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Promoting bike-and-ride: The Dutch experience

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Abstract

The number of policy initiatives to promote the use of bike-and-ride, or the combined use of bicycle and public transport for one trip, has grown considerably over the past decade as part of the search for more sustainable transport solutions. This paper discusses the experiences with, and impacts of, such initiatives in the Netherlands. The Dutch measures to promote bicycle use in access trips have been generally successful. A country-wide program to upgrade regular and secure bicycle parking at train stations has led to an increase in user satisfaction and a growth in bicycles parked at stations. Smaller programs to stimulate the combined use of bike-and-bus have resulted in an increase in bicycle use, bus use, and share of infrequent bus passengers. Bicycle lockers at bus stops are hardly used by bus passengers, due in part to the dominance of students among bus users as well as the relatively high price of lockers in comparison to the value of bicycles used for access trips. Measures to promote the use of the bicycle in egress trips have met with more varying results. Projects to introduce leasing bicycles for egress trips have failed to attract passengers, for both train and bus services. In contrast, the introduction of flexible rental bicycles at train stations has resulted in a small reduction in car use, growth in train trips, and growth in bicycle use for non-recurrent trips. The Dutch experiences suggest some lessons for promoting bike-and-ride in countries and cities with a less well-developed bicycle infrastructure.

Keywords: Bicycle; Public transport; Multimodality; Interconnectivity

1. Introduction

The number of policy initiatives to promote the use of bike-and-ride, the combined use of the bicycle and public transport for one trip, has seen a substantial increase over the past decade in many industrialized countries as part of the search for more sustainable transport solutions (e.g. Doolittle and Porter, 1994; Hagelin, 2005). The increasing interest stems from the fact that bike-and-ride can help solve a key weakness of public transport: the accessibility of public transport stops. The time and inconvenience related to trips to and from

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these stops substantially reduces the attractiveness of public transport vis-à-vis the private car. Even fast types of public transport, such as the train, are often slower than the private car in terms of door-to-door travel times (Rietveld, 2000).

The use of the bicycle in access trips (at the home-end of a trip) and/or egress trips (at the activity-end of a trip) can substantial reduce the door-to-door travel time of public transport trips. As a feedering mode, the bicycle is substantially faster than walking and more flexible than public transport due to its 'continuous' character eliminating waiting and scheduling costs, suggesting that the use of the bicycle in access and/or egress trips can help closing the 'travel time gap' between car and public transport (Keijer and Rietveld, 2000). A comparison of travel times on 25 home-to-work links in the Netherlands, for instance, showed that the travel time ratio between public transport and the private car can drop from an average of 1.43 to 1.25 if the bicycle is used for access and egress trips to train and bus stations rather than public transport or walking (Anonymous, 1998).

In comparison to the private car, bike-and-ride offers a number of environmental and social benefits (Martens, 2004). These include reduction in energy use, air and noise pollution, as well as lower congestion levels on specific corridors and access routes to public transport stops. The combined use of bicycle and public transport may also increase public transport ridership on specific lines, thereby strengthening the economic performance of these services. Furthermore, bike-and-ride may help to enable car-free lifestyles, as it will improve the overall competitiveness of the 'green' modes of transport (public transport, cycling, walking) vis-à-vis the private car. Bike-and-ride may especially play a role here for trips of intermediary distance, i.e. trips that extend beyond 'normal' walking or cycling distances but are too short for truly competitive public transport like long-distance train services. Especially these intermediary trips proof to be difficult to serve by regular public transport services (Krämer-Badoni, 1994). Taken together, the environmental and social benefits provide the impetus for many public bodies to stimulate the combined use of bicycle and public transport.

While the interest in bike-and-ride is on the rise and the number of countries that are developing policies to promote bike-and-ride is increasing (see e.g. Department of Environment, Transport and the Regions, 1999; Bundesministerium fuer Verkehr, Bau- und Wohnungswesen, 2002; Hagelin, 2005), there is hardly any knowledge on the success of different types of measures to promote the combined use of bicycle and public transport. The goal of this paper is to provide insight into this issue, focusing on various measures implemented since the early 1990s in the Netherlands. Given the lack of large-scale before-and-after studies, the data presented in the paper are mostly derived from small-scale evaluation studies. Despite the limitations of these studies, the results do shed light on the possible effectiveness of various measures to promote bike-and-ride, as well as on the possible impacts of the measures to reduce car use. While the Netherlands represents a special case, given the near-universal availability of bicycle infrastructure and related high levels of bicycle use, lessons will be drawn for countries that are currently characterized by lower levels of bicycle ridership and a less developed bicycle infrastructure, as well as for the growing number of cities around the world that have invested substantially over the past decades in the promotion of bicycle use.

2. Bike-and-ride use in the Netherlands

The Netherlands has the highest level of bicycle use within the industrialized world. More than 27% of all trips are made by bicycle, a figure that has been relatively stable over the last decades (Pucher and Dijkstra, 2000). Medium-sized cities, in particular, show high levels of bicycle ridership, with some reporting a bicycle share of trips exceeding 35% (de la Bruheze and Veraart, 1999).

The high level of bicycle ridership is reflected to a large extent in the average levels of bike-and-ride (Table 1). While walking is the most popular access mode with a share of 65% of all trips, the bicycle accounts for a quarter of all access trips to public transport stops and stations. In comparison to other industrialized countries, the car is of relatively limited importance as an access mode in the Netherlands, with a share of only 10%.

The average figure for bike-and-ride hides the wide variety in the share of the bicycle as an access mode. At a closer look, the share of the bicycle in access trips is actually substantially lower than the general levels of bicycle ridership for most public transport modes, with the exception of train services (Table 2). The bicycle accounts for only 6% of access trips to bus and tram stops and for as little as 2% for metro stations. The differences between train services on the one hand, and bus, tram and metro services on the other, can be partly

Table 1
Share of various access modes (%) in total number of public transport trips

Possible public transport chains	Share in total number of public transport trips (%)
Walking and one public transport mode	55
Walking and two or more public transport modes	10
Bicycle and one or more public transport modes	25
Car passenger and one or more public transport modes	7
Car driver and one or more public transport modes	3
Total	100

Source: van der Loop (1997, p. 22).

Table 2
Share of the bicycle (%) in access and egress trips for various types of public transport

Type of public transport	Access (%)	Egress (%)
Train	29.3	6.7
Bus	6.0	1.0
Tram/metro	2.3	0.9
Share of bicycle in all trips	27	

Source: van Goeverden and Egeter (1993), processed.

related to differences in access distances (Martens, 2004). Railway stations tend to be characterized by substantially larger catchment areas than stops of slower modes of public transport, which makes the bicycle a relatively attractive access mode compared to walking, which is the most common feedering mode for bus, tram and metro (Keijer and Rietveld, 2000). Apart from the differences in catchment area, the availability of facilities will also play a role. Train stations in the Netherlands are fairly well-equipped with bicycle parking facilities, while these facilities are lacking at the vast majority of bus, tram and metro stops and stations (see below).

The share of the bicycle at the activity end of a public transport trip is substantially lower than in access trips. Even for the train, the share of the bicycle in egress trips is considerably lower than the general level of bicycle ridership, while the bicycle's share in egress trips from bus, tram and metro stops is negligible. The vast difference between the use of the bicycle in access and egress trips is the result of the asymmetry in bicycle availability (Rietveld, 2000). While bicycle availability at the home end is virtually ubiquitous in the Netherlands, it is problematic at the activity end. Since bicycles can only be taken on train and metro services outside rush hours and not at all on most buses and trams, public transport passengers can only use a bicycle for egress trips if they rent a bicycle at the destination station (if possible), purchase a second bicycle and store it at the activity end, or carry a folding bicycle onto a public transport vehicle. Each option has its impediments and is only relevant for a specific group of public transport users.

The data on bike-and-ride use in the Netherlands reveal the relatively small role of the bicycle in access trips to slower modes of public transport and in egress trips for all modes of transport. During the 1990s and the early 2000s, a number of pilot projects have been initiated that have aimed to stimulate the bicycle use in both instances. In addition, a number of measures has been implemented to further strengthen the use of the bicycle in access trips to train stations. Before discussing these measures in detail, the national policy framework will be briefly sketched.

3. National policies to promote bike-and-ride

The Dutch national government has actively promoted cycling since the early seventies, following the oil crisis and growing concern over environmental issues. The focus in these early years was primarily on the construction of bicycle paths within and in between urban areas. The combined use of bicycle and public transport received hardly any attention during the seventies and eighties. Investments were limited to the upgrading and extension of bicycle parking facilities at train stations (de la Bruheze and Veraart, 1999). The situation

changed in the early nineties. Against the background of the UN report 'Our Common Future' (Brundtland, 1987) and a Dutch report on the state of the environment (Langeweg, 1988), harsh criticism was voiced concerning the lack of attention for the bicycle in the Second Transport Structure Plan of the Ministry of Transport (Ministerie van Verkeer and Waterstaat, 1990). The criticism resulted in the formation of a special task force to develop a comprehensive bicycle policy, which resulted in the publication of the Bicycle Master Plan (BMP) in 1992.

The BMP identified five 'policy spearheads', among which 'the switch from the car to public transport and bicycle'. The goal of this 'spearhead' was to foster 'an increase of 15% in the number of kilometers traveled by public transport by the year 2010 through a better connection between bicycle and public transport infrastructure and facilities' (Ministerie van Verkeer and Waterstaat, 1999, p. 51). The strategy of the BMP was to stimulate regional and local authorities, companies and organizations, and public transport operators to incorporate a bicycle policy in their regular policies and activity programs, so that the BMP goals could be achieved in the long run. All the research, pilot and model projects carried out under the banner of the BMP were intended to provide these actors, most notably local authorities, with knowledge, arguments and instruments that would assist them developing their own bicycle policies.

The BMP encompassed a total of 112 projects, 24 of which focused on bike-and-ride. The bike-and-ride projects varied from experiments with automated bicycle storage facilities to a research into the combination of bus and bicycle lease, and from experiments with daytime lockers for bicycles to pilots with improved bicycle parking facilities at major bus stops (see Table 3). The projects were carried out in the period 1993–1998. Several of the pilot and model projects will be discussed in detail below.

Since the conclusion of the BMP, the Dutch national government has not engaged in comprehensive initiatives to promote bike-and-ride. The main focus has been on action-oriented programs to promote the combined use of bicycle and train. This includes the investment program 'Space for the Bicycle' ('Ruimte voor de Fiets'), as well as several initiatives to generate feasible solutions for the 'egress problem'.

Table 3
Overview of bike-and-ride projects carried out as part of the Bicycle Master Plan (BMP)

Type of project	Focus of project
Research projects	Potential of combined public transport and bicycle trips
	Comparison of travel times by car versus bike-and-ride
	Impacts of the introduction of student travel pass
	Compact automated bicycle parking at train stations
	Role of the bicycle for bus, tram and metro
	Criteria concerning the provision of bicycle parking at rural bus stops
	Feasibility of bicycle lease
	New concepts for rental bicycles at train stations
Pilot projects	Experiment travel chain train and bicycle
	Bicycle lockers for infrequent use at train stations
	Automatic entrance control for guarded bicycle parking facilities
	Unguarded bicycle parking facilities in Leiden
	Bike-and-bus on corridor Enschede-Oldenzaal
	Bicycle parking at bus stops in the province of Utrecht
	Bicycle parking at bus stops around the city of Leeuwarden
	Bicycle parking at bus stops in the province of Noord-Brabant
	Bicycle ferry Rhoon-Oud-Beijerland
	Public transport and bicycle lease in Rotterdam
	Express bus and bicycle lease in Friesland
	Interbike: express bus and bicycle lease
	Train and flexible bicycle rental along the River Maas
Development of instruments	Bicycle parking policy for train stations
	Bicycle parking at bus stations

Projects marked in italic are discussed in the paper.
Source: Ministerie van Verkeer and Waterstaat (1997, p. 105). For a brief discussion in English of projects not discussed in the paper see Ministerie van Verkeer and Waterstaat (1999, pp. 117–119).

4. Measures to promote the combined use of bicycle and train

Facilities enabling the combined use of bicycle and train have been part and parcel of the Dutch transportation system for a long time and the high share of the bicycle in access trips can at least in part be attributed to this. Bicycle parking facilities have been available at most train stations for the past decades and have been gradually upgraded since the 1970s. At the beginning of the 1990s virtually all main train station were equipped with specialized cycle centers that included guarded parking, bicycle hire and maintenance facilities, while bicycle lockers and covered parking facilities were usually available at smaller train stations (Table 4). However, the growing number of train passengers since the end of the 1980s, partly as a result of the introduction of a free public transport pass for students, resulted in problems in the quantity and quality of bicycle parking facilities at many train stations (Naegele et al., 1992). Furthermore, the use of the bicycle at the activity-end of a train trip has remained low over the past decades, as discussed above.

Since the early 1990s a number of initiatives have been launched to cope with the problems in quantity and quality of bicycle parking facilities at train stations. In 1992, the Dutch Railway Company presented an investment program with the aim to realize 60,000 bicycle parking places in the period 1993–1997. In the following two years close to 30,000 additional bicycle parking places were realized (Ligtermoet and Welleman, 1997, p. 32). Further implementation of the program was stalled, partly as a result of the change in status of the Dutch Railway Company from a government unit to an independent body in 1995. Since then, the Dutch national government has been responsible for bicycle parking at railway stations. This new division in tasks has led the Ministry of Transport to launch a new investment program 'Space for the Bicycle' ('Ruimte voor de Fiets') with the goal to upgrade the bicycle parking facilities at all 380 train stations in the country by 2007. The Ministry has also set guidelines with regard to the quantity and quality of bicycle parking facilities. These guidelines, developed in conjunction with the Dutch Cyclist Association and the Dutch Organization for Public Transport Passengers, include the following principles (Leeuw, 1998; Ministerie van Verkeer and Waterstaat, 1998):

- bicycle parking places are available for regular and incidental train travelers;
- a mix of secure (guarded parking and bicycle lockers) and regular parking facilities is available at all stations;
- the maximum walking distance between secure parking facilities and the station entrance is 200 meter;
- regular parking facilities should be visible from busy areas so as to reduce bicycle theft and vandalism.

A key element of the quality standards is the availability of bicycle parking for users. The guidelines demand an overcapacity of 20% for both secure and regular parking facilities, in order to make sure bike-and-ride users can easily find a free parking place, even during days and hours of peak demand.

Since the launching of the program the bicycle parking facilities at 187 train stations have been improved (situation at the end of 2002) (Railned, 2003, p. 3). The improvements include extension of capacity, upgrading of existing facilities, and improvement of walking routes to train platforms. A small survey at five smaller stations shows that the satisfaction about bicycle parking facilities among bike-and-ride users has increased

Table 4
Number of bicycle parking places at Dutch train stations

Type of bicycle parking facility	1985	1992	1999
Guarded	115,000	100,000	120,000
Bicycle lockers	3000	8500	16,000
Not guarded	65,000	90,000	143,000
Total	183,000	198,500	279,000
Number of train stations	348	358	370
Number of passenger kilometers by train (billion km)	8.3	15.1	15.4

Sources: Ministerie van Verkeer and Waterstaat (2000) (parking facilities and passenger kilometers); Anonymous (2005) (number of train stations).

substantially since the introduction of the improvements. The rates of satisfaction jumped from 5.3 to 7.1 on average, on a scale from 1 to 10. The users were most satisfied with the walking distance and walking route to the train platforms, as well as with the convenience of the bicycle parking facilities. The improved facilities received less favorable assessment regarding theft security and available capacity. The survey also suggests that the improvements have had some impact on the use of bike-and-ride: about 11% of the respondents indicated that the improved bicycle parking facilities were a reason to travel more often by bicycle to the train station. Another indicator for the impact of the improved bicycle parking facilities on the level of bike-and-ride is the strong growth in the number of parked bicycles at the new facilities. This growth has outpaced the forecasts underlying the investment program, as well as the growth in train ridership (Anonymous, 2003a,b).

Bicycle use in egress trips from train stations has only received explicit policy attention in the Netherlands since the publication of the Bicycle Master Plan. As part of the BMP, a number of research and pilot projects has been carried out to explore the possibilities to stimulate bicycle use at the activity-end of a train trip (Table 3). One of the more innovative projects concerned an assessment of the interest among close to 30 large employers in the Rotterdam region to lease bicycles for use by employees in home-to-work travel. None of the approached employers proofed to be prepared to lease or purchase bicycles solely for trips between office premises and train station. As a result of this outcome, the project was stopped (Ministerie van Verkeer and Waterstaat, 1997, p. 114).

More recently, and partly as a result of a number of studies into possibilities for flexible bicycle rental, the so-called 'public transport-bicycle' or 'PT-bicycle' ('OV-fiets') has been introduced by the Dutch Cyclist Association and ProRail, a government-owned company responsible for maintenance, operation and expansion of the Dutch railway infrastructure. The PT-bicycle aims to reduce the inconvenience that is related to the use of a rental bicycle at the activity-end of a train trip: the need for identification, the need to pay a deposit, and the time that is involved in these transactions. The PT-bicycle replaces these transactions by a system of user registration. Public transport users who expect to use a PT-bicycle in the future can register for a small fee with a special administrative organization. They receive a special card which allows for fast identification and easy payment when someone wants to use a PT-bicycle. The PT-bicycles are parked at regular guarded parking facilities or in special bicycle lockers, within easy access from the train platforms. The cost of using a PT-bicycle is identical to the price of a return fare by city bus. Frequent users, such as those using the bicycle for daily commuting, pay a maximum sum per month, for which they are able to use a PT-bicycle for the whole month at all stations equipped with PT-bicycle facilities (Emmen et al., 2004).

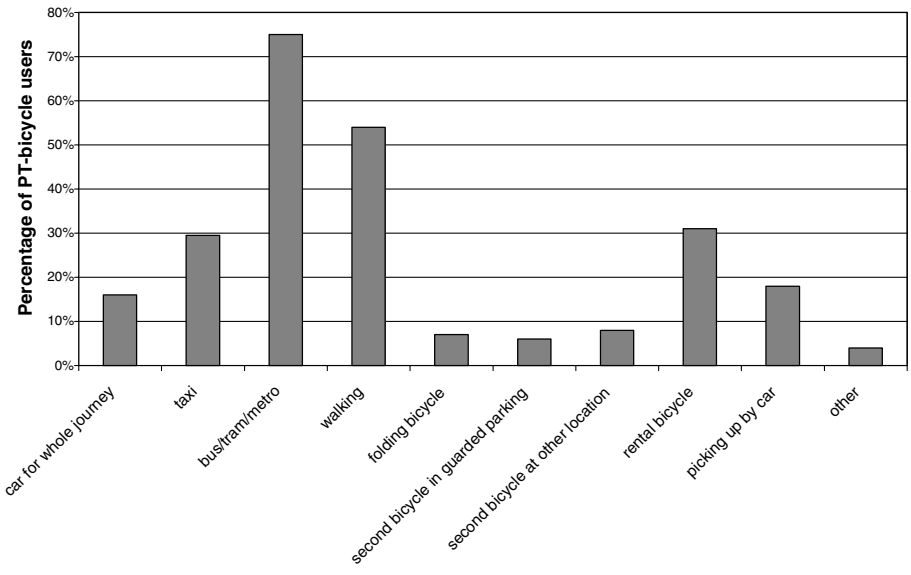

Fig. 1. Egress mode of PT-bicycle users before they started using the PT-bicycle.

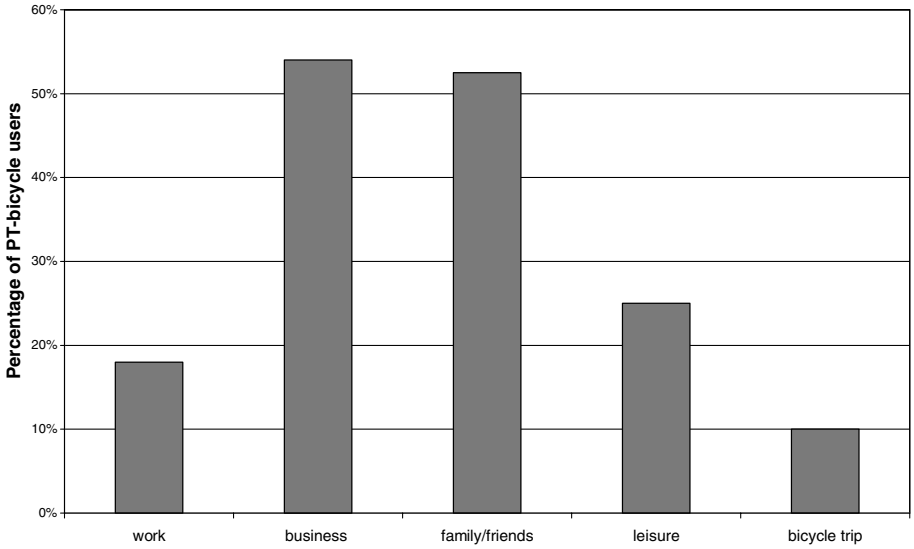

Fig. 2. Travel motive of PT-bicycle users.

Since its introduction, the number of stations equipped with PT-bicycles has grown steadily from 4 in 2000 to 72 in 2004. In the same period, the number of subscribers has grown to 10,000 people, while the number of trips has gone up to over 100,000 a year (Maartens, 2005). A survey carried out in 2003 shows that the PT-bicycle has led to a substantial increase in bicycle use for egress trips among PT-bicycle subscribers. The PT-bicycle has especially replaced egress trips by bus, tram or metro, but also by foot, by bicycle (second bicycle, folding bicycle or regular rental bicycle), by taxi, and as a car passenger (Fig. 1). No data are available on the overall share of the bicycle in egress trips on train stations equipped with PT-bicycles, but these results suggest that the PT-bicycle had some positive effect on bicycle's share. Furthermore, data on trip purposes show that the PT-bicycle provides an egress solution for especially non-recurrent trips, notably business trips and trips to family or friends (Fig. 2). Since these trips are infrequent, the purchase of a second bicycle cannot solve the egress problem. The PT-bicycle thus substantially extends the number of train passengers that can use the bicycle as an egress mode. The high share of business trips further suggests that the combined use of train and PT-bicycle can compete with the private car in terms of comfort and travel time.

The introduction of the PT-bicycle has also led to a small rise in train ridership. In the survey mentioned above, about 15% of all PT-bicycle users indicated that the bike-and-train combination has replaced trips previously made by car (Fig. 1). The Dutch Cycle Federation estimates that every PT-bicycle subscriber currently generates about 4.5 extra train trips per year, especially outside rush hours (ProRail, 2003; Becht and van Bree, 2003). These figures indicate that improved egress services may lead to an increase in public transport ridership and a (small) decrease in car use on specific routes.

5. Promoting the combined use of bicycle and bus

The combined use of bus and bicycle has been neglected for quite a long time in the Netherlands. Generally the bicycle has been viewed as a competitor of bus lines. The fact that most buses travel over relatively short distances in the Netherlands has strengthened this opinion (Ligtermoet and Welleman, 1997). Another major problem is the unclear division of responsibilities between public transport operators, municipalities, regional authorities and the road management authority (van Uum et al., 1995a). The lack of systematic attention for the combination of bicycle and bus is reflected in the limited number of stops that are equipped with bicycle parking facilities. A study among ten regional bus lines showed that less than 20% of all stops along these lines had such facilities. Estimates point out that the percentage is even lower for many other bus lines. Most existing bicycle parking facilities have been provided following an apparent demand in terms of parked bicycles at

bus stops. Only in a limited amount of cases more large-scale facilities have been built in order to serve existing and generate additional demand (van Uum et al., 1995b). The main bus stations in large and medium-sized cities are the exception to the rule. Most of these stations are located directly adjacent to main train stations and thus benefit from the bicycle parking facilities, as well as the newly introduced PT-bicycle, available at these stations.

The Bicycle Master Plan included a substantial number of pilot projects that aimed to stimulate the combined use of bicycle and bus services, with an emphasis on regional (town-central city) bus services (Table 3). Below, the most relevant projects are discussed, starting with three projects that focus on improved bicycle parking facilities.

The first pilot project with improved bicycle parking facilities discussed here focused on rural bus stops in the province of Brabant. The experiment encompassed seven bus stops located in or at the edge of smaller regional centers, or in rural areas at a substantial distance of small towns. Six of the seven bus stops were served by high quality bus lines linking regional centers and small towns to major urban areas (Janse and van Bremen, 1995). Each of the bus stops was equipped with bicycle parking facilities varying from simple bike stands to larger covered facilities and secure bicycle lockers. In most cases also other measures were taken to improve the quality of the bus stop, such as the placement of a bus shelter or a public telephone. In all cases the improvements were combined with a marketing campaign to make public transport users and the wider public aware of the new facilities. The analysis shows that measures have resulted in an absolute growth in the number of bike-and-ride users at five of the seven bus stops (Table 5). The improved bicycle facilities also had an impact on the behavior of people that used the bus before *and* after the improvements. About 9% of this group started to use the bicycle instead of another access mode, while about 1% of them changed the bus stop of origin. In addition to these impacts on bike-and-ride, the new facilities have also led to an increase in the total number of passengers at five of the seven bus stops, outpacing the development in bus users at comparable stops in the area. Furthermore, in terms of passenger composition, the improvements have led to a diversification of bus users. This is reflected in a drop in the share of dominant groups of bus users, like captives, students, women, youth and young adults, and frequent users. Janse and Van Bremen attribute the growth in passenger numbers and changes in composition to the increased attractiveness of the bus stop as a result of the various improvements that were implemented. These observations are confirmed by several other studies (Haskoning, 1991; Awareness, 1995; van der Loop, 1997). The study of Haskoning (1991), for instance, showed that the improvement of bus stops including bicycle parking facilities resulted in an increase in bus use among regular bus users (13%), as well as among passengers that primarily use the car (2%) or the bicycle (1%) as a mode of transport.

A second pilot project encompassed the improvement of bicycle parking facilities at bus stops located in or close to small towns and villages around the regional center of Leeuwarden, a city of about 90,000 inhabitants. The program included the placement of a total of 51 bicycle lockers, 256 places in covered parking facilities, and 75 uncovered parking places at a total of 15 bus stops. Lacking a before-and-after study, it is hard to

Table 5
Change in number of passengers and bike-and-ride users for seven bus stops before and after improvement of bicycle parking facilities (The Netherlands)

Name of bus stop	Number of passengers			Number of bike-and-ride users		Growth in bike-and-ride users (%)	Share of bike-and-ride users	
	Before	After	Growth (%)	Before	After		Before (%)	After (%)
Zevenbergen-Drie Hoefijzers	28	28	0	23	18	−18	82	65
Oosterhout-Europaweg	32	47	47	4	14	250	13	30
Oosterhout-Napoleonlaan	195	211	8	10	17	90	5	8
Oosterhout-Elkhuizenlaan	127	123	−3	14	27	80	11	22
Oosterhout-Busstation	409	647	58	168	220	35	41	34
Werkendam-Sleewijk	129	184	43	92	127	32	71	69
Raamsdonkveer-Busstation	448	478	7	211	196	−6	47	41
Total	1368	1718	26	520	618	20	38	36

Source: Janse and van Bremen (1995).

assess the impacts of the improvements on the level of bike-and-ride, but some lessons can be drawn from the evaluation study carried out shortly after the facilities were installed (Grontmij Noord, 1995). First of all, the bicycle is especially used as an access mode at bus stops that are located outside, but not far away from, a small town or village. At one such bus stop the bicycle accounted for 78% of all access trips, while bicycle's share was around 50% at two bus stops located within a small town. Second, bike-and-ride users did not show a strong preference for covered parking facilities at the bus stops that provided both covered and uncovered parking places. The occupancy rate for both types of facilities was around 50%, despite the fact that counts were carried out in the winter (rainy) period. Third, the walking route between the parking facilities and the bus stop proofed to play a role in the use of parking facilities. In one case, more than half of the bike-and-ride users preferred to park their bicycle close to the bus stop, rather than in the dedicated covered parking facility located at about 100 m from the stop. In another case, more than half of the bike-and-bus users preferred to park their bicycle on the side of the road of their origin and destination, rather than cross the road to use the newly provided covered parking facility. These findings are in conformance with the 'conformity and peer effect' discussed by Fukuda and Morichi (2006) in their analysis of illegal bicycle parking, and suggest that the exact location of bicycle parking facilities is an important determinant of future use. Finally, the bicycle lockers were hardly used at the 10 bus stops at which they were provided. From a total of 51 lockers, only 8 (16%) were rented out at the time of the evaluation study, while only half of this amount was in actual use. The low level is remarkable, given the dominance of daily commuters to school or work among bike-and-ride users, and the low monthly rental costs (Euro 4.50). One explanation might be that regular bike-and-bus users use a relatively cheap bicycle to travel to the bus stop (see also below). Another may be that bike-and-ride users have hardly any negative experiences with bicycle theft or vandalism in this predominantly rural area.

A third pilot project focusing on bicycle parking facilities was carried out in the centrally located and densely populated province of Utrecht. The goal of the project was to stimulate bike-and-ride levels through improvements in the quantity and quality of bicycle parking facilities at bus stops along secondary roads. During the first half of 1993 42 bus stops were equipped with various kinds of parking facilities, ranging from simple stands for two to ten bicycles to larger scale covered facilities for up to thirty bicycles. The majority of the involved bus stops was located in rural areas, while about one fifth was located in or on the edge of a (small) town. Most bus stops were served by regular, half hourly, bus services linking towns and villages to the main urban centers in the region. Bicycle accessibility of most stops was reasonable to good, with many accessible via dedicated bicycle lanes or paths. The results of a small-scale survey carried out directly after installing the facilities, show that the impacts of the improvements were limited, at least in the short term. The occupancy rate of the new parking facilities was about 25%, with larger, covered, bicycle parking facilities scoring substantially higher than small, uncovered, bicycle stands. In terms of impacts on travel behavior, the survey suggests that the bicycle parking facilities did result in some changes in behavior. Some of the respondents indicated that they started to use the bike-and-bus combination instead of car, bicycle or public transport for the whole trip, while others indicated that they changed the bus stop they used in favor of the bus stop with the bicycle parking facilities (AGV, 1994).

The last result suggests that bicycle parking facilities, like the availability of bicycle lanes, can induce cyclists to choose a longer route, which in turn stresses the value they attach to both facilities (see Tilahun et al., 2006). In the case of the pilot project, bike-and-ride users indicated that the value of bicycle parking facilities primarily lies in the protection against weather and climate influences and the decrease in chances of bicycle theft (AGV, 1994).

The Bicycle Master Plan did not only include experiments with improved bicycle parking at bus stops. In addition to the experiments described above, one pilot project focused on the development of an integrated set of facilities to promote bike-and-ride on the transport corridor between the medium-sized cities of Enschede and Oldenzaal. The new facilities included traffic arrangements at key junctions to increase reliability and speed of bus services, improvements in spatial lay-out of bus stops, and three high quality bicycle parking facilities (including bicycle lockers). One bicycle parking facility was erected in the center of each city, while a third one was located on the edge of one of the cities. The improved services resulted in an increase in bus passengers and a substantial rise in the number of bike-and-ride users to about 25% of all bus passengers (Haskoning, 1995, p. 12). However, the bicycle lockers were hardly used. A first explanation for this is the high share of students among bus users (about 70%). In contrast to commuters traveling to work, students are less

likely to invest in secure bicycle parking facilities against pay. Virtually all people that did rent a bicycle locker used it for home-to-work trips. A second reason for the low use of the bicycle lockers lies in the use of relatively cheap bicycles for the access trip. More than half of the bike-and-ride users estimated that their bicycle was worth less than 45 Euro, in comparison to the cost of a bicycle locker of 4.50 Euro per month. Given the relatively short access trips by bicycle (up to 5 min) the use of a cheaper, less comfortable, bicycle is hardly problematic. Bike-and-ride users apparently prefer to use a cheap bicycle as a strategy to cope with bicycle theft, rather than invest in a subscription for a bicycle locker (Anonymous, 2004). The relatively high use of the bicycle lockers at the urban edge location also points in this direction. The higher use here is most likely related to the (perceived) higher risk of bicycle theft given the low numbers of passers-by at this location. In addition, the access distances might be higher at this location, inducing people to use a more comfortable and thus more expensive bicycle for the access trips. This, in turn, may also be a trigger to use bicycle lockers rather than regular bicycle parking facilities (Haskoning, 1995).

In addition to the infrastructure-based improvements, the project in Enschede and Oldenzaal aimed to launch an integrated 'bicycle-bus-bicycle product' as an alternative to car-based home-to-work trips. The 'product' consisted of an integrated package of access and egress services encompassing a secure bicycle locker at the home-end of the trip, a travel pass for an improved and high quality bus service, and a bicycle locker and rental bicycle at the activity-end of the trip. The product was offered through a mailing to around 1000 employees of companies located in the corridor, for a price of 500–650 Euro for a yearly subscription. From a total of 190 employees that returned the preliminary subscription form, only 11 (6%) were interested in a subscription. The prime reasons for not participating in the project were the high price (19%), a strong preference to cycle to work (17%), dependency on the car for various reasons (15%), cumbersome arrangement (10%), and not-suitable bus times (8%). Interestingly enough, all persons that responded positively to the offer were driving to the workplace at the time of the offer, while the highest share of people not interested at all in the bicycle-bus-bicycle product were those cycling to work at the time of the offer. Given the low positive response, the project was stopped. The initiators blamed the failure of the project on a number of factors, among which the short travel distance on the corridor (in many cases less than 10 km), the high price of the product, the minimum subscription time of half a year, as well as the uncertainty about improvements in the bus service (Grontmij Overijssel, 1994, pp. 20–27).

Finally, two pilot projects were carried out as part of the Bicycle Master Plan to solve the 'egress problem' for bus trips by introducing leasing bicycles. Both focused on high quality express bus services. One pilot project encompassed the introduction of a new express bus service between two small cities in combination with secure bicycle parking (lockers or guarded parking) and leasing bicycles for the access and/or egress trip. The results of the pilot showed that bus passengers hardly used the bicycle lockers and considered bicycle lease too cumbersome and complicated. The extra bicycle facilities did neither attract car users to the new bus service, nor did they lure other additional bus passengers. The passengers that did use the bicycle in combination with the bus, preferred to use their own bicycle and regular bicycle parking facilities, rather than a leasing bicycle and bicycle locker. The second pilot showed comparable results. The pilot included the provision of 240 bicycle lockers at 10 stops of express bus lines. Bus passengers could lease a bicycle and bicycle locker, or use a bicycle locker to stall their own bicycle. The passengers hardly used the new bicycle services. Most regular bus users already solved the 'egress' problem without a leasing bicycle or bicycle locker. Furthermore, about 75% of all bus passengers consisted of (high school) students, most of whom regard bicycle lease or the bicycle locker as too expensive (Ministerie van Verkeer and Waterstaat, 1997, pp. 114–115).

6. Conclusions and lessons for other localities

Since the early 1990s the Dutch government has invested substantially in the promotion of bike-and-ride. The measures have focused to a large extent on feedering trips for which the bicycle is currently hardly used: egress trips for train services and access and egress trips for slower modes of public transport. In addition, investments have been made in bicycle parking facilities at train stations in an effort to maintain and increase the combined use of bike-and-train.

The measures to promote the use of the bicycle in access trips have generally produced favorable results. The program to upgrade regular and secure bicycle parking facilities at all Dutch train stations has led to

an increase in user satisfaction, a growth in the number of parked bicycles, and an increase in bicycle use for access trips among regular bike-and-ride users. The small-scale experiments with improved bicycle parking facilities at stops of regional bus services have generally resulted in an increase in bicycle use, primarily at the expense of walking as an access mode. In some cases, the new facilities have also resulted in an increase in the total number of bus passengers, in a limited switch from car to bike-and-ride, as well as in a diversification of bus users away from captive riders. The provision of parking facilities has been especially effective for bus stops located beyond walking distance of (potential) bus users, such as bus stops located outside built-up areas along regional roads. The small switch from car to bike-and-ride as a result of the improved bicycle parking corresponds with the findings of Wardman et al. (2006), who show that the provision of bicycle parking facilities at workplaces may lead to a limited modal shift from private car to the bicycle. The Dutch experiments further show that the walking route (distance and comfort) between parking facility and bus stop has an impact on the actual utilization of bicycle parking facilities, suggesting the need for careful planning and design of facilities. In contrast to regular parking facilities, bicycle lockers were hardly used by bus passengers. The poor results can be partly explained by the high share of students among bus users, the use of cheap bicycles for access trips, and the perceived low risks of theft and vandalism among bike-and-ride users.

The measures to stimulate the use of the bicycle in egress trips show more mixed results. The best results have been booked with the introduction of the 'PT-bicycle' as a solution for the egress problem of train trips. The PT-bicycle has primarily replaced egress trips by public transport, but also some egress trips as a car passenger. In addition, a small number of travelers has switched from the car to a combined use of train and PT-bicycle. Analysis of travel motives shows that the PT-bicycle offers a solution to the egress problem for less frequent trips, most notably business trips and trips to family or friends. Less positive results have been booked with measures to promote the bicycle as an egress mode for bus trips. The experiments with bicycle lease, as well as the experiment with an integrated service package, have failed to attract users. The failure can be partly related to the dominance of students among bus users, which are less willing and able to invest in additional transport services. But the failed experiment with train and bicycle lease suggests that the lack of interest cannot solely be related to characteristics of the bus passengers. A more important factor is possibly the attractiveness of the product itself: public transport users consider it too expensive and too complicated a solution for a relatively small part of their trip.

The Dutch experiences give rise to some lessons for other countries and localities. First, the lack of attention for the bicycle as a feedering mode for public transport trips even in a country like the Netherlands suggests that measures to promote bike-and-ride are hardly likely to be implemented without an explicit bike-and-ride policy. In the Netherlands it took widespread criticism on the national transport policy as well as a special task force to launch a program that partly consisted of rather basic measures to promote bike-and-ride. Especially in the case of slower public transport modes, none of the involved authorities – public transport operators, municipalities, road authorities, or the national government – considered access and egress trips to public transport stops their responsibility. If the same holds true for other countries, bike-and-ride policies will only come about as the result of deliberate effort to promote the issue, rather than as part of the regular efforts to improve public transport services.

Second, the Dutch experience shows that bicycle use in access trips can be promoted by simply providing sufficient and attractive bicycle parking facilities. Obviously, the availability of safe bicycle routes in the Netherlands makes it easier to limit the attention to various types of parking facilities. But the fact that travelers did not use bike-and-ride before the placement of parking facilities despite the availability of safe routes, suggests that cities and towns with more than negligible levels of bicycle ridership could also promote bike-and-ride by simply improving bicycle parking facilities at key stations and stops. The success of the Dutch experiments even seems to suggest that the barriers for changing travel behavior in access trips may be substantially lower than those that prevent overall mode change (Gatersleben, 2006), perhaps because public transport users are confronted everyday with the relative inconvenience of access trips. In addition, the 'conformity and peer' effect may be at work here (Fukuda and Morichi, 2006): once bicycle parking facilities are available and the first travelers start making use of it, others will follow. With some caution, this may suggest that the promotion of bicycle use in access trips may help to increase bicycle ridership in general, by introducing the bicycle as a means of everyday travel to new groups of travelers. The Dutch experience shows that improvements in bicycle parking can especially have an impact at stations with high passenger numbers, high

shares of commuters and students, and relatively high densities in an area of 3–4 km around the station. This includes train stations in city centers and suburbs. The possibilities to promote the combined use of bus and bicycle are more limited. The smaller catchment areas, the lower number of passengers per stop, and the slower service make it more difficult to assess whether or not stops may attract bike-and-ride users. The most potential seems to lie in high quality bus lines that connect residential areas and employment areas and/or educational facilities, especially in cases of large distances between subsequent stations.

Third, the chances to promote bicycle use for egress trips in other countries and cities seem to be limited. The generally lower levels of bicycle ridership and less well-developed bicycle infrastructure will substantially reduce the number of people that may consider using the bicycle as an egress mode. This implies that measures aimed at bicycle use in egress trips will need to focus on public transport stations and stops with high numbers of passengers. Furthermore, the failure in the Netherlands of measures that require long-term commitment from users, such as bicycle lease, suggests that only simple and flexible solutions have a chance to succeed in localities with lower levels of bicycle ridership. Given the Dutch experiences, the only measure that has some chance of succeeding in other cities or countries is the PT-bicycle. Cities with a relatively well-developed bicycle infrastructure, such as Strasbourg, Munich, Cambridge or Copenhagen, could introduce the PT-bicycle at key destination stations that lack a fine-grained public transport network for egress trips, such as train stations outside the urban center with land uses such as universities, offices, or conference centers located beyond walking distance (3–4 km).

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References

AGV, 1994. Onderzoek fietsvoorzieningen bij openbaar vervoerhaltes. AGV/Provincie Utrecht, Utrecht.

Anonymous, 1998. Reistijdvergelijking auto versus OV + fiets. Web: http://www.fietsberaad.nl/ (accessed June 2005).

Anonymous, 2003a. Fietsparkeren bij NS stations. Web: www.kennisplatform-verdi.l/mobiliteitsmanagement/FC%20Fietsparkeren%20bij%20NS%20stations.htm (accessed February 2005).

Anonymous, 2003b. Ruimte voor de fiets: een problematisch succes. Fietsverkeer 2 (6), 6.

Anonymous, 2004. Evaluatie COREO-project Enschede-Oldenzaal: leerzaam, maar resultaten vallen tegen. Fietsverkeer 3 (9), 5.

Anonymous, 2005. Lijst van NS-stations. Web: http://nl.wikipedia.org/wiki/Lijst_van_NS-stations (accessed June 2005).

Awareness, 1995. Fietsparkeervoorzieningen bij streekvervoerhalten. Awareness, Den Haag.

Becht, R., van Bree, M., 2003. Hoe bevalt de OV-fiets? Klantenonderzoek. Fietsersbond, Utrecht/Woerden.

Brundtland, G. (Ed.), 1987. Our Common Future: The World Commission on Environment and Development. Oxford University Press, Oxford.

Bundesministerium fuer Verkehr, Bau- und Wohnungswesen, 2002. Fahrrad! Nationaler Radverkehrsplan 2002–2012: Massnahmen zur Foerderung des Radverkehrs in Deutschland. Berlin, Bericht der Bundesregierung.

de la Bruheze, A.A.A., Veraart, F.C.A., 1999. Fietsverkeer in praktijk en beleid in de twintigste eeuw. Ministerie van Verkeer & Waterstaat, Den Haag.

Department of Environment, Transport and the Regions, 1999. Bikerail: combined journeys by cycle and rail, DETR.

Doolittle, J.T., Porter, E.K., 1994. Integration of bicycles and transit. National Academy Press, Washington, DC.

Emmen, M., Pauwels, H., et al., 2004. The public transport – bike services in the Netherlands: pilot, evaluation and country wide introduction. Web: http://www.epommweb.org/ecomm2004/workshops/anglais/Kramer.pdf (accessed April 2005).

Fukuda, D., Morichi, S., 2006. Incorporating aggregate behavior in an individual's discrete choice: an application to analyzing illegal bicycle parking behavior. Transportation Research Part A: Policy and Practice, in press, doi:10.1016/j.tra.2006.09.001.

Gatersleben, B., 2006. Contemplating cycling to work; attitudes and perceptions in different stages of change. Transportation Research Part A: Policy and Practice, in press, doi:10.1016/j.tra.2006.09.002.

Grontmij Noord, 1995. Evaluatie-onderzoek keten fiets-openbaar vervoer Stadsgewest Leeuwarden. Eindrapport. Grontmij Noord, Haren.

Grontmij Overijssel, 1994. Coreo-Project, proces- en projectevaluatie. Voorbeeldproject Masterplan Fiets op Corridor Enschede-Oldenzaal. Grontmij, Arnhem.

Hagelin, C.A., 2005. A Return on Investment Analysis of Bikes-on-Bus Programs. State of Florida Department of Transportation/ National Center for Transit Research, Tallahassee, FL/Tampa, FL.
Haskoning, 1991. Corridorstudie Enschede-Oldenzaal. Haskoning Ingenieurs en Architectenburea, Nijmegen.
Haskoning, 1995. Evaluatie effecten COREO-project: Corridorstudie Enschede-Oldenzaal. Haskoning Ingenieurs en Architectenburea, Nijmegen.
Janse, J.A., van Bremen, J.C.P.M., 1995. Effectmeting fietsinfrastructuur bij zeven streekvervoerhalten: eindrapport. DTV Consultants, Breda.
Keijer, M.J.N., Rietveld, P., 2000. How do people get to the railway station? The Dutch experience. Transportation Planning and Technology 23, 215–235.
Krämer-Badoni, T., 1994. Life without the car: an experiment and a plan. International Journal of Urban and Regional Research 18 (2), 347–356.
Langeweg, F., 1988. Zorgen voor morgen: nationale milieuverkenning 1985–2010. RIVM – Rijksinstituut voor Volksgezondheid en Milieu, Bilthoven.
Leeuw, P.d., 1998. Met de fiets naar de trein. Ministerie van Verkeer & Waterstaat, Den Haag.
Ligtermoet, D., Welleman, T., 1997. De keten ov+fiets. Verkeerskunde 5, 30–34.
Maartens, M., 2005. Tien mijlpalen van 2004. OV-Fietsnieuws (January), 2005.
Martens, K., 2004. The bicycle as a feedering mode: experiences from three European countries. Transportation Research Part D: Transport and Environment 9 (4), 281–294.
Ministerie van Verkeer and Waterstaat, 1990. Structuuurschema Verkeer en Vervoer. Ministerie van Verkeer and Waterstaat, Den Haag.
Ministerie van Verkeer and Waterstaat, 1997. Evaluatierapport Masterplan Fiets. Ministerie van Verkeer and Waterstaat, Den Haag.
Ministerie van Verkeer and Waterstaat, 1998. Met de fiets naar de trein: voorwaarden die de rijksoverheid stelt aan fietsenstallingen bij spoorwegstations. Ministerie van Verkeer and Waterstaat, Delft/Den Haag.
Ministerie van Verkeer and Waterstaat, 1999. The Dutch Bicycle Master Plan: description and evaluation in a historical context. Ministerie van Verkeer and Waterstaat, Den Haag.
Ministerie van Verkeer and Waterstaat, 2000. Feiten over het fietsen in Nederland. Ministerie van Verkeer and Waterstaat, Den Haag.
Naegele, R.C., Wilbers, P.T., et al., 1992. Integratie fiets – openbaar vervoer. Veenendaal, Traffic Test.
ProRail, 2003. OV-fiets de huurfiets in het openbaar vervoer. Prorail Strategie & Innovatie, Utrecht.
Pucher, J., Dijkstra, L., 2000. Making walking and cycling safer: lessons from Europe. Transportation Quarterly 54 (3), 25–50.
Railned, 2003. Monitor 2003. Railned, Utrecht.
Rietveld, P., 2000. The accessibility of railway stations: the role of the bicycle in the Netherlands. Transportation Research Part D: Transport and Environment 5, 71–75.
Tilahun, N.Y., Levinson, D.M., et al., 2006. Trails, lanes, or traffic: valuing bicycle facilities with an adaptive stated preference survey. Transportation Research Part A: Policy and Practice, in press, doi:10.1016/j.tra.2006.09.007.
van der Loop, J.T.A., 1997. Intermodality: successes by integrating public transport modes and cycling. Public transport planning and operations. In: Proceedings of Seminar G held at the European Transport Forum Annual Meeting, 1–5 September 1997, European Transport Forum/Brunel University. vol. P416.
van Goeverden, C.D., Egeter, B., 1993. Gecombineerd gebruik van fiets en openbaar vervoer: verwachte effecten op de vervoerwijzekeuze van optimale fietsbeschikbaarheid in voor- en natransport. Delft, TU Delft, Faculteit der Civiele Techniek.
van Uum, J.R.G., Salverda, J.C., et al., 1995a. De rol van de fiets in het verbindend stads- en streekvervoer. Veenendaal, Traffic Test.
van Uum, J.R.G., Salverda, J.C., et al., 1995b. Fietsenstallingen bij bushaltes: de stand van zaken en een aantal voorbeelden. Veenendaal, Traffic Test.
Wardman, M., Tight, M., et al., 2006. Factors influencing the propensity to cycle to work. Transportation Research Part A: Policy and Practice, in press, doi:10.1016/j.tra.2006.09.011.