision makers see the operational characteristics of CTS as a possibility to solve the current problems of car usage.

### 3.4. Short conclusion and introduction to the next chapter

With this chapter the first part of the research has been concluded, so the answers to the research questions of this part can be given as well as short conclusions that can be derived from these answers.

The research questions to perform research step 1 are defined as follows.

- What is the background of the development of Cybernetic Transport Systems?
- What is a Cybernetic Transport System?

#### Answers to the research questions

An important reason to develop CTS is its expected contribution to sustainable mobility. The development takes mainly place in the framework of international programs and focuses on the technical possibilities with the accompanying system functionalities.

CTS is an electric automated transport system for urban areas. Its vehicles drive on asphalt. It is developed to provide a high-quality, highly flexible and frequent service on a dedicated track. It has not yet proven itself in a professional application, only several projects sites have been realized to test the possibilities.

#### Short conclusions on the research step

The expected contribution of CTS to sustainability, an important reason for the initial development of the system, is not firmly proven, but also has not been tackled. There are a lot of measures that can contribute to sustainable mobility and CTS is just one of them. The development of CTS is in a very early and uncertain stage. The further development of CTS and its possibilities is uncertain and depends on technical possibilities, development of legislation and the possibility to test it.

It is important to keep in mind that this chapter is not meant to articulate judgments on the performance of CTS on sustainability, but it has been aimed at creating insight in the system that forms the framework of the further research.

With the next chapter starts the second part of the research. This chapter describes theory around the development of a transport service. Theory about the markets in the transport system, the design of service networks for transport and the transportation flows in urban areas is elaborated. Furthermore the transport patterns of travelers are described and implications of the realization of CTS on these patterns. This information will be used to identify possible services for CTS in urban areas in chapter 5.
4. DESIGNING A SERVICE FOR A TRANSPORT SYSTEM

The second part of the research will be described in this chapter and chapter 5. This chapter presents the theory that is necessary to design a adequate service for CTS in urban areas. Chapter 5 shows what kind of service can be performed by CTS for certain travelers in urban traffic flows. Research step two looks as follows.

Figure 4-1 Step two of the research partly elaborated in this chapter

Figure 4-2 Service for CTS in urban area

It gives an overview of aspects that have to be taken into account when designing a service for a new transport system in urban areas. Paragraph 4.1 identifies the markets in the transport system are identified. Paragraph 4.2 discusses the structure and parts of a service network. Because the service is pointed at an urban area it has to be suitable for the flows that occur in these areas. Therefore paragraph 4.3 identifies the transportation patterns in urban areas. Paragraph 4.4 explains the behavior of a traveler and a possibility is given to change it. Finally paragraph 4.5 explains how this analysis will be used in chapter five.
4.1. **THE MARKETS IN THE TRANSPORT SYSTEM**

The transport system can be presented as the coherence between the traffic and transportation market. This paragraph describes the transport system and the market in which this research takes place.

A market is an interaction between supply and demand. The transport system in which the traffic system and the transportation system are combined, consists of two markets: the traffic market and the transportation market. The demand on the transportation market is formed by the transport pattern and the supply by transportation services. The transportation services do not only form the supply side of the transportation market, but also function as the demand side of the traffic market. The supply side of the traffic market is formed by traffic networks. Since this research is aimed at the service networks for CTS, an analysis is made of the transportation market, which will be used to determine suitable market segments for CTS.

The traffic market is not taken into account, since the research is not aimed at the physical realization. However, it is important to keep in mind that the transportation services depend on the traffic supply and that the realization of a new transportation service, in this case CTS, has to reckon with the traffic supply as well. Figure 4-3 shows the schematic representation of the two markets. (Schoemaker, 2002)

![Layered transport scheme (Schoemaker, 2002)](image)

The *elements* of the transportation demand –the transportation pattern- consist of travelers and freight. This research only takes travelers into account. The elements of the transportation supply –the transportation services- are the vehicles. Both elements have to fit in order to design an adequate transport service.

Whether there is a market for CTS depends on several aspects. In this research the market segments for which CTS can be suitable are determined on the occurrence of traffic flows in urban zones and the purposes for which these flows are built. In chapter 4.3 a theory about the traffic flows in urban areas will be elaborated. In chapter 5 the theories from this chapter will be applied to the characteristics of CTS.

In order to determine a market for CTS, the product needs to be described first. The following paragraph describes the theory behind the design of a service network.
4.2. **A SERVICE NETWORK FOR TRANSPORT SYSTEMS**

This section gives an overview of the features that are necessary to design a service network for a transport system. A service network determines which vehicle is at a certain moment in a certain place (Schoemaker, 2002). Therefore a service network is judged by the performance of a public service for the traveler and not by the physical network. Insight in the service network is necessary to give an overview of possible services of CTS in the future.

The existing infrastructure network forms the basis of a service network, such as the lay-out of ways (for example grid or radial) and the availability of dedicated infrastructure. Insight in the desired service network is needed in order to plan an infrastructure network. It is important to determine the purpose of the transportation service: to open up an area or to connect areas. This purpose partly depends on the existing transportation flows. Therefore, it is necessary to have insight in the transportation flows to design a service network. Transportation flows are built up out of different movements. Different types of service are necessary to attend to different motivations of transportation. A movement can have two purposes: the movement is an activity on its own or a movement is a derivative of an activity. In the latter case the spreading of activities or the concentration of activities determine the transportation flows. This is shown in Figure 4-4.

![Figure 4-4 Interaction between the transportation system and the activity system](image)

The relations 1a & b, 2 and 3 show how transport patterns originate and how they change on a long (2 and 3) and on a short term (1a and 1b). According to Mannheim (1979) the transport pattern is built of the demand for transport and the availability of transport on short term. On a long term the transport pattern influences the available transport and the activities.

A service network consists of several parts: supply elements, a demand side and a possible network. These parts are described in the next sections. Several features of a service network can be designed by using these elements. These features will be described after the different parts.
4.2.1. **Parts of a service network**

In this section the supply elements, the demand side and the possible networks forms are described, which are all parts of a service network.

**Supply elements**

Supply elements can be subdivided in spatial and time parts. Spatial parts are:

- Entrances to the network
- Links between entrances
- Connections between entrances

The difference between a link and a connection is that a connection can include more links. This is shown in the next figure.

```
  • entrance point
  — line
  — connection
```

*Figure 4-5 Three entrances, two lines, one connection*

Several levels can be distinguished when a service network is described. It is possible to mention the entrances only, i.e. entrances of the metro on a city plan, to mention the links between the entrances, i.e. a public transport network with its crossings and transfer points or to describe the whole network of connections between the entrances, i.e. different bus routes on a city plan. In this description an entrance is also an exit.

Time parts are:

- Time schedule per link
- Time schedule per line

The time schedule can be represented in several ways, such as a (digital) railroad timetable, a time-road chart or dynamic traffic information at an entrance.

**Demand side**

Services that depend on the demand side originate when supply elements of a service network depend on the actual transportation demand. There are several forms of services varying from regular services, i.e. buses and trains, to services that totally depend on the transportation demand, i.e. taxies.

**Possible network forms for service networks**

There are two important parts that determine the form of a network. The pattern of the transportation flows to answer the demand and the combination of the transportation flows to perform a service as efficient as possible.

Concentration of passengers can occur in time and space:
Concentration in time: not departing before a vehicle is filled
Concentration in space: collecting and combining different transportation flows
Concentration in hub-spoke networks: the possibility to switch to an underlying transport network, a hierarchy of networks.

These forms of concentration can be allocated to different patterns of the transportation demand:

- Few to few → concentration in time
- Many to few → concentration in time and/ or place
- Few to many → concentration in place
- Many to many → possibilities of concentration depend on wishes of the traveler, i.e. the possibility to concentrate by time or the possibility to transfer

In the main literature source for the development of an adequate service by CTS (Janse M., 2003; Eijkelenberg, 200x) spreading in time and spreading in space is used. Spreading in time is the opposite of concentration in time. Spreading in space is the opposite of concentration in space. In the next sections spreading in time and space will be used.

### 4.2.2. Features of a service network

In this section the features of which a service network consists are described. These features are designed by using and combining the parts of the service networks that are described in section 4.2.1.

A service network consists of several features, which are designed using the parts of a service network described above. These features are:

- Density of entrances: the number of entrances per square unit
- Density of links: the number of links per square unit
- Frequency: number of transportation services per time unit. This can be an attribute of a line, link or a route of several lines
- Detour factor: the total length of links over the network from A to B divided by the astronomical latitude. Longer detours can be compensated with higher frequencies.

A service network can be designed by using the described elements and features. A designed network is evaluated by a number of aspects. These aspects can be subdivided in a user optimum and a system optimum. The first optimum aims at minimizing the
total traveling time. The second optimum aims at minimizing the total number of kilometers. Furthermore, travelers value a system on quality elements: costs, time and comfort (Van Goeverden et al., 1998)

The following paragraph describes the transportation demand and transportation patterns in urban areas in order to distinguish suitable market segments for a service of CTS.

4.3. Transportation Demand and Transport Patterns

A service can not only be designed using the characteristics of the service network. The service has to be built on the transportation demand and the transport patterns that the passengers perform as well. In this section the terms transportation demand, transportation flows and transportation motives are explained.

4.3.1. Transportation Demand

Knowledge of the type of movements taking place in urban areas and their consequences for the transport patterns is necessary to design a service network for CTS on the basis of transportation demand. TNO in corporation with the TU Delft has identified several clusters in the “staalkaart vervoersvraag”. (Van Goeverden et al., 1998) These clusters can be divided in two main groups. One group of clusters originates from the quality demands of the traveler: who travels and why? These clusters are segmentations of persons and activities. These segmentations are based on several quality demands for time, price and comfort. The second group is built of clusters that originate from the quality of transportation: where does a movement take place, with which transportation mode and when does it take place? These clusters are segmented to time and space. Information of both groups is necessary in order to design a service network. Appendix VIII discusses the categorization of transport quality demands.

The required capacity to meet the transportation demand depends on the transportation pattern. A service that is only designed on the basis of a transportation motive is too narrow; for example: somebody who works in a shoe store and travels there every morning is commuter traffic, the neighbor who goes to the same store to buy her new shoes is leisure traffic. Since it is likely that they travel the same route, it is better to determine the capacity of a service on transportation flows than on transportation motives. Therefore, there are several clusters in the first group, which can cause the same transportation flow. Additionally the second group determines the quality of transportation for the different travelers. Travelers that follow the same route can use different modes of transportation on the basis of the first group of clusters and choose for different modes on the basis of their appreciation for certain quality aspects.

When the transportation demands are answered, they cause transportation flows. These occur in several zones in urban areas. The following section describes these flows over the different zones.
4.3.2. Transportation flows in urban zones

Urban areas can be divided in several zones. Traffic moves within and between these zones. To design a service network for a transportation system based on the transportation patterns it is useful to get insight in the transport in urban areas. In the project Utopia (Zwaneveld et. al., 1998) a summary of travel pattern typology around urban areas was made according to a zonal model.

The zonal model

The zonal modal divides a city in zones, as shown in Figure 4-7

![Zonal Model Diagram](image)

Figure 4-7 The zonal modal

These zones can be described as follows.

Zone 1: the inner city

The city centre is mostly dating back to the origin of the settlement and is usually the most frequently used place for various activities. The inner city is well accessible and relatively easily reached from the outside. A large part of the movements within, to or from the inner city is often made by transportation modes other than the car. This is partly due to short distances and good collective, public transport supply, but also due to limited parking possibilities. Limitation of individual car usage in the inner city is well accepted as a necessity to preserve the urban livability and attractiveness. Despite these measures, excessive car usage remains a significant problem in most inner cities.

Zone 2: the central districts

The central districts are situated around the city centre. These districts usually feature a high population density, have a compact building structure and are multifunctional. Other than housing, shopping and recreation, some districts fulfill functions of city wide or regional importance, i.e. universities, company offices, train stations. Due to the compactness and dense population, collective transport often provides a good connection to the inner city. However, private car usage is still the dominant mode, causing serious traffic problems.
Zone 3: the suburban districts

The suburban districts used to have a regional character, but this has changed because of substantial growth in surface as well as population. Usually settlement patterns have emerged in close interaction with traffic links such as highways or rail lines, providing quick access to the city centre. Suburbs typically involve low-density housing, with some urban functions such as shopping and also have work concentrated along the city links. The car is the dominant mode due to lack of alternative transportation modes and because common car-related traffic problems, i.e. air pollution, noise and lack of (parking) space, are not perceived as pressing as elsewhere.

Zone 4: the periphery

Further away from the city area the structure changes to mixed land use. Housing takes place in villages, which offer supply of all daily goods. Other prominent land functions are shopping, large company facilities, leisure development, agriculture etc. Almost all major development is connected to the city through high capacity roads and rail links. Because these scattered settlement patterns lack effective collective transit systems even more than the suburbs, the private car is the dominant mode in this area.

The following paragraph describes the traffic flows that occur in and between the identified zones.

Traffic flows in the different zones

In the various zones in urban areas occur several traffic flows. They can be described as follows.

All-purpose inner urban traffic (Figure 4-8)

Traveling in the inner urban area, which includes the inner city and central districts, usually concerns large numbers of people. Trips are made for many different purposes, and trip times are highly dispersed. A considerable amount of all inner urban trips is made at off-peak times. Destinations are also situated within the whole area, therefore no regular travel patterns can be distinguished. A large proportion (some 50%) is short trips of up to 3 kilometers.

Figure 4-8 All purpose inner traffic
Suburban – center linkage (Figure 4-9)

Trips between the suburban districts and the inner urban area are made by large numbers of people only at peak times. This can be explained by the fact that most trip purposes are made for work, therefore the major part of traffic is at morning and evening peak times. Other trip purposes are shopping and leisure. Trips associated with those activities are spread more evenly across the day. Most trips have a distance of 10 to 20 kilometers.

Figure 4-9 Suburban - center linkage

Residential area collection & distribution (Figure 4-10)

Trips within the residential area (central districts and suburban districts), between local centers and homes, are mostly short distance and usually made in smaller numbers. These trips are usually associated with shopping, leisure and education, but access to connections with the inner urban area is also a valid trip purpose. Most trips are divided rather evenly across the day, with some pronounced peak times related to transportation to or from the inner urban area.

Figure 4-10 Residential area and collection & distribution
Peripheral linkage (Figure 4-11)

Trips between the residential areas and the outlying facilities in the periphery, like shopping malls, companies and leisure facilities, are usually made by smaller numbers of people. A large amount of these trips are made for shopping or working, a minor part is associated with other activities. Trip times have a rather dispersed pattern, with a peak in the morning and evening due to trips to and from work.

Focal traffic I and II (Figure 4-12 and Figure 4-13)

Focal traffic concerns long-range trips between the areas outside the city and the city centre. Usually large numbers of people travel to or from the city centre at peak times. Trip purposes are mostly work and business, and occasionally shopping and leisure (e.g. tourism). A large amount of these trips, mainly the work-related traffic, is concentrated to peak times. Trips associated with other activities show no clear pattern in trip time.

The study done by Van der Eijk (2001) uses a rather similar classification of typical urban traffic relations, although residential area collection and distribution (demand case 3) is not mentioned. According to Van der Eijk (2001) the focal traffic is not necessarily aimed at the city centre. He makes a distinction between focal traffic towards (and from) the city centre and focal traffic towards (and from) residential or working districts. This latter traffic relation will be added to the five traffic flow cases above and is called focal traffic II.
Finally the behavior of the traveler is important. This behavior comes forth out of the resistance to travel and the choices of a traveler. The following chapter describes the behavior of the traveler, based on its movements and how this behavior can be influenced.

4.4. **Changing a Travel Pattern**

People perform different movements. This paragraph describes how a movement is built, how a traveler makes a choice for a certain movement and how this choice can be influenced. This is described, because people are expected to change their travel behavior when a new transport system is introduced in order to make this introduction successful. Finally the method will be described how this change can be achieved or stimulated.

**Travel patterns**

People often perform a (complex) trip chain. The complexity of a trip chain depends on the activity pattern that is performed along a chain. This is depicted in Figure 4-14.

![Figure 4-14 Complexity of trip chains; one movement, a simple chain, a complex chain](image)

A movement is a joined chain of trips. A trip is a part of a movement with the same mean of transportation. Therefore a movement can be performed with several transportation modes. An example of a movement is shown in Figure 4-15.

![Figure 4-15 Trip chain of a public transport trip](image)

The introduction of CTS can change the chain trip. When CTS is used as a feeder, the walking parts can be replaced by CTS. When CTS is used as a park shuttle the trip chain of a traveler can also change. For example: the total chain will not start or end with a car but with a trip in a cybercar. The introduction of CTS can also mean that people are going to change their trip chain more drastically. They can choose to change their means of transportation and change their trip plan at the same time. For example: first a traveler went by car from his home to his work and at the end of the day to the store. With the realization of CTS, the traveler parks his car, takes a cybercar to his work and
takes in a free hour a cyber car to a store. His new trip chain is displayed in figure 4.17. Figure 4-16 shows the changed travel pattern.

![Figure 4-16 Change of movements with the introduction of CTS](image)

![Figure 4-17 Possible chain of a public transport trip](image)

**Behavior of a traveler**

The transport behavior of a traveler is a short term choice that is often based on a custom manner. Choices of the traveler on longer or mid-longer term can influence the behavior of the traveler. The individual choices are influenced by economic, demographic, cultural, technological and spatial factors. These factors have an influence on several spatial levels and they determine the conditions at which individuals, households, companies and organizations base their behavior choices. The choices of the individuals together can lead to changes on macro level. This means that they can influence congestion, the environment and traffic safety. (Dijst, 2002)

**Resistance to travel**

Another aspect that influences the choices of the traveler is the resistance of a movement. Resistance consists according to Van Wee edt. (2002) of travel time, travel costs and effort. Effort can be divided in comfort, safety and reliability of transportation.

Van Goeverden et. al. (1998) used the same subdivision to categorize the quality demands of travelers for certain trip purposes. In this research reliability and safety are not taken into account separately, but are shared under the term of comfort. Filarski (2004) states that travelers in the past have made their choices on the basis of: speed, status, comfort, the option to travel independently, personal security and travel costs. Speed, status and convenience have always been much more important factors than costs. The less wealthy consumer was forced to use the cheaper alternative.
Flanking policies

This information shows that the success of a new transport system not only depends on the traffic flows, but also on the behavior of the traveler. A traveler often needs to change its behavior before he is going to use a new mean of transportation. He will not change his behavior automatically, because there is a new mean of transportation available. He will probably need an incentive to change it. This incentive can be a problem perception that he perceives or can be given by flanking policies.

It is suspected that flanking policies are more necessary to get car users to make use of CTS then to get users of public transport to use CTS, since the user of public transport always depends on the services of others. This traveler will change his travel behavior easier when he finds a more efficient mean of transport. Information about costs, travel times and services are necessary for the passenger to let him make a choice. A flanking policy for car users could be traffic management related; for example the limitation of traffic in a city centre or parking policies in a business district.

4.5. INTRODUCTION TO THE NEXT CHAPTER

This chapter forms the first part in the second step of the research. It introduced the ingredients to design a public transport system in an urban area. The parts of a network have been described. They gives insight in the way a service network can be expressed. The fill in of these parts will partly be used to describe a possible service in chapter five. Since the service also depends on the actual implementation the parts will not be specified.

Furthermore this chapter has shown that several traffic flows can be identified in urban areas. Every flow has certain characteristics: service characteristics and travelers’ trip purposes that form such a flow. The flows and their characteristics will be used to analyze for which flows CTS can provide a suitable service in chapter 5.

Finally, this chapter has shown that only a decent service for CTS is not a guarantee for success. The behavior of the traveler has to change as well, before the traveler will make use of the system.

In chapter five the service for CTS will be defined and the second research step will be concluded. The theory that has been discussed in this chapter will be combined with the specific features of CTS and with the demands of the traveler. Based on this combination services for CTS can be defined for certain flows and travelers.
5. A SERVICE NETWORK FOR CTS

This chapter will identify which service CTS could provide in urban areas based on the theories that have been explained in the previous chapter and the analysis of the service possibilities of CTS and the actual demands of travelers in urban areas. It forms the final piece of the second part of the research – as can be seen in Figure 5-1.

First, will be described which services CTS can provide and for which target groups this service can be suitable (paragraph 5.1 - 5.3) Based on data of the 'Statistics Netherlands' (Centraal Bureau voor de Statistiek, CBS) market segments (target groups in urban areas) are defined. (paragraph 5.4) This data will be used to describe which traffic flows mainly occur in urban areas and what service possibilities of CTS can provide to serve these flows. Paragraph 5.5 describes the possibilities of CTS in urban areas based on the results of the interviews. Finally, the second research step will be concluded in paragraph 5.6 where the answers to the research questions will be drawn as well as short conclusions. Paragraph 5.7 introduces chapter 6.

Figure 5-2 shows the elements of the service that will be defined. The bold blocks and lines are the parts that will be elaborated in this chapter.
First applications of CTS are drawn based on an enquiry that has been held in the project CyberMove (paragraph 5.1). In paragraph 5.2 the identified applications of CTS will be expressed in the terms of the features of a service network. Since a service has to be provided to travelers, paragraph 5.3 shows which transport flows can be served by CTS. Finally, the features of a service by CTS are linked to the transport quality demands that people attend. This link has been made in order to determine whether the service of CTS can answer the quality demands of the traveler. When the service of CTS is defined will be analyzed which markets in urban zones are suitable for such a service, based on traffic data of the Statistics Netherlands. (Centraal Bureau voor de Statistiek, in Dutch).

5.1. Applications for CTS

This paragraph shows the likely applications based on the results of an enquiry of Cybermove by Janse et al. (2003) and defined by Eijkelenberg et al. (2003). The results of the enquiry showed that there are six feasible applications for cybercars. These applications are described in terms of a service network. They are divided in three applications for individual traffic and three for collective traffic. Finally these applications have been turned into general descriptions (Eijkelenberg et al., 2003). This is shown in Table 5-1. The demand characteristics show the features that are necessary for the design of CTS. These features are the way of traveling (car use or not), the reason for the movement (activity density) and the way movements come together (spreading in time and spreading in space). Furthermore, parking problems are taken into account. Solving parking problems has advantages for the traveler as well as the inhabitant of that area. The enquiry shows that parking problems can be a plausible reason for travelers to use CTS. The cursive row (network design) is added on the basis of the theory in section 4.2. So, a possible network design is added, based on the absence or presence of spreading in time and or place.
Table 5-1 Likely applications for CTS according to demand and supply characteristics (Eijkelenberg et al. 2003)

<table>
<thead>
<tr>
<th>Supply Characteristics Demand characteristics</th>
<th>Individual 1</th>
<th>Individual 2</th>
<th>Individual 3</th>
<th>Collective 1</th>
<th>Collective 2</th>
<th>Collective 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spreading in space</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Spreading in time</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Activity density</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Car use</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Parking problems</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Network design</td>
<td>Few to many</td>
<td>Many to many</td>
<td>Few to few</td>
<td>Few to many</td>
<td>Few to many</td>
<td>Few to few</td>
</tr>
<tr>
<td>Possible sites</td>
<td>Central car park and business park</td>
<td>Holiday park</td>
<td>Between central car park and city centre</td>
<td>From a central car park to central business district</td>
<td>From station to university</td>
<td>From the station at an airport to the departure terminal</td>
</tr>
</tbody>
</table>

The table shows that spreading in time and/or in space is always necessary to realize a service with cybercars. Furthermore, the activity density has to be high. Otherwise the surplus value of CTS will be too little, because too less people visit an area.

Based on these six likely service applications for CTS the design of the service network can be elaborated. This will be presented in the following paragraph.

5.2. The features of a service for the possibilities of CTS

This paragraph is aimed at describing service networks for CTS and for conventional public transport in urban areas (paragraph 5.2.1). Second, short conclusions will be drawn on the service that both systems can provide in urban areas and how the systems can fit together in the urban transport system.

5.2.1. Service characteristics of CTS and conventional traffic

This section links the features of a service system with the selected possibilities of CTS that emerged from the enquiry. Table 5-1 does not describe the desired service for CTS on the basis of the characteristics of a service network; it only describes the possible sites and necessary demand characteristics. The features that are necessary to design a service network are named and explained in section 4.2. This section links the features of the design of a service network with the possible sites of CTS. This is shown in Table 5-2 and Table 5-3.

These tables give an overview of the features and the parts of a service network for conventional public road transportation and CTS. The comparison with the conventional road traffic has been made, because eventually CTS has to be integrated in the current
transport system. The tables are meant to show the differences between the systems on the characteristics of service networks and to give an overview of the services of the separate systems and the combination of the systems.

The table is not designed for other modes of public transportation than road transportation. Metro systems and tram systems are not described, because they cannot be compared with CTS.

Metro and tram systems are used to provide transport for large flows of passengers over a longer distance in urban areas. CTS is aimed at providing individual transport over shorter distances. So, the services of the two systems cannot be compared. However, CTS can be a feeder for these systems. Furthermore, CTS and a metro/tram are sustainable transport systems from an environmental view. So, based on sustainability, both systems are suitable. For these reasons it is expected that CTS cannot substitute metros and trams, but that the systems can be complementary.

As described before (chapter 3), CTS can be more flexible than other public transport modes, because of its operational advantages and lower labor costs. Therefore the criteria operational costs and capacity are added as characteristics.

Table 5-2 and Table 5-3 on the next pages give an overview of the performance of the several possible forms of transport for the features and parts of a service network as well as the operational costs and the capacity.
### Table 5-2 A service network for conventional road traffic in urban areas (service characteristics based on Delle Site, Filippi, 2005)

<table>
<thead>
<tr>
<th>Possible form of transport</th>
<th>Bus connection “lijnbus”</th>
<th>Taxi</th>
<th>Tailor made transport “vervoer op maat”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic flow</td>
<td>few to many</td>
<td>many to many</td>
<td>many to many</td>
</tr>
<tr>
<td>Spreading in space</td>
<td>yes</td>
<td>Yes</td>
<td>yes</td>
</tr>
<tr>
<td>Spreading in time</td>
<td>no</td>
<td>Yes</td>
<td>yes</td>
</tr>
<tr>
<td>Schedule</td>
<td>yes</td>
<td>No</td>
<td>no</td>
</tr>
<tr>
<td>Frequency</td>
<td>depends on # of passengers</td>
<td>on demand</td>
<td>on demand</td>
</tr>
<tr>
<td>Network density</td>
<td>different incomplete network</td>
<td>indifferent complete network</td>
<td>indifferent complete network</td>
</tr>
<tr>
<td>Entrance density</td>
<td>high density in inner cities</td>
<td>high density – pick up everywhere</td>
<td>high density - pick up everywhere</td>
</tr>
<tr>
<td>Detour factor</td>
<td>can be high</td>
<td>low</td>
<td>depends on number of requests</td>
</tr>
<tr>
<td>Operational costs</td>
<td>high</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>Capacity of system</td>
<td>large</td>
<td>smaller</td>
<td>small</td>
</tr>
<tr>
<td>User optimum</td>
<td>no</td>
<td>partly*</td>
<td>partly**</td>
</tr>
<tr>
<td>System optimum</td>
<td>yes</td>
<td>yes</td>
<td>partly – their route isn’t always efficient</td>
</tr>
</tbody>
</table>

### Table 5-3 A service network for CTS in urban areas

<table>
<thead>
<tr>
<th>Possible form of transport</th>
<th>I1</th>
<th>I2</th>
<th>I3</th>
<th>C1 = C2</th>
<th>C3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic flow</td>
<td>few to many</td>
<td>many to many</td>
<td>few to few</td>
<td>few to many</td>
<td>few to few</td>
</tr>
<tr>
<td>Spreading in space</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Spreading in time</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Schedule</td>
<td>no</td>
<td>no</td>
<td>can be possible</td>
<td>can be possible</td>
<td>can be possible</td>
</tr>
<tr>
<td>Frequency</td>
<td>on demand</td>
<td>on demand</td>
<td>depends on spreading in time</td>
<td>depends on spreading in time</td>
<td>depends on spreading in time</td>
</tr>
<tr>
<td>Network density</td>
<td>different incomplete network</td>
<td>indifferent complete network</td>
<td>different incomplete network</td>
<td>indifferent incomplete network</td>
<td>indifferent incomplete network</td>
</tr>
<tr>
<td>Entrance density</td>
<td>can be high***</td>
<td>can be high***</td>
<td>low</td>
<td>can be high***</td>
<td>low</td>
</tr>
<tr>
<td>Detour factor</td>
<td>as low as possible</td>
<td>as low as possible</td>
<td>low</td>
<td>can be high, due to large groups</td>
<td>low</td>
</tr>
<tr>
<td>Operational costs+</td>
<td>lower****</td>
<td>lower ****</td>
<td>lower *****</td>
<td>lower******</td>
<td>low*******</td>
</tr>
<tr>
<td>Capacity of the system</td>
<td>Average</td>
<td>Average</td>
<td>average</td>
<td>Large</td>
<td>large</td>
</tr>
<tr>
<td>User optimum</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>depends on the service</td>
<td>hardly</td>
</tr>
<tr>
<td>System optimum</td>
<td>average</td>
<td>average</td>
<td>average</td>
<td>high</td>
<td>high</td>
</tr>
</tbody>
</table>
### Legenda

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different</td>
<td>If the different entrances are not equally important</td>
</tr>
<tr>
<td>Indifferent</td>
<td>If the different entrances are more or less equally important</td>
</tr>
<tr>
<td>Taxi</td>
<td>Performs an individual transport over an unknown distances</td>
</tr>
<tr>
<td>Tailor made transport (vervoer op maat)</td>
<td>Delivers half individual special traffic. This depends on the number of requests. Transport from door-to-door. Several passengers can be move at once with different origins and destinations (<a href="http://www.nsvnamsterdam.nl">www.nsvnamsterdam.nl</a>; <a href="http://www.flevoland.nl">www.flevoland.nl</a>; <a href="http://www.rotterdam.nl">www.rotterdam.nl</a>)</td>
</tr>
<tr>
<td>Bus connection (lijnbus)</td>
<td>Delivers bus service in urban areas, where the distances between the stops are relatively short. The frequency is high when there are many travelers, for example at rush hours</td>
</tr>
<tr>
<td>+</td>
<td>Compared to operational costs of conventional traffic</td>
</tr>
<tr>
<td>C1 = C2</td>
<td>These alternatives only differ in car use or not, they do not differ in the features of a service network</td>
</tr>
<tr>
<td>*</td>
<td>Depends on available capacity of cars</td>
</tr>
<tr>
<td>**</td>
<td>Depends on conditions for service and available capacity</td>
</tr>
<tr>
<td>***</td>
<td>Depends on the definition of &quot;spreading in space&quot;: this can be a bus connection</td>
</tr>
<tr>
<td>****</td>
<td>No driver but a lot of cars are necessary</td>
</tr>
<tr>
<td>*****</td>
<td>No driver and no spreading in space</td>
</tr>
<tr>
<td>******</td>
<td>No driver, there are less cars necessary because large groups of people are transported</td>
</tr>
<tr>
<td>*******</td>
<td>No driver, large groups of people and no spreading in space</td>
</tr>
</tbody>
</table>
Explanation of the tables

The service that can be provide by conventional forms of traffic and by forms of CTS will be explained.

Services of conventional traffic (Table 5-2)

Next the performances of the services of conventional traffic are considered. This is based on the features of the service network that are explained in the table on the previous page, but the explanation can be read independent from these tables.

Bus connection

The bus connection is a very standardized system. It is a fixed service with a schedule and a given track. Of course the design reckons with the different traveler characteristics in the determination of the frequency, the entrance density and the network density. However, the design of the service is always a consideration between a user and a system optimum, because of the operational costs and the occupancy against the necessary capacity.

The advantage of the bus is that it can transport many people at once and that the service is not expensive when the occupancy is high. The disadvantage of a bus is that its service always needs a consideration between the user and the system optimum, because of the labor costs. This enlarges the detour factor. Furthermore the service is not flexible as its service is bond to a route and a time schedule.

Taxi

The taxi is a perfect individual system. It has a complete indifferent network for any passenger at any time. The service on demand principle makes it very expensive, because it is only possible to reach a system optimum when the prices are high enough to cover the labor costs. The labor costs are very high, because a high capacity needs to be available, but it is quite uncertain whether this capacity is demanded. So the occupancy is partly unknown and a driver makes a lot of costs when he stands still.

The main advantage of a taxi is its service. This can be a perfect fit for the traveler, with service on time and with a small detour factor. A main disadvantage is its costs. A lot of people are excluded from this service, because they can not or are not willing to pay for it.

Tailor made transport

This form of transport also serves a lot of individual travelers. It is especially useful for sparsely populated areas and special traffic for people who are not able to make use of conventional public transport. It serves an indifferent complete network, but its service is not as individual as a taxi. The service can be adapted to be able to transport more passengers at once from several locations when this is more efficient.

A main advantage is that it makes transport possible for people who are not able to make use of conventional public transport such as a bus. A main disadvantage is that it brings about large costs to obtain a good tailor made service.

Performances of CTS (Table 5-3)

In this section the performance of the services of CTS are considered based on the features of the service network that are explained in the table above.

Individual service 1

The drawn example in Table 5-1 shows that this form can be implemented as a service between a central car park and a central business park. The service is park shuttle. It brings people from a main location to several locations in a business park.
An advantage is that the traveler has an on demand service from its parking place to the business centre. It also diminishes the parking problems and congestion in the business centre. The car calculates its optimal route through the network; this can diminish the detour factor. However, the traveler still can be tied to a number of stops. This depends on the fellow passengers. This can be a disadvantage.

**Individual service 2**

The drawn example in Table 5-1 shows that this form can be implemented as a service in a holiday park. This means that in a dedicated area, the service is on demand and overall the area. The passenger can get on and off at every desired spot in the area. In the table the network is indicated as indifferent and complete, like a taxi. This is not totally correct, because the service is bound to a network. It is stated as such, because every desired service can be executed inside this network.

An advantage of this service is that a real individual service can be accomplished against lower costs then a taxi, because there are no labor costs. A disadvantage however is the limitation to a network. Especially in the development phase of CTS this network will not be very comprehensive. It is necessary to start with a small network and extend this bit by bit, because of the expected technical development path (appendix III).

**Individual service 3**

The drawn example in Table 5-1 shows that this form can be implemented as a service between a central car park and a city centre. This service is aimed at linking two central spots. The service is again on demand and can have an individual character. Of course, this individual character depends on the number of requests.

An advantage of this system is that the city centre can be free of cars and passengers are still served on demand. A disadvantage is that passengers are bound to specific stops.

**Individual services in general**

The individual service is always aimed at people who use their car for a main part of their trip. Travelers by car arrive at different moments in time. This makes it possible to provide a individuals service. A collective service is more appropriate when passengers arrive en masse at certain moments in time. Possibilities for collective services are explained below. A general disadvantage of the individual service is that people who are used to the car have to get used to a modal split and continue their trip with another mode.

**Collective service 1 and 2**

These services are combined, because they share the demand characteristics in Table 5-1 except for car use and parking problems. The examples that are given in this table are from a central car park to a central business district and from a station to a university. The example of the central car park to a central business district has been given in individual service 1 as well. The difference between collective transport 1 and 2 is for example that a collective service can be suitable for commuter traffic. A lot of people arrive at and leave from their work at the same time. However, the evening rush-hour is longer and has a smaller peak than the morning rush-hour. The individual service can be executed during the day for visitors of the business park. People that arrive at a station always arrive en masse. It is not useful to transport these people with an individual service.

Since the only difference between these two collective services is the mode of arriving at an entrance for CTS, the demand characteristics are comparable. Therefore the service is comparable. The service has the same characteristics as individual service 1, except for the spreading in time.

An advantage of this collective transport is that travelers have an on demand service from its parking place to the business centre. It also diminishes the parking problems and congestion in the business centre. The car calculates its optimal route through the network, which can diminish the detour factor. However, the traveler still can be tied to a
number of stops. This depends on the fellow passengers. This can be a disadvantage. Another disadvantage is getting used to the extra modal split – compared to a trip by car. This disadvantage can be weakened by making the transfer convenient and keep the waiting time as low as possible. CTS can provide this service, since a high frequent service is possible due to financial benefits of CTS.

Collective service

An example of this service in Table 5-1 is from a station at an airport to the terminal. People are not spreading in space, so it is possible to collect more passengers that need to go to the same terminal. They are spreading in time, because they do not all arrive with for example the same train. The frequency of the service depends on the spreading in time: people cannot wait to long and when a large amount of people arrives they all have to be served.

An advantage of this system is that it is a flexible mean to travel people through an airport. The cars can be called where necessary. A disadvantage of this system can be that people have to wait when they arrive at a station before a service is arriving or leaving.

Based on the previous analysis the following paragraph gives short conclusions on the performances of both means of transport.

5.2.2. Short conclusion on the performances

This paragraph first gives an overview of the main differences between the identified services. Second, conclusions are drawn about the integration of services by CTS in the current transport system.

The differences between CTS and conventional forms of transport

The main difference between the service of CTS and conventional road transport is that it is easier and cheaper for CTS to provide an individual service. It is easier, because CTS is not bound to a time schedule and cheaper, mainly because CTS does not have to reckon with labor costs of drivers. A short overview of the costs specifications of CTS compared to cost of an conventional system can be found in chapter 3.

CTS is bound to a network and can therefore be bound to a certain route. CTS is more flexible when it comes to time and track schedules, but CTS is less flexible when it comes to the network. The provided service is always over a short distance. Another advantage above a bus system is that the detour factor is smaller. The disadvantage is that the covered distance is shorter, so a transfer is needed more often. Depending on the importance a traveler attaches to the transfer, an extra transfer can be a drawback for the success of CTS. However, when the regional bus connects to CTS, the detour factor of each trip can be diminished, since the regional bus does not have to cover the city area anymore. Both services can be efficient and complementary.

An important advantage of CTS above a taxi are the operational costs – when it is assumed that the number of vehicles and transported passengers is equal, and it is presumed that the labor costs of a bus driver can be compared to the labor costs of a taxi driver (Chapter 3). The disadvantage compared to the taxi is that CTS covers only a small network. The same holds for tailor made travel.

CTS has few advantages and disadvantages when it is compared to tailor made transport, especially, when it concerns special transport. Tailor made transport can also serve people in sparsely populated areas. CTS can provide a good service when the activity density is high. This shows that CTS and tailor made transport have very small changes to become each others substitute. CTS can connect to tailor made transport when this is used to link sparsely populated areas with activity centers or inner cities.

In general CTS covers shorter distances than conventional means of transport. The operational advantages are sketched, but for the end user it means that a new transfer
between means of transport occurs. Bos (2003) shows the value of passengers for an extra transfer. This is often negative, but the design of the transfer can improve the value to transfer of the traveler.

Since there are so many differences between services of CTS and services of conventional transport it is hard to compare the services on their performances in order to determine which mean of transport performs best. Since CTS is not per se aimed at substituting conventional transport, it is not necessary to compare the performance of one system against another.

The integration of CTS in the current transport system

The introduction of CTS is aimed at making the transport system more efficient, comfortable and sustainable. The way conventional means of transportation are used at the moment can change when CTS is implemented. Furthermore the use of a mean of transportation can be encourage or discouraged by flanking policies. When this happens the use of conventional means of transport can increase or decrease with the introduction of CTS. Finally, with the introduction of CTS the design of the service networks can be reconsidered and design of the total transport system can become more efficient.

It is expected, however, that the demand for transport will grow. Therefore it is not likely that the use of any mean of transport will decrease, while it is still possible that the use of transportation modes will change, because of the introduction of CTS.

The service possibilities of CTS and of conventional traffic should be put together and filled in to the wishes of the traveler –based on their patterns and quality demands- and the community. When the travelers demands and the service possibilities of the systems are combined a new transport system can be designed in which the good benefits of the services of conventional traffic and CTS are integrated.

So, as can be concluded from the performance of the systems CTS can be a supplement to the current transport system, because it covers short distances, is more flexible and cheaper in operational costs. Some examples of CTS in combination with the current transport system are:

- a feeder for larger transport systems and a shuttle from a larger transport system into a nearby center
- a connection for the regional bus into a city centre or a business park. In this case it can be a substitute for the city bus or the city bus can drive a more efficient route, because CTS covers a part of the network.
- a connection for tailor made transport into a centre
- a park shuttle from a large parking lot into a center

The following paragraph matches the transportation demand in urban areas with possible service that CTS can provide in order to determine whether CTS can form a suitable supply to answer the demand.

5.3. TRANSPORTATION DEMAND ANSWERED BY CTS

In section 4.3 a general overview has been given about the traffic flows in urban areas with a zonal modal. Next to this an overview has been given of the transport quality demands a traveler has for a certain trip purpose. In this section will be analyzed which kind of traffic flows can be suited by CTS. Furthermore will be analyzed which travelers' transport quality demand can be answered by CTS. Section 5.3.1 will show which traffic flows can be suited with CTS and section 5.3.2 will show which transport quality demand can be answered by CTS.
5.3.1. **The suitability of CTS for transport flows in urban areas**

It is necessary to get insight in the transport patterns that fit with the characteristics of CTS in order to determine where a service can contribute to the transportation demand. A summary of travel pattern typology around urban areas has been made according to a zonal model in the project Utopia (Zwaneveld et. al., 1999). Table 5-4 shows the features of these traffic flows.

<table>
<thead>
<tr>
<th>Pattern features</th>
<th>Traffic Volume</th>
<th>Spatial Spreading</th>
<th>Temporal Spreading</th>
<th>Trip Distance</th>
<th>Trip Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-purpose inner urban traffic</td>
<td>High</td>
<td>Highly Dispersed</td>
<td>Highly Dispersed</td>
<td>Short</td>
<td>Any</td>
</tr>
<tr>
<td>Suburban – center linkage</td>
<td>High at peak times</td>
<td>Bundled</td>
<td>Peak times</td>
<td>Rather long</td>
<td>Mostly work, some shopping and leisure</td>
</tr>
<tr>
<td>Residential area collection &amp; distribution</td>
<td>Low</td>
<td>Highly Dispersed</td>
<td>Dispersed, except work related trips to access points</td>
<td>Short</td>
<td>Shopping, leisure, education, trips to access points</td>
</tr>
<tr>
<td>Peripheral linkage</td>
<td>Low</td>
<td>Highly Dispersed</td>
<td>Dispersed, except work</td>
<td>Rather long</td>
<td>Shopping and work</td>
</tr>
<tr>
<td>Focal Traffic</td>
<td>High at peak times</td>
<td>Bundled</td>
<td>Peak times for work related trips, otherwise dispersed</td>
<td>Long</td>
<td>Mostly work and business, some shopping and leisure</td>
</tr>
<tr>
<td>Focal Traffic II</td>
<td>High at peak times</td>
<td>Dispersed</td>
<td>Peak times for work related trips, otherwise dispersed</td>
<td>Long</td>
<td>Mostly work and leisure</td>
</tr>
</tbody>
</table>

When the features of these traffic flows are combined with the features of a service of CTS can be determined for which traffic flows CTS can be suitable. The description of the features of CTS from Table 5-1 corresponds to the description of pattern features of the table above. The translation is as follows.

<table>
<thead>
<tr>
<th>Description</th>
<th>Table 5-1</th>
<th>table 5-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>spreading in time</td>
<td>temporal spreading</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>dispersed</td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>&lt;exceptions explained&gt;</td>
<td></td>
</tr>
<tr>
<td>spreading in space</td>
<td>spatial spreading</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>dispersed</td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>bundled</td>
<td></td>
</tr>
<tr>
<td>activity density</td>
<td>traffic volume</td>
<td></td>
</tr>
</tbody>
</table>

Based on this features can be determined for which traffic flows CTS can be suitable. This determination has been made by combining the features of the services of CTS with the features of the traffic flows.
Table 5-5 traffic flows for which CTS can be suitable

<table>
<thead>
<tr>
<th>traffic flows</th>
<th>All-purpose inner urban traffic</th>
<th>Suburban - center linkage</th>
<th>Residential area collection &amp; distribution</th>
<th>Peripheral linkage</th>
<th>Focal Traffic</th>
<th>Focal Traffic II</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5-5 shows that CTS in urban areas is suitable for four traffic flows. This is explained below.

**All-purpose inner urban traffic**

Because of the high traffic volumes that have a spreading in space as well as in time this kind of traffic flows can be suited by an individual service by CTS.

**Suburban – center linkage**

In peak times it is possible to serve travelers with a collective service. In off-peak hours it is possible to serve travelers with an individual service. To avoid parking problems in city centers and to improve sustainability, it is possible to design a service from a terminal or a parking lot at the edge of a center.

**Residential area collection and distribution**

The traffic volume is low, but the trips are short and the flows are evenly spread along the day. When there are problems according to sustainability or parking, CTS can offer an adequate service. It depends on the volume of the transport flows and the spatial planning whether a collective or an individual service can be used.

**Focal traffic and focal traffic II**

CTS are probably not suitable for focal traffic itself, because the distances of the movements are too large. However, CTS can be a part of the trip of this traffic, when there are problems with congestion, emissions, parking when this traffic wants to enter the city. An individual service can be adequate when there is spreading in space and spreading in time. A collective service can be adequate when there is either no spreading in space or no spreading in time or no spreading in space and time. This situation is probable to occur during peak hours when commuter traffic wants to enter the city.

So, CTS can provide services for four traffic flows in urban areas. The following paragraph describes the performance of CTS to the travelers’ quality demands. This analysis is necessary to determine whether travelers will indeed make use of CTS.

### 5.3.2. Performance of CTS on travelers’ transport quality demands

Travelers have certain quality demands for transport. Each trip purpose is build with travelers with different quality demands. Therefore it is also necessary to know whether CTS can suit these passengers. The transport qualities can be expressed in: time, price and comfort. (Van Goeverden, et.al., 1998) This is shown in Table VIII- in appendix VIII. The quality demands that different travelers have for different trip purposes are explained in this table. It only shows one or two characteristic when the demand is obviously higher.
then the demand for the other characteristics. All three characteristics are shown, when the demand for all characteristics is equal.

Therefore the performance of CTS on the different qualities is discussed in this paragraph.

**Time**

Time is a very relative concept. CTS are not a very fast transportation mode in terms of vehicle speed, but it can be relatively fast compared to other modes in urban areas. This depends on the problem that travelers are confronted with. For example: when there is a lot of congestion in an urban area through which cars are prohibited in a certain area, CTS can be a mode that is far faster than walking. In this case it can also be faster than a car, because transportation modes are not bothered by traffic jam or congestion any more. CTS can also be a fast transport system for people that do not use the car but have to take the bus from a terminal. The bus can not serve an individual traveler, so the detour factor of a bus is probably higher than the detour factor of a cybercar. This makes CTS a faster transportation system.

Next to this, people find the reliability of a system very important. They want to get accurate and actual information about the service they get. Time is a very important subject of reliability: travelers want to know when they get served. This is among other one of the results of the enquiry held in CyberMove (Janse, 2003).

People who find time an important characteristic of transport can use CTS, since it should be one of the possibilities of the design of CTS to gain time.

**Price**

The financial evaluation of CyberMove (Filippi, 2004) shows that from the 10 sites, two sites are able to re-pay the initial investments over 10 years. Furthermore four sites were able to contribute in re-paying the initial investment and two more sites were able to cover at least the operational costs. Furthermore the operational costs of a cybercar compared to a bus are lower, but the initial investment is lower (see chapter 3). This shows that CTS could be financially neutral when mobility policies (flanking policies) are used to encourage people to make use of CTS.

Although this evaluation shows that the operation of CTS can be financially neutral, there are a few thoughts that need to be taken into account.

- **Risks of the development**

  CTS has not very often been implemented and the production of the cars is not standardized yet. Therefore there are a lot of uncertainties in the eventual costs of a realization of CTS. It could be that the first professional applications for CTS are not financially feasible, due to unexpected setbacks. These setbacks will decrease when the experiences with the system increase. The experiences and the accompanying improvements that will take place when CTS is more often realized will increase the reliability of the system. A better reliability results in lower unexpected costs.

  So, in this stage of the development of CTS the financial feasibility may not be proven in practice. These setbacks need to be taken along in the development of CTS. They will probably re-pay themselves when the introduction of CTS becomes more standardized and less risky.

- **Costs for the user**

  The performance of CTS on price for the user is different than the financial performance of CTS, since the public transport in the Netherlands is often subsidized. Without subsidy the financial performance of CTS can be neutral over a period of 10 years. (Filippi, 2004) Due to the uncertainties the costs of CTS can be high. This does not have to influence the quality demands of the user for CTS, since the costs to perform a service by CTS can be subsidized. This is often the case with public transport systems. When the use of CTS
needs to be stimulated and travelers attaches a significant value to the price, one can choose to subsidize the use of CTS.

- The willingness to pay

Filarski (2004) shows that speed, status and convenience have always been much more important factors than costs. So, the willingness to pay for CTS increases when it scores well on time and comfort. Furthermore it can be expected that the willingness to pay for a service with CTS is higher than the willingness to pay for a bus service, since the status of a new, innovative automated mean of transport is high. This, it can be presumed that the price for CTS can be higher in the first stages of the development.

As is shown, the performance of CTS on price is uncertain and depends on a lot of factors. It is possible for CTS to live up to the quality demands of the traveler on price, when the service is subsidized.

It is presumed that CTS can serve the quality demands of travelers whom find price as well as time important or price as well as comfort or price as well as time as well as comfort. It is presumed that people who find only price important will not make use of CTS initially, because of two reasons. First, their willingness to pay is low and second, the expected price of CTS, when not subsidized, is high due to uncertainties.

**Comfort**

Public transport hardly beats the car as transportation mode. People often show a form of automatic behavior, which means that they do not consider to use another transportation mode when it is not necessary to change their current mode. Moments to change from transportation mode are for example when a current mode causes problems or when people make mid-term changes, such as the choice for a place to work or to live (Dijst et. al., 2002)

People that use the car find this means of transport often very comfortable. It gives a feeling of freedom to depart any time you want, to play music as loud as you want and not to be disturbed by other people that use the same transportation mode. When car users are forced to leave the car and make a transfer to a public mean of transport it can be assumed that they prefer CTS. This is assumed, because several forms of CTS get close to the service that a car can offer. After all, the system is able to provide a rather fast, direct and individual service.

People that are used to public transport modes will probably find it easier to use CTS than car users. However, CTS has to be at least as reliable as their old transportation mode. The advantages of CTS to provide a more direct service for the customer also hold for these travelers.

Another important aspect of CTS is that the social safety has to be guaranteed. The enquiry of CyberMove (Janse, 2003) showed that this is a very important aspect, especially because there are no drivers on board anymore. Social security can be effectuated by a conductor, but a disadvantage is that the profit of the disappearance of the labor costs does not count anymore. Experiments in Cybercars (McDonald, 2002) as well as in CyberMove (Filippi, 2004) have been executed by which a television was visible in the cybercar that showed actual views from inside the car (a CCTV). It was noticed that people felt more save in this vehicle than in a vehicle without such a system. Next to this it is according to the enquiry (Janse, 2003) very important that these cars are clean. According to the interviews (appendix VIII) it can be expected that social security can improve when entrance is only possible for people with a ticket and the service is individual.

On short term CTS are not able to perform individual “many to many” transports in a dedicated network with a lot of entrances and exits, so people who are looking for this kind of service are not served at first. It should be possible to provide different kinds of transport in the initial phases in accordance with the users. So, CTS are a good alternative for people who find comfort important and are willing to be served by a form of individual or collective transport in a different incomplete network with a short detour factor.
In the next section the analysis of the traffic flows for which CTS can be suitable is combined with the categories of people that are likely to use CTS in urban areas according to their transport quality demands.

### 5.3.3. Service possibilities for CTS

This section combines the analyses in the previous two chapters in order to show for whom and for which traffic flows a service by CTS can be designed. This overview can be found in Table 5-6. The table is explained in this section.

#### Traffic flows which can be suited by CTS

CTS can be suitable for four traffic flows in urban areas. These traffic flows consist of people with a different motive to travel. These motives are called trip purposes in table 5-4.

Inner traffic consists of traffic with every possible motive. Suburban – center linkage traffic is only undertaken for working, shopping and leisure activities. Residential area collection and distribution is undertaken for work, shopping, visiting, recreation and take away / pick up. Finally, focal traffic is undertaken for working, business, shopping, visiting and recreation.

Most of the trips that can (partly) be executed by CTS are performed by inner traffic. A lot of different kinds of trips are also executed by residential area collection and distribution traffic and by focal traffic. When CTS is aimed at focal traffic, it should be aimed at executing a part of a trip; for example from a large parking lot to a center. Least possibilities for CTS are for the suburban – center linkage. This can be improved when it is combined with focal traffic that enters the city through the suburbs.

#### Traveler groups which can be served by CTS

It is assumed that people who only find price important will not use CTS, since it is uncertain how CTS will compete on price with other transport modes. It is expected that CTS will be cheaper than conventional transport, because of its operational advantages. However, a lot of practice and research need to be done before CTS indeed will be cheaper. At the moment the performance is eventually more expensive.

Therefore it is assumed that only people will use CTS that find time; comfort; time and comfort; time and price; comfort and price; or time, price and comfort together important. When people find time important and they travel by car, the use of CTS can only be worth to consider when they are made to choose between different means of transport. This happens for example when there is a problem in reaching a destination by car.

When people find time important and they travel by public transport, switching is probably easier, because they are used to public transport services. When people find comfort important and they travel by car, CTS can be a consideration, since individual transport is possible when the transport flows are not too substantial. However, it does not seem logical that people will switch from car to CTS only for their comfort.

When people find comfort important and they travel by public transport, CTS can be a consideration, since the service can be more direct and sometimes individual. When people find time and comfort important and they travel by car, CTS can be considered as a good alternative. These travelers do not lose a lot of comfort and they can even gain time especially when there is a problem by reaching their destination by car.

When people find time and comfort important and they travel by public transport, CTS can be a good alternative. Both the advantages mentioned for time and comfort also hold for people who find time and comfort important.

For people who find price important in combination with time and/or comfort, CTS can be an alternative too. For people who drive by car it can be an alternative, because, they can save parking money in the city center in case CTS is used as a park shuttle. For people
who use public transport it can be an alternative, because the service that is offered by CTS is better than the service offered by conventional transport. This service would be far more expensive when it is offered by conventional transport –think for example about the price of current taxi services, where even “drive up” costs have to be paid. These vary between 0 Euros and 5.12 Euros (www.iwv.nl, April 29, 2005)

According to the “staalkaart vervoersvraag” (van Goeverden et al., 1998) all modes are used to get into the city and are used to travel in the city when time is important. When costs are important only slow traffic on short distance is attractive. When comfort is important the car and public transport are dominant modes on trips in the city and over longer distances. The car is dominant on short trips outside the city.

**Explanation of Table 5-6**

The following table gives an overview of travel purposes for which CTS can be suitable and which group of traveler can use CTS for the specific travel purpose. The goal of this table is to make clear which groups of travelers can be served in which area for which purpose. As said before, it is better to focus on traffic flows than on travel purposes when a service for CTS is designed. The travel purposes are still in this table to show that each purpose contains travelers whom can be served by CTS based on their demand characteristics. When the characteristics of the travelers are known in a certain area, it should be possible to design a service for this area; because it can be estimated for how many travelers CTS could be suitable.

This differs per region so this should be done in a feasibility study. This overview can be used to determine what people are likely to make use of CTS based on their demand characteristics.

**Building the table**

CTS can perform a service for four traffic flows in urban areas (Table 5-5). These traffic flows are built of travelers that have different purposes (table 5-4). This is shown in the upper part of the table. The travelers that perform trips with certain purposes all have different transport quality demands. (Table VIII- in appendix VIII, Van Goeverden et al., 1998) The performance of CTS on these quality demands determines which groups of travelers (divided on four characteristics, Table VIII- in appendix VIII, Van Goeverden et al, 1998) can make use of CTS.
Table 5-6 Users that can be served by CTS, according to their user characteristics in different urban areas

<table>
<thead>
<tr>
<th>Traffic purpose</th>
<th>Work/education</th>
<th>Business</th>
<th>Shop</th>
<th>Visit*</th>
<th>Recreation*</th>
<th>Take away/pick up</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic flows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All purpose inner traffic</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Suburban - center linkage</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential area collection and distribution</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Focal traffic I and II</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Travelers quality demands</td>
<td>T/C/TP/ TC/TPC</td>
<td>TC</td>
<td>TC/TPC/PC</td>
<td>TC/TPC/PC</td>
<td>TC/TPC</td>
<td>TC/TPC/PC/PC</td>
<td>T/C/TPC/TP/PC</td>
</tr>
<tr>
<td>Groups that use it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobility</td>
<td>high mobility</td>
<td>any mobility</td>
<td>any mobility</td>
<td>any mobility</td>
<td>high mobility</td>
<td>any mobility</td>
<td>high mobility</td>
</tr>
<tr>
<td>Income</td>
<td>high income</td>
<td>any income</td>
<td>any income</td>
<td>any income</td>
<td>high income</td>
<td>any income</td>
<td>high income</td>
</tr>
<tr>
<td>Main activity</td>
<td>any activity</td>
<td>any activity</td>
<td>any activity</td>
<td>any activity</td>
<td>any activity</td>
<td>any activity</td>
<td>any activity</td>
</tr>
<tr>
<td>Responsibility</td>
<td>any responsibility</td>
<td>any responsibility</td>
<td>any responsibility</td>
<td>any responsibility</td>
<td>any responsibility</td>
<td>any responsibility</td>
<td>any responsibility</td>
</tr>
<tr>
<td>Mobility</td>
<td>high mobility</td>
<td>high mobility</td>
<td>high mobility</td>
<td>high mobility</td>
<td>high mobility</td>
<td>high mobility</td>
<td>high mobility</td>
</tr>
<tr>
<td>Income</td>
<td>low income</td>
<td>low income</td>
<td>low income</td>
<td>low income</td>
<td>low income</td>
<td>low income</td>
<td>low income</td>
</tr>
<tr>
<td>Main activity</td>
<td>full time</td>
<td>any activity</td>
<td>full time</td>
<td></td>
<td>full time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsibility</td>
<td>any responsibility</td>
<td>children</td>
<td>any responsibility</td>
<td>children, adults</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobility</td>
<td>high mobility</td>
<td>low mobility</td>
<td>low mobility</td>
<td>high mobility</td>
<td>low mobility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>low income</td>
<td>any income</td>
<td>part time</td>
<td>part time/ none</td>
<td>low income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main activity</td>
<td>part time</td>
<td>any activity</td>
<td>part time, none</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsibility</td>
<td>children</td>
<td>any responsibility</td>
<td>children, adults</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobility</td>
<td>low mobility</td>
<td>any income</td>
<td>any activity</td>
<td>any activity</td>
<td>any income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>any income</td>
<td>any activity</td>
<td>any activity</td>
<td>any activity</td>
<td>any income</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Leisure trips in table 5-4 are translated to visit and recreation in this table.
Based on the previous table can be determined which traffic purpose occur in an urban zone and which travelers are likely to use CTS based on their demand characteristics. This is only based on theories and analyses about traffic flows and travelers that cause them. The following paragraph will link this analysis to the data of Statistics Netherlands about traffic flows that occur in urban areas.

5.4. **MARKET SEGMENTS FOR CTS**

CTS can be used for different traffic flows and for different traveler categories as is shown in chapter 5.3. In this section the different traffic flows in an urban area based on the zonal modal are also subdivided to several trip purposes.

Trip purposes and traffic flows for which CTS can be suitable can be determined by the analysis of data of the Statistics Netherlands (CBS) about trip purposes in urban areas and used means of transportation in urban areas. They are similar to the purposes that are used in the zonal modal except for the specific trip purposes “take away/ pick up” in its division for motives.

This information will be combined with determined traffic flows that occur in several zones in urban areas in order to determine for which traffic flows CTS can be suitable. This is a qualitative analysis and not a quantitative analysis. The results do not have to hold for every urban area, but can be used to determine which traffic flows can be served by CTS. A quantitative analysis of the present traffic flows is always necessary to determine whether a service and what kind of service can be useful, profitable and suitable.

Paragraph 5.4.1 shows which purposes occur mostly in urban areas and it identifies which trip purposes can be suited buy CTS. Paragraph 5.4.2 determines which traffic flows based on the occurrence of the purposes can be properly served by CTS. Finally paragraph 5.4.3 shows the results of the interviews about the choice the municipalities made for a system and a certain service that they want this system to provide.

5.4.1. **Analysis of travel behavior based on statistics of the Netherlands**

The data in the following table is generated from the data of the Statistics Netherlands (CBS) for trips in urban areas subdivided in “means of transportation” and “motives”. The shortest distance per mean of transportation is drawn, because it is likely that CTS in urban areas performs short trips. This means that it can be possible that CTS replaces the transportation mode on these short trips or that CTS is complementary to existing means of transportation that perform (short) trips in urban areas. It is not likely that CTS will replace a transportation mode that covers a very long distance.

No information can be found on chain trips. It is presumed that all the parts of a movement of a traveler are taken into account and are represented in the data.
Table 5-7 Urban traffic patterns

<table>
<thead>
<tr>
<th>Characteristics of patterns</th>
<th>Most often motive for movements</th>
<th>Motive with shortest distance/movement</th>
<th>Most used mean of transportation</th>
<th>Mean of transportation that covers shortest distances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Recreation</td>
<td>Other motives</td>
<td>Car</td>
<td>Walk</td>
</tr>
<tr>
<td>2</td>
<td>Shopping</td>
<td>Shopping</td>
<td>Bicycle</td>
<td>Bicycle</td>
</tr>
<tr>
<td>3</td>
<td>Commuter traffic</td>
<td>Visiting</td>
<td>Walk</td>
<td>Moped</td>
</tr>
<tr>
<td>4</td>
<td>Visiting</td>
<td>Commuter traffic</td>
<td>Train</td>
<td>Bus/tram/metro</td>
</tr>
</tbody>
</table>

Next to these general conclusions for all motives, the following conclusions can be drawn from each motive separately.

Table 5-8 Conclusions per motive

<table>
<thead>
<tr>
<th>Means per motive</th>
<th>Transport motives</th>
<th>Mean of transportation for most movements</th>
<th>Mean of transportation that is mainly used</th>
<th>Mean of transportation that covers distance &lt;10km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commuter</td>
<td>Car, bicycle</td>
<td>All</td>
<td>Walk, bicycle, moped</td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td>Car</td>
<td>Car, bicycle</td>
<td>Bicycle</td>
<td></td>
</tr>
<tr>
<td>Shop</td>
<td>Car, bicycle</td>
<td>All</td>
<td>Walk, moped, bicycle, bus/tram/metro</td>
<td></td>
</tr>
<tr>
<td>Visit</td>
<td>Car</td>
<td>All</td>
<td>Walk, bicycle, moped, other</td>
<td></td>
</tr>
<tr>
<td>Recreation</td>
<td>Car</td>
<td>All</td>
<td>Walk, moped</td>
<td></td>
</tr>
<tr>
<td>Other motives</td>
<td>Car</td>
<td>Car, bicycle, walk</td>
<td>Walk, bicycle</td>
<td></td>
</tr>
</tbody>
</table>

Furthermore the "Nota Mobiliteitsmanagement" (Ministerie van Verkeer en Waterstaat, 2002) shows that more than 50% of the car movements cover a distance that is shorter than 7.5 kilometer. This shows that also a lot of car movements take place in urban areas. Furthermore a lot of trips take place by foot or bicycle.

Trip purposes that can be suited by CTS

When it is presumed that CTS can be suitable as a feeder or a park shuttle (on short term) or transportation system that can cover short distances in a dedicated network in urban areas (on longer term) it can serve several trip purposes.

In order to serve trip purposes that are mostly performed by car extra policy is needed to serve these travelers, because CTS is not yet able to perform a door-to-door service. Therefore car users need to make a modal split in their movement.

According to the characteristics of a service network for CTS (paragraph 5.4.2) it is necessary that the system is realized in a zone with high activity and where traffic is spread in space and/ or spread in time. According to the data of the CBS occur the trip purposes recreation, shopping and commuting occur often. CTS can serve these trip purposes when the demand in a certain area is known and large enough for a new transport system.
The most certain trips that can be suited by CTS are trips performed to shop and commute. These trips are always processed in a certain area and the amount of travelers can be estimated based on the shopping facilities and the number of offices in an area. Furthermore the behavior of the travelers can be estimated based on the existing traffic flows. This is useful to analyze the characteristics of the traffic flows, which can be used to determine the necessary service characteristics.

Trips with a recreation purpose contain a lot of different reasons for transportation. It is necessary to get insight in the reasons why recreation trips are performed. It is hard to provide a decent and profitable service for this kind of purpose when the transport pattern is too diffuse and too small – so there need to be constant activities present in the area. The chances for CTS to be able to serve recreation trips are when there are a lot of activities that draw a lot of visitors or when other, less diffuse traffic flows are served as well.

Areas in which traffic occurs with shopping and commuting purposes can be suitable for a service performed by CTS. It is uncertain whether CTS can be profitable or useful in areas in which there are no shopping or commuting travelers. Of course CTS can be used by travelers with other purposes as well; this enlarges the chances for CTS to become profitable even more.

When shopping or commuting purposes do not occur in an area, it is uncertain whether CTS can be profitable, because traffic flows based on the other motives can be too diffuse – this holds for visit purposes and possibly recreation purposes. Possibilities for recreation purposes can be private applications – for example at exhibitions or in theme parks. It is also uncertain whether CTS can be profitable in areas with mainly business traffic, since it is expected that it is hard to get these travelers out of their car into a public transport mode. According to the data of the CBS, these travelers do not use any public transport mode.

The following paragraph determines markets for CTS in urban zones. These markets are based on traffic flows in urban areas and will be identified by matching the purposes for which CTS can be suitable with the purposes that occur in the different urban zones.

### 5.4.2. Markets for CTS in urban zones

The linkage of the information of the movements in urban areas to the traffic in the different urban zones determines in which zones CTS can serve passengers. In the last section is concluded that CTS can be suitable in areas in which in any case commuting traffic and/or shopping traffic occurs. These purposes occur in each identified zone. Furthermore, according to the analysis in paragraph 0 it is important that the activity level is high and that traffic is spread in space and/or time. The activity density is high in places where large centers for shopping or business are present. Another feature that can increase the chances of CTS in urban areas is when traffic cause problems for the quality of the environment or when there are large spatial problems such as congestion or parking space.
So, in short, chances for CTS in urban areas occur, when:

- the activity level is high
- there is spreading in time and/or space
- the covered distances are small
- there is an incentive for travelers to use CTS, this can be a policy or a problem perception of the traveler
- present traffic flows consist commuter and shopping traffic

There are four traffic flows identified in urban areas for which CTS can be suitable. Next, it will be analyzed whether the identified traffic flows for CTS can be suited with a service of CTS in practice as well. This will be determined on the basis of the chance that a certain trip purpose indeed is important in forming a traffic flow.

**Inner city traffic**

This traffic occurs in inner cities. In these zones, the activity level is high and all kinds of trip purposes occur. There are a lot of chances for CTS to contribute to the transportation system based on the criteria above. The activity level is high, which means that next to shopping and commuting traffic also other traffic purposes can be served. Since there are so many different kinds of traffic in these areas the spreading in time and space is also available. However, it could be that the service changes along the day: a more collective service during the peak hours and a more individual service during off peak hours. The completion of this service needs to be further examined. Often, the quality of the environment in urban areas is stricken by the amount of traffic in these areas. Next to this in peak hours the traffic flows are often very large. It can be possible that travelers perceive a problem perception, then the chances for CTS increase. It could also be possible that side policies are necessary to make people use CTS.

A problem with CTS in inner cities can be the lay out of the area. Often in these areas space is very dense. Possibilities need to be looked for to realize dedicated infrastructure in inner city areas.

**Suburban – center linkage traffic**

This traffic occurs on the border between the suburban and the city center. There are a lot of possibilities for CTS to serve this traffic, since there is often a lot of traffic that needs to reach the inner city. Problems that occur with traffic in inner cities occur with traffic that wants to reach the inner city as well. It can be desirable to look for possibilities to make the travelers switch from their own mode to CTS at the border of the city centre. This makes possibilities for CTS as well, since the travelers will be arriving at certain places. This facilitates the service that CTS can offer, since the network can be less complicated.

**Residential area collection and distribution**

The chances for a profitable service with CTS for this traffic are smaller than possibilities for CTS when it serves the previous called traffic flows. This traffic occurs at the border of the suburban areas. These zones are larger and the distances that need to be covered are larger. Furthermore the activity level in these areas is often smaller and more
spread. This makes the traffic flows less constant and less dense. Therefore it is harder to provide a profitable and suitable service with CTS. Furthermore, the problems that occur with traffic in these areas are often less large than in very dense areas. Parking problems can occur in these areas. However, it is not probable that CTS is suitable to solve these problems on short term, since the distances that need to be covered are larger and more spread and a service of CTS all over the area is not possible yet.

### Focal traffic I and II

This is traffic that comes from outside of the city. It can be suited by CTS, when it wants to go to the inner city. When this traffic wants to go to the residential areas the same problems will occur as when CTS has to suit residential traffic. However there are possibilities when there is a large business centre at the border of the city. In these areas parking problems can occur and problems with congestion as well. In these areas CTS can be suitable. Focal traffic can be lead to a central parking place or public transport entrance at which they can transfer to a CTS. This can also be useful for residential traffic with a commuter purpose that goes to these areas. In these areas the activity level is often very high and the distances that need to be covered are not too long.

In summary, every traffic flow can be suited by CTS, depending on the possibilities to realize infrastructure and on the choices of a municipality to reassess their system.

### 5.4.3. Modal split in urban areas

The performed analysis has shown that CTS can provide a service in urban areas for the existing traffic flows. Although it should be kept in mind that CTS cannot replace an existing transport mode, due its character and the impacts its realization brings along. Furthermore it can be expected that the use of CTS will be low compared to the use of other transport modes, when there are no side-policies designed to stimulate the use of CTS and to get people out of the private car into the cybercar. For example municipalities are not yet willing to free their inner cities of private car users (according to the interviews, appendix IX) and the functioning of transferia is not always satisfying.

CTS can be transport service which makes the existing functioning of the transport system more efficient on short term. Thus, on short term the share of CTS in the urban modal split will be low.

On longer term when people are used to CTS and when the possibilities to make infrastructure available or realize new infrastructure increase, the use of CTS can be stimulated. When this happens the share of CTS in the modal split can increase.

The current modal split in urban areas is shown in table 5.3. It can be expected that the first users of CTS are the current users of means of public transport, since they are used to transfer and collective traveling. Thus, at first the introduction of CTS will effect the share in the modal split of the current public means of transport. Furthermore it can be expected that CTS will influence the share of walking in the modal split.

When side-policies are introduced to stimulate car users to make use of CTS at least a part of their trip, the share in the total modal split of CTS will increase and the share of cars will decrease.
The following paragraph will show how municipalities view a service of CTS or another mean of automated transport that they have researched.

### 5.5. SERVICES FOR CTS IN DUTCH MUNICIPALITIES

From the interviews with the municipalities (appendix IX) can be derived for which service an automated transport system was designed. Municipalities choose for a CTS, because it can function as a feeder for a larger transportation mode. When they want to relieve the current transport system by creating a more extended system, they do not initially choose for CTS. There are several reasons for this. An important reason is the lack of experience with the performance of CTS in a network. Another important reason is the essential availability of free infrastructure. Infrastructure is scarce in many cities. Creating new infrastructure is hard to implement and very expensive. The last fact makes CTS less economic efficient.

Furthermore when a municipality wants an automated transport system to serve a larger area –for example at The Hague or Almelo - she chooses for another transport system. This system is based on the monorail technique and needs always its own infrastructure and cannot mingle with other traffic. An advantage of this system is that the average speed of a vehicle is higher than with CTS. An initiative to perform a feasibility study for CTS in the inner city of Delft was not yet executed. Resources to perform this study have not yet been found. A network for CTS in a historic city centre is one of the likely applications according to Janse et. al. (2003). The advantage of Delft is that its inner city already is for a large deal free of cars.

The traffic flows that should be suited by the systems are visitors into the city, commuters as well as recreation visitors. In inner city zones it is aimed at commuters
and shopping public. The areas that are served have a high activity density with spreading in time and space. In the Hague, spreading in time was not always possible. This was one of the reasons why an automated transport system was not realized.

5.6. RESULTS AND CONCLUSIONS FOR THE SERVICE OF CTS

The analysis to define a service for CTS has been concluded in this chapter. The second step of the research is finished. This paragraph will answer the research questions of the second step, which will be followed by short conclusions. With the answers to the research questions the second research step accomplished.

Answers to the research questions

- What can a service of CTS look like based on the characteristics of a service network and the service characteristics of CTS?

CTS will be able to perform a service for travelers that arrives spread in time and / or space. The service of CTS can be individual of collective and is on demand. The individual service is preferred, but can only be realized when the capacity of the infrastructure is sufficient and when the traffic flows are not too dense.

Since CTS is automated and does not necessarily depend on a schedule, but is on demand, it is possible to have exits all over the network. The cybercar is able to find its shortest route through the network, based on the demand destinations of the traveler(s) – this diminishes the detour factor. Depending on the lay-out of the network and the automated possibilities CTS is not bond to certain entrances and exits.

However, since CTS is bond to a specific network and infrastructure is scarce, the distances which can cover are probably short. The covered distances on long term can increase when more infrastructures is made available – for example, because cars have a dual mode. CTS can mingle with these cars, when they are in the automated mode.

In summary, a service by CTS can live up to specific user demands, but –on short term-only in a limited area.

- What transportation demand can be answered by a service of CTS, based on traffic flows in urban areas?

Based on the analysis of the traffic flows, CTS can perform a service for four kinds of traffic flows: all-purpose inner urban traffic, suburban-linkage traffic, focal traffic, focal traffic II. An efficient service can be designed when traffic flows at least exist of travelers with commuting or shopping purposes. These travelers will guarantee a constant flow of travelers.

CTS can provide a good service for travelers with demands on time, comfort, time and price, time and comfort, price and comfort. It is not certain whether CTS can provide a good service for travelers who find price the most important criteria of a service.

In summary: CTS can provide an efficient service, if the identified traffic flows are build of travelers with commuting or shopping purposes and for travelers with demands on every aspect, except for price on itself.
What can a service of CTS look like to serve transportation demand in urban areas?

Based on the service characteristics and on the transportation demand that can be answered with these service characteristics, possible services for CTS in urban areas are a line service or network service over short distance with a certain flow of passengers. Municipalities recognize several possibilities, from serving an autonomous flow to filling a gap in the existing transport system.

Conclusions for the second research step

It can be concluded that CTS can provide a suitable service in urban areas under certain conditions. CTS cannot replace existing means of public transport on short term, but due to its flexible character it can be used to design the current transport system more financially and socially efficient.

Since CTS covers short distances, the market share in the total public transport market will not be large in quantitative terms.

CTS can live up to most of the travelers demands. This is no guarantee that travelers will eventually use CTS. The use of CTS should be stimulated by flanking policies which focus on the choice a traveler has to make. The extra transfer that is created, because of the limited network CTS covers can be a drawback to use the system. Policies to make the transfer more comfortable will be necessary to satisfy the traveler. The innovative character of CTS can be a stimulant in the development of the system in urban areas, since people tend to choose a service on the basis of the status it brings along.

5.7. Introduction to the next chapter

With these answers and conclusions the second step of the research is concluded. An analysis of the service that CTS can provide is not enough to indeed realize a CTS in urban areas. The organizational feasibility of the development is important as well. The third part of this research focuses on the organizational aspects of the development of a new transport system in urban areas. This is elaborated in chapter six. In chapter seven success factors for a new transport system in urban areas will be generated based on the results of the second and third step of the research.
6. ORGANIZATIONAL DEVELOPMENT OF CTS

The previous analysis has shown that a service by CTS, based on the functional service characteristics in urban areas can contribute to the current transport system. However, it needs to be realized in urban areas. This paragraph is aimed at defining possibilities for the municipality to develop a system in her area. It performs the third step in the research.

![Diagram of Step Three of the Research]

Figure 6-1 Step three of the research

Therefore, paragraph 6.1 shows the development path of transport systems, which can also be used for CTS. Paragraph 6.2 describes what is necessary in the development of CTS to make it to the next development stage. Paragraph 6.3 elaborates the role of the different parties that are involved in this development. The emphasis is on the role of the municipality in this development. The third research step will be concluded in paragraph 6.4. The research questions will be answered and short conclusions will be drawn. Paragraph 6.5 introduces chapter 7 in which the results of the analyses will be presented.

6.1. THE DEVELOPMENT OF NEW TRANSPORT SYSTEMS

This paragraph shows which phases can be distinguished in the development of transport systems and at in which phase CTS is at the moment.

Phases in the development of a transport system

The introduction of a new transport system does not go in one step. It takes many years of development and experimenting. Moreover, not every transport system does come to full growth. The developments of transport technologies in the past have all gone through the same phases. These are, among others, described by Filarski (2004).
The following phases can be distinguished.

- **Pioneering stage** – experiments are being carried out with new means of transport and means of transport that are being improved. Many new developments do not get past this stage and quietly disappear.
- **Phase of rapid growth** – new means evolve to its final forms.
- **Dominant mean and has a large share** – the motor car is in this stage. Some means do not get into this stage but go from rapid growth to the decline process.
- **After a zenith a process of decline follows.** Some means are pushed into a niche in the market and still exist, some disappear.

Next to these phases Van Zuylen et.al. (2001) in Ouwehand et.al. (2003) distinguish seven phases in a process of innovation: Invention, test, first application, market introduction, maturity, decline and replacement. The progress of these phases can be graphically shown as follows. Figure 6-2 shows the life cycle of a transport system (Filarski, 1997).

![Life cycle of transport systems (Filarski, 1997)](image)

**Figure 6-2 Life cycle of transport systems (Filarski, 1997)**

Figure 6-3 shows the development of transport systems over the years. This figure also shows the increase in the number of traveled kilometers in the past century, among others because of the increase of travel speed and comfort. (Filarski, 2004) It is not expected that the demand of transport will decline.
The recognized phases by Filarski (2004) and Van Zuylen (2001) do not significantly differ. The phases of Filarski are useful because they show through which phases other transport systems went. The phases of Filarski will be used in this chapter to describe the development of CTS.

The current phase of CTS

A lot of developments take place in the field of automated transportation. In urban areas in the Netherlands mostly two systems of people movers are studied, according to the interviews that have been held. One system is aimed at transport on existing infrastructure with cars that should be able to mingle with conventional traffic – in this research called the CyberCar – and other one is a system based on the monorail. The main difference in the design of the system is the needed infrastructure; the CyberCar drives on asphalt and is lead by small magnets in the infrastructure, systems such as the monorail are lead by a rail. The second system always depends on the availability new infrastructure. The differences in physical lay-out of the system also have consequences for the service a system can provide. Many parties are developing different kinds of these systems – take for example the project of CyberMove in which several technical developers are involved.

It can be seen that a lot of developments are going on; furthermore the development of these systems is stimulated by national and international subsidies. These systems have not proven themselves in practice yet in spite of these many initiatives, except for the extensive pilot with the ‘Park shuttle’ at Rivium in Capelle aan den IJssel. Soon a second generation of this system will be realized to extend the knowledge and experience with automated transport systems.

The development of these systems expressed in the terms Filarski introduced, is in the pioneering phase. In the development cycle of Van Zuylen (2001) CTS is somewhere between the test and the market introduction. The Capelle case is close to the market introduction phase, but for a lot of municipalities automated vehicles are still in the test phase. They are studying whether a form of automated transport can contribute to the service they want to provide or not. No standardization has taken place yet in the
development. A lot of pilots and feasibility studies are being carried out in different areas by different parties with different subsidies that have different demands. This makes that the knowledge about the performance of the different systems is scattered. Furthermore it takes a lot of persistence to indeed realize a professional system or pilot. These aspects make that there is no standardization yet to determine which system can be used to meet specific demands. Therefore, it is not clear yet whether a system will make it to the following phase, when this will happen and which system(s) it will be.

There are several factors that determine whether CTS will make it to the next phase. This is described in paragraph 6.2.

6.2. **Step to the Following Development Phase**

This paragraph describes the possibilities to make a step to a new phase based on the theory of Filarski (2004) and on the theory about transition management (Rotmans, 2004).

6.2.1. **Factors to reach a new development phase**

It takes a long time for a new system to grow from the pioneering stage to the dominance stage. This is due to three factors (Filarski, 2004):

- the technology has to be improved and geared to the wishes of the customer
- an infrastructure network and a system of supporting facilities had to be built up before new means of transport could compete effectively within large areas
- a manufacturing process and operating practices had to be developed so that the means of transport became affordable for large groups of users

These three factors can also be applied to CTS. First, several user-needs analyses have been executed in order to gear the development to the wishes of the customers. Furthermore, the improvement of the technology continues in several European and national research programs by many participating institutes. Second, the development of the infrastructure is very difficult. A lot of cities have to deal with scarcity in space and have very few expansion possibilities for infrastructure. The possibility of CTS to drive on existing infrastructure can therefore be very positive. Only, this is not yet possible on short term. This makes that flanking policies are necessary to obtain the desired infrastructure or that space has to be found to realize new infrastructure. Third, there are very few real projects for CTS. A lot of the intended projects do not become a real project because of varied reasons. More projects need to be realized in order to make the system known by a large amount of people, to make it really cost efficient and thereby affordable for people as well as for governments.

Furthermore Filarski (2004) gives chances for success of the realization of a new transport system as well as failures. The step towards the following phase starts when a larger group of travelers starts to use the new mean of transport.

A transition takes place in the development of a system from the pioneering phase towards the dominance phase. Filarski (2003) calls the development and evolution of the different transport systems transitions. In order to reach sustainable mobility, the government wants to guide transitions. This is further explained in the next paragraph.
6.2.2. Transition towards sustainable mobility

The growth of transport not only brings advantages with it. Measures need to be taken to counteract the negative aspects of transport. That is why stricter norms for the environment, air quality, and accessibility of areas are designed. A lot of possibilities can be used to reach these norms and to improve the quality of urban areas. Automated transport is seen as one of these possibilities.

The development, evolvement and introduction of a new transport system have not followed a standardized path with determined steps to take in order to make the introduction successful. Changes in the transport system were often called transition. Transitions (Rotmans 2004) are "structural societal changes which are a result of developments that influence and strengthen each other in the field of economics, culture, technique, institutions and ecology.” A transition requires 25-50 years and consists of many small jumps that eventually can perform one large jump when they are all aimed at the same direction. This makes a transition a change in which the direction is clear, but the final destination is not. The changes in the transport system that took place in the past were often called transition. The transitions that have been identified to take place in the past received the predicate transitions after the transition had taken place. Thus transitions had not been steered.

In the "Nationaal Milieubeleidsplan 4” (Ministry of VROM, 2001) it has been concluded that persistent ecology problems only can be solved by transitions. Therefore the ministry of VROM is defining policies to reach sustainability in several fields. One of these fields is sustainable mobility. Even though the result of a transition cannot be predicted, the direction of a transition is known. The path that is characteristic for a transition is drawn in Figure 6-4.

![Figure 6-4 Course of a transition (Rotmans, 2004)](image)

The phases Filarski noticed in the development of transport systems can be presented by the same graph. Many possibilities follow the road towards sustainable mobility. Therefore, the end of the stabilization phase is a view that has to be specified along the way. Automated vehicles are seen as one of the possibilities that can contribute to the development of sustainable mobility (Chapter 3) – and can therefore be seen as one of the path that form the transition towards sustainable mobility. It is expected that the
evolvement of these systems follows the path of a transition as well because a lot of steps need to be taken in development from the pioneering phase towards the dominance phase. The contribution of automated transport towards sustainable mobility can be sketched as follows.

Reasons for the expected, needed transition for CTS to come to full growth are a lot of uncertainties on the technical, functional, organization and societal fields. The professional performance of the system is uncertain because of several reasons:

- no system has proven itself yet in a professional application
- the effects of the contribution to the current system are unknown, since a professional application has not been realized;
- the behavior of customers and the willingness to use the system is only known for the pilot projects
- the willingness of a broad range of governments, financers and producers to put a lot of effort and energy in making a broad introduction of these system is uncertain

Since there are so many uncertainties in the development of CTS it is not possible to say whether or when CTS will reach the next phase in its development. Another important aspect of the success of a system is the flexibility during the development phase to adjust to user-needs. Finally, Rotmans (2003) states the success of a new system depends on the contribution to the solution of a problem.

Several governments want to steer the transition towards sustainable development. The next section shows where the several governments take place in the transition.

**Transitions on governmental levels**

Several governmental authorities are involved in the transition towards sustainable mobility. It is expected every authority goes through its own transition. Therefore there is a time dependency in the development of sustainable mobility. When an idea is initiated on a high governmental level it takes a lot of time before it is really implemented on operation level in a municipality. This is because the lower governmental authorities depend on resources and regulation on the plans and possibilities of the higher authorities. Of course these lower authorities have influence on the agenda of the national and international authorities since they are the authority that knows best what problems and possibilities are in their communities. Therefore this time dependency and the dependence between the different authorities is sketched in Figure 6-5.
Next to the governmental parties, private parties are also involved in the development of CTS. The roles of these parties will be described in the following paragraph.

6.3. **PARTIES INVOLVED IN THE DEVELOPMENT OF CTS**

This paragraph explains which parties (public and private) are involved in the development of CTS and in what way. First, the governmental participants will be described. In the second part the private parties will be described.

6.3.1. **Governmental participants**

All levels of governmental organisation play a role in the development of CTS. This research is mainly aimed at the role of the municipality. In this paragraph the roles of the other governments in the development of CTS are shortly described. The role of the municipality is further elaborated.

Every governmental party is involved in the development of new transport systems. This is graphically shown in Figure 6-6.
European government

The European government is in several ways involved in the development of sustainable mobility. It designs guidelines for participating countries in order to stimulate the sustainable development. Furthermore they facilitate and subsidise a lot of framework programs in which projects can be executed to develop and test new systems. The focus of these projects varies largely - from the introduction of people movers in cities (EDICT, 2000) to projects in the field Information Society Technology (IST program, 2000) and projects in the field of environment and sustainability (EESD, 2003). Projects to develop CTS take part in these programs. In the past in the EESD and at the moment several new projects are initiated.

National government

The national government undertakes activities to develop sustainable mobility as well. Several resources can be found that stimulate the development of sustainable and / or innovative forms of transport. For example the department MOVE from SenterNovem. SenterNovem is a Dutch agency office from the Ministry of Economic Affairs that grants subsidies for innovations.

The department MOVE is responsible for the requests in the field of transportation. Almost every ministry that is related to traffic, sustainability or innovations grants subsidies for developments in the field of automated transport. However, often these subsidies are only granted when an organization wants to do an innovative research. This means, for example, that feasibility studies for the development of the ParkShuttle in urban areas is no longer funded by MOVE, because a lot of information about the
feasibility of these systems is already known (www.move-mobiliteit.nl, 23 March 2005). A subsidy request would be more interesting for MOVE to grant when it is about the realization of a system in an urbanized area (R. Lindeman of MOVE, 23 March 2005)

Furthermore, the national government initiates transition arenas. One of these arenas is aimed at the transition towards sustainable mobility. (www.vrom.nl) These arenas are networks of experts and stakeholders, representatives of governments, companies, civil society organizations and research institutes. A network in which these participants are represented is called TRANSUMO. They perform a knowledge development program in several clusters. The ultimate goal of TRANSUMO is to reach an international trendsetting knowledge network in the field of mobility in the long run (www.transumo.nl; 2 April 2005). In this network participants bring in knowledge and resources to perform cluster related projects.

In summary, the national and international governments initiated programs and grant subsidies for the development of sustainable transportation, and finally in the case of urban transport, regional and local governments need to realize and exploit these developments. These initiatives and role of the regional authorities and the municipalities are explained below.

Regional authorities

The responsibility for traffic and transportation in urban areas lies at a regional level. In practice, the responsibility and distribution of tasks can differ per authority inside the legitimate restrictions. Since 1 January 2005 “kaderwetgebieden” have become WGR-plus regions. These regions are legally bound in the Joint Regulations Act (Wet Gemeenschappelijke Regelingen, WGR). Responsible administrative agencies at regional level are called ‘WGR-plus+ regions’. The Netherlands counts 19 WGR+ regions. The twelve provinces and seven densely populated areas that have been split from the provinces receive a BDU ‘Brede gemeenschappelijke Doeluitkering’. These regions have several tasks in the field of traffic and transport, spatial planning and economic development. The BDU finances the tasks in the field of traffic and transport. (Remkes, 2002) The tasks of a WGR plus region are:

- The synchronization of and cooperation with the performance of responsibilities of a municipality in spatial planning and traffic and transport policies: designing a regional plan for traffic and transport, financing regional infrastructure and the exploitation of traffic and transport.
- Spatial planning, urban renewal, housing, the allotment of houses and the physical post of the ‘grote stedenbeleid’.
- Economic development, acquisition and spatial policies for businesses, agencies and retail.
- Environmental policies and investments in regional vegetation

Only the first point is relevant for all the regional authorities. The responsibilities for the last three points depend on the specific characteristics of a region.

Furthermore, the regional authorities have a duty in supporting the municipality in the finance of the infrastructure and the execution of the tender procedure. They have several ways to provide finances, but this is far less than what national government used to make available. According to the interviews, a regional authority will be able to finance 50% of infrastructural investments while the national government was able to finance 90-95% of these investment costs (appendix VIII. interview Almelo).
Furthermore, the regional authority needs to pay the losses on the exploitation to the operator. The cost cover degree of conventional public transport is around 35 percent. This means that 65% percent of the cost of conventional public transport cannot be covered by merits of the travellers, but have to be paid by the government. The regional authority needs to pay these costs from the BDU. They receive this fund from the Dutch government. When a project is more expensive than 225 milion Euro’s the Dutch government becomes responsible for the project. (Ministry of VROM, 2004) The funds that the regional authority has at its disposal are granted by the national government. These funds tend to decline, because of the cuts of the national government. Because of the loss of resources the regional authorities now have to make a consideration whether the development of automated transport is financially feasible or not.

In summary, the municipality depends on the WGR+ region in the realization of public transport, infrastructure and the tender for as well regulation as resources. However, the municipality plays an important role in this WGR+ region. Municipalities choose their own representatives and the daily governing board consists of councillors and majors of the municipalities in the region. This can be drawn from the organizational structure of a WGR+ region according to the interviews with these regions and the website of the WGR+ region of Amsterdam (www.roa.nl).

Results from the interviews for role of the regional authority

From the interviews it can be concluded that regional authorities rarely undertake any actions to stimulate or initiate projects in the field of sustainable mobility. In the developed plans of a regional authority there has been little mention yet of the development of new transport systems. This has several reasons: e.g. the reason for Stadsregio Rotterdam is the responsibility for the development of transport lies with the operator who needs to design a system that is economically feasible and is sufficient according to the tender. The WGR+ region around The Hague has no policy to develop new means of urban transport because of sustainability – the existing system with trams and buses with smut filters contribute to sustainability.

A very important aspect in granting tender for both WGR+ regions (Stadsgewest Haaglanden and Stadsregio Rotterdam) is the economical feasibility. The regions always consider the economical feasibility against the extra wishes of an operator. At this moment an automated transport system has rather large investment costs and its result and returns are not yet proven – except for in several pilot projects. However, the operational costs are expected to be far lower than a bus system. Both WGR+ regions agree with this. Nevertheless, the uncertainty about the performance of a new system makes investors cautious to invest when a government does not back them, and this makes regional governments cautious to grant a concession to an operator of an automated system. This can be a large drawback for the further development of these systems. The municipality of Rotterdam has put a large effort in convincing the Stadsregio Rotterdam of the necessity of their role in the further development of clean transport systems since the Stadsregio draws the conditions for the granting of a tender. They can build in an incentive for operators to develop cleaner or innovative ways of transportation.

The municipalities have a lot of influence on the composition of the regional authority. They also have their own structure and tasks in the field of traffic and transport. The functioning of a municipality and structure of the organization and the roles in the development of automated transport systems are described below.
A municipality

A municipality depends for a lot of aspects on the resources of a regional authority. However, the municipality is the government that knows and recognizes the local transportation possibilities and problems best. Below, the structure of a municipality is explained, the roles a municipality has in the development of public transport and the policy departments that are involved in the development of transportation. Finally the roles and motives of a municipality in the field of sustainable mobility are described.

Domains in a municipality

A municipality is an extensive organization that is build of several domains. These are, according to Hiemstra (1996), based on Tops, Moorman (1996): a professional domain, a public domain and a political domain. The professional domain is composed of the official part of the municipality, the political domain is composed of the Mayor, Councilors and the City Council and the public domain is composed of several organized or non-organized citizens. There is a representative relation between the public and political domain, because citizens choose their councilors. Therefore in this research the public is not taken into account as an actor. It is presumed that their interests are reflected by the City Council.

There is a service relation between the professional domain and the public domain and there is a controlling relation between the political and the professional domain. However, this last relation is not only controlling but also steering because the political domain takes guiding initiatives from the professional domain (Hiemstra, 1996). The relationships between these domains are shown in Figure 6-7.

![Figure 6-7 Domains in the local democracy](image)

According to Tops, the authority of the political domain becomes less obvious. Citizens want to have a say about matters that influence them directly. A tendency that the official and administrative bodies integrate further and further becomes visible. This change can also be seen in practice – policy departments partly develop their own plans, but the political perception and political support stays essential to realize a new and innovative project. The interviews showed that the support of the Council and alderman is indispensable for the success of a project. They are often able to influence the public opinion.

On administrative level one or more alderman is involved in the development of new transport systems. How many aldermen are involved depends mainly on the policy fields
that are involved in the development process. The next section describes the policy fields that can be involved in the development of CTS.

**Involved policy fields in the development of CTS**

Many policy fields are involved when a new transport system is developed because, as can be seen in chapter 3, transport influences a lot of aspects in the society. The main fields are identified: spatial planning, traffic and transportation, environment and economic affairs.

The department of traffic and transportation is mainly involved in the development of CTS – they design views on the future of transportation based on their knowledge of the subject and the experiences in practice. Spatial planning and urbanism have to deal with traffic because space and infrastructure is needed in order to process traffic and to park cars and public means of transport. The environment has to deal with traffic in its policy, and vice versa, because traffic harms the environment and can harm the health and quality of the living space of inhabitants, due to emissions, smell and noise nuisance. These effects increase when congestion occurs. Businesses often benefit from good accessibility, which allows them to host and visit customers and relations. When business thrives, the economic affairs often thrive as well.

**Results from the interviews on the involved policy fields**

From the interviews it can be concluded that the involved policy fields of a municipality often are bedded in the department for urban development. This department is subdivided in several smaller divisions, such as “traffic and transportation”, “spatial planning” and “urbanism”. It occurs more and more that these policy fields are integrally developed.

Next to this, cooperation with other departments becomes more important as well, but does not yet occur at every municipality. The integration of policy fields is also shown by the development of municipalities, according to Hiemstra (1996), where the managers of the departments have to feel a responsibility for the organization as a whole. Although the integration of policy departments appears more often, it seems not very common yet – as can be derived from the interviews. A reason can be the individual planning processes of the old departments which often had to convince related policy departments of their plans.
Furthermore, according to the interviews, the goals of the departments not always correspond and departments are still trying to find a way how this integration can be embedded in their policy. The same holds true for the policy departments at the regional authorities. They have to design a regional spatial plan (‘streekplan’) and a regional traffic and transportation plan (Regionaal verkeer en vervoersplan, RVVP), but these plans are not yet integrally developed. However, the regional authorities explained that initiatives from other parties (e.g. the municipality) to make an integral design for a new region are always taken into consideration.

Because more policy fields are involved, more aldermen are involved as well. The alderman with “traffic and transportation” in his file is mainly involved, but also the alderman responsible for “urban development” or “urban renewal” has a large share in the development of CTS. Especially because the integration of traffic and spatial planning becomes more and more important for densely set up areas or areas that want to concentrate their constructions in spatial design. The aldermen take a very important position in the success of the development because they have eventually the most influence on the decision. They have to defend their policy in the City Council and are responsible for the executed policy in their field and have to publically justify it.

The domains in a municipality give her several roles. These are described next.

The roles of a municipality

The municipality consists of three domains, each of which plays its roles in the organization. Several authors wrote about the roles of a municipality in general as well as on the field of transport policies. A very general description is given by Geerlings (1997). According to Geerlings (1997) the roles of a municipality can be subdivided in three. One is the representative of the collective interest that she has to serve. Second is the player in the field with other parties in order to realize new projects and third she is the regulator of administrative policies.

Kennel (2003) notices that the role of a local government changes. This makes that the role appears to be ambiguous. On one hand, the role of a municipality is diminishing due to the loss of power: “Local government no longer plays an exclusive role as the leading policymaker in a particular local setting. City governments are now more than before merely one of many actors in the governance arena, competing for control of agendas and access to resources.” (Healey, 1997). On the other hand, local government can also be described as the ‘key player’ and ‘central actor’ (Smith, 2000) in the urban governance arena. Kennel describes new roles for the government due to these changes. First, the local government has to frame the agenda for an open and broad discourse on local issues. The process of the agenda-setting has to be orientated on issues meeting the needs of the local community. Second, it has to coordinate and manage the network of participating parties. It has to ensure that the “weak” but important partners are participating. Third, the municipality needs to create an atmosphere that enables actors to cooperate. When conflicts occur due to the increasing number of actors, the municipality has a role in facilitating the negotiations. So, governance more and more occurs in networks.

The strong position of the municipality is not based on its formal position, but on its success in fostering cooperation and bridging the gaps in the fragmented political landscape. The interviews show the same developments. Ouwehand (2001) agrees with
this and adds that governments have a role in keeping the rapidity in the process and in keeping the processes democratic.

In summary, it seems that the power of a municipality not only lies in its formal position, but also in its managing position. This can be seen in practice of the development of sustainable mobility as well. Even though the responsibility for public transport shifts to the regional authorities, the role of a municipality is very important in the development of CTS in urban areas, because: they know the city best, have insight in the problems and effects due to transportation and have decent insight in transport policies and their effects. They also have less responsibilities and dependencies in the field of exploiting and tendering new concessions. This makes them more independent towards the functioning of the transport system and enables them to search freely for other options. Because of these reasons, a municipality is often initiator of projects or processes to look for better ways to solve their problems.

Its role as initiator, its large interest in the success of a project and therefore its commitment to the project and their knowledge of the city in all her aspects often makes a municipality a good process manager. Municipalities are also often a stimulator of the development and of the willingness to accept a new system by the public, since especially their administrative body can have a large influence on the public opinion. As stated before, the influence and support of aldermen is indispensable for the success of a project.

Motives for a municipality to develop automated transport

According to the interviews there are several reasons why a municipality wants to develop an automated transport system in its area. However, some reasons have a bigger influence on the successful realization of a system than other reasons.

Most of the municipalities recognize a problem in the field of the further development of transportation, due to several reasons: accessibility of urban areas because of congestion, the unlocking of an area and sustainability in residential areas due to negative environmental effects of transport. Next to the problem perception, the improvement of the image of a city and the expected economic gains that can come forth out of the improvement of the image can be a reason to develop automated transport. However, this cannot be the only reason.

One of the conclusions in Eindhoven has been that the leading party needs to have a large interest in the project that is likely to weigh up against the risks. (Ouwehand & Van Zuylen, 2003) Stadsgewest Haaglanden agrees with this. Sometimes a municipality designs a long term vision for their transport system and urban development. In this vision problems can be expected. A new transport system can contribute to the solution of this problem and these problems can also serve as a motive to study a new transport system (according to the municipality of Almelo). This is agreed by Ouwehand in an article of the DTO-KOV (2001).

So, often the municipality is initiator of studies for the possibility of sustainable transport in urban areas, because they recognize the problems most of the time. However, this task and the essential knowledge should also shift slowly to the regional authorities. Sometimes this is the case and sometimes it is not, for example, at Stadsgewest Haaglanden. This authority is responsible for the tender for public transport, but also for the design of the public transport system and the services. Therefore they have a lot of knowledge about the possibilities of the design of a transport system. In the Stadsregio
Rotterdam and at the Regional Authority of Amsterdam this is not yet the case. They describe the conditions for the system in their concession and leave the design to the operator. The operator knows its market best. However, the development of automated transport most of the time has to go in close cooperation with the regional authority, because they are the main financer.

**Conclusion on the governmental part in the development of transport**

The previous paragraph showed that the several governmental levels have a complex and extensive role in the development of transport.

The non-transparent and comprehensive structure of regulation, financing and legislation, can make the government an unreliable party in the development of new transport systems. Important factors for the success of a transportation policy are the power of the municipality in its playing field and the effects of this power and proposed policies on other players in this field (Filarski, 2004). Reliability is important to reach this. (Ouwehand, 2001)

In the past the role of the government according to Filarski (2004) varied greatly in the transformation process. This depended on the country, mode of transport and era. The development of new means of transport was mainly influenced by technical possibilities and consumer reactions, but the readiness of government to invest in new means of transport could accelerate the diffusion process. When making predictions, it has to be taken into account that the government will intervene in the transformation process more than before to ensure that environmental and social requirements are met. The activities of the governments in every field validate these premises.

The overview of funds and resources that are available at other governmental levels show that municipalities have a lot of places where they can find resources in order to be able to pay the investment costs and feasibility studies. Municipalities need to go look for these subsidies, because otherwise it is hard to realize new infrastructure for automated transport. Furthermore the overview shows that a municipality needs to search thoroughly for suitable subsidies, which takes a lot of time.

A drawback of the detailed description of the funds in combination with the necessity of a municipality to find resources for every project they want to undertake is that municipalities often go for more possible funds. This means that the focus of a project can change and the chances for the development of automated transport can diminish. This was the case in Beverwijk, according to ANT (appendix IX).

Next to the difficulties with finding and collecting subsidies, the regulation around tender procedures for infrastructure as well as the exploitation of transport is very complex which can slow down the process. Furthermore, the experience of the licensor of concessions—the regional authorities—in the field of automated transport is often little. The uncertainties about the economic feasibility, the high investment costs and the unfamiliarity with the system lower the chances for automated transport.

The following graph shows the way regulations and resources are divided between the several governmental institutions and the dependencies of the municipalities.
This figure shows that a municipality can only place requests and has no resources or say of its own in the development of transport systems. However, the municipality does not only depend on other authorities. Also private parties play a role in the development of CTS in urban areas. These participants are shortly described in the following paragraph.

6.3.2. Private parties

In the last paragraph the public parties involved in the development of automated transport are described. The role of the private parties is also an important one and will be clarified in this paragraph.

Designers and manufacturers

The development of CTS and other automated transport systems are further initiated by designers and manufacturers. They have a lot of knowledge about technical possibilities. Therefore often the introduction of a new system is often technology driven. During the development phase of a new system the supply side and the demand side of the market where the system will be introduced have to combine their possibilities and wishes for the further introduction.

Knowledge and research institutes

Knowledge and research institutes can fulfill an important role in bringing the knowledge and necessities of the parties together. They can design ways to introduce the new product to the market in a way that the public as well as the private parties’ wishes are
combined in the product. Furthermore they can be a place where comprehensive knowledge can be stored systematically. Moreover, they can provide this knowledge to a broad range of participants in the development.

**Consultants**

Since consultants perform projects for many organizations and authorities they are an important knowledge centre for bringing parties together and spreading experiences that they gathered in the different studies. Furthermore they can fulfill the role of process manager or supporter of the process manager of the municipality.

**Municipalities and private initiatives**

Of course a municipality can try to get money from private parties for the payment of the infrastructure and the exploitation. Several incentives to let a private party cooperate in the development of automated transport are possible. For example a better accessibility of their properties or the possibility to diminish the parking space in their area because car users can access their property very fast from another parking lot. Since parking space is very expensive, it can be attractive to invest in the development of automated transport when this leads to more space to develop businesses. (Almelo, Appendix IX)

However, when a transportation project becomes too extensive (larger than 200.000 Euro’s – interview A. Vermie, Appendix IX), a municipality is obligate to tender. This holds for the infrastructure as well as for the exploitation. However the national government thinks of possibilities to make exemptions in the obligation to tender publicly when innovations can be stimulated. (http://www.kpvv.nl/, 23 March 2005). Furthermore sometimes the national government gives exemptions in the tender obligation, because it can be better to grant a concession to an operator that is involved in developments in the field of transport in an urban area on the long term. This is, for example the case with the concession for the tram system in The Hague – HTM got the concession because they are involved in the development of RandstadRail, of which exploitation the is due to start in two years. (Appendix IX) Also the European government has possibilities to elude from tender obligations. This is when a project is executed inside a European program or when a project only can be realized by one private party. Of course, municipalities can steer towards these possibilities.

**6.4. RESULTS AND CONCLUSIONS FOR THE ORGANIZATIONAL DEVELOPMENT**

This chapter elaborated the third part of the research. With the answers and conclusions on the research questions, the research steps have been accomplished. The answers will be defined in this paragraph.

**Answers to the research questions**

The final research questions will be answered in this paragraph.

- What does the development of new transport systems look like?

Every transport systems has gone through similar stages in their development. Four stages can be recognized: pioneering stage, Stage of rapid growth, dominance stage
and a decline after a stage of zenith. Just a few transport systems make it to the dominance phase. At this moment CTS and other means of automated transport are still in the pioneering phase. It is not certain yet whether, which and how forms of automated transport will make it to the phase of rapid growth. This depends on three factors. The question whether CTS can live up to these factors and will make it to the following stage cannot be firmly answered, because of the many uncertainties in the development of CTS.

The development of transport systems can be described as a transition. For a successful transition, it is essential that a system the contributes to the solution of a problem. Municipalities hardly see sustainability as a very large problem that they can solve by reassessing their transport system and implementing new, more sustainable modes of transport. Therefore this is not a problem yet on operational level. Municipalities recognize other problems in their transport system, that they want to solve. The development of CTS can contribute to the solution.

- What are the roles and possibilities of the municipalities in the development of transport systems?

The responsibility for development of urban transport systems lies at the WGR-plus regions. The municipality is only responsible for the realization and maintenance of the local road infrastructure. However, mainly due to the problem perception a municipality encounters, the involvement, ideas and commitment of a municipality is essential for the further development of CTS. Her role is strengthened since regional authorities do not yet initiate activities to develop it. A role for the municipality can be in setting the agenda and inviting necessary participants.

The motives of a municipality to develop a new transport system are not only derived from a problem perception, although the presence of a problem perception is necessary for a successful introduction of CTS. Other important motives are the improvement of the image of the city and knowledge development. The contribution to sustainability can be a catalyst to the development of the system, but is rarely an initial motive.

Since the municipality has no own responsibilities on the development of transport, they have also very few resources for the development of a new transport system. They depend for financial resources on the regional or national authority, depending on the extension of the project. Another way to receive financial resources is by subsidies and funds from programs of authorities and agencies. These funds are often bond to a specific purpose which can be a drawback for the development of CTS. Furthermore the availability of funds is diffuse over many authorizations. Therefore the search for funds is difficult and time-consuming. Municipalities do not only steer at achieving content and problem related subsidies. They also steer at financing possibilities that can solve their problem partly or in another way. These searching policies are a result from this diffusion and the demands that are associated with the grant of the subsidies. The municipality depends on regional, national and European authorities for legislation.
Conclusion on the results

The organizational development of CTS is very uncertain, just like the chance for CTS to grow to the next development stage. A problem perception is necessary to perform a successful development process of the realization of CTS in urban areas.

The role of the municipality in the development of CTS in urban areas is essential. Without commitment of the municipality the development is doomed to fail. However, because of the organizational structure of public transport in urban areas, municipalities have no official role anymore and depend therefore on higher governments. Thus, the development of CTS in urban areas depends on the commitment of the municipality, but only the commitment of the municipality is not sufficient to realize CTS.

Possibilities for municipalities to design new urban transport system are hard to find. Financial resources are scarce, spread and bond to specific, strict requests. The regional authority does not stimulate the development of new urban transport systems, because of the financial risks and the chance that the system is not economically feasible. These characteristics are a drawback for the organizational development of CTS.

6.5. Introduction to the following chapter

Based on the performed analyses that have been elaborated in the chapters 4, 5 and 6 the research steps, necessary to define conditions for success and failure of the development of CTS, are concluded. The main results of the analysis of the service can be found in paragraph 5.5. The main results for the organizational development can be found in paragraph 6.4. These results will be used to fill in the framework that has been presented in chapter 2. The following chapter will define the conditions for the development.
7. DEFINING CONDITIONS FOR SUCCESS AND FAILURE

This is the final part in the research, in which the successes and failures of CTS will be developed, based on the performed analyses. The results of the analysis which have been performed can be found in chapter 5 and 6.

In paragraph 7.1 the framework of Van der Panne (2003) will be filled in with results of the analyses. Paragraph 7.2 the successes and failures will be deduced from the information that has been assembled in the framework. The last paragraph will give a short reflection on the success and failures and an introduction to the following chapter. As is explained in chapter two, with success and failures is meant the conditions for success and failure of the development of CTS.

### 7.1. A STRUCTURE FOR CRITICAL FACTORS FOR INNOVATIONS

By use of the framework of Van der Panne et. al. (2003) factors related to the development of innovations can be structured in order to determine success for this innovation. This paragraph shows how the framework will look like in this research an fills in the framework. Chapter two has elaborated the theory behind the framework.

Van der Panne et al. (2003) distinguishes four different groups of features. The identified features can be split according to the two analyses that have been performed: first, features derived from the development of a new service by CTS and second, features derived from the role of the municipality when it wants to develop a new transport system. In the framework, the features are split up in two as well. Features derived from the service that a CTS can offer, determine the commercial viability and are therefore divided in product related factors and market related factors. Features that are derived from the role of the municipality determine the technological viability and are therefore divided in firm related factors and project related factors. Since this research did not focus on the developer of CTS but on the problem owner, the municipality, technological viability is not the most proper term to use. Organizational viability is more suitable for the context of the research.
The framework as it will be used in this research is presented in Figure 7-2.

![Diagram showing factors and their interrelations](Figure 7-2 A framework to develop conditions for successes and failures for innovations (Based on Van der Panne, 2003))

The results of the analysis will be split over the four factors as follows.

Organizational viability
- **Firm related factors**: description of the different governmental parties and the roles they perform in the development of new transport systems (Table 7-1)
- **Project related factors**: the possibilities and dependencies of the different governmental parties – based on their structure and responsibilities (Table 7-2)

Commercial viability
- **Product related factors**: service characteristics of CTS (Table 7-3)
- **Market related factors**: the contribution of a service by CTS to the current transport system (Table 7-4)

The following paragraphs describe the organizational viability (paragraph 7.1.1) and the commercial viability (paragraph 7.1.2). Paragraph 7.1.3 describes the involvement of other parties. There are no features identified for these parties based on the framework, because the analyses do not provide these features. However, insight in the influences that these private parties can have in the development of CTS is necessary to determine the chances for success or failure.

### 7.1.1. Organizational viability

The firm related factors and the project related factors determine the organizational viability. The features of the regional and higher authorities are taken into account as well, since a municipality has no direct say in the development of public transport anymore, but depends on the other authorities.
Table 7-1 Firm related factors

<table>
<thead>
<tr>
<th>Authorities Factors</th>
<th>Municipality</th>
<th>Regional authority</th>
<th>Higher authorities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organizational structure</strong></td>
<td>Responsible Council, executing policy departments</td>
<td>Responsible daily board, executing policy departments</td>
<td>Many Ministries responsible for small part</td>
</tr>
<tr>
<td></td>
<td>Alderman take place in regional board</td>
<td>Daily board exist of aldermen municipalities/ or chosen representatives</td>
<td>Responsibility at different Ministers</td>
</tr>
<tr>
<td></td>
<td>Structure changes: integrating policy fields, political domain less obvious, influence citizens increase</td>
<td>Integrating policy fields – economy, spatial planning, transport and traffic</td>
<td>Several departments involved in the development of innovations / new transport systems</td>
</tr>
<tr>
<td><strong>Role</strong></td>
<td>Initiator, facilitator, process manager, stimulator, problem owner</td>
<td>Financer of transport in urban areas (BDU), granter tender</td>
<td>Granting resources (BDU), developing subsidy programs, designing tender legislations</td>
</tr>
<tr>
<td></td>
<td>Main local authority</td>
<td>Responsible organ for development and regulation public urban transport</td>
<td>Stimulating new developments, creating possibilities for new developments</td>
</tr>
<tr>
<td></td>
<td>Problem owner several local policy fields, knowledge expert in own city</td>
<td>Every authority fills in its responsibilities for development public transport differently</td>
<td>Developer of legislation</td>
</tr>
<tr>
<td></td>
<td>Bring in local wishes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Motives</strong></td>
<td>Improving transport system (e.g. accessibility, unlocking specific areas) improving image city, developing long term vision</td>
<td>Economic consideration for granting tender very important</td>
<td>Introducing sustainable mobility</td>
</tr>
<tr>
<td></td>
<td>Sustainability is hardly a motive – more a catalyst</td>
<td></td>
<td>Stimulating innovative developments</td>
</tr>
</tbody>
</table>

Table 7-1 gives a structured overview of the different organizations and their motives to develop a new transport system. From the table can be concluded that all authorities are necessary in the development of a new innovative transport system in urban areas, because of the resources that have to be shared and the different stimulating possibilities that are available at the different organizations. The following table (Table
7-2) shows the dependencies and possibilities of the different authorities to develop a new transport system.

**Table 7-2 Project related factors**

<table>
<thead>
<tr>
<th>Participants Factors</th>
<th>Municipality</th>
<th>Regional authority</th>
<th>Higher authority</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependencies</strong></td>
<td>Regional authorities: legislation, financial resources</td>
<td>Policy fields municipality: cooperation, knowledge about urban transport systems</td>
<td>Minister controlled by House of Representatives</td>
</tr>
<tr>
<td></td>
<td>Higher authorities: legislation, financial resources</td>
<td>Higher authorities: financial resources (BDU)</td>
<td>Citizens: choose house of representatives</td>
</tr>
<tr>
<td></td>
<td>Citizens: elections, acceptance of a system</td>
<td>Political field municipality: Alderman take important place in daily board WGR-plus regions</td>
<td>Financial department: Scarce resources / cutting of payments</td>
</tr>
<tr>
<td></td>
<td>Policy organ: Different, independent, internal policies</td>
<td>Private party/ operator: knowledge about new means of transport</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Political organ: Support alderman necessary for development</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Takes part in daily board regional authority</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private parties: Receiving knowledge about new means of transport accidentally</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private parties: Received knowledge is not complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Available funds and granting of funds – to the disadvantage of other municipalities</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Possibilities</strong></td>
<td>Influencing public opinion by convincing alderman</td>
<td>Designing tender regulations</td>
<td>Designing stimulating regulations for development</td>
</tr>
<tr>
<td></td>
<td>Influence in daily board regional authority</td>
<td>Development of infrastructure</td>
<td>Designing development programs</td>
</tr>
<tr>
<td></td>
<td>Finding programs for the development of CTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Receiving subsidies for a project</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Development of infrastructure</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Committing highly to the project</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
From this table can be concluded that the municipality has most dependencies in the development process. Furthermore it shows that citizens have an important say, due to the democratic system in the Netherlands. In this research it is presumed that the authorities represent the citizens. The influence of the citizens is therefore no longer taken into account. Next to this, the regional authority depends highly on financial resources. Therefore its main consideration in granting a tender is on the basis of the economic feasibility.

**Results for the organizational viability**

The organizational viability can be determined on the basis of the identified factors.

The organizational viability of CTS is very uncertain, due to the following facts:

- No authority has a clear responsibility in the development of new transport system
- Every regional authority fills in its responsibility differently
- The responsible – regional - authority has no incentive to develop new means of transport
- The economical consideration when granting a concession is very important – the cuttings on the BDU strengthen the need for an economic consideration
- The available subsidies and funds are scarce and bond to specific demands – municipalities have to compete for the same subsidy
- The knowledge about the different systems is spread and not available at every authority – often because an authority accidentally meets a supplier and becomes familiar with the system

The organizational viability can increase if:

- The municipality is a decent process manager that can assure the speed in the process and is able to gain commitment of involved parties
- The regional authorities gets better acquainted with problems and possibilities of urban transport and the side-effects, so they depend less on the knowledge of the municipality
- The authorities are able to influence the public opinion
- The influence of the alderman in the regional daily board leads to concessions of the regional authority
- The knowledge about different systems is present in a broader field of decision makers / responsible authorities
- Finding and receiving of possible financial resources for municipalities will become easier
- Legislation for automated transport systems is settled

It can be concluded, that organizational viability is not very certain, mainly because of scarce financial resources, an uncertain process, the diffuse spread of knowledge and the lack of legislation and experiences.

**7.1.2. Commercial viability**

The commercial viability can be determined by product related factors and market related factors. The product related factors focus on the technical features and system functionalities of the CTS itself. The market related factors focus on the contribution of a service with CTS to the current transport system.
Table 7-3 Product related factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relative price</strong></td>
<td>Low operational costs – when a high number of vehicle kilometers are supplied (Filippi, 2003)</td>
</tr>
<tr>
<td></td>
<td>High investment costs compared to realizing a bus line, lower than investments for a metro (Filippi, 2003)</td>
</tr>
<tr>
<td></td>
<td>Due to lower costs, flexible service is possible</td>
</tr>
<tr>
<td></td>
<td>Travelers motives “work” and “shopping” need to be present to provide a decent service in order to provide an efficient service</td>
</tr>
<tr>
<td><strong>Relative quality</strong></td>
<td>Covers short distances, so extra transfer necessary for passengers</td>
</tr>
<tr>
<td></td>
<td>Short waiting times / high frequency, due to “service on demand”</td>
</tr>
<tr>
<td></td>
<td>Better door-to-door service, shorter detour</td>
</tr>
<tr>
<td></td>
<td>Can be unreliable due to few experiences</td>
</tr>
<tr>
<td></td>
<td>Service possible in several zones for people with demands on Time, Price and Comfort</td>
</tr>
<tr>
<td></td>
<td>Individual transport possible – when capacity is sufficient and affordable</td>
</tr>
<tr>
<td></td>
<td>Expected contribution to sustainable mobility on long term with flanking policies</td>
</tr>
<tr>
<td><strong>Innovativeness</strong></td>
<td>High – no professional system proven yet in the Netherlands / several techniques combined in one system</td>
</tr>
<tr>
<td></td>
<td>Development is in (uncertain) pioneering stage</td>
</tr>
</tbody>
</table>

This table shows that the development of CTS brings along a lot of uncertainties, because of the lack of professional experiences. The relative quality that CTS can deliver is quite high – apart from the extra transfer that the use of it brings about.
Table 7-4 Market related factors

<table>
<thead>
<tr>
<th>Factors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration of target market</td>
<td>The traffic market (supply of infrastructure) is very concentrated – available infrastructure is scarce</td>
</tr>
<tr>
<td></td>
<td>There are a lot of public transport services that are not yet economic efficient</td>
</tr>
<tr>
<td></td>
<td>Most public transport services are collective or expensive</td>
</tr>
<tr>
<td>Competitive pressure</td>
<td>CTS can provide an individual, on demand service with short waiting times – high quality public transport service compared to a bus</td>
</tr>
<tr>
<td></td>
<td>The introduction of CTS parallel with the introduction of ADA</td>
</tr>
<tr>
<td>Marketing</td>
<td>CTS can improve the image of a city</td>
</tr>
<tr>
<td></td>
<td>CTS can provide an individual, on-demand, door-to-door service (on long term)</td>
</tr>
<tr>
<td></td>
<td>The innovativeness can contribute to the economic development</td>
</tr>
<tr>
<td></td>
<td>New towns (spatial planning) with new means of transport</td>
</tr>
<tr>
<td>Contribution to current market</td>
<td>CTS can provide a service when the activity level in an area is high</td>
</tr>
<tr>
<td></td>
<td>CTS can provide a service when the traffic flows are spread in time and/or space</td>
</tr>
<tr>
<td></td>
<td>CTS can provide a feeder function where the bus is not socially or financially efficient</td>
</tr>
<tr>
<td></td>
<td>CTS can provide an individual door-to-door function in a space where cars are prohibited</td>
</tr>
</tbody>
</table>

This table shows that CTS has chances on the existing transport market. However, since infrastructure is scarce the chances on the traffic market seem to be lower. It does show that CTS can contribute to the current market when certain conditions are met. Furthermore, CTS can contribute to side goals of a municipality such as image, accessibility, design of space and transport, contribution to economic development.

Results for the commercial viability

These tables show that CTS can be commercially viable. The commercial viability of CTS is present, when:

- There are parts in the current transport market that can not be served by conventional urban transport
- It is possible to make existing infrastructure available or realize new infrastructure for CTS to provide an individual and on-demand service.
- CTS gets the chance to become more reliable and cheaper by experiences in practice
- The exploitation is long enough to get the return-investments – the operational costs are lower than a bus
CTS becomes less commercial viable, when:

- It is not possible to experience with CTS furthermore
- When other means of transport become cheaper
- When no free infrastructure can be made available

So, the chances are best when CTS is designed to serve a specific traffic flow where its characteristics can provide a surplus value above the existing urban transport systems. These possibilities can be found in places where conventional urban transport is not economically or socially feasible.

Based on the organizational and commercial viability, success and failures for the development of CTS can be defined. The combination of organizational and commercial viability towards successes and failures will be presented in the next paragraph.

### 7.1.3. Involvement of other parties

In the previous tables the participation of other parties has not been taken into account, because the perceived information in this research about other parties in the development is not suitable for the framework that has been used. However, their involvement is very important for a successful realization.

The system developing party is important to give insight in the technical features and the possible system functionalities. A drawback of the involvement of this party is that the technology push is very important for him – he wants to sell his product. The competition between the different developers does not improve the standardization of the system and spread of knowledge about the different system that are available.

The operator is important, since he needs to provide the service and is responsible for the cars and their performance. He should be stimulated when offering for a concession.

Consultants / advisors can be used as a process manager, since they are merely independent: they have no direct interests in selling the product or realizing a new system.

Knowledge platforms can be used to get a broad range of involved parties together and to collect and store their knowledge. The storage of knowledge should be with one organ that is accessible for every party involved. The government can fulfill a role in facilitating this service.

### 7.2. Successes and Failures for CTS

Based on the previous paragraph successes and failures can be identified for CTS in urban areas. First successes will be elaborated and then the failures. The successes and failures can be divided in successes respectively failures for a municipality, for CTS in urban areas and for the combination of the possibilities of a municipality and the development of CTS.

As described in chapter 2, successes are features in the organizational development of CTS as well as the technical/ system development of CTS that can stimulate or even accelerate the development and actual realization of CTS. Failures – as they are used in this research - are features in the development of CTS that can prevent or delay the further development or realization of CTS.
7.2.1. **Successes for CTS**

The success can be subdivided in organizational, technical /functional and integrated features. In this paragraph these successes will be formulated.

**Organizational success**

A very important condition for success is commitment of the municipality to the development of a new transport system. This has several reasons: the municipality has a lot of knowledge about the problems with and possibilities for urban transport systems, and the municipality is responsible for flanking policies. Therefore the municipality should be able to design an adequate agenda, keep progress in the process and get the relevant parties involved.

Albeit the internal structure of a municipality changes towards the integration of political and policy field and the say of the policymakers becomes more important, the support of an alderman in urban areas stays essential for a successful development of CTS.

Influencing the public opinion is important, since the role (the say) of the citizen in large projects increases. A successful alderman is the proper person for this job.

The reduction of barriers to find financial resources and the specific demands that resources are bond to – for municipalities as well as regional authorities – improves the chances for success of CTS.

Receiving insight in the possibilities and impossibilities on the field of legislation is important to make the risks and the different responsibilities explicit when a project is realized.

The integration of policy fields and cooperation between policy fields is important, since transport and traffic have effects on more policy fields than just traffic and transportation. The design of a new urban area can make this integration easier.

Finally, the cooperation between the municipality and the regional authority is important for the development of a public transport in general in urban areas. So the responsible party can reckon with the wishes of the municipality in its policies and tendering.

**Technical / functional success**

A very important success for the development of CTS will be the available transport market in urban areas where CTS can provide an adequate and efficient service, socially as well as financially.

Another chance to improve the success of CTS is the availability of free infrastructure.

The possibility to perform a high quality, frequent and flexible service, due to the automated character of the system, forms a large chance for success of the development of CTS in spaces where the service of a bus is not socially or financially feasible.

**Success by combining organizational and technical features**

It is very important to diminish the uncertainties in the development of CTS. An excellent possibility to increase the confidence in the system and to diminish the uncertainties and risks is the realization of the system more often. This will also diminish the costs of the implementation of the system. Furthermore, more people are able to use the system, when it is realized more often. The larger the group of users of CTS will
be, the sooner CTS will grow from the pioneering phase towards the phase of rapid growth. (Filarski, 2004)

CTS can fill a gap in the transport system on short term. On longer term, when the need for sustainability becomes more urgent, it is expected that CTS can provide a part of the suitable solution for mobility in this field as well. The contribution of CTS to solving two problems (at least partly) improves the chances for CTS. The technical features of CTS can contribute to the policy fields of the municipality and other authorities.

Another important factor is the systematical and central storage and spread of knowledge. This storage should exist of different, available automated systems and its functionalities and of organizational experiences.

The design of a new area can increase the chances for success of CTS, since it is easier to integrate infrastructure for CTS in the spatial design.

Of course, the main factor for success is eventually the acceptance of the user. This acceptance can be influenced by informing the user of the possibilities, designing flanking policies and getting the future user involved in the design process of the functionalities.

7.2.2. Failures for CTS

Next to the successes for the development of CTS, failures can be determined as well. In this paragraph the failures will also be divided in three parts.

Organizational failure

If one of the participants in the development project has no problem perception on transport, the realization of CTS will fail – only the improvement of the image of a certain city or area is not enough to realize the complex introduction.

The lack of cooperation of regional authorities is a failure for the development of CTS. The responsible authority for the development of transport systems in urban areas, the WGR-plus regions, should be stimulated to build in an incentive in their concessions for operators to improve the development of new transport systems.

A drawback for the development can be the anxiousness of politicians to stimulate the development of new transport systems, because of the uncertainties that these investments bring along. (Ouwehand in report DTO-KOV, 2001).

Technical / functional failures

If it is not possible to develop new infrastructure or to free infrastructure for CTS it can not be realized on short term.

When vehicles with ADA are not introduced on large scale, the mix of ADA and AVG in dedicated areas is not possible. This makes it harder to free more infrastructures and expand the infrastructure network for CTS.

When CTS cannot be tested, the technical failures cannot be solved and the reliability of the system cannot be proven.

When the features of the market do not match with the service characteristics of CTS a system cannot be realized – unless flanking policies are introduced.
Failures by combining the organizational and technical features

When decision makers have no knowledge and / or faith in the possibilities of CTS the realization will probably fail.

When the organizational barriers are too high – no insight in legislation, no funds – and no infrastructure is or can be made available, the introduction will probably fail.

When organizations design a service based on the technical system in stead of designing a system based on a problem, it will be hard to define a suitable service and to get insight in the broad range of possibilities that automated transport system can offer.

Finally, a very important organizational failure is the lack of commitment of parties involved, since the development is technically and organizationally very complex.

7.3. CONCLUSIONS AND INTRODUCTION TO THE NEXT CHAPTER

Through defining conditions for successes and failures for the development of CTS the final research step has been concluded.

Summary of conditions for failure or success

The following conditions for success and failure have been defined

The regional authority is the main responsible for the development of transport systems in urban areas. She hardly takes initiatives on the development of new forms of transport. The consideration of the regional authority for granting a concession is mainly based on the economical feasibility of this concession. Furthermore the regional authority has not the largest interest for designing a new transport system in an urban area – since she is not confronted and responsible for the side-effects of transport. These features do not stimulate the development of new systems.

The knowledge of municipalities about the different systems and their applications seems limited. The knowledge about these systems is diffuse and is not received systematically by a large group of parties on operational level. Receiving knowledge often goes accidentally. The development of a new system in an urban areas seems technology pushed as well.

Many different automated transport systems are available. No standardization has taken place yet about the likely applications that these systems can fulfill according to the technical conditions and accompanying system functionalities.

Innovations, among others automated transport systems, are not stimulated when the financial consideration is decisive for the development, when finding financial funds are restricted to specific demands and when financial funds are not central available but spread over various institutions and governmental departments on every level.

Private initiatives can be complicated, because of the lack of suitable regulation and legislation around automated transport and because of the complex tender procedure and its demands.

Short conclusions on the conditions for success or failure

A successful development of CTS can not be guaranteed when all conditions for success are present. Moreover, not every condition has to be present to all the time to make a development successful. It is difficult to determine which features are most important,
since every development process is custom made and depends on its own demands, functional characteristics and organizational characteristics. Therefore, the development of CTS in urban areas cannot be performed by fixed steps.

It can be concluded that combining the technical development of CTS with the organizational development is very important for a further growth of CTS in the transport market. Otherwise the development can never be geared to the wishes of the user. Another important, essential feature is the presence of a problem perception when a development track is started. And perhaps the most important conclusion for success can be the necessity of parties to commit to the length of the project, regardless of the complexity.

At the end of every chapter the conclusions of the different steps have been drawn. General conclusions on the research and recommendations for further research will be defined in the following chapter.
8. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the final conclusions on the research and recommendations for further research in this field. The separate research questions and short conclusions have been drawn at the end of each chapter. This chapter will define general conclusions (paragraph 8.1) on the research and recommendations for further research (paragraph 8.2). The final paragraph will give a short reflection on the research and its results.

8.1. GENERAL CONCLUSIONS

Several general conclusions for the development of CTS in urban areas can be drawn on the basis of the whole research. The general general conclusions will be followed with a conclusion about achieving the research goal.

A transport market for CTS in urban areas

The current experiences with CTS have only been in pilot projects. These were aimed at niches in the transport market. The view of the development of CTS has been to pull the development out of the niches and to implement an urban, network wide service in which cybercars can move freely and can mix with other traffic with an automated character – private cars with ADA for example.

It can be concluded that the uncertainties in a professional performance of CTS are very large. Municipalities and other decision makers are not yet willing to implement CTS on a large scale at once. However, interviews with the municipalities have shown that the current transport system has several niches that can not be served economically or socially sufficient with the current means of transport. Municipalities and WGR+ regions recognize the possibility to serve these flows with an automated transport system. Due to the automated character CTS will be able to perform a high frequent and flexible service on demand. Characteristics which cannot be provided by other transport possibilities when the financial feasibility is important.

Therefore it can be concluded that the development of CTS may not be possible yet over the total urban area, but can be used to improve the performance of the total urban transport systems for the operator as well as for the user.

The organizational development of CTS in urban areas

It can be concluded that the development of CTS in urban areas depends on the commitment of the municipality, but only the commitment of the municipality is not sufficient to realize CTS. In despite of the few responsibilities of municipalities in the development of urban transport system, their role is indispensable in the development of them, because their knowledge about their city and commitment to solving a problem with the current transport system.

Since a municipality has no financial resources on its own to realize a new systems, other ways need to be found. Many funds and programs that focus on the development of new transport systems, initiated by national or international governments are available. However, these initiatives are often hard to find and bond to very specific demands. This can be a drawback for the development of CTS, because of several reasons. Municipalities do not always have resources and people available to perform an extensive search for the decent subsidies. Since municipalities are mainly bond to
external resources, they will take every available fund which can contribute to the solution of their problem one way or the other. Thus, it can be expected that the choice for a certain solution is based on the available financial resources and not on the quality of the solution.

The legislation for automated transport systems is not finished yet. Legislation has to be designed on every governmental level and influences each other – European legislation stands higher in range than national legislation etc. Therefore the European legislation has to be designed on a tactical level, before the legislation on an operational level (national authorities) can be designed. The lack of legislation hinders the realization of these systems on a large scale.

The design and path of the process forms a large deal of the success of the realization of CTS. The support of the political body, and especially the responsible alderman, is essential for the realization of the project. Being able to convince the public opinion creates a large chance for success. Furthermore a committed problem owner with high interest in the realization of the project is needed. The process manager needs to be backed by other participants and needs to have a lot of credits in its environment.

Finally, developing CTS from a solutions perspective is the main condition to fail a project. Most important for the a successful development of CTS is its contribution to the solution for an identified problem.

The realization of CTS in urban areas

Automated transport is not a clear mean of transport that is considered when designing a transport system. The choice for an automated transport system depends on the knowledge of a municipality of a certain system. However, the choice should depend on the analysis of the characteristics of different systems to find a satisfying solution to a certain problem.

The lack of a compilation of knowledge about different systems and the lack of standardization of the different systems are important explanations for the technology driven character of the development of CTS and other automated transport systems.

An important reason for the lack of standardization seems to be that a successful integration and realization of an automated transport system is not because of the excellent match that is created between transport supply and transport demand. It is because of the success of the cooperation between different parties in the process. A lot of projects came not to realization, because of process related drawbacks. Because of the little experience outside the pilots, the systems are not standardized and not proven yet. Therefore the development of a system in urban areas depends mainly on the path of the process and knowledge of a municipality, instead of on the match between the supply and demand in the transportation market.

Further development of functionalities CTS

It can be concluded that CTS has advantage that be used to improve the current transport system. Therefore it seems useful to develop CTS further. However there is a discrepancy in this development. It is necessary to realize CTS more often in order to improve the system and make it suitable for urban areas and for consumers. At the moment, The impacts of the realization of CTS are large and the risks are high. A standard for CTS to make the development cheaper, more reliable and easier can only be achieved when the realization is impossible. Therefore, anyone should be willing to take the risks to make CTS evolve to a mature system.
Evolvement of CTS
At the moment, CTS is at the pioneering stage and the expected share in the modal split when it will be realized is small. It is not certain whether CTS will make it to a next phase and will become dominant eventually. The different functionalities of CTS make a broad range of services possible. But the uncertainties about choices that will be made in the future for further development and the uncertainties about changes in the environment in which CTS is developed, make it impossible to draw conclusions about the final result of the analysis. This makes the development a true transition in which the direction is known and the destination unknown. The reflection will elaborate on this.

The achievement of the research goal
The goal of the research has been described as follows.

| Define conditions for success and failure for the development of CTS in urban areas, by identifying and analyzing the contribution of a service by CTS to the transport services in urban areas and by identifying and analyzing the possibilities of municipality to development a new transport system |

The reason for this goal was the lack of knowledge about the development of CTS in urban areas and the role of the municipality in this development. It can be concluded that the goal has been reached, since it was possible to define conditions for success and failure for the further development of CTS.

It can be concluded that a service by CTS can contribute to the current transport system. The development of CTS to contribute to sustainability is not proven and is not an important condition for a municipality to develop it. The service it can offer is more important. The technical advantages and possibilities are no guarantee for success. The evolvement of the process is even more important. Every process has its own characteristics, participants and resources. Thus a successful development of CTS depends on the choices that are made along the process. Conditions for success and failure have been derived to increase the chances for successful development. However, it should be noted it is not possible to design a general planning of the development of CTS on the basis of these conditions. The research turned out that, even though there are many possibilities for a successful development, there are also many uncertainties present in the technical, functional and organizational development of CTS. The identified conditions should be taken into account when a system is designed since they can give insight in the pitfalls of the development and in necessary conditions.

Recommendations have been defined to create possibilities to develop CTS further and to make a realization more reliable.
8.2. Recommendations

Several recommendations follow out of this research and can contribute to the further development of CTS.

A custom made process

Both the analysis of a possible service and the interviews have shown that there can be a place for CTS in the current transport market. Due to the many uncertainties the development of CTS stays a custom made process. The analysis in this research which shows traffic flows and travelers that can be suited with CTS can be used to define flows for which CTS can be suitable in urban areas. For each new projects needs to be quantified what the service should look like – the capacity of the cars, collective or individual service, scheduled in place and time or not –, what the contribution to the problem can be and whether it will be financially feasible on longer term.

In order to make good use of CTS, its design should be placed in the total design of the urban transport system and not in just a small niche that is not yet served. So municipalities should integrate their spatial design with the design of traffic and transport systems to make fully use of the advantages that the different available means of transportation can offer.

Adjust to users wishes

The wishes of the user are very important for a successful development of CTS. CTS causes an extra transfer on short term – since it covers only short distances. The willingness to transfer of a user is in general not positive, but depends on a lot of factors as well. The willingness to transfer should be researched as well as ways to comfort the transfer.

When CTS is realized more often, the reactions and suggestions of users can be analyzed. The functionalities of the system can be adjusted to these reactions.

Designing a decision support system

Another important necessity to make good use of CTS is to be able to make an objective consideration whether to use the system or not. An objective consideration is hard at the moment, since there are a lot of different systems and functionalities and the knowledge about these systems is widely spread. Knowledge development and the dissemination of knowledge about automated transport systems are necessary to assist in this consideration. An overview of the technical possible systems and their accompanying functionalities makes it for municipalities easier to approach a problem from a broader point of view. This enables them to define the place of the different transport systems – conventional and automated - in the total transport system.

Therefore, the storage of knowledge about systems, their impacts and functionalities should be structured and easily accessible. A decision support system can be designed on the basis of this knowledge to enable decision makers to make a choice out of the broad range of available transport systems.

In order to design a useful system, not only the technical and functional knowledge of a system should be used. It should be tried to design a system in which experiences and knowledge of parties involved are processed. That way, an integrated decision can be made.
The results of this research, the identified conditions for failure and success, can be used in this decision support system, in order to take pitfalls and chances into account. In order to use the conditions to make decisions, they should be specified / operationalized.

Furthermore a lot of knowledge can be derived from projects executed by the cooperation of parties from every field - private companies/ financiers, technical developers, research and knowledge institutes, governments and consultants. The formation of these alliances should be stimulated to increase knowledge about the complex development and to create chances for successful development by cooperation of different parties. An example of such an alliance can be Transumo – an establishment of public and private parties that focuses on ways to realize innovations in transport and on whom this innovation can realize. (www.transumo.nl)

The design of the system can be done by research or knowledge institutes. The storage of knowledge should be with organizations where decision makers can easily access the information and with organizations that support decision makers already in their choices, e.g. by the Knowledge Platform for Traffic and Transport (KPVV).

The long term vision of CTS

This research has not elaborated on the long term possibilities for CTS: the coverage of a large urban network. However, the following recommendations to stimulate the research to the possibilities and the development of a network system for CTS can be draw:

- keep the possibility open to expand an existing line of CTS towards a more complex system and broader area
- spread the knowledge about the differences in functionalities of the automated systems that can perform a network bond service in urban areas
- perform further research to the possibilities of CTS in a network compared to other systems.
- The development of ADA parallel to CTS can create possibilities for increasing the market share of automated transport systems. A larger market share improves development chances.

An important reason for the developing parties of CTS was its expected contribution to sustainability. This contribution is not firmly proven in this research. Further research to this contribution is necessary. However, the research has shown that CTS can also be a good solution for certain transport problems. CTS can make a large developing step, if it is developed to contribute to the solution of transport problems on short term, if the contribution of CTS to sustainable mobility will be proven and if sustainable mobility becomes more urgent in the policies of municipalities. The knowledge and experiences with CTS will give CTS a possible lead in the development of sustainable mobility in urban areas.

The step to the next development stage

It has been concluded that the development of CTS is a transition and that many aspects are necessary for CTS to make it to the next phase. It is expected that the switch of users of public modes is necessary to develop CTS. Furthermore, travelers need to change their behavior. So, the use of flanking policies is necessary to make people choose. The experiences of the common users of public means of transport in combination with flanking policies can contribute to a switch of a larger group of
passengers. Flanking policies can be aimed at making the use of CTS more attractive or making the use of another system less attractive.

**Stimulants to develop new transport systems**

Local and regional governments are cautious to develop CTS, because of the uncertainties the system brings along. Municipalities and regional authorities acknowledge the possibilities of the cheaper operation, but this advantage does not counterbalance the uncertainties. Therefore regional authorities should stimulate and be stimulated to develop new transport systems, with among other CTS.

Since the financial feasibility of a system cannot be guaranteed on short term, due to uncertainties in the development, this should not be a drawback for the development. Therefore financial resources for the development of CTS should not be limited to standard governmental investments. Furthermore the demands for granting financial resources (funds and development programs) should be less strict and should be easily accessible. This can be stimulated by creating an overview of available funds and make this central available. Second, the knowledge received in the different sponsored projects should be stored as well and can be used to make the decision support system more accurate.

It should be remembered by financing parties that the development in one case cannot be compared to a development in another case. The cases can learn from each other, but are not the same and neither will be a third case. Therefore finances should not only be available to develop a new system, finances should also be available to develop the same system in a different context or to develop a system further. An innovation has not suddenly become common sense after one or two practices.

This research mainly focused on the possibility of CTS to contribute to the current transport system. However, since transport has many influences in very different fields the contribution of CTS to the function of these fields should be researched as well. – for example the economic contribution due to the innovative character, the influence on spatial design and urban renewal.

There are a lot of possibilities to stimulate the further development of CTS and to make a development successful. However, this research could not give a milestone or next step. It could only give a direction – contributing to the problems in the current transport systems. It is presumed that designing a milestone is not possible, since the development of CTS can be characterized as a transition. However, the user of CTS is eventually most important. When they do not make use of the system, the development has had no success. Most important recommendation for a successful development of CTS should be: try to realize the system in a way that it contributes to the solution of a problem and try to gain users reactions about and suggestions to improve the service. The ability to make the users enthusiastic about CTS by integrating their demands in the system will be a very large part of the success. Therefore the formulation for a next milestone in the development of CTS can be “reaching the reversal in the development of CTS from technology driven towards transportation demands.” A first step has been made with this research, since it showed the possible service of CTS on the demand side of the transport system and gave insight in the roles and possibilities to realize a public application.

The following paragraph can gives a short reflection to the research.
8.3. **Reflection on the Research**

This research started with the believe of developing parties of CTS, that CTS contributes to sustainable mobility in urban areas. Furthermore it was assumed that the development of sustainable mobility was so urgent that this contribution could lead to a successful development of CTS. Therefore a milestone for an the integrated development of CTS in the urban transport system should be designed.

It turned out that it was hard to define a milestone. Remarks as "what is its contents?", "what do you take into account?" and "why is CTS such a useful system?" turned the focus of the research towards the possibilities that CTS can offer – a service by CTS in urban areas. Reasons have been that the introduction of CTS only because of its expected contribution to sustainable mobility is too narrow. Insight in the possible transport services is needed well. Second, it is impossible to define the possibilities for a municipality to develop CTS when the possibilities of CTS are not known – there is no process without a content.

On this basis, conditions for success and failures have been designed. However, due to the elusive process, an action plan with different milestones on a time axis for the development of CTS cannot be developed. Developers should make use of the defined conditions, but cannot use them as their main guideline, since these features are conditions for success, no guarantees. Every project is different: another environment and other participants.

CTS can contribute to parts of the urban system. Technically speaking, CTS will become able to perform a flexible, high quality service over a large range in urban areas. Whether it is possible for CTS make it to such a service depends mainly on the adoption by the users and on choices involved participants are willing to make. Before CTS will make it to the dominant stage, a lot of choices favoring the development of CTS need to made. But perhaps these choices turn out into the possibility to visit a city center that is not congested by cars or harmed by emissions and that is still well accessible with system that provide an on demand and frequent service. Such a city does not need to look like the designs made in the sixties (U.S. Department of Housing and Development 1968), but can look like the current, trusted city.
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Automated transport in Urban Areas

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ACRONYMS

The following acronyms have been used in the report.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTS</td>
<td>Cybernetic Transport Systems</td>
</tr>
<tr>
<td>FAV</td>
<td>Fully Automated Vehicles</td>
</tr>
<tr>
<td>ADA(S)</td>
<td>Automated Driver Assistance (Systems)</td>
</tr>
<tr>
<td>AGV</td>
<td>Automated Guided Vehicles</td>
</tr>
<tr>
<td>BDU</td>
<td>Brede doeluitkering (in Dutch)</td>
</tr>
<tr>
<td>VROM</td>
<td>Ministerie voor Volkshuisvesting, Ruimtelijke Ordening en Milieu</td>
</tr>
<tr>
<td>V&amp;W</td>
<td>Ministerie van Verkeer en Waterstaat</td>
</tr>
<tr>
<td>WGR-plus</td>
<td>Wet Gemeenschappelijke Regelingen – plus Joint Regulations Act</td>
</tr>
<tr>
<td>KPVV</td>
<td>Kennisplatform Verkeer en Vervoer Knowledge platform Traffic and Transport</td>
</tr>
</tbody>
</table>
I. DEFINITIONS FOR SUSTAINABLE MOBILITY


Als mobiliteitsontwikkeling in het bijzonder aan dezelfde voorwaarden voldoet als duurzame ontwikkeling in het algemeen, namelijk het voorzien in de mobiliteitsbehoeften van de huidige generatie, zonder daarmee voor toekomstige generaties de mogelijkheid in gevaar te brengen om ook in hun mobiliteitsbehoeften te voorzien.

2. World Business Council for Sustainable Development (www.wbcsd.org)

The ability to meet the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values, today or in the future.

3. The European Union uses this definition in their EXTR@ project

A transport system and patterns that can provide the means and opportunities to meet economic, environmental and social needs efficiently and equitably, while minimizing avoidable or unnecessary adverse impacts and their associated costs, over relevant space and time scales.


Sustainable mobility is the dividing line between the positive and negative aspects of mobility. It involves utilizing the benefits of mobility for society and the economy without further depletion of scarce resources.
II. SUSTAINABLE MOBILITY INDICATORS

Table II-1 Sustainable indicators (Bryld, 1997)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Driving force indicators</th>
<th>State indicators</th>
<th>Response indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promoting sustainable human settlement development</td>
<td>Rate of growth of urban population</td>
<td>Per cent of population in urban areas</td>
<td>Infrastructure expenditure per capita</td>
</tr>
<tr>
<td></td>
<td>Per capita consumption of fossil fuel by motor vehicle transport</td>
<td>Per cent of population in urban areas and population of urban formal and informal settlements floor area per person</td>
<td></td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td>annual energy consumption</td>
<td>Proven mineral reserves</td>
<td></td>
</tr>
<tr>
<td>Changing consumption patterns</td>
<td>share of natural resource-intensive industries in manufacturing value added</td>
<td>Proven fossil fuel energy reserves</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lifetime of proven energy reserves</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intensity of material use</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Share of consumption of renewable resources</td>
<td></td>
</tr>
<tr>
<td><strong>Transfer of environmentally sound technology, cooperation and capacity building</strong></td>
<td>Capital goods imports</td>
<td>Share of environmentally sound capital goods imports</td>
<td>Technical cooperation grants</td>
</tr>
<tr>
<td></td>
<td>Foreign direct investments</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>Emissions of greenhouse gases</td>
<td>Ambient concentrations of pollutants in urban areas</td>
<td>Expenditure on air pollution abatement</td>
</tr>
<tr>
<td>protection of the atmosphere</td>
<td>Emissions of sulphur oxides</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emissions on nitrogen oxides</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Consumption of ozone depleting substances</td>
<td></td>
<td></td>
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</tbody>
</table>
III. TECHNICAL ROADMAP OF THE DEVELOPMENT OF CTS

- **system functions**
  - reliable
  - comfortable
  - dedicated track
- **energy**
- **obstacle detection**
- **navigation**
- **comm. control**
- **legislation certification**
- formulation national legislation
- international coordination
- idea legislative framework

Figure III-1 Roadmap to sustainability (Van Hylckama Vlieg et al., 2003)
IV. CAUSAL RELATION DIAGRAMS

This appendix shows the causal relation diagrams that have been used to clarify the relations between the factors that are related to the development of transport systems and the development of transportation demand. Several non-scalable factors can be found in the diagram. These factors are used, since they are influenced by a transport system or transport demand. The explanation of the diagrams has been described in chapter 3.3.

The first diagram is drawn to sketch the impact of CTS on the infrastructure and the transportation demand.

![Diagram showing the influence of CTS on physical infrastructure]

*Figure IV-1 Influence of CTS on physical infrastructure*

The purpose of the second causal diagram is to show the causes of transportation demand, its effect on accessibility and on aspects of sustainability.
Figure IV-2 the effects of transportation demand in urban areas
V. PARTNERS IN CYBERCARS AND CYBERMOVE

(www.cybercars.org; www.cybermove.org)

<table>
<thead>
<tr>
<th>Company</th>
<th>Description</th>
<th>Participates in</th>
</tr>
</thead>
<tbody>
<tr>
<td>A&amp;E Autos and Energy</td>
<td>A specialist in electric vehicles</td>
<td>Cybercars</td>
</tr>
<tr>
<td>CN Serpentine S.A.</td>
<td>The developer of the Serpentine automated transportation system</td>
<td>Cybercars</td>
</tr>
<tr>
<td>DITS</td>
<td>Dipartimento Idraulica Trasporti e Strade, University of Roma, &quot;La Sapienza&quot;</td>
<td>Cybercars</td>
</tr>
<tr>
<td>Fiat Research (CRF)</td>
<td>the research branch of the Italian car manufacturer, involved in many projects on driving assistance as well as on car-sharing and electric vehicles</td>
<td>Cybercars</td>
</tr>
<tr>
<td>Frog Navigation Systems (NL)</td>
<td>world leader in automated transportation of goods and people, who has developed and operated the ParkShuttle</td>
<td>Cybercars</td>
</tr>
<tr>
<td>GEA</td>
<td>Groupe d’Etudes en Aménagement</td>
<td>Cybermove</td>
</tr>
<tr>
<td>INRIA</td>
<td>a leading French research institute in computer science and automation and home site of the experimentations</td>
<td>Cybercars</td>
</tr>
<tr>
<td>ISR</td>
<td>Instituto de Sistemas e Robotica, University of Coimbra</td>
<td>Cybercars</td>
</tr>
<tr>
<td>Robosoft</td>
<td>a French high-tech company involved in advanced robotics and imbedded computer systems and manufacturer of the CyCab</td>
<td>Cybercars</td>
</tr>
<tr>
<td>RUF Denmark</td>
<td>an engineering company in Denmark which is developing dual-mode vehicles, fully automated on dedicated tracks</td>
<td>Cybercars</td>
</tr>
<tr>
<td>Technion</td>
<td>a leading technical university in Israel, with a specialty in environmental impacts of transportation</td>
<td>Cybercars</td>
</tr>
<tr>
<td>TNO</td>
<td>a large research organization in the Netherlands, with many activities in the field of transportation</td>
<td>Cybercars</td>
</tr>
<tr>
<td>Transportation Research Group (TRG), University of Southampton</td>
<td>where the transportation department has a large experience in the evaluation of new transportation technologies</td>
<td>Cybercars</td>
</tr>
<tr>
<td>Company</td>
<td>Description</td>
<td>Participates in</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>University of Bristol</td>
<td>a leading university which is developing the Ultra, an automated transportation system based on electric cars</td>
<td>Cybercars, Cybermove</td>
</tr>
<tr>
<td>YAMAHA</td>
<td>Yamaha Motor Europe N.V., manufacturer of automatic electric vehicles</td>
<td>Cybercars, Cybermove</td>
</tr>
<tr>
<td>GRIFFITH University</td>
<td>A university in Australia</td>
<td>Cybercars, Cybermove</td>
</tr>
</tbody>
</table>
VI. TEN SITES TO EXPLORE CYBERCARS

The following sites for CTS have been realized in the project Cybercars and Cybermove. (Allessandrini, 2004) For each site, the kind of application is named and the accompanying service that can be generated (I1 etc.) The explanation of these services can be found in chapter 5.1

Antibes – park shuttle – I3
Bayonne – park shuttle – I1, I3, C1
Coimbra – hill top, linking new car park and train station with city centre – C... I3
Copenhagen – city wide application – I3, C1
Lausanne EPFL – campus mobility and link metro – C2
Nancy
Ouchy – metro linking with museum/ promenade – I2
Rivium – shuttle link – C1
Haifa – Technion university mobility – C2
Werfenweng (Austria) – only inner city transport system – I2

Figure VI-1 sites in the projects CyberMove (www.cybercars.org)
Abstract

One of the first people mover systems in the Netherlands is the ParkShuttle system. The ParkShuttle is a low-capacity automatic navigating vehicle that operates without any physical guidance. It finds its own way automatically and travels on a simple ground-level asphalt track. This innovative form of passenger transport is ideally suited for short-distance feeder transport to public transport stations. Pilot projects were implemented at a long term car park (P3) at Amsterdam's Airport Schiphol and business park Rivium in the city of Capelle a/d IJssel (near Rotterdam). The ParkShuttle and the CyberCab are products of 2getthere, a subsidiary of Frog Navigation Systems.

2getthere markets and develops short range Automated People Mover systems for personal and group transportation, which provide efficient, high quality, tailored transport solutions. The product range consists of the ParkShuttle and the CyberCab. Possible applications, whether they concern simple connections or complicated networks, range from city centers to residential areas, business and industrial parks, theme parks and resorts. To implement applications, 2getthere cooperates with expert companies in the areas of vehicle and infrastructure development and operations of public transportation systems.

Public transport often isn't suitable for door-to-door transport. The attractiveness of present-day public transport systems is often limited by the time-consuming nature of getting to and from it. This is the result of:
- change-overs which involve long waiting times
- wide grid of PT-network, which causes long walking distances
- the routing (detours)

Also the low frequency of public transport provides the traveler with long waiting-times at a stop. The frequency cannot be increased because of the high labor cost of the drivers (in the Netherlands some 70% of total operating costs). Cost-effective operation of present day public transport modes often results in a low frequency.

The concept of automated transport combined with a network of closely spaced stops provides an excellent solution for moving people over short distances. The ParkShuttle pilot project was started both to provide a better service for existing and new transport markets by improving the quality of public transport and to produce environmental benefits in the densely populated area. The system uses autonomously operating vehicles that travel along a simple infrastructure using electronic navigation. Due to the simple infrastructure the cost-factor is low compared to other people mover systems. Generally people mover systems involve high investments because they require extensive infrastructure.

Navigation with FROG technology

The FROG technology consists of a navigation system which allows vehicles to travel under fully automated control. FROG is shorthand for Free Ranging On Grid and has been proven in many types of vehicles.
Each vehicle has an on-board computer which stores an electronic map of the area in which the vehicle is required to operate. Using this map, the vehicle is able to plan its route to drive from point A to point B. The vehicle's starting position is known. As soon as the vehicle starts to move, it measures the distance traveled by means of encoders that count the number of wheel revolutions. At bends it is possible to calculate the vehicle's position from the angle of the wheels. This method may suffer from slight inaccuracies as a result of changes in vehicle load (full or empty) or an uneven or slippery road surface. For this reason, a number of calibration points are required at regular distances to check the calculated position and adjust it when necessary. These points are magnets embedded in the road surface. Each vehicle measures the location of magnets by means of a magnet ruler. Positioning accuracy of better than 3 cm is achieved, sufficient for the vehicle to come to a halt right next to the platform at a stop.

The main reason to make use of ground-level infrastructure is to reduce the cost of the infrastructure, compared to other peoplemover systems. The infrastructure consists of a simple, 2.50-meter wide asphalt track. The track is not fully-separated. The only separation consists of a one meter high fence and a greenzone with bushes. Most applications of automated public transport systems will require a complete separation of the track, mostly for safety reasons.

The ParkShuttle however has a safety system of sensitive and intelligent sensors. The sensors scan the area in front of the vehicle and will decelerate or stop the vehicle when an unknown obstacle is detected. An additional safety feature is provided by the bumper system that brings the vehicle to an immediate halt when it is impressed. In addition, the vehicle has emergency stop buttons (both inside and outside) that can be operated by the passengers. The speed is limited to 40 km/h obtain a good ride quality.

The ParkShuttle peoplemover can be compared with a horizontal elevator. The ParkShuttle operates on-demand. The different stops or stations are similar to the floors of a building with a vertical elevator. An elevator can be called by pressing the elevator button. The ParkShuttle operates the same way; a vehicle can be requested by pushing the button on the request-console. When a vehicle arrives, the passenger boards and pushes the destination button inside the vehicle, similar to a vertical elevator. After all passengers have boarded the on-board computer calculates the shortest route to all chosen destinations and automatically drive to the destinations.

The vehicles are controlled by a supervisory computer system (SuperFROG) that sends the traffic control and request-messages to the vehicles via a radio data link. This is the only centrally-controlled function; the driving control takes place in the vehicle itself. This means there is no need for extensive radio communication with the central computer.

Traffic control with respect to other traffic (pedestrians, cyclists, cars and other public transport) is accomplished by means of traffic lights and/or barrier gates controlled by SuperFROG. SuperFROG activates the traffic lights and the barrier gates whenever a FROG vehicle approaches a crossing. SuperFROG will allow the vehicle to cross only after the traffic lights and/or barrier gates have reported back to confirm that they have been activated so that traffic control is reliable and fail-safe. Also, there is the in-vehicle obstacle detection system to prevent collisions.

The ParkShuttle vehicle runs on four rubber tires. Traction is provided by an electric motor powered by a rechargeable battery. Up to 100 km can be covered on one battery-load. It has a capacity of 10 passengers, 6 seated and 4 standees. It is easy to get into
and out of the vehicle (wheelchair accessible) and provides good all-round visibility. Inside the vehicle is a console on which the passengers can indicate their destination. Each vehicle is also fitted with an information display that announces the stop at which the vehicle has arrived. The maximum load is 800 kg. The maximum vehicle weight is monitored by means of weight sensor. As soon as the total weight of the passengers and cargo exceeds the limit, the vehicle will refuse to depart and a message will automatically be announced. Sensors fitted in the doorways monitor the entrance and exit of passengers. The vehicle will never depart while a passenger is in the process of boarding and exiting.

The safety system consists of the obstacle detection system mentioned before. A camera and communications system are mounted in the vehicle. Both are in contact with the central control room. The camera allows constant monitoring of vehicle security and a rapid response to any irregularity. The communication system permits communication between the passengers and the control room, functioning as an intercom.

**SuperFROG supervisory computer system**

The SuperFROG supervisory computer system communicates via radio with the vehicles, the request-consoles and the traffic lights. SuperFROG receives the requests for the vehicles and decides which vehicle it will instruct to go to the station where the request was made. Vehicle instructions are managed efficiently and take into account the distances between the vehicles and stations and the status of the vehicles.

SuperFROG keeps a graphical record of the position of each vehicle. It also keeps record of the issued instructions, the status of each vehicle, the status of the traffic zones and all relevant messages. Any malfunction is immediately reported to SuperFROG, which is linked to the central control room. The operator can continuously monitor the condition of the system. It is also very easy to change the lay-out of the routes so that routing can be altered, stations moved or added and the system expanded.

**Pilot project: ParkShuttle Rivium (Capelle a/d IJssel)**

The Rivium Business Park in the municipality of Capelle aan den IJssel near Rotterdam in the Netherlands, is an ideal location because a public transport link between the business park and the nearest metro-station is missing. Before the ParkShuttle application was implemented in February 1999, a shuttle-bus provided public transport service to the business park. The low frequency decreased the attractiveness of public transport for people who wished to travel to the business park.

The ParkShuttle connects Rivium to bus and subway station Kralingse Zoom – a 1300 meter journey over a single lane track with three passing locations. At Kralingse Zoom metro station direct access to the ParkShuttle track is prevented by a fence. Automatic platform doors give access to the ParkShuttle vehicle. The separation of the track gives extra safety and discourages people from walking on the track. The track is not fully separated. The only separation consists of a one meter high fence and a greenzone with bushes. Most applications of automated public transport systems will require a complete separation of the track, mostly for safety reasons.
Figure VII- presents a geographical overview of the system in Capelle aan den IJssel. Based on the success of the system, it was decided in December 2001 to upgrade the system from its’ pilot status. With the installation of six 2nd-generation ParkShuttles the capacity will be tripled. At the same time the track will be extended. Operations are expected to resume in the summer of 2003. The extended Rivium application is a dual lane track, 2000 meters long with five stations. A highway is crossed by a specially constructed single lane bridge. Traffic management controls the access to the bridge and the flow of vehicles.

**The start of second generation park shuttles**

The second generation of park shuttles in Rivium is realized. However its introduction is delayed, not for technical reasons, but for organizational reasons. The maintenance of the infrastructure became an issue: who is responsible: the operator or the municipality. This has not been an issue with the first generation of park shuttles, since the building and the design of the infrastructure was subsidized.
### VIII. CATEGORIZATION OF TRANSPORT QUALITY DEMANDS

This table shows the categorization of quality demands. These demands are *time, price* and *comfort*. This overview has been made by Van Goeverden et al. (1998).

*Table VIII-1 Categorization transport quality demands*

<table>
<thead>
<tr>
<th>Mobility</th>
<th>Income</th>
<th>Main activity</th>
<th>Responsibility</th>
<th>Number of people (× 1000)</th>
<th>Work, study</th>
<th>Shop</th>
<th>Visit</th>
<th>Recreation</th>
<th>Take away, pick up</th>
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<td>Any</td>
<td>357</td>
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<td>C</td>
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<td>298</td>
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<td>PC</td>
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IX. INTERVIEW REPORTS

The reports of the interviews that have been held are described in this appendix. They are placed in chronological order.

Interviews have been held with:

Drs. N. de Ronde Bresser, Algemeen directeur ANT
- J.J. van Trigt, Beleidsadviseur Stedelijke Ontwikkeling, Gemeente Capelle aan den Ijssel
- Drs. J.J. Tideman, Senior projectleider verkeer en infrastructuur, Gemeente Den Haag
- Dhr. A.N.J. Busse, afdeling Verkeer en Vervoer, Gemeente Leeuwarden
- Dhr. Ing. J.G.B. Veldscholten, Verkeer en Vervoer, Gemeente Almelo
- De heer A. Vermie, Senior adviseur Ingenieursbureau, Gemeente Rotterdam
- Ir. J. Termorshuizen, Senior Beleidsmedewerker verkeer en vervoer, Stadsgewest Haaglanden
- Ing. L. Peterse, Senior Beleidsmedewerker verkeer en vervoer, Stadsregio Rotterdam

Furthermore an article has been used from A. Ouwehand and H. Van Zuijlen that describe the process of the pilot project in Eindhoven. The source of this article can be found in the literature.

Structure of the interviews

The interviews start with a description of the project that a municipality executes or has been executing in the field of automated transport. Next to this, will be spoken about the playing field in which a municipality operates and the internal structure of a municipality itself. Furthermore is spoken about the perceptions, motives, possibilities and dependencies of a municipality in the view of the automated transport. When the context of the project and role of the municipality in this project is clear successes and failures of the development of automated traffic will be defined. At the end, the perception of the respondent about the changes of the development of automated transport will be discussed. Finally the flanking policies, perceptions on public transport and other developments in the transport system of a city are discussed to broaden the knowledge and get a better insight in choices in this field and executed policies by a municipality.
Drs. N. de Ronde Bresser, Algemeen directeur ANT

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<td>Waldorpstraat 17</td>
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<th>Onderwerp</th>
<th>De ervaringen in onderzoek naar de haalbaarheid van concepten voor automatisch vervoer in verscheidene gemeenten en de rol van de gemeenten in deze onderzoeken</th>
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<table>
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<td>Aben</td>
<td>Interviewer Emmylou</td>
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Datum en plaats 15 februari 2005 te Den Haag

Capelle aan den IJssel

In Capelle aan den IJssel is een parkshuttle gerealiseerd. Het initiatief kwam voort uit de samenwerking tussen ANT en een exploitant van openbaar vervoer (eerst was dat ZWN, dit is overgegaan in Connexxion). Zij wilden een automatisch vervoerssysteem realiseren en vonden in Capelle een mooie toepassing: de gemeente had een subsidie om een fietsverbinding aan te leggen tussen metrostation 'Kralingse Zoom' en bedrijvenpark 'Rivium'. Een aantal jaar voordat deze subsidie uitgekeerd zou worden, is dit geld aangewend om infrastructuur te realiseren voor automatisch vervoer om de dunnere vervoersstroom tussen het metrostation en het bedrijvenpark toch van verbinding te voorzien met een goede kwaliteit service graad, die tot dan toe nog niet aanwezig was. Door het aanwenden van de subsidie, kostte de realisatie de gemeente geen geld. Als het project niet zou slagen, kon de gemeente de aangelegde infrastructuur alsnog gebruiken voor een fietspad en als het project slaagt, kan het traject gemakkelijk uitgebreid worden met een fietspad.

Almelo

In Almelo komt het initiatief voor een andere vorm van vervoer voort uit gemeente zelf. In deze stad is nog geen automatisch vervoerssysteem gerealiseerd, maar is al veel tijd gestoken in de ontwikkeling van de mogelijkheden. Almelo ziet op langere termijn een verkeersprobleem aankomen: het verkeer in de binnenstad loopt vast, net als het verkeer op de toegangswegen naar de binnenstad. Ook het huidige OV zal vast komen te staan op deze wegen. Het gemeentebestuur heeft al langere tijd zitting in deze stad en vertrouwen van de burgers. De wethouder van verkeer en vervoer krijgt in deze gemeente veel voor elkaar. Het project omvat het verbinden van verschillende wijken met het stadscentrum en wordt mede ontwikkeld in Europees verband. De problemen die Almelo op langere termijn ziet aankomen, kunnen ook voor andere steden gaan gelden.

Beverwijk

De gemeente Beverwijk zag mogelijkheden voor een automatisch vervoerssysteem dat de parkeervoorziening van de Beverwijkse Bazaar verbindt met het centrum op dagen dat de Bazaar minder bezoekers trekt en daarmee tevens als een vervoerssysteem kan dienen tussen het station en de Bazaar als de Bazaar drukker bezocht wordt. Zo kan het transportsysteem twee tegengestelde stromen bedienen en is
de bezettingsgraad constanter. De gemeente was hier initiatiefnemer. Het project is niet gerealiseerd, omdat er een extra parkeervoorziening in het centrum gebouwd werd met behulp van een andere subsidie. Hierdoor was een gedeelte van het doel van het automatisch vervoersconcept minder aantrekkelijk – gebruik maken van de parkeervoorziening van de Beverwijkse Bazaar was minder noodzakelijk en daarmee ook het openbaar vervoer verbinding van deze parkeervoorziening naar het centrum.

**Den Haag**

In Den Haag is onderzoek gedaan naar een hoogwaardige openbaar vervoer verbinding tussen het treinstation Den Haag CS, het knooppunt Prins Clausplein en het nieuw te ontwikkelen GAVI-kavel waar wellicht het ADO-station gebouwd zal worden. Een monorail zou hier een goede uitkomst bieden. Omdat een monorail op niveau +1 wordt gebouwd, kunnen infrastructurele belemmeringen die haaks op het traject lopen overbrugd worden. De gemeente Den Haag zag voor dit traject goede mogelijkheden. Eventueel kon er nog een aftakking gemaakt worden naar het treinstation Den Haag Holland Spoor. Voorlopig gaat dit project niet door, omdat de gemeente langs deze as liever een aftakking maakt van de Randstad Rail die Den Haag met Rotterdam verbindt. Dit is een voorbeeld van het voortborduren op bestaande infrastructuur bij het uitbreiden van het transportnetwerk, terwijl dit niet altijd wenselijk is, omdat een stroom bediend wordt met een niet-passend systeem: lokale stromen worden bediend door een op regionaal verkeer gericht vervoerssysteem. De grootte van de vervoersstroom op het traject tussen Den Haag CS en de GAVI-kavel is twee keer zo groot als de vervoersstroom die door de Randstadrail bediend zal worden op de rest van het traject. De exploitatie van de RandstadRail is daardoor op dit traject nooit optimaal: de tram zal vaker moeten rijden om alle passagiers te bedienen op een relatief kort gedeelte van het traject of de dienst wordt zo ingericht dat hij efficiënt is, maar dat niet alle passagiers bediend kunnen worden.

**Eindhoven/ Provincie Noord-Brabant**

De initiatiefnemer voor het onderzoek was de provincie Noord-Brabant. Het onderzoek draaide om inventarisatie, onderzoek en selectie van potentiële pilots voor het project “Vervoersysteem van de Toekomst” in de provincie Noord-Brabant en om uitwerking van de gekozen pilot bij de TU Eindhoven. Redenen om voor de TU Eindhoven te kiezen was, omdat het ging om niet-kritieke, maar wel grote vervoersstromen. Daarnaast kon bestaande infrastructuur gebruikt worden, waardoor de desinvestering niet te hoog zou zijn als het project niet zou slagen. Bij het project waren drie partijen betrokken die het project steunden: de Gemeente Eindhoven, de provincie Noord-Brabant en de TU Eindhoven. Het project is uiteindelijk vanwege bestuurlijke problemen niet gerealiseerd: het management was in handen van een onafhankelijke partij die niet in staat was om de vaart in het project te behouden. In die tijd is het college van de TU Eindhoven gewisseld. Het nieuwe college is uit het project gestapt, omdat ze andere (financiële) prioriteiten stelde. Daarnaast is in die tijd ook de burgemeester van Eindhoven gewisseld. Nadat de TU zich had teruggetrokken uit het project, was het de reden om een vervoerssysteem van en naar de TU te realiseren grotendeels weggevallen.

**Utrecht**

In Utrecht is in het kader van het Utrecht Centrum Project (UCP) een studie uitgevoerd naar de mogelijkheden van automatisch vervoer door NOVEM om Leidsche Rijn te ontsluiten. Dit is niet doorgegaan, omdat de NS (een grote speler in het UCP) een ander alternatief voor ogen had voor dit doel.

Algemene opmerkingen
Gemeenten zijn voor financiering van de ontwikkeling van een nieuw vervoerssysteem voor een groot deel afhankelijk van andere partijen. Ze zijn minder snel bereid om grote investeringen te doen als een probleem ook op een minder risicovolle manier opgelost kan worden. Hierin zijn gemeenten vaak opportunistisch, maar dit is niet onbegrijpelijk. Daarnaast zijn ze afhankelijk van verschillende subsidies, die niet aan elkaar gekoppeld zijn. Daardoor worden vaak projecten door waarvoor ze geld kunnen krijgen ook al gaat dit ten koste van andere projecten.

Een idee dat door een wethouder gelanceerd wordt, heeft vaak een korte levensduur, omdat een bestuur van een gemeente vaak kan wisselen en de ontwikkeling van projecten daardoor onzeker kan zijn.

Welk automatisch vervoerssysteem het meest geschikt is, moet op gemeentelijk niveau bepaald worden. Het is afhankelijk van de bestaande infrastructuur en de te bedienen stromen. Kansen voor het realiseren van automatische vervoersystemen liggen in een stabiel gemeentebestuur, een lange termijn visie en een koppeling van verkeer en vervoer met de ruimtelijke structuur.

De techniek van automatische vervoersystemen heeft zich in de praktijk nog nergens echt bewezen, behalve in Capelle aan den IJssel. Een technisch concept dat veelbelovend lijkt is de automatische metro – een systeem waarbij de voertuigen op rubber luchtbanden rijden, en extern geleid en aangedreven worden door een onderliggende rail. Dit vervoersysteem is gericht op het halen van een hoge gemiddelde snelheid. (tot 90 km/u.) Vaak wordt gesteld dat automatisch vervoer op langere termijn kan mengen met conventioneel vervoer. De vraag is echter of dit wenselijk is. De functionaliteiten van het systeem moeten afgestemd worden op de eisen die aan de dienst gesteld worden. Bijvoorbeeld: Als de dichtheid van automatische voertuigen in een netwerk zo groot is, dat de bus/auto niet meer past, dan hoeft het netwerk niet zo ingericht te worden dat het voor conventionele modaliteiten geschikt is.

Automatische voertuigssystemen worden vaak riskant gevonden vanwege de onbekendheid – het is onduidelijk of reizigers er gebruik van maken –; vanwege de onzekere exploitatie – de exploitatieopbrengsten van een project zijn onzeker en de investeringskosten zijn hoog –; vanwege de technische risico’s – het is vaak onduidelijk wanneer iets mis gaat, waarom iets misgaat en hoe het opgelost kan worden. De operationele kosten van een bus zijn vaak hoger dan van automatisch vervoer, maar de investeringskosten zijn veel lager. Een automatisch vervoerssysteem heeft dus veel langere terugverdientijd en het risico op desinvesteringen is daardoor groter als blijkt dat het systeem niet succesvol is. Het aanpassen van een bussysteem is makkelijker als blijkt dat dit systeem niet voldoende functioneert.

Voor een exploitant is het belangrijk dat een alternatief economisch interessant is. Een alternatief is riskant als de investeringskosten hoog zijn, waardoor het een lange tijd duurt voordat deze terug verdient kunnen worden. Met de mogelijkheid tot tariefdifferentiatie liggen kansen voor automatisch vervoer. Als er een kwalitatief hoge service graad aangeboden kan worden, en hiervoor ook een bijbehorende prijs gerekend kan worden, stijgen de kansen voor automatisch vervoer.

Het is niet wenselijk om de ontwikkeling van automatisch vervoer in steden in een stramien te gieten, omdat het gaat om inpassing op gemeentelijk niveau. De projecten zijn niet te vergelijken en de investeringen zijn afhankelijk van de gewenste functie van de dienst en de te bedienen volumes.
Als een gemeente ook concessieverlener is, heeft dit zowel voor- als nadelen. Een nadeel is dat een concessieverlener meerdere belangen moet afwegen: ze moeten passagiers op een zo efficiënt mogelijke manier bedienen. Een voordeel is dat ze verantwoordelijk is voor haar eigen vervoer en een uitgebreidere afweging kan maken. Een gemeente die geen concessieverlener is, hoeft minder rekening te houden met de financiële afweging tussen het bedienen van vervoersstromen en het ontwikkelen van transport systemen. Steeds minder gemeenten zijn ook concessieverlener.

Om een project succesvol te ontwikkelen is het nodig dat er een echte sterke trekker is binnen het project.

**Criteria om gemeenten voor te selecteren voor interviews**

De criteria die ik heb opgesteld, heb ik voorgelegd om te bepalen of deze geschikt zijn om gemeenten op te selecteren en welke gemeenten dit kunnen zijn. De criteria waren:

- de gemeente is bekend met vormen van automatisch vervoer
- concessieverlener
- de gemeente beschikt over een kansrijke toepassing als geschetst in de enquête uit CyberMove
- de gemeente heeft al dan niet een uitgebreid transportsysteem met metro’s dan wel trams.

Gemeenten kunnen geselecteerd worden op deze criteria. Geschikte gemeenten die bij ANT bekend zijn en op wie een of meerdere criteria van toepassing zijn, zijn: Capelle aan den IJssel (criteria 1, 3, 4); Almelo (criteria 1, 3); Provincie Noord Brabant -de betrokkenen uit de gemeenten Eindhoven zijn daar niet meer actief en de provincie had het project geïnitieerd- (criteria 1, 3) en Den Haag (criteria 1, 3, 4) Ik heb een aantal namen van personen gekregen bij gemeenten die ik hiervoor kan benaderen.

**Gespreksfeer**

De heer De Ronde Bresser heeft veel praktijkervaring in studies naar automatisch vervoer in gemeenten. Aan de hand van voorbeelden van projecten van ANT werd de complexiteit rondom het ontwikkelen van een automatisch transportsysteem en de rol van gemeenten in deze projecten goed duidelijk.

**Afspraken**


**Verwijzigingen**

Van een aantal gemeenten heb ik de namen ontvangen van de personen die zich op beleidsniveau hebben bezig gehouden met de ontwikkeling van automatisch transport, zodat ik deze personen kan benaderen voor een interview. Dit zijn: De heer A. Fousert, in Capelle aan den IJssel de verantwoordelijke voor het project; Hans Veltscholten en de heer Sjoers, in Almelo de betrokken ambtenaar en de betrokken wethouder bij het project; de heer A. Van den Hurk, een lagere ambtenaar betrokken bij het project in Eindhoven; Mevrouw A. Ouwerhand, een beleidsmedewerker van de provincie Noord-Brabant die verantwoordelijk was voor het project; Mevrouw J. Tideman van de gemeente Den Haag.

**Verslag dd.** 18 februari 2005
**J.J. van Trigt**, Beleidsadviseur Stedelijke Ontwikkeling, Gemeente Capelle aan den IJssel

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**Onderwerp**
De rol die de gemeente Capelle aan den IJssel speelt bij de ontwikkeling van de parkshuttle tussen het metro station Kralingse Zoom en het bedrijventerrein Rivium en de mogelijkheden voor de gemeente bij in dit project.

**Kenmerk**
Niet vertrouwelijk

**Datum en plaats**
7 maart 2005 te Capelle aan den IJssel

**Proefproject 2000-2002** Capelle aan den IJssel is de eerste gemeente in Nederland waarin automatisch vervoer wordt ontwikkeld als een volwaardig onderdeel van het openbaar vervoer. De ontwikkeling van de parkshuttle is in eerste instantie begonnen als een proef project. De aanleiding was het plan van de gemeente Capelle aan den IJssel om een bedrijvenpark op Rivium te ontwikkelen. De stadsregio Rotterdam gaf aan dat het terrein ontwikkeld mocht worden, mits er een hoogwaardige verbinding aangelegd zou worden tussen het metrostation bij de Kralingse Zoom en het bedrijvenpark. Samen met Connexxion en een verkeerskundige adviesbureau dat bekend was met mogelijkheden van automatisch vervoer, zijn de mogelijkheden verkend naar een hoogwaardige openbaar vervoersverbinding met een automatisch systeem.

De proef met de park shuttle heeft twee jaar gedraaid. Het automatische voertuig reed over een recht traject tussen metrostation “de Kralingse Zoom” en de Rivium 1e straat. Het traject had twee haltes. Dagelijks vervoerden 3 wagentjes 500 personen. Er was een gelijkvloerse kruising met de oprit van een bedrijf. Deze werd afgesloten met een slagboom die tegelijkertijd diende als toegangscontrole voor dit bedrijf. Deze slagboom functioneerde slecht en heeft het merendeel van de tijd open gestaan. Hierdoor was de overgang niet bewaakt. In de tijd van het proefproject zijn hier geen ernstige ongelukken met de ParkShuttle voorgevallen. De prestaties van het systeem gedurende het proefproject waren niet optimaal, omdat er nog wat kinderziektes verholpen moesten worden bij de voertuigen.

**Realisatie tweede fase** Inmiddels wordt de tweede fase van de parkshuttle gerealiseerd en naar verwachting in september wordt het nieuwe traject geopend. Het systeem wordt geëxploiteerd door Connexxion. Zij verwacht dat het mogelijk is om de parkshuttle rendabel te exploiteren. De inrichting van het systeem is uitgebreider dan het proefproject: Het aantal haltes in het nieuwe ontwerp is toegenomen van twee naar vijf. Er komen haltes bij ter hoogte van het brainpark 3/ Fascinatio, dat ontwikkeld wordt door de gemeente Rotterdam en ter hoogte van de 2e en 3e straat van Rivium. Bij de haltes worden tegelijkertijd keermogelijkheden gerealiseerd voor de voertuigen, zodat ze flexibel kunnen bewegen over het traject. In het nieuwe systeem zullen 6
voertuigen gaan rijden met een capaciteit van 20 personen per voertuig. De verwachting is dat in het nieuwe project elke dag minimaal 1600 personen vervoerd kunnen worden. Er zullen twee gelijkvloerse kruispunten met autoverkeer gerealiseerd worden die worden afgesloten met slagbomen. De baan zal afgeschermd worden, omdat deze door een woonwijk loopt. Het traject is wederom volledig afgeschermd door hekwerk en borden geven aan dat het traject niet betreden mag worden. De informatie voorziening in het voertuig en op het traject gaat als volgt. Bij de halte kunnen reizigers op een knop drukken om een voertuig op te roepen. Een aftelmechanisme geeft aan hoe lang het duurt voordat het voertuig arriveert. In het voertuig geeft de passagier door een druk op de knop zijn eindbestemming aan. Het systeem werkt hiermee eigenlijk als een horizontale lift. In het voertuig is een display te zien dat aangeeft waar het voertuig zich bevindt op het traject. De parkshuttle bedient hoofdzakelijk woon-werkverkeer. De aanleg van het tweede traject en systeem heeft veel vertraging opgelopen. Dit kwam voor een belangrijk deel door de juridische aspecten die van belang zijn voor de aansprakelijkheid op de twee gelijkvloerse kruisingen. Daarnaast was er vertraging in de aanleg door de ontwikkeling van de Kralingse Zoom. Het traject loopt in een smalle tunnel onder de A16 door. Van deze tunnel moeten ook fietsers en voetgangers gebruik kunnen maken. De dwarsdoorsnede bleek uiteindelijk net groot genoeg, maar het overleg over de ligging van de halte van de parkshuttle bij het metrostation – voor of na deze tunnel – heeft voor vertraging gezorgd.

Deze tweede fase van het project betekent een definitieve invoering. De concessie is voor zes jaar gegund aan Connexxion. De verwachting is dat deze over zes jaar weer verlengd zal worden, omdat Connexxion en de gemeente veel tijd en geld in de ontwikkeling van het systeem hebben gestoken.

Perspectieven op de parkshuttle Binnen de gemeente zijn de reacties op de parkshuttle wisselend. De gemeente staat iets kritischer tegenover deze ontwikkeling dan bedrijven. Bedrijven op Rivium zijn erg enthousiast over de ontwikkeling van de parkshuttle. De politieke partijen die het project steunen worden tegengewerkt door de andere politieke partijen, maar binnen de beleidsafdelingen en beheerafdelingen van de gemeente zijn er weinig tegenstrijdige belangen te vinden. De bestuurders hebben als motto "Capelle wordt de stad van het automatische vervoer". Naast dat het een goede verbinding verzorgt voor haar werknemers geeft het ook een extra allure aan het bedrijventerrein.

Verantwoordelijkheden betrokkenen De gemeente is gedurende het project projecttrekker en budgetverantwoordelijke. Daarnaast is ze is verantwoordelijk voor het bezit, beheer en onderhoud van de infrastructuur. Binnen de gemeente Capelle is de dienst Stedelijke Ontwikkeling verantwoordelijk voor de realisatie van de parkshuttle. Binnen deze dienst vallen de afdelingen verkeer en vervoer, ruimtelijke ordening, economische zaken en stedenbouw. Het project wordt getrokken door een externe projectleider van een klein verkeerskundig adviesbureau. De stadsregio Rotterdam is verantwoordelijk voor de concessieverlening en de financiering. Connexxion is verantwoordelijk voor de voertuigen en de vervoersdienst, maar de gemeente is verantwoordelijk voor de financiering. Connexxion heeft een verzekeringmaatschappij gecontracteerd die de risico’s van ongelukken met de parkshuttle dekt.

Financiële afhankelijkheden gemeente De gemeente is bij de ontwikkeling van de parkshuttle afhankelijk van de stadsregio Rotterdam, die de grootste financier is van het project en verantwoordelijk is voor de concessieverlening. Daarnaast wordt een deel van de financiën gedragen door het ontwikkelbedrijf van Rotterdam, omdat de parkshuttle
het brainpark 3 ontsluit die op Rotterdams grondgebied ligt. De gemeente Rotterdam wilde graag een halte bij dit park.

**Flankerend beleid** Om ervoor te zorgen dat mensen gebruik maken van de parkshuttle worden verschillende vormen van flankerend beleid gerealiseerd. Het aantal alternatieven om het bedrijventerrein te bereiken wordt vermindert; het shuttlebusje dat op dit moment de lijndienst verzorgt tussen Rivium en het metro station niet meer rijden; de busdienst vanaf Capelse Brug naar Rivium stopgezet worden door Connexxion -dit vergroot de passagiersstroom voor de parkshuttle en de lijn zou niet meer geëxploiteerd worden in verband met de bezuinigingen bij Connexxion. Daarnaast doet de gemeente aan vervoersmanagement, Bedrijven en bewoners van de wijk Fascinatio worden geïnformeerd over de komst van de parkshuttle en er is een vervoerscoördinatiecentrum Rijnmond waarin informatie over de parkshuttle te verkrijgen is. De verwachting is dat veel inwoners op de fiets of lopend naar het station zullen gaan, omdat de afstand van deze wijk tot het metrostation heel kort is. Om de drempel voor het gebruik van de parkshuttle verder te verlagen wordt de betaling voor de parkshuttle gelijk aan de betaling voor de metro. Als er een project wordt ingevoerd om de betaling per OV chipknip te realiseren, zal dit tegelijkertijd voor de parkshuttle ingevoerd worden. Bij de ontwikkeling van de Kralingse Zoom hoort ook de realisatie van een centrale parkeergelegenheid/ Park and Ride voorziening. Het aantal parkeerplaatsen op Rivium is gebonden aan wettelijke voorschriften.

**Lange termijn visie** Op lange termijn is het doel om te kunnen mengen met ander verkeer. Voorlopig ziet de heer van Trigt dit nog niet gerealiseerd. Technisch is het hoogstwaarschijnlijk wel mogelijk, maar als de inrichting complexer wordt, wordt het moeilijker om het project te verzekeren. De aansprakelijkheid is nog niet goed genoeg geregeld. Wellicht liggen voor de menging met ander verkeer meer mogelijkheden voor dual mode systemen die op bepaalde trajecten in colonne kunnen rijden en buiten het traject handmatig bestuurd kunnen worden.

**Duurzaamheid** De parkshuttle draagt bij aan de duurzaamheid van de stad, zeker op langere termijn. Capelle ligt nabij een aantal grote steden en verwerkt veel autoverkeer. Als de maximale capaciteit is bereikt, nemen de uitbreidingsmogelijkheden voor de verwerking van autoverkeer af. Een parkshuttle kan bijdragen aan een oplossing voor het verwerken van het verkeer.

**Faalfactoren** Een faalfactor voor de ontwikkeling van automatisch vervoer is het automatische karakter van het systeem. Automatisch vervoer is veelal veiliger dan een systeem met een chauffeur – er kunnen geen fouten gemaakt worden door menselijk handelen -, maar als er een ongeluk plaatsvindt met een automatisch voertuig weegt dit voor de omgeving veel zwaarder. Dit ligt waarschijnlijk voor een belangrijk deel aan het voorstellingenvermogen van personen; mensen kunnen zich voorstellen dat een buschauffeur een fout maakt, maar niet dat een automatisch systeem dat doet. Als dat wel gebeurt, is het systeem onbetrouwbaar. Op het voertuig zit een camera bevestigd, die constant de omgeving filmt. Zo kunnen ongelukken vastgelegd worden en kan worden nagegaan hoe het ongeluk heeft kunnen gebeuren. Het afbreukrisico bij een ongeval is dus erg hoog, maar dat is bij elk automatisch vervoerssysteem het geval. Dit verkleint de kansen voor de realisatie. Een ander nadeel van de parkshuttle is dat het systeem geen duale functie heeft. Omdat de parkshuttle volledig automatisch geleid is, is een afsluiting van het traject tot nog toe noodzakelijk. Dit maakt de verkeersafwikkeling complexer en de loopafstand naar de haltes langer. Een andere faalfactor kan het vertrouwen in het systeem zijn. De functionering van de parkshuttle
was tijdens het proefproject nog niet optimaal, waardoor de reacties binnen de gemeenten wisselden. Dit is echter niet vreemd in vergelijking met de ontwikkeling van andere innovatieve projecten. Vaak is er periode van gewenning nodig om vertrouwen te kweken.

Er wordt erg intensief samengewerkt met de gemeente Rotterdam. Enerzijds omdat het traject van de park shuttle gedeeltelijk op Rotterdams grondgebied ligt en anderzijds omdat de gemeente Rotterdam invloed heeft op de inrichting van het metrogebied de Kralingse Zoom. Aan de andere kant van het metrostation wordt een bedrijventerrein ontwikkeld door de gemeente Rotterdam. Er wordt een grote P&R faciliteit gerealiseerd bij het metro station die gericht is op zowel de bezoekers van Rivium, als op de bezoekers van het bedrijventerrein van Rotterdam. Het ontwerpteam van de gemeente Rotterdam bepaalt dus mede de inrichting van de Kralingse Zoom en daarmee de inrichting van het transport systeem. De projecten die de gemeente Rotterdam ontplooipt rondom de Kralingse Zoom, de gedeeltelijke realisatie van de parkshuttle op Rotterdams grondgebied en de ligging van een halte ter hoogte van Brainpark 3 / Fascinatio zorgen voor wederzijdse afhankelijkheden. Hierdoor is het ontwikkelingsproces af en toe vertraagd. Een juridisch obstakel is nu nog de kruising met de openbare weg. De gemeente wil dat de verantwoordelijkheid voor de infrastructuur op gelijkvloerse kruisingen bij de vervoerder ligt op het moment dat de slagbomen gesloten zijn. Hiervoor wordt op dit moment nog een contract opgesteld. Daarnaast wordt er een risicodocument opgesteld wat mogelijke risico’s zijn en hoe hiermee omgegaan moet worden. De verwachting is dat de techniek voldoende ontwikkeld is om de risico’s klein te laten zijn, maar of het risicodocument afdoende is, moet de praktijk uitwijzen. Als de risico’s in de praktijk klein blijken te zijn, zullen de systemen vaker aangelegd worden, waardoor het goedkoper en aantrekkelijker wordt om ze te realiseren.

Kansen De kansen voor de realisatie van de parkshuttle lagen op een aantal vlakken.

- de bestuurders van de gemeente Capelle aan den IJssel waren enthousiast. Ze vinden automatisch vervoer een mooi project voor de gemeente; het is goed voor haar imago.
- Om het bedrijventerrein te mogen ontwikkelen was een hoogwaardige verbinding met het metrostation noodzakelijk.
- Automatisch vervoer werkt alleen als de stroom van te vervoeren passagiers constant is. Door de economische bedrijvigheid is dit het geval.
- De stadsregio financierde bijna 100% van het project.
- Hoe vaker een automatisch vervoerssysteem wordt gerealiseerd, hoe goedkoper ze zullen worden en hoe meer vertrouwen mensen erin zullen krijgen.
- De kennisontwikkeling die de gemeente Capelle aan den IJssel en de stadsregio Rotterdam opdoen voor de realisatie van een peoplemover.

De parkshuttle of de monorail? Een nadeel van de parkshuttle is de afwikkeling van twee verschillende verkeersstromen door de eigen infrastructuur op gelijk niveau. De gebruikers zijn wel erg enthousiast over het systeem. In vergelijking met de monorail is de parkshuttle te prefereren, omdat het gelijkvloers ingepast kan worden, waardoor de toegankelijkheid vergroot wordt ten opzichte van de monorail. Daarnaast zijn de investeringskosten in een monorail hoger. Verder kent de monorail niet veel nadelen. Een bijkomende kans voor dit project, was dat de stadsregio Rotterdam waarschijnlijk minder geld had geïnvesteerd in de aanleg van een monorail, omdat dat een systeem is waarmee al veel ervaring op is gedaan. Hierdoor zou de kennisontwikkeling minder zijn.
**Haalbaarheid van het tweede project** De realisatie van de tweede fase ging erg moeizaam, maar op dit moment is het proces zover gevorderd dat de implementatie in ieder geval plaats zal vinden, ondanks dat nog niet alle juridische aspecten geregeld zijn tussen de betrokken partijen. Het project is in een ver gevorderd stadium, waardoor de verwachting is dat het zeker door zal gaan. Het proefproject is een *goede pilot* geweest voor de ontwikkeling van automatisch vervoer in stedelijk gebied, omdat het traject over het grondgebied van twee gemeenten loopt en dat het zowel langs een woonwijk als over een bedrijventerrein loopt. De gemeente Capelle aan den IJssel zal in de toekomst een actieve rol vervullen in de *kennisverspreiding* van zulke systemen. De kennisontwikkeling op het gebied van automatisch vervoer is een van de redenen geweest van de stadsregio om hierin te investeren.

**Andere mogelijkheden automatisch vervoer in Capelle** Een andere mogelijkheid voor automatisch vervoer in de gemeente Capelle aan den IJssel is bijvoorbeeld bij het IJsselland ziekenhuis. De metro halte ligt hier iets te ver van het ziekenhuis verwijderd en de route naar het ziekenhuis toe vanaf de metro is door een "sluip en kruip wijk". Een vorm van openbaar vervoer die deze stroom reizigers kan bedienen kan van nut zijn. Daarnaast zijn er *continue vervoersstromen*: wisselende diensten en bezoekersstromen.

**Gesprekssfeer** Het was een prettig gesprek. De heer Van Trigt is al geruime tijd betrokken bij de ontwikkeling van de parkshuttle en wist veel te vertellen over de kansen en problemen rondom de ontwikkeling van dit systeem.

**Afspraken** Het interviewverslag mag toegevoegd worden aan mijn afstudeerscriptie. Vooraf wordt het verslag nagelezen door de heer Van Trigt. Een exemplaar van de afstudeerscriptie zal worden toegezonden.

**Verslag dd. 9 maart 2005**
**Drs. J.J. Tideman, Senior projectleider verkeer en infrastructuur, Gemeente Den Haag**

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**Onderwerp**
Het proces rondom het onderzoek naar de mogelijkheden voor automatisch vervoer tussen het Den Haag CS en station Ypenburg en de succes- en faalfactoren voor de gemeente om innovatief vervoer te realiseren.

**Kenmerk**
Niet vertrouwelijk

**Interviewer**
Emmylou Aben

**Datum en plaats**
9 maart 2005 te Den Haag

**Procesverloop**
Het initiatief om de nieuw te ontwikkelen locatie Ypenburg te ontsluiten met een rechtstreekse hoogwaardige en hoogfrequente verbinding kwam van de "vernieuwende" projectontwikkelaar Bohemen. Deze introduceerde ook de mogelijkheid van een innovatief vervoerssysteem. Twee wethouders, wethouder Meijer van "Verkeer en Vervoer, Binnenstad en Monumenten" en wethouder Noordanus van "Ruimtelijke Ordening, Stadsvernieuwing en Volkshuisvesting" raakten na een presentatie geïnteresseerd in de plannen van de projectontwikkelaar, maar waren nog niet tevreden over het gekozen tracé. Met ambtelijke ondersteuning is daarna een haalbaarheidsstudie uitgevoerd naar een nieuw, vrijwel rechtstreeks tracé. Daarnaast is een vergelijkende studie uitgevoerd naar verschillende systemen. Uiteindelijk is gekozen voor een monorail.

De aanleg van de peoplemover is inmiddels van de baan. Hier zijn verschillende redenen voor aan te geven. Ten eerste waren rondom het Prins Clausplein vier gemeenten (Den Haag, Rijswijk, Voorburg en Leidschendam) hun gebied aan het ontwikkelen "met de ruggen naar elkaar toe". Daardoor was het voor de gemeente Den Haag erg moeilijk om een monorail te ontwikkelen die deels aangelegd zou worden op het grondgebied van andere gemeenten. Inmiddels is grond rondom het Prins Clausplein van de gemeenten Leidschendam en Voorburg overgegaan naar de gemeente Den Haag. De gemeente Den Haag is nu voor het gebied tussen CS en de A4/A12 – de Centrale Zone geheten - een integraal ontwerp aan het ontwikkelen. Hierdoor komt de ontwikkeling van het tussengelegen gebied in een stroomversnelling. Mede hierom is besloten om het gebied te ontsluiten met een systeem dat aan kan sluiten op al bestaande infrastructuur van de tram en de Randstadrail.

Het autonome karakter van de monorail is een tweede reden waarom het project niet gerealiseerd is. Reizigers die verder willen reizen dan Den Haag CS moeten als ze gebruik maken van de monorail altijd een overstap maken naar een ander systeem. Veel reizigers willen verder de stad in dan het Centraal Station. Met de aanleg van een systeem dat kan aansluiten op de bestaande systemen is dit niet meer nodig. Ten derde was het niet ondenkbeeldig dat de people mover als een tijdelijk systeem voor ongeveer 15-20 jaar zou functioneren, vooruitlopend op een systeem dat grotere vervoersstromen
kan verwerken. Deze vervanging zou nodig zijn, omdat het gebied rondom het tracé de komende jaren verder wordt ontwikkeld, waardoor grotere vervoersstromen verwerkt moeten worden. Ten vierde kwam het projectvoorstel voort uit een initiatief van een projectontwikkelaar, waarbij de financiering grotendeels door de overheid zou moeten geschieden. Een deel zou in de perceptie van de projectontwikkelaar door private partijen gefinancierd kunnen worden. De overheid lijkt in zulke gevallen iets minder bereid om zich fanatiek in te zetten voor de ontwikkeling van het project, mede omdat inpassing in vastgesteld beleid vaak complexer is dan aanvankelijk gedacht. Hierdoor waren er weinig partijen die zich committeerden aan het project.

**Flankerend beleid** De verwachting was dat het systeem voornamelijk forensen zou vervoeren die parkeren in het transferium dat gesitueerd was op het GAVI-kavel en hun bestemming op de Binckhorst of in het Centrum van Den Haag hebben. Mevrouw Tideman geeft aan dat Den Haag een redelijk volgend beleid kent voor de wensen van de autogebruiker. De politieke signatuur van de wethouder Verkeer en de samenstelling van het college zal mede oorzaak zijn waarom het gemeentebestuur minder geneigd is om grote beperkingen op te leggen aan het autoverkeer. De perceptie en inzet van de bestuurder is belangrijk voor het realiseren van het project. Duurzaamheid speelt met de komst van de eisen aan de luchtkwaliteit een belangrijkere rol en blijkt een katalysator in het maken van keuzes. Nu wordt nagedacht over de haalbaarheid, bijvoorbeeld door belangrijke routes de stad in te ontlasten door de aanleg van het Trekvliet-tracé of door verkeer rondom de stad te leiden of te doseren. Dit beleid is wel nog gericht op het verwerken van het autoverkeer.

**Verantwoordelijkheden** Binnen de gemeente Den Haag waren voornamelijk de afdelingen Verkeer en Infrastructuur, Ruimtelijke Ordening, Stedenbouw en Planologie betrokken. Economische Zaken heeft geen actieve rol gespeeld. De kosten voor de monorail zouden voor 95% uit rijksmiddelen gefinancierd moeten worden. Hierover werd wel gesproken maar was nog geen overeenstemming bereikt met Stadsgewest Haaglanden, die de rijksmiddelen binnen het stadsgewest verdeelt. Daarnaast heeft het Rijk potjes om innovatieve ontwikkelingen te stimuleren. Het moet dan wel nieuw zijn in Nederland.

**Kansen en mogelijkheden** voor de aanleg van een automatisch vervoerssysteem zijn volgens mevrouw Tideman:

- Als er over een **kort traject** een **constante** en **autonome** stroom reizigers verwerkt moet worden. Het systeem is geschikt om een autonome schakel naar een netwerk te dichten. Het is minder geschikt om een schakel in een netwerk te vormen. Regelmatig komt een peoplemoversysteem terug in de ideeënforming voor een verbinding tussen bijvoorbeeld Scheveningen-haven en Scheveningen-Bad.
- Als overheid mag je af en toe je nek uitsteken en iets vernieuwends doen. Inmiddels heeft Den Haag een nieuwe wethouder die hier voor staat. “Den Haag moet wat minder gewoon”. Een persoon met zo’n instelling is nodig om een innovatief project van de grond te krijgen, al moet bij elk project steeds kritisch naar het nut en de noodzaak worden gekeken.
- **De investeringskosten** voor de aanleg van een peoplemover bleken niet veel hoger dan voor de aanleg van een tram. Dit komt doordat het tracé verschillende barrières kruist, waaronder de Vliet. Doordat de monorail op niveau 1 wordt aangelegd, is de kruising geen probleem meer. Bij de aanleg van een tram moeten bruggen gerealiseerd worden.
Een innovatief systeem biedt mogelijkheden om het imago van de stad te verbeteren. Het is een hoogwaardiger systeem dan een bus. Het is geschikt als een hoogfrequente bediening nodig is. Als bestuurders/politici bekend zijn met het systeem, zijn ze vaker bereid er harder voor te werken.

**Risico’s en faalfactoren** bij de aanleg van een innovatief vervoerssysteem zijn:

- Een onvoorziene kostenverhoging, waardoor de investeringen te hoog worden. De gemeente zou dit geld zelf bij moeten dragen.
- Het vinden van een exploitant – de exploitatierisico’s zijn hoger, waardoor het moeilijker wordt om het rendabel te exploiteren. Dat betekent in praktijk dat de gemeente of de risico’s draagt of meer bijdraagt aan de exploitatie.
- Het beheer van de infrastructuur. Deze moet er wel representatief uit blijven zien.
- Het afbreukrisico is groot als de verbinding onvoldoende gebruikt wordt als het gerealiseerd is. Dit heeft zich voorgedaan bij de realisatie van de tramtunnel. Als er iets mis gaat, is er veel kritiek, maar nu het resultaat mooi is, zijn de reacties positiever. Als het project uiteindelijk niet zo goed geslaagd was, had Den Haag een groter probleem gehad bij het starten van andere vernieuwende en risicovolle projecten.
- De gemeente kan initiatiefnemer zijn om een innovatief project te realiseren, al moet altijd ze waken voor desinvesteringen.
- Elk systeem heeft zijn eigen inpassingproblemen.
- De monorail, met kleine eenheden, is gericht op een constante stroom reizigers. Ten tijde van de ontwikkeling van het plan was sprake van de aanleg van het ADO-stadion op het GAVI-kavel. De piekstroom, veroorzaakt door een voetbalwedstrijd, zou niet verwerkt kunnen worden door de monorail. De gemeente zou dan alsnog een extra vervoersmogelijkheid moeten inzetten.

**Algemene factoren voor de ontwikkeling van innovatieve vervoersystemen**

- Het proces verloopt beter als zich meer partijen committeren.
- De aanleg van het transferium was erg belangrijk voor het ontwikkelen van de hoogfrequente verbinding met het centrum van Den Haag. Maar er moet wel veel aandacht worden besteed aan de ligging en de ontwikkeling van een transferium, om te zorgen dat er daadwerkelijk gebruik van wordt gemaakt.
- De communicatie rondom een innovatief traject is heel belangrijk.
- Financiering van private partijen is altijd onzeker, uiteindelijk wil een private partij altijd winst maken.

**Beleid rondom verkeer en vervoer**

De gemeente Den Haag gaat de inrichting van de stad meer afstemmen op de verkeersinfrastructuur. Er wordt gekeken naar mogelijkheden om verkeer en vervoer meer sturen te laten zijn, door bijvoorbeeld te verdichten rond haltes voor het openbaar vervoer. Deze ontwikkelingen zijn erop gericht om de groei van het verkeer op te vangen door het openbaar vervoer en er dus meer mensen gebruik laten maken van het openbaar vervoer. Ze ontstaan mede door de strengere milieueisen. Als meer mensen gebruik maken van het openbaar vervoer gaat de kostendekkingsgraad omhoog. De kostendekkingsgraad van een lijn wordt voor een gemeente steeds belangrijker, want hoe lager die graad, hoe duurder een reiziger is voor de gemeente.
Daarnaast wordt in de ontwikkeling rekening gehouden met de beschikbaarheid van openbaar vervoer voor alle reizigers. In 2010 moet al het openbaar vervoer over de weg (en in 2030 over het spoor) voor iedereen toegankelijk zijn.

In het verleden was uitgangspunt dat elke woonwijk een rechtstreekse verbinding had met het centrum en één van de stations. Nu er meer bezuinigd wordt op openbaar vervoer wordt de inrichting van de vervoerslijnen herzien. Als gevolg van de schaalvergroting (de uitbreiding van de stad met de Vinex-lacaties) zal de reistijd naar het centrum op peil moeten blijven, waardoor op sommige lijnen bijvoorbeeld de halte dichtheid zal afnemen. Stadsgewest Haaglanden is verantwoordelijk voor de lijnvoering binnen het gewest. Het beleid van het Rijk is in dat opzicht paradoxaal: er wordt meer bezuinigd, terwijl de eisen aan milieu en sociale aspecten van het openbaar vervoer strenger worden, waardoor het openbaar vervoer weer duurder wordt. Elke reiziger méér in het openbaar vervoer kost het stadsgewest geld. Op dit moment lijkt er nog enige rek te zitten in het netwerk, maar dat houdt een keer op. Om het netwerk efficiënter in te richten komen er naast de aanwezige radiale lijnen meer tangentiële lijnen en extra knooppunten. Zo wordt de "sternet"-variant uitgewerkt.

**Gesprekssfeer**

Het was een prettig gesprek. Mevrouw Tideman wist veel te vertellen over de redenen waarom de monorail uiteindelijk niet verder ontwikkeld is. Aan het eind weken we af van het onderwerp innovatief vervoer in de richting van het huidige beleid rondom de ontwikkeling van openbaar vervoer. Dit geeft een duidelijker beeld van de context waarin deze ontwikkelingen zich afspelen.

**Afspraken**


**Verslag dd. 10 maart 2005**
Dhr. A.N.J. Busse, afdeling Verkeer en Vervoer, Gemeente Leeuwarden

Onderwerp De gemeente Leeuwarden heeft onderzoek gedaan naar de herinrichting van het gebied tussen de FEC en de binnenstad. Bij deze herinrichting is gekeken naar de mogelijkheden voor automatisch vervoer.

Kenmerk Niet vertrouwelijk

Interviewer Emmylou Aben

Datum 9 maart 2005

Planvorming Tijdens de aanleg van een grote parkeergelegenheid bij de FEC waren er plannen voor de herinrichting van het gebied vanaf de FEC richting het station. Hierbij is gekeken naar een vorm van hoogwaardig verkeer om de verkeersstroom tussen de FEC en het station te bedienen. Een traject voor een peoplemover (automatische wagentjes over asfalt, zoals op de floriade) zou aangelegd kunnen worden op het midden tracé. De herinrichting van de straat is niet doorgegaan en daarom de verdere ontwikkeling van dit project ook niet.

Keuze voor peoplemover De beweegredenen van de gemeente om voor een peoplemover te kiezen, waren de frequentie veel hoger kan zijn dan een bus kon worden vanwege de lage arbeidskosten. Een pendelbus haalt een frequentie van 4 keer per uur. De peoplemover kan flexibel ingezet worden als dat nodig is, terwijl de realisatie van een extra buslijn 100.000 euro kost. De hogere investeringskosten van een peoplemover kunnen eruit gehaald worden als het project een langere doorlooptijd kent. De peoplemover zou erop gericht zijn om reizigers op zaterdag van en naar de stad te vervoeren, omdat de parkeercapaciteit in het centrum op deze dag te klein is. Verder zou hij ingezet kunnen worden tijdens de spitsuren voor woon-werkverkeer. De flexibele inzetbaarheid van de peoplemover zorgt dat de stromen bediend kunnen worden als dat nodig is.

Risico’s Het systeem heeft een conflictvrije baan nodig. Dit is moeilijk te realiseren. Daarnaast moet het gebruik van het voertuig aantrekkelijk zijn: de snelheid en het comfort zijn daarbij belangrijk. Het voertuig op de floriade was nog erg langzaam. De sociale veiligheid is een risico, maar kan verbeterd worden door het installeren van een camera in het voertuig. Daarnaast zorgt de aanwezigheid van activiteiten in de omgeving van de haltes en op de route voor sociale controle.

Concessieverlening De gemeente Leeuwarden is concessieverlener, totdat er opnieuw aanbesteed moet worden. Dan neemt de provincie het over. De gemeente verwacht dat ze dan afspraken met de provincie kan maken om alsnog zelf aan te besteden of dat de aanbesteding in nauwe samenwerking zal gaan. De gemeente kent de vervoersstromen en verkeerssituatie in de stad immers het beste en kan daardoor een goede afweging maken.

Afspraken De gegevens uit het telefoongesprek mag ik gebruiken voor mijn afstudeerscriptie.

Verslag dd. 10 maart 2005
Almelo

Almelo is erg actief op het gebied van nieuwe ontwikkelingen in het verkeer en vervoer. Zo heeft ze als eerste gemeente GPS geïntroduceerd in 1998 voor het geven van dynamische reisinformatie en bussen voorrang te geven bij stoplichten. Almelo is echter wel een arme gemeente en kan zelf geen geld vrijmaken voor innovatieve projecten. De heer Vermie is inmiddels 13 jaar werkzaam bij de afdeling Verkeer en Vervoer.

Procesverloop


Inzet wagentjes

Er zullen 35-40 wagentjes rijden over het traject, deze moeten zo efficiënt mogelijk worden ingezet. Het systeem is zelflerend. In eerste instantie wordt de positie en parkeerplaats van een wagentje ingegeven. Uiteindelijk zal het systeem zelf bepalen waar welke stromen bediend moeten worden op welk moment. Om ervoor te zorgen dat de wachttijd voor reizigers zo klein mogelijk is, zal er buffercapaciteit worden ingebouwd bij de haltes.

Er is gekozen voor een monorail, omdat het nieuwe transportsysteem vanuit het netwerkprincipe ingehuld werd en niet vanuit het lijnprincipe. Een inpassing op maaiveldniveau van een parkshuttle ziet de heer Veldscholten niet gebeuren, omdat er te veel conflicten op zouden treden met fietsers en voetgangers, die veel in het Nederlandse straatbeeld aanwezig zijn. Een afscheiding van het traject middels een hekwerk is in een binnenstad niet te realiseren en niet wenselijk. Dit systeem hoeft niet per se verhoogd aangelegd te worden. Het kan op maaiveld niveau aangelegd worden als er sprake is van een natuurlijk afscheiding. Dit betekent dat op het traject geen mensen...
kunnen komen. In sterk verstedelijkte gebied zijn geen mogelijkheden op maai- enveld niveau.

Tijdens een symposium waarin de gemeente haar toekomstplannen presenteerd was ook een proefexemplaar van de peoplemover te bezichtigen in het stadhuis. Hierdoor nuanceerden de reacties van inwoners en raakten mensen enthousiaster over het concept.

Het plan dat ontwikkeld wordt, is om de drukste buslijn – in zuidelijke richting – op te hogen. Dit traject loopt langs een groot aantal activiteitencentra, zoals een bejaardentehuis, het nieuwe stadion van voetbalclub Heracles, een groot Regionaal OpleidingsCentrum en een grote sportaccomodatie. Deze centra bieden een hoop parkeergelegenheid. Dit zijn kansen voor flankerend beleid. De parkeertarieven in de stad kunnen aangepast worden, maar er kan ook voor gekozen worden om de parkeermogelijkheden in de binnenstad niet uit te breiden. Daarnaast zijn er plannen om de snelweg door te trekken langs de zuidas van Almelo. Wellicht zijn hier mogelijkheden voor het realiseren van een transferium, zodat forensen niet meer met de auto de binnenstad ingaan. Bij de inrichting is bewust gekeken naar de locaties waarlangs het traject wordt aangelegd. Nieuwe ontwikkelingen langs het traject bieden kansen, terwijl de aanleg in een historisch stukje stad een afbreukrisico kan zijn.

Vervoersstromen die verwacht worden zijn woon-werkverkeer van reizigers die gebruik maken van de P&R voorzieningen in het zuidelijke gebied van de peoplemover en vandaaruit naar het station of hun werkplek in het centrum gaan. Daarnaast de bezoekers van de binnenstad vanuit andere gemeenten of woonwijken die ontwikkeld worden aan de zuidkant van Almelo. Er is een frequente stroom tussen het verzorgingstehuis en het ziekenhuis. Daarnaast komen veel bezoekers naar het ziekenhuis zelf. Een extra stroom reizigers is te verwachten als Almelo de eerste gemeente in Nederland is die de peoplemover realiseert. Dan zullen er ook toeristen op af komen.

De regio Twente is concessieverlener en verantwoordelijk voor het busvervoer in de stad. Op gedeelten van het traject rijdt op dit moment ook een bus. De bus en de monorail kunnen concurrenten zijn. De heer Veldscholten ziet dit liefst dat de buslijn vervalt als de peoplemover gerealiseerd wordt. Als de regio Twente niet wil participeren in de realisatie van de peoplemover, dan wil de gemeente de mogelijkheden bekijken voor private realisatie. Dit wordt echter veel moeilijker als ze de verliezen van de buslijn moet dragen. De gemeente ziet veel mogelijkheden voor private financiering: de verscheidene activiteiten die aan het traject liggen en een halte krijgen, reclame in het voertuig, investeringen van een projectontwikkelaar die flats exploiteert. Deze flats kunnen bijvoorbeeld een halte krijgen in het gebouw. Een combinatie van private en publieke realisatie is ook nog mogelijk.

De aanleg van de monorail zou 40 miljoen euro kosten, de exploitatiekosten zouden neerkomen op 2,1 miljoen euro. De exploitatieopbrengsten zouden 1,9 miljoen euro zijn op jaarbasis. Een grove berekening gaf aan dat de kostendekkingsgraad van een peoplemover veel hoger (over 90%) ligt dan de kostendekkingsgraad van huidig openbaar vervoer (30%). Aangezien Almelo een arme gemeente is, kan ze zelf geen geld vrijmaken voor innovatieve projecten. Daarom is ze afhankelijk van subsidies. In de jaren '90 financierde de Rijksoverheid nog 90-95% van de investeringen in infrastructuur. Nu ligt deze verantwoordelijkheid bij de regionale
overheden en is de verwachte financiering maximaal 50%. Daarom zoekt de gemeente naar andere mogelijkheden. Via het Europese project EDICT kreeg de gemeente de mogelijkheid om de mogelijkheden van een peoplemover verder te verkennen. Almelo was eerst follower city in dit project, maar heeft later de plek van de gemeente Eindhoven overgenomen, toen bleek dat de pilot daar niet meer gerealiseerd zou worden. Op dit moment loopt er een aanvraag voor deelname in het EDICT 2 programma. De EU heeft 15 miljoen euro tot haar beschikking dat ze wil besteden aan 3 projecten. Daarbij verwacht ze dat gemeenten vergenoeg gevorderd zijn in het ontwikkeltraject dat ze met marktpartijen kan praten om de investeringen in de infrastructuur te realiseren. Zo ver zijn gemeenten volgens de heer Veldscholten nog niet gevorderd. De EU kan het geld beter in een project steken, waarin de peoplemover dan ook daadwerkelijk gerealiseerd kan worden. Een geslaagde pilot kan andere gemeenten enthousiast maken om ook hiermee aan de slag te gaan. Het Rijk biedt verschillende financieringsmogelijkheden voor innovatieve initiatieven bij verschillende ministeries.

**Toekomstmogelijkheden** Omdat de gemeente Almelo ook veel projecten aan de noordkant van de stad aan het ontwikkelen is, ziet ze mogelijkheden om het netwerk uit te breiden die richting op. Deze plannen bieden vooral kansen op het gebied van ruimtelijke inrichting. Omdat het gebied nog ingericht moet worden, kan de peoplemover in het ontwerp geïntegreerd worden. De aanleg van het zuidelijke traject biedt vooral verkeerskundige mogelijkheden.

**Beleidsvelden** Verkeer en Vervoer valt onder de dienst Ruimtelijke Ordening en Milieu. Stedebouw valt ook onder deze dienst, maar raakte pas enthousiast over de mogelijkheden van de peoplemover, nadat ze een DVD had gezien waarin de peoplemover was geïntegreerd in het straatbeeld van Almelo. Op het gebied van ruimtelijke ordening liggen nog een aantal onzekerheden, omdat het bestemmingsplan hoogstwaarschijnlijk gewijzigd moet worden voor de realisatie van het project. Vanaf het begin van de verkenningen naar de mogelijkheden van automatisch vervoer is de beleidsafdeling Economische Zaken betrokken bij de plannen om draagvlak te kweken bij de middenstand en bedrijven. Daarnaast wordt veel gesproken met private partijen die belangen hebben langs het traject om te kijken hoe zij in het geheel kunnen participeren. Hierbij gaat het om ontwikkelaarsbedrijven van vastgoed, woningcorporaties, zorginstellingen. Vanwege de zorginstellingen die langs het traject liggen is ook de beleidsafdeling Welzijn van de gemeente betrokken in het project.

**Rol van de gemeente** De gemeente is de probleemeigenaar met betrekking tot de bereikbaarheid van de stad. Daarom is ze vaak initiatiefnemer voor projecten op het gebied van verkeer en vervoer. Daarnaast ligt er een rol voor de gemeente in het enthousiasmeren van partijen al voor de inspraak, zodat de kennis bij de belanghebbenden en betrokkenen vergroot wordt en er draagvlak gecreëerd wordt. Er ligt ook een rol op het gebied van procesmanagement. De gemeente is sterk afhankelijk van andere partijen en het kaderwetgebody voor de financiering van het project. Als het kaderwet niet geïnteresseerd is in de ontwikkeling van OV is het veel moeilijker om het te realiseren.

Tijdens een symposium is al eens gesuggereerd dat er eigenlijk een hoofdverantwoordelijke zou moeten zitten op dit project die de eerste contactpersoon is en trekker is van het project.
**Faalfactoren** De toekomstvisie van de gemeente Almelo was gestoeld op het toevoegen van meerwaarde aan het openbaar vervoer en vanuit de netwerkgedachte. De realisatie van een testbaan spreekt niet genoeg tot de verbeelding van de mogelijkheden van automatisch vervoer en kan daarbij nadelig zijn voor een verdere ontwikkeling. Daarnaast is het erg onwaarschijnlijk dat een automatisch vervoerssysteem op maaiveld niveau ingepast kan worden.

Daarnaast liggen er nog risico’s op bestuurlijk vlak. De publieke opinie speelt een belangrijke rol als het project uiteindelijk voorgelegd wordt aan de gemeenteraad. Hier ligt een groot abreukrisico. De publieke opinie is moeilijk te sturen, maar de wethouder heeft veel draagvlak in de gemeente en is een goede bestuurder die de belangen van alle partijen aanhoort en mee zal nemen. Daarnaast staat hij op goede voet met de pers. Een ander risico op dit vlak is de wijziging van het bestemmingsplan.

Over de financiering bestaat nog veel onduidelijkheid – zoals de rol van publieke en private partijen. Dit kan een aantal risico’s met zich meenemen.

Het omgaan met het risico van mogelijke ongevallen is erg belangrijk. Er zal extra mankracht ingezet moeten worden om het geheel te monitoren. De richtlijnen op dit gebied worden nog uitgewerkt.

**Kansen** De ontwikkeling van automatisch vervoer verbetert het aanzien van de stad op twee punten: vanuit de hightech hoek gezien zal Almelo aantrekkelijker worden voor bedrijven om zich er te vestigen. Een tweede voordeel is dat de werkgelegenheid die die bedrijven met zich meebrengen. Daarnaast biedt het mogelijkheden voor Almelo als derde grote stad, maar toch klein in vergelijking met Hengelo en Enschede, om zich te profileren in Twente.

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**Gesprekssfeer** De heer Veldscholten is 13 jaar werkzaam bij de afdeling Verkeer en Vervoer in de Gemeente Almelo en weet veel te vertellen over de ontwikkelingen en visies op het gebied van openbaar vervoer en de innovativiteit van deze stad.


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De heer A. Vermie, Senior adviseur Ingenieursbureau, Gemeente Rotterdam

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Onderwerp
De ontwikkelingen in de gemeente Rotterdam op het gebied van automatisch personenvervoer en schone voertuigen

Kenmerk
Niet vertrouwelijk

Interviewer
Emmylou Aben

Datum en plaats 17 maart 2005 te Rotterdam

Projecten
Op dit moment is de gemeente Rotterdam niet actief met het ontwikkelen van automatisch vervoer. Ze heeft wel een aantal projecten lopen om schoon vervoer in de stad te realiseren. Een van deze projecten is de inzet van de Piershuttle op de Kop van Zuid over de Wilhelminapier. Dit is een elektrische shuttlebus gaat dienen als een feeder voor de metro. Voor dit traject is onderzoek gedaan naar het inzetten van automatisch vervoer. Het resultaat van dit onderzoek was de aanleg van een ondergrondse kabeltrein. Dit alternatief bleek erg kostbaar te zijn. Er is gekeken naar de inzet van een CyberCar, maar dit was niet realiseerbaar, vanwege het gebrek aan ruimte voor de aanleg van nieuwe infrastructuur. De huidige infrastructuur moet beschikbaar blijven voor het huidige verkeer. Het aanleggen van verhoogde infrastructuur zou wat betreft financieel resultaat gelijk staan aan het inzetten van een elektrische bus. De aandrijving van de bus kan binnen twee jaar vervangen worden door een brandstofmotor. Daarom heeft de gemeente Rotterdam voor deze vorm gekozen. De realisatie is in de handen van private partijen en valt vanwege haar geringe omvang buiten de concessieverlening.

Duurzaamheid
In Rotterdam wordt veel aandacht besteed aan duurzame initiatieven; onder meer op het gebied van verkeer. Bovendien is het een onderwerp dat de betrokken wethouder aanspreekt. De daadwerkelijke realisatie van duurzame projecten staat echter vaak ver van de gemaakte plannen: ‘Duurzaamheid is goed, zolang het niets extra’s kost’. Het stimuleren van duurzame initiatieven ligt voor een gedeelte ook bij de stadsregio die verantwoordelijk is voor de concessieverleningen in het openbaar vervoer en hier de meeste kennis van heeft. De gemeente Rotterdam heeft voorgesteld dat de stadsregio prikkel in kan bouwen in de concessieaanvraag waardoor partijen gestimuleerd worden om duurzame vormen van openbaar vervoer te realiseren. Hierbij kan gedacht worden aan een bonus-malusregeling of het toekennen van punten aan duurzame initiatieven.

Bestuurlijk draagvlak
De duurzame initiatieven hebben bestuurlijk draagvlak omdat enerzijds de wethouder enthousiast is over de voorgenomen projecten en anderzijds omdat de projecten zijn opgenomen in het milieubeleidsplan. De luchtkwaliteitdiscussie heeft kansen voor de inzet van de piershuttle vergroot. Het beleid is er echter wel op gericht dat elke plek in de stad met de auto bereikbaar moet zijn.
Kansen voor duurzame mobiliteit

De kansen voor het verbeteren van de duurzaamheid in de stad liggen ook op het gebied van **nieuwe, efficiëntere en schonere brandstof**en, zoals bio-ethanol. Deze brandstof kan gemengd worden met gewone benzine waarbij maximaal 85% bio-ethanol toegevoegd kan worden (E85). Het wagenpark van Rotterdam (dienstwagens en openbare vervoermiddelen) zal gedeeltelijk worden ingericht met wagens die rijden op biobrandstoffen. Om dit uit de ‘niche’ te halen en de kansen voor een succesvolle introductie van de biobrandstof te vergroten op de Nederlandse markt wordt geprobeerd om via een landelijke partij de introductie van biobrandstof **grootschaliger** uit te voeren. Verschillende autoproducenten -Opel, Volvo, Saab en Volkswagen- zijn bezig met de ontwikkeling en introductie van een auto die geschikt is voor het gebruik van bio-ethanol als brandstof. Een **nadeel** aan auto’s op bio-ethanol is het iets hogere onderhoudsritme dan nu gebruikelijk is. Daarnaast moeten er **pompinstallaties** worden geïnstalleerd. Hier ligt een rol voor de landelijke overheid. Het gebruik van biobrandstoffen moet aantrekkelijk zijn om over te stappen, zo moet de literprijs van E85 op energiebasis (E85 is iets minder zuinig dan benzine) veel lager zijn dan van gewone benzine.

Andere kansrijke duurzame vervoersmogelijkheden zijn bijvoorbeeld de hybride techniek, de waterstofcel, de elektrische auto en schonere brandstoffen. Een nadeel aan de **hybride auto** is het gebrek aan keuzemogelijkheden voor de consument – alleen Honda en Toyota hebben tot nog toe een hybride auto ontwikkeld. De kans voor hybride technologie is groot, omdat deze techniek niet afhankelijk is van de soort brandstof, maar gericht is op het zuinige verbruik van brandstof. De **waterstofcel** lijkt minder kansrijk dan de hybride techniek, omdat de waterstofcel wel afhankelijk is van het soort brandstof. Een nadeel aan de **elektrische auto** is de kleine actieradius. Daarnaast wordt meer onderzoek gedaan naar **schonere brandstoffen**; al kunnen deze maar 35% van de totale energiebehoefte dekken.

Mogelijkheden om nieuwe initiatieven buiten de aanbesteding te realiseren zijn er als een initiatief onder een Europees project valt of, als dit niet het geval is, als er geen alternatief voor handen is; dus als een aanbieder een natuurlijk monopolie heeft, zo is toegezegd door Brussel. De vragende partij kan dit proces sturen bijvoorbeeld door de gestelde eisen in de aanbesteding. Dit kan de introductie van nieuwe technieken een push geven.

Verder zijn sommige **openbare vervoerders** zijn bereid om biodiesel in te zetten. De **autoindustrie** is bezig met de ontwikkeling van nieuwe technieken en bereid om mee te werken.

De **introductie van een innovatieve technologie in een niche blijft nodig**, waarbij de gemeente een stimulerende rol dient te vervullen in het mobiliseren van markten voor schone vervoermiddelen. De gemeente Rotterdam merkt dat er latente private markten aanwezig zijn, maar die zijn niet groot genoeg om een kritieke massa te vormen. Het samenbrengen van deze markten is nodig om de autoproducenten te stimuleren in het ontwikkelen van duurzame technieken en de private markt bekend te maken met de mogelijkheden.

Een **faalfactor** voor het realiseren van duurzaamheid is dat milieu wordt gepresenteerd als een **probleem**. Dat is niet nodig, het kan ook gezien worden als een meerwaarde.

**Langetermijn verwachting** Het gebruik van fossiele brandstoffen zal afnemen, de prijs van een vat olie zal blijven stijgen. De heer Vermie verwacht dat de **omslaag naar duurzame alternatieven** ineens heel snel zal gaan, zeker als biobrandstoffen goedkoper
zijn dan fossiele brandstoffen. Flankerende (prijs)mechanismen kunnen dit proces versnellen – bijvoorbeeld gunstiger parkeerbeleid voor duurzame auto’s, accijnssverlaging op duurzame brandstoffen.

**Automatisch vervoer** De kansen voor automatisch vervoer lijken zich vooral te beperken tot de niches, bijvoorbeeld op de kop van Zuid of ECT in de haven van Rotterdam. Omdat het gemeentebestuur het beleid voert dat elke plek in de stad met de auto bereikbaar moet zijn, zijn de kansen voor het autovrij maken van de binnenstad erg klein. De auto geeft veel mensen een groot gevoel van vrijheid. De verwachting is daarbij ook dat het congestieprobleem altijd een evenwicht zal vinden, waardoor dit probleem nooit zo groot zal worden dat het autogebrek drastisch gaat afnemen. Al is de inzet van volledig automatisch vervoer in de binnenstad voor het bereiken van duurzaamheid en een goede luchtkwaliteit een erg interessante optie.

In een historische binnenstad lijken de kansen voor automatisch vervoer beter. Bijvoorbeeld het introduceren van elektrische huurautootjes – zoals nu greenwheels bestaan. In LaRochele is in samenwerking met PSA een project gerealiseerd waarbij het binnenstedelijke verkeer gecombineerd wordt met een dergelijk verhuur systeem. Er worden studenten ingezet om de autootjes tussen de verschillende parkeerplaatsen te verplaatsen als dit qua capaciteit nodig blijkt. Een automatisch systeem kan zelfregulerend werken.

**Transities** Het moeilijke aan het realiseren van een transitie is de vraag of het in kleine stapjes moet of dat het grote omslagen zijn die toevalligheden afhangen. Het lijkt nodig om kleine stapjes te zetten, omdat het nodig is om keuzes te maken voor de ontwikkeling van bepaalde technieken. Het resultaat valt echter niet te garanderen. Een gemeente speelt een belangrijke rol in het realiseren van transities als initiatiefnemer. Ze kan een markt bieden – 3000 dienstwagens die worden uitgerust voor het gebruik van biobrandstoffen en ze kan particuliere partijen uit de stad mobiliseren. De kansen voor gemeenten om projecten te realiseren lijken, volgens de heer Vermie op dit moment meer binnen Europa te liggen dan op nationaal overheidsniveau. Op planmatig gebied loopt Nederland nog mee voorop, maar in de uitvoering ligt Nederland inmiddels achter op andere landen. Dit lijkt onder meer gelegen aan het verminderen van politieke durf en het uitstellen van keuzes. Met deze instelling kan een transitie niet gestuurd worden. Daarnaast worden private partijen die iets willen ondernemen vaak niet gesteund in hun initiatieven door de nationale overheid. Inmiddels wordt de stadsregio wel actiever in het stimuleren van de ontwikkeling van duurzame technieken.

**Organisatie gemeente Rotterdam** Binnen de gemeente Rotterdam zijn veel partijen betrokken bij het realiseren van duurzaam transport. Gemeentewerken Rotterdam is opdrachtnemer van de stad en heeft daardoor geen direct contact met de bestuurder, maar meer met beleidsafdelingen van de gemeente Rotterdam. D S+V is de denkpartner van de gemeentewerken en het ontwikkelbedrijf Rotterdam is een belangrijke financier van projecten. Daarnaast was het Ontwikkelbedrijf eerst verantwoordelijk voor de Europese projecten. Inmiddels is Gemeentewerken ook zelf een partner in deze projecten, omdat ze binnen de gemeente Rotterdam erg actief is in de ontwikkeling van duurzame mobiliteit.

De afdelingen Ruimtelijke Ordening en Verkeer zijn binnen de gemeente samengevoegd. De beleidsafdeling milieu is afgesplitst en ondergebracht bij het DCMR. Daarnaast is elke afdeling verantwoordelijk voor haar eigen milieubeleid.
Gesprekssfeer Het was een prettig gesprek waarin veel duidelijk werd over andere mogelijkheden om duurzaamheid te realiseren en afwegingen die gemaakt worden bij het maken van keuzes voor duurzaamheid. De heer Vermie is erg bekend op dit terrein zowel voor wat de technische mogelijkheden als voor wat de organisatorische mogelijkheden betreft.

Afspraken Het verslag zal worden toegezonden aan de heer Vermie en mag opgenomen worden in het afstudeerrapport.

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Kenmerk
Niet vertrouwelijk

Datum en plaats
24 maart 2005 te Den Haag

Taken in de ontwikkeling van openbaar vervoer


Visie van het stadsgewest Haaglanden op openbaar vervoer
In de ‘Regionale Nota Mobiliteit’ – die op dit moment ter inzage ligt - wordt een visie gepresenteerd van het verkeer en vervoer tot 2015-2020. Een deel is gericht op de consolidatie van de huidige projecten, zoals de randstadrail, de ontwikkeling van lijn 19 en het verdichten van bepaalde stedelijke zones. De verdichten zijn er onder meer op gericht om de bezettingsgraad in het openbaar vervoer te verhogen. Daarnaast wordt een aantal projecten ontwikkeld op regionaal en stedelijk niveau om het openbaar vervoer efficiënter in te richten en vervoersstromen beter op maat te bedienen. Hierbij wordt het openbaar vervoer ook aangepast aan de ruimtelijke inrichting. Door het openbaar
vervoer in te richten op bestaande vervoersstromen kunnen meer knooppunten gecreëerd worden en lijnen beter op elkaar aansluiten.

**Problemen openbaar vervoer** Het autoveerkeer vormt een probleem, maar de gedachte om mensen uit de auto te krijgen is irreëel. De verwachting is dat P&R voorzieningen een winst kunnen opleveren van 5% - dat lijkt niet zo veel, maar een afname van 15% autogebruikers zou het einde van files kunnen betekenen. Het oplossen van problemen op het gebied van verkeer gaat in veel kleine stapjes die allemaal een stukje bijdragen aan de oplossing van de problemen. Ook kan het openbaar vervoer efficiënter worden ingericht. Er wordt verwacht dat de kostendekkingsgraad van de Randstadrail rond de 40% zal liggen.

**Visie op automatisch vervoer** Bij het ontwikkelen van een nieuw vervoersysteem dient iedere keer te worden gekeken naar de mogelijkheden van het systeem om de vervoersvraag te beantwoorden – een automatisch vervoersysteem ontwikkelen omdat het innovatief is, mag niet de enige reden zijn. Een nieuw systeem moet ook economisch haalbaar zijn, de middelen van het stadsgewest zijn beperkt. Er kan gebruikt gemaakt worden van Europese subsidies om innovatieve systemen te realiseren. Hierbij is het van belang dat het systeem na het ophouden van de subsidie niet een te grote kostenpost wordt voor het Stadsgewest.

De ontwikkeling van de ‘Sky shuttle’ in Den Haag is om een aantal redenen niet heel positief ontvangen: het zou een concurrent van de tram worden, terwijl het tramsysteem in Den Haag goed werkt. Daarnaast brengt de realisatie van een geheel nieuw systeem veel onzekerheden en extra kosten met zich mee. Bovendien kon de ‘sky shuttle’ niet aansluiten op het bestaande systeem. De overstap tussen twee verschillende systemen die niet hetzelfde perron kunnen delen geeft een hogere drempel dan de overstap tussen 2 trams die aan hetzelfde station kunnen stoppen. Een ‘sky shuttle’ past verder niet goed binnen de huidige stedenbouw van Den Haag. Een laatste, belangrijke reden, waarom de aanleg niet doorgegaan is, is dat het systeem de vraag niet voldoende kan bedienen. Bij het realiseren van een nieuw systeem dient verder te worden gekeken dan de stroom die bediend moet worden – ook de bediening van de andere stromen in het gebied moet meegenomen worden om een efficiënt vervoersysteem te ontwikkelen.

Door de aanwezigheid van een tramsysteem en bussen die met een roetfilter uitgerust dienen te zijn, neemt de noodzaak voor een nieuw duurzaam transportsysteem af in Den Haag. In kleinere gemeenten is er geen noodzaak om een nieuwe vervoersysteem aan te leggen. Het streekvervoer is zo ingericht dat het de vervoersstromen in de kleinere gemeenten rondom Den Haag kan bedienen.

Het stadsgewest is bekend met de mogelijkheden van automatisch vervoer, maar ze heeft nog geen mogelijkheden gezien om de benodigde vervoersdiensten met zulke systemen te realiseren zonder extra problemen te creëren; bijvoorbeeld op het gebied van economische haalbaarheid.

De heer Termorshuizen kan zich voorstellen dat een gemeente het imago van de stad wil verbeteren met automatisch vervoer – zij zijn immers niet verantwoordelijk voor de financiële realisatie. Uiteindelijk besluit het dagelijkse bestuur of een systeem al dan niet ontwikkeld wordt.

**Betrokken partijen bij de ontwikkeling van openbaar vervoer** Stadsgewest Haaglanden is verantwoordelijk voor de lijnvoering, concessieverlening en aanbesteding
van de ontwikkeling van de infrastructuur. Verder zijn gemeenten betrokken bij het opstellen van het verkeer en vervoersbeleid. Tot slot voeren de vervoerders de opdrachten van het stadsgewest uit. Hierbij vinden onderhandelingen plaats over de kosten voor de extra exploitatie van een lijn of bij het afschaffen van een lijn. De middelen van het stadsgewest komen bij het Rijk vandaan – uit de zogenaamde BDU - brede doeluitkering. Hiermee kan een deel van de kosten voor openbaar vervoer gedekt worden. De gemeente draagt in principe niet bij aan de financiering van een openbaar vervoerysteem, tenzij ze speciale wensen heeft ten aanzien van een voorziening. Dit was bijvoorbeeld het geval in Delft. Door een financiële meevaller van het Rijk en een verhoging van de BDU met 1% kwam geld vrij voor het doortrekken van tramlijn 19 naar Delft. Daarnaast draagt de gemeente een gedeelte van de investeringskosten bij, omdat ze de tramlijn graag zou doortrekken naar de TU wijk.

**Ontwikkelingen in Scheveningen** Binnen Den Haag wordt ook gekeken naar mogelijkheden om vervoersproblemen rondom Scheveningen op te lossen. Deze problemen – die ontstaan door topdrukte vanwege het mooie weer - doen zich echter maar een paar keer per jaar voor. Op deze dagen zet de HTM extra trams in. Een nieuw systeem realiseren om de topdrukte in Scheveningen aan te kunnen, zou economisch niet haalbaar zijn, omdat de constante vraag niet groot genoeg is. Het doortrekken van de RandstadRail naar Scheveningen levert problemen op voor het bedienen van de werknemers aan de Koninginnegracht, omdat de tramlijn die daar nu loopt bij de aanleg van de RandstadRail verdwijnt. Daarnaast is de haltedichtheid van de RandstadRail kleiner dan van de tram. De reistijd voor werknemers in Den Haag zou hiermee toenemen. Dit is niet wenselijk; het is immers belangrijker om de werknemers in Den Haag goed te bedienen – zij reizen dagelijks met de tram.

**Gesprekssfeer** Het was een prettig gesprek. De heer Termorshuizen had duidelijke ideeën over de ontwikkeling en inrichting van het openbaar vervoer in zijn regio. De verantwoordelijkheden en afwegingen van de regio op het gebied van verkeer en vervoer zijn goed ter sprake gekomen.

**Afspraken** Het interviewverslag mag toegevoegd worden aan mijn afstudeerscriptie. Vooraf wordt het verslag nagelezen door de heer Termorshuizen.

*Verslag dd. 24 maart 2005*
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**Kenmerk**  
Niet vertrouwelijk

**Datum en plaats**  
29 maart 2005 te Rotterdam

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**Taken WGR-plus regio**  
De stadsregio Rotterdam (SRR) is een samenwerkingsverband waarin 18 gemeenten vertegenwoordigd zijn en heeft de status van een WGR+ regio. De **taken** van de WGR-plus regio zijn: opdrachtgever openbaar vervoer, concessieverlener en aanbesteder van rail infraprojecten. De businfrastructuur valt onder de verantwoordelijkheid van de gemeente. Deze infrastructuur wordt gesubsidieerd door de SRR, maar de gemeente is verantwoordelijk voor het beheer, onderhoud en aanbesteding van de. De **middelen** van de SRR komen van het Rijk in de vorm van de zogeheten BDU – brede doeluitkering. In 1996 werden de bevoegdheiten op het gebied van openbaar vervoer van het Rijk overgeheveld naar de regio’s – de kaderwetgebieden en de provincies. Per 1 januari 2005 zijn kaderwetgebieden veranderd in WGR-plusregio’s.

**Ontwikkelingen Park Shuttle Capelle aan den IJssel**  
In 2002 heeft de SRR op **initiatief** van Gemeente Capelle en de vervoerder Connexxion besloten om een doorstart te maken met de parkshuttle te Rivium. In dezelfde tijd heeft het AVV een **evaluatie** gemaakt van het pilot project van de parkshuttle. Deze was niet overwegend positief. Het pilotproject bleek niet kosteneffectief. Aanbevelingen voor een vervolgproject waren het uitbreiden van de infrastructuur, het vergroten van de capaciteit van de wagentjes en het verhogen van de betrouwbaarheid van het systeem.

De SRR wilde het **vervolgproject** financieel ondersteunen. Connexxion was verantwoordelijk voor de bouw van het voertuig, de gemeente Rotterdam droeg bij aan de realisatie van de infrastructuur en de gemeente Capelle was verantwoordelijk voor het beheer en onderhoud van de businfrastructuur. De gemeente Capelle heeft hiervoor een subsidieverzoek ingediend bij de SRR die dit gehonoreerd heeft.

De **financiële exploitatie** van de pilot was niet positief. Dit is grotendeels te verklaren door de kosten van de aanleg van de infrastructuur en de kleinschaligheid van de toepassing. Als de toepassingsmogelijkheden uitgebreid worden, nemen de kosten af, zeker omdat de personeelskosten veel lager zullen zijn dan bij conventioneel vervoer. Er zal personeel nodig zijn voor extra toezicht in en rondom het systeem, en er zullen maatregelen worden genomen om vandalisme tegen te gaan. Op het gebied van **sociale veiligheid** is de gemeente verantwoordelijk in de openbare ruimte. De vervoerder is
verantwoordelijk voor de veiligheid in het voertuig en op het grondgebied van haar perrons. Aangezien sociale veiligheid een speerpunt is van het Rijk is hier geld voor vrijgekomen. De SRR vervult een coördinerende rol in de ontwikkeling van sociale veiligheid binnen gemeente. Sociale veiligheid in automatische voertuigen kan preventief en achteraf gerealiseerd worden door ondermeer het monitoren met camera's en het inzetten van extra conducteurs. Dit gebeurt al in metro's. Medewerkers die monitoren zijn getraind op het herkennen van vandalisme en het herkennen van hun “klanten” – bijvoorbeeld zakkenrollers.

De SRR ziet meerdere gebieden waar systemen als de parkshuttle uitkomst kunnen bieden. Deze gebieden zijn te klein voor een nieuwe buslijn en zijn tevens niet voldoende ontsloten door het openbaar vervoer.

**Visie RVVP en ontwikkeling concessies** In het RVVP wordt beschreven hoe het vervoersnetwerk er in 2020 uit dient te zien. De eisen aan de inrichting van het verbindingen net dienen zo te worden gesteld dat de inrichting aantrekkelijk is voor de consument. De richtlijnen voor de ontsluiting van de stad worden overgelaten aan de vervoerder. Een eis die de SRR stelt aan de ontsluiting is het mogelijk maken van ketenverplaatsingen. De aansluiting op andere vervoerslagent moet hiervoor goed zijn.

De concessie is opgesteld aan de hand van de wettelijke richtlijnen uit de Wet Personenvervoer 2000. De theorie achter de inhoud van de concessie is dat de overheid het openbaar vervoer moet overlaten aan de markt. De SRR werkt volgens deze theorie, omdat ze van mening is dat de vervoerder degene is die de markt het beste kent. Als de eisen in de concessie strenger worden zal de exploitatie duurder worden. De SRR zit met een beperkt budget en zal hierin een afweging moeten maken. In eerste instantie ontwerpt de SRR een zo minimaal mogelijk PvE, om ervoor te zorgen dat de realisatie economisch haalbaar blijft. De SRR ontwerpt een functioneel programma van eisen (PvE) waaraan de vervoerder in de aanbesteding moet voldoen. Het PvE geeft onder meer de dekking van het gebied weer, de afstand tot een halte, de exploitatie termijn en de frequentie van de dienst afhankelijk van de omvang van de vervoersstromen. Bij het ontwerpen van een concessie wordt de bewonerskant als uitgangspunt genomen. De bedrijventerreinen worden niet meegenomen in de concessie. De SRR verwacht dat de vervoerder deze markt zal bedienen als daar vraag naar is. De bijdrage van de SRR aan de vervoerder is gebaseerd op reisigerssinkomsten.

**Initiatieven automatisch vervoer** De SRR legt de verantwoordelijkheid voor het ontwikkelen van nieuwe mogelijkheden op het gebied van openbaar vervoer bij de vervoerders – zij kennen de markt en de klanten en kunnen hun vervoer hierop inrichten. Verder moet de stadsregio in de toekomst al met meer eisen vanuit de EU rekening houden binnen de gestelde concessie, zoals roetfilters voor bussen en toegankelijkheidseisen voor het OV. Hoe complexer een concessie wordt, hoe duurder.

Als de gemeente en/ of de vervoerder een initiatief hebben die niet past binnen de concessie, maar wel een aantrekkelijk product voor de consument is, dan is de SRR bereid om hierover te overleggen en naar de mogelijkheden te kijken. Bijvoorbeeld bij de herinrichting of nieuwe ontwikkeling van een gebied, waar er een synergie tussen Verkeer en Vervoer en Ruimtelijk Ordening tot stand kan komen.

**Samenwerking RO en VV** Binnen de SRR worden een Ruimtelijk Plan Regio Rotterdam (RPRR) en een Regionaal Verkeer en Vervoerplan (RVVP) geschreven. Deze plannen vertonen enige frictie ten opzichte van elkaar. Fricies zijn bijvoorbeeld dat de ontwikkelde locaties kunnen niet voorzien worden van een gewenste ontsluitende structuur; dat de OV lijnen die verwacht worden in een gebied niet genoemd zijn in het RVVP of dat stedebouwkundingen een andere visie op een gebied hebben dan dat op verkeerskundig gebied efficiënt is. Deze visies zijn levende producten en in praktijk worden deze fricties opgelost. In de uitwerking van de plannen op lokaal niveau is het gemakkelijker om de plannen integraal uit te voeren.

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**Gespreksfeer** Het was een goed gesprek. De heer Peterse kon de visie van de stadsregio en de rol van de stadsregio in de ontwikkeling van het openbaar vervoer goed toelichten. De verantwoordelijkheden en afwegingen van de regio op het gebied van verkeer en vervoer zijn goed ter sprake gekomen.

**Afspraken** Het interviewverslag mag toegevoegd worden aan mijn afstudeerscriptie. Vooraf wordt het verslag nagelezen door de heer Peterse.

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