Exploring bike sharing system design scenarios focused on facilitating commuting and business trips in the Netherlands

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Abstract A bike sharing programme focused on facilitating commuting and business trips can help tackle a variety of traffic problems in Dutch cities. In order for such a system to be successful however, it must be designed according to the preferences of potential users. This paper identifies several recommendations for bike sharing system design based on a mixed logit panel model describing the bike share mode choice. SP data is gathered to estimate this mode choice model through distributing a web survey amongst employees of various companies located throughout the Netherlands with varying transport mode preferences. It is found that a system implemented on a citywide scale, with either a coarsely distributed or a fine-grained network of docking stations, which only provides traditional bicycles and limits the trip costs is preferred by commuters. In addition, a system that provides electric bicycles and focuses on a small region so that access and egress times is also an attractive design alternative.

Keywords: bike sharing, bicycle commuting, choice experiment, mixed logit, mode choice

1. Introduction

Ever since the rise of the industrial revolution, one of the greatest challenges for governments relates to the variety of traffic problems that have emerged in urbanized areas (Buchanan, 2015; Headicar, 2015). A vastly growing and promising worldwide spread transport policy is the development of urban bike sharing programmes. These programmes can be found in cities all over the world and have been proven to contribute to: a modal shift towards the use of more sustainable transportation modes, a reduction in externalities of non-sustainable modes, an increase in the accessibility of urban regions and a decrease in bicycle parking and traffic congestion (e.g. DeMaio, 2009; Fishman et al., 2014).

These systems provide the public with shared use of a bicycle fleet for a small fee, making cycling a possible mode choice at any location throughout an urban region (Shaheen et al., 2010a). There is currently only one bike sharing system found in the Netherlands: the Public Transport bicycle (PT-bicycle). This system is found at medium to large railway stations where the PT-bicycle can be used for the last leg of the journey (NS, 2015). Although this system is very successful, it does not provide the variety of trip options and flexibility that urban bike sharing systems offer in other countries. Its success does indicate however that there is indeed a demand for bicycles at locations where the privately owned bicycle is not available. This raises the question whether there is a market for destination-based bike sharing systems in the Netherlands which are not limited to train stations, and what such a system should look like.

Since commuting and business travel highly contribute to urban traffic congestion and emissions in the Netherlands, it is important to increase the use of sustainable modalities for these travel motives. The objective of this research is therefore to provide recommendations for bike sharing system design in order to introduce the service as an attractive mode option to commuters and business travellers in the Netherlands.

1.1 Basic elements of a Dutch bike sharing system

Based on extensive background research and expert interviews the basic elements of a bike sharing concept aimed towards Dutch commuters and business travellers were identified. This concept is developed to serve as a basis for testing preferences with regards to bike sharing system design and its use as well as to determine the characteristics of Dutch commuters and business travellers that are interested in using a shared bicycle. Based on this research it was found that several conditions are to be met in order for this bike sharing concept to be a realistic representation of how bike sharing will exist in Dutch cities in the future, so that preferences and user characteristics can be determined.

Firstly, the concept should be able to provide a mix of both traditional and electric bicycles so that preferences regarding the type of bicycle can be studied in more detail. Secondly, the bicycles should be able to be picked up at any location thereby creating a hypothetical situation in which all potential users are able to access the system, allowing their preferences to be tested. Thirdly, the system should be flexible with regards to two aspects: the system should allow the bicycles to be able to be locked anywhere and at any time and in addition the drop-off or return location of the bicycles should be flexible. This means that the shared bicycle should be allowed to be returned at any docking station. Lastly, the pricing structure presented in the concept has to

allow the potential user to pay for use through a fixed fee per kilometre so that the trip costs reflect the cost structure that is expected to be used in Dutch bike sharing systems.

2. Methodology

Preferences and the perception with regards to making use of a shared bicycle as well as preferences regarding several system characteristics and the characteristics of potential users are studied using a web survey which consists of a questionnaire as well as a stated choice (SC) experiment.

The questionnaire consists of questions that study the characteristics of potential users, the current trip characteristics of the respondents and questions that explore user preferences regarding the use of a shared bicycle, while the SC experiment is used to study preferences regarding several system characteristics. An SC experiment is used here as this method allows us to be able to determine the influence of design attributes upon the choices that are observed, thereby gaining understanding of how different characteristics or attributes are balanced against each other in the bike share mode choice.

The SC experiment that is developed in order to study how several system characteristics influence the bike share mode choice consists of a series of choice sets, in which for every choice set three alternatives are presented to the respondent. The first two involve shared bicycle alternatives varying in attribute values, while the third alternative is a no-choice alternative, representing any other transport mode. The attributes that make up the shared bicycle alternatives are the bicycle type (traditional versus electric), access time, egress time and the trip costs. While making their choices, respondents are told to assume that they have to travel a certain distance with the shared bicycle, which varies across the choice sets. This context variable allows for examining how different trip distances influence the preference for certain attribute values and the general preference for a shared bicycle over other transport modes.

Using the data gathered through the SC experiment a mixed logit panel model is estimated to determine to what extent the system and user characteristics influence the bike share mode choice. The estimated mode choice model is then used to determine the choice probabilities for different system design scenarios to identify recommendations for bike sharing system design.

3. Results

3.1 Descriptive statistics

The web survey was distributed amongst a sample of the population of Dutch commuters and business travellers to gather stated preference data on potential users of a bike sharing system that aims to facilitate commuting and business trips. In order to incorporate commuters and business travellers who vary regarding their preferences towards driving and cycling, the survey was distributed amongst employees from one large and three smaller employers whom all have multiple office locations throughout the country. The 293 respondents were found to be predominantly male, on average aged 47 years old, have different educational backgrounds and professions. A large portion of the respondents uses a (company) car for their commuting trip, while public

transportation and the bicycle are chosen by smaller portions of the respondent sample. This sample is therefore believed to be a reasonable representation of the population.

3.2 Estimated ML panel model

From the observed choices made in the SC experiment and the data gathered on user characteristics throughout the questionnaire a mixed logit (ML) model is estimated which takes in account panel effects as well as taste heterogeneity for the bike sharing constant and the bicycle type parameter. The log-likelihood of the model is equal to -1497 and the adjusted ρ^2 is equal to 0.403. The outcomes of the model are presented in Table 1.

Variable	Unit	β coefficient	t-value
		Panel ML model	
		Random pa	rameters
Constant	-	5.04	10.99
Bicycle type	-	1.11	11.71
		Non-random	parameters
Bike sharing constant*	-	3.2400	0.94
Bicycle type*	-	-0.8750	-1.28
Access time	Minutes	-0.1670	-2.75
Egress time	Minutes	-0.1020	-1.99
Trip cost	Euro / km	-5.4800	-7.27
DistanceA (linear component)	Kilometre	-1.9500	-3.06
DistanceB (non-linear component)	Kilometre	1.7500	2.76
Type / Access*	Minutes	0.03760	0.73
Type / Egress*	Minutes	0.05060	0.96
Type / Trip cost	Euro / km	-1.4700	-2.52
DistanceA / Type	-	0.2690	3.17
DistanceA / Access*	Minutes	0.08220	1.16
DistanceA / Egress*	Minutes	0.08110	1.33
DistanceA / Trip cost*	Euro / km	0.1090	0.15
DistanceB / Type	-	0.2480	2.99
DistanceB / Access	Minutes	-0.1620	-2.30
DistanceB / Egress*	Minutes	-0.1120	-1.82
DistanceB / Trip cost	Euro / km	-1.6700	-2.31
Gender*	-	0.9390	0.91
Age*	Years	0.3250	0.83
Age / Type*	-	0.01390	1.61
Net monthly income*	Euro/month	0.05300	0.28
Education	-	-2.0400	-3.19
Habit: Car*	-	-1.1700	-0.82
Habit: Public transportation*	-	-1.8900	-1.01
Habit: Bicycle*	-	0.4530	0.29
(traditional or electric)			
Influence: Car*	-	0.7200	0.87
Influence: Public transportation*	-	0.5640	0.43
Influence: Bicycle*	-	2.1300	1.04
Knowledge: PT-bicycle*	-	0.8350	1.26
Knowledge: Urban bike sharing*	-	0.6610	0.93
Knowledge: Car sharing*	-	-0.8740	-0.99

Table 1: Estimated ML panel model

Travel allowance: Car*	-	-0.347	-0.46
Travel allowance: Public transport.*	-	0.205	0.26
Travel allowance: Bicycle*	-	-2.24	-1.41
Preference for privately owned bicycle	-	-0.681	-2.58
over shared bicycle			
Perceived attractiveness of shared bicycle	-	0.765	3.81
when the privately owned bicycle is not			
available			
Model fit			
Log-likelihood = -1497			
Adjusted $\rho^2 = 0.403$			

* Significance level of 95%

The ML panel model shows there is a high degree of variation in unobserved preferences for bike sharing over other modalities. For the reference alternative however, averaged over all respondents, there is no preference for a shared bicycle compared to other modalities or vice versa. Next to the bike sharing constant, the results show that the trip cost and interaction effects with trip cost are the most important attributes influencing the commuters' bike share mode choice. The parameter estimates for the random parameters bicycle type and the bike sharing constant are by far the most accurately measured estimates. Other attributes such as the trip distance and education seem secondary attributes in determining the bike share mode choice.

In addition there is quite a bit of unobserved variation in the importance of the bicycle type parameter. Furthermore, the interaction effect of trip distance on bicycle type shows that the traditional bicycle is preferred for shorter distances while the electric bicycle is preferred for trip distances of over 4.5 kilometres. The difference in utility between both types of bicycles however is relatively small. With regards to the utility of trip distance itself, it is found that commuters are open towards using a shared bicycle for trips up to 8 kilometres.

Increasing access and egress times averaged over all trip distances do not affect the utility of the shared bicycle much, while the effect of access time becomes stronger for increasing distances up to 6 kilometres. The same type of interaction effect is true for the trip cost estimate. In additon, an interesting effect is shown by the interaction effect between bicycle type and trip cost, which indicates that people are less willing to pay a certain amount for an electric bicycle compared to a traditional bicycle. It is believed this is because the electric bicycle is experienced as being more expensive than the traditional bicycle even though they cost the same.

Of all user characteristic parameters included in the model, the education parameter as well as the parameters discussing the preference towards the privately owned bicycle over the shared bicycle and the perceived attractiveness of a shared bicycle when the privately owned bicycle is not available are found to be significant. Higher education levels show a relatively strong negative effect on the bike share mode choice. It remains unclear what the reason is for the negative sign of the education parameter. The other two parameters show that the general perception of using a shared bicycle is also a relatively important factor in determining the bike share mode choice. As most user characteristic parameters were not significant, no other conclusions can be made on the characteristics of potential users.

3.3 Analyses of Questionnaire Data

Next to the ML panel model, data gathered through the web survey was also used to study preferences regarding the use of a shared bicycle. It was found that for the commuting trip respondents are most interested in using a shared bicycle for the trip towards and from a train station, as well as for the entire trip. For the business trip respondents prefer to use a shared bicycle for a wider variety of trip types. In addition, approximately 25% of the respondents were found to be open to using a shared bicycle for either their commuting or business trips, while only 12% of the respondents believe the shared bicycle would improve their current commuting or business trip. Furthermore, the respondents strongly prefer to use their privately owned bicycle instead of the shared bicycle, but do find the shared bicycle an attractive mode choice when the privately owned bicycle is not available. Lastly, most respondents state that they would not be interested in a system without flexibility of the drop-off location.

3.4 Application of ML panel model

In addition to determining the influence of design attributes upon the choices that are observed, the estimated bike share mode choice model can be used to predict the choice probabilities of people opting for a shared bicycle for different system design setups. Several system design scenarios were tested using this method to determine recommendations for bike sharing system design. As stated-preference data is gathered the choice probabilities are unreliable and should not be interpreted as market shares. They can be used however to test different designs by determining the change in choice probabilities for different design scenarios. The findings from these analyses are discussed here.

Scenario 1: Minimizing costs

The first bike sharing system design scenario is a system that would be easy to implement and have low costs. Such a system would provide people with traditional bicycles and not with electric bicycles as these are both very costly and difficult to implement due to the need for charging infrastructure. To keep costs low, the docking stations are coarsely distributed and can therefore only be found at key points in a city like near public transport stops, P+R locations and city attractions. As the systems costs are kept low, the trip cost can be low as well. The following shared bicycle alternative is defined as to reflect the system characteristics described above:

- Bicycle type = Traditional
- Access time = 7 minutes
- Egress time = 7 minutes
- Trip costs = €0.10 p/km

The probabilities averaged over the population of people opting for this shared bicycle for different trip distances are shown in Table 2.

Table 2: Choice probabilities for different trip distance for system design scenario 1

Trip distance	2.5km	5km	7.5km	10km
Choice probability	58%	51%	43%	34%

While this system limits costs, the coarse distribution of docking stations causes the system to have a limited reach towards potential users. It can only facilitate trips for people who are travelling from a key point like a public transport stop, P+R location or city attraction. It is therefore well suited to complement public transportation and other locations where there is a large demand for transportation, but it does not allow for much flexibility and it is not able to facilitate a service for a variety of people at different locations.

Scenario 2: Acceptable costs and a Fine-grained network

Although it is important to keep costs low, implementing a relatively fine-grained network of docking stations can keep access and egress times low and expand reach of the system. This is done by not only placing docking stations at key points throughout the city, but by also placing them at even distances from each other at for example large crossings, neighbourhoods and nearby industrial areas. This way the distribution of docking stations becomes evenly distributed over the city. As more docking stations need to be implemented in this system the trip costs will be higher to compensate compared to the previous design scenario. The following shared bicycle alternative is defined as to reflect the system characteristics described above:

- Bicycle type = Traditional
- Access time = 4 minutes
- Egress time = 4 minutes
- Trip costs = €0.20

The probabilities averaged over the population of people opting for this shared bicycle for different trip distances are shown in Table 3.

 Table 3: Choice probabilities for different trip distance for system design scenario 2

Trip distance	2.5km	5km	7.5km	10km
Choice probability	58%	53%	46%	36%

The choice probabilities are slightly higher for medium to long distances than for the previous scenario, indicating that this system setup is slightly more attractive because of its more evenly distributed network of docking stations which compensates for the rise in trip costs, especially for medium distance trips as people then value shorter access times more strongly. In reality this system will have a much larger reach compared to the previous scenario because docking stations can be found at a variety of locations which makes returning the bicycle much easier as well. The flexibility of this system is greatly improved while maintaining acceptable trip costs.

Scenario 3: Facilitating all

This design scenario focuses on a system which does not limit costs but provides a system in which bicycle sharing can be facilitated for all using the newest technology. This is done by both providing both traditional and electric bicycles so that the system allows use for different types of trips for different types of people. In addition, the bicycles can be found evenly distributed throughout the city to keep access and egress times low. Lastly, due to adding electric bicycles to the system and the

fine-grained network of docking stations the trip costs are high. The following shared bicycle alternative is defined as to reflect the system characteristics described above:

- Bicycle type = Electric & Traditional
- Access time = 4 minutes
- Egress time = 4 minutes
- Trip costs = €0.30 p/km

The probabilities averaged over the population of people opting for this shared bicycle for different trip distances are shown in Table 4. As both types of bicycles are presented the highest choice probabilities are presented per trip distance.

Table 4: Choice probabilities for different trip distance for system design scenario 3

Trip distance	2.5km	5km	7.5km	10km
Choice probability	55%	50%	45%	36%

The choice probabilities for this scenario are lower compared to the first and second scenario especially for short to medium distances. This shows that even though this system provides both electric and traditional bicycles and has a fine-grained network, the high trip costs make the system less attractive from the users' perspective.

Implementation of this system described is extremely expensive due to the addition of electric bicycles as well as the fine-grained network of docking stations that needs to be implemented for both types of bicycles. It is unlikely that the maximum acceptable trip cost of ≤ 0.30 could cover even a portion of these costs. As the implementation and operation of this system is extremely expensive and it is not able to increase the attractiveness of the system due to the high trip costs, it is the least likely of the scenarios discussed up until now to be implemented.

Both the first and second scenarios are preferred from both a cost perspective and the users' perspective. The next two scenarios will discuss systems in which the implementation of electric bicycles is more realistically possible.

Scenario 4: Acceptable costs while implementing electric bicycles

This scenario limits costs while providing people with both types of bicycles through a coarsely distributed network of docking stations. Because of this the trip cost of the system stay at a moderate value. The following shared bicycle alternative is defined as to reflect the system characteristics described above:

- Bicycle type = Electric & Traditional
- Access time = 7 minutes
- Egress time = 7 minutes
- Trip costs = €0.20

The probabilities averaged over the population of people opting for this shared bicycle for different trip distances are shown in Table 5. As both types of bicycles are presented the highest choice probabilities are presented per trip distance.

Table 5: Choice probabilities for different trip distances for system design scenario 4

Trip distance	2.5km	5km	7.5km	10km
Choice probability	55%	48%	42%	34%

The choice probabilities for this system are slightly lower as this system has its docking station more coarsely distributed. The difference in trip costs does not compensate for this. However, this system is more feasible from the perspective of the operator and from the party that has to implement the system. However, as other systems are slightly more attractive in the eyes of the users, it is advised implementing a system with only provides traditional bicycles for lower trip costs is recommended.

Scenario 5: Bike Sharing Exclusively for Commuting and Business Trips

The second scenario in which electric bicycles can be provided to people would be when companies or industrial areas decide to provide their employees with electric bicycles. It is believed electric bicycles are preferred in this setting as electric bicycles create more comfort for commuters on which this system is specifically focused and because electric bicycles are more modern and better showcase the 'green' image companies want to project into the world.

As the bicycles will be located very close by the companies and people are allowed to take the bicycles home, such a system leads to minimization of access and egress times. In addition, as these systems are set up by or with the backing of the employers, the trip costs will be covered through giving people travel allowances to support the use of the sustainable electric shared bicycle. The following shared bicycle alternative is defined to reflect the system characteristics described above:

- Bicycle type = Electric
- Access time = 1 minute
- Egress time = 1 minute
- Trip costs = €0 p/km

The probabilities averaged over the population of people opting for this shared bicycle for different trip distances are shown in Table 6.

Table 6: Choice probabilities for different trip distance	es for system design scenario 5, without trip costs
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Trip distance	2.5km	5km	7.5km	10km
Choice probability	60%	67%	62%	50%

These choice probabilities show that this scenario is the most preferred from the user perspective, especially with regards to the medium to long distance trips which shows an increase in probability of approximately 15%. This is to be expected as both the trip costs and access and egress times are minimized and the electric bicycle is preferred for long distance trips.

This scenario is comparable to the bike sharing initiatives that are found in for example Utrecht where electric shared bicycles are placed at several locations spread over an industrial terrain so that people can use the bikes for their last mile and for business trips. For this system to function as described above however, the employers have to be willing to include the use of shared bicycles into their travel allowances so that the trip costs from the users' perspective are equal to zero. If this is not the case, the choice probabilities are as shown in Table 7 (with a trip cost of 0.30 p/km):

Table 7: Choice probabilities for different trip distances for system design scenario 5, with trip costs

Trip distance	2.5km	5km	7.5km	10km
Choice probability	53%	56%	51%	40%

While this system is still preferred for longer distances, its attractiveness for short distance trips is now the lowest of all scenarios discussed. A regular bike sharing system as discussed in scenario 1 or 2 with a traditional bicycle provides more possibilities with regards to short distance trips. The system design therefore also depends on the length of the trips the system should facilitate.

4. Recommendations for bike sharing system design

Bicycles The traditional bicycle is preferred for short distances while the electric bicycle is preferred for longer distances. When both types of trips are to be facilitated a combination of bicycle types can be implemented. It must be kept in mind however that implementing electric bicycles in a bike sharing system leads to high acquisition costs, maintenance costs and high instalment costs regarding the charging infrastructure of the docking stations. Due to these increasing costs the trip cost of the system from the users' perspective will have to be increased which greatly decreases the attractiveness of the system. Therefore it is recommended to only provide electric bicycles in a bike sharing system if the system specifically focuses on facilitating medium to long distance trips. In order to keep the trip cost low however the distribution of docking stations will have to be coarse which means the reach of the system will be limited. Another possibility for the implementation of electric bicycles lies in systems that are setup in cooperation with employers who can include use of the shared bicycle in their employees' travel allowances, removing the issue of trip costs.

Distribution of docking stations A fine-grained network of docking station is preferred from the users' perspective as the reach of the system will be enhanced and the access and egress times will be minimized. A fine-grained network is costly however. To decrease costs one can opt to only place bicycles at key locations throughout the city like public transport stops, P+R locations and city attractions, however this would increase access and egress times as well as limit the system's ability to facilitate a variety of trips for a variety of people. Depending on the target groups and the types of trips the system has to facilitate, the operating party can either opt for a fine-grained or coarsely distributed network of docking station.

System access and user registration Bicycles should be easily accessible, meaning that a new user should not have to go through the frustrating process of registering and authenticating in order to rent a bicycle. Being able to reserve a bicycle might also be an attractive added feature to the system for commuters and business travellers to deal with the issue of punctuality. Research has to be done on ways to solve these issues and to determine the added value of features like being able to reserve a bicycle.

System status information system The system status information should be optimized. When a commuter of business traveller wants to make use of a shared bicycle and they are not able to easily check whether a bicycle is available, or the information is not up to date, the bad experience with the system could cause the potential user to not opting for the system again as arriving on time on a commuting or business trip is much more important compared to recreational trips.

Bicycle redistribution mechanisms As it is recommended to design a flexible bike sharing system in the Netherlands, meaning that users can return the shared bicycle at any docking station, redistribution of bicycles will be necessary. To decrease the cost of redistribution user-based redistribution schemes can be implemented in which users are stimulated to return their vehicle to a non-saturated station, thereby rebalancing the distribution of the bikes without operating costs. This can be done by providing a discount, a free ride or giving money when users place their bicycle at an empty station. Such schemes need to be studied in more detail to determine the most efficient way to deal with the problem of bicycle redistribution

Models of Provision The preferred model of provision is dependent on the focus and aim of the system. In case the system is focused on a broad region and the costs of the system need to be kept to a minimum so that a variety of people can make use of the system, the system should either be publicly owned and operated or publicly owned and operated by a contractor. In case this is not the case, the system can be either third-party operated or vendor operated. The advertising model should be avoided in as the focus of the operator will not be on providing the best service level.

Pricing As the trip costs have a large effect on the attractiveness of the system, these should be kept to a minimum which can be achieved by making choices on the distribution of docking stations and the bicycle type that is provided. In addition, by stimulating employers to include the use of shared bicycles into the travel allowances that are granted to their employees, users will be much more open towards using a shared bicycle for their commuting and business trips.

5. Conclusion

Based on the results from the questionnaire and the SC experiment it can be concluded that people are interested in using a shared bicycle for their commuting trips, and even more so for business trips. From the perspective of the user there are three preferred system design scenarios with regards to commuting trips. The first two scenarios describe a bike sharing system implemented on a citywide scale, with either a coarsely distributed or a fine-grained network of docking stations, which only provides traditional bicycles limits the trip costs. The third option is a system that only focuses on a limited group of commuters and business travellers in a smaller region. Such a system would minimize access and egress time through providing electric bicycles exactly where needed. To implement such a system however, trip costs need to be minimized through providing users with a travel allowance aimed towards using a shared bicycle.

6. Discussion

The introduction of bike sharing systems in Dutch cities remains a controversial subject. Although in many countries people applaud the arising sharing economy and its possibilities in terms of shared mobility, such trends are not yet as visible and welcomed in the Netherlands. The Dutch population has a very high bicycle ownership and in addition the Dutch value flexibility and comfort strongly, which makes owning a vehicle very attractive. It remains to be seen whether shared mobility will catch on in the Netherlands, with regards to any vehicle sharing services.

In addition, it must be determined whether the implementation of bike sharing systems is really necessary, and whether it is worth the costs of implementation and operation. While people

may be open to using a shared bicycle, such a system is very costly and should therefore have a clear and achievable goal. While in foreign cities this goal is to stimulate bicycle use, which is often achieved through the implementation of a bike sharing system, the goal in Dutch cities is generally to decrease traffic congestion and improve the accessibility of certain regions. These goals are much more difficult to achieve using a citywide bike sharing system as it is not feasible for such a system to focus on specific bottlenecks. Systems introduced for smaller regions however, for example for industrial terrains located at the outskirts of cities, will be able to tackle congestion and accessibility problems as these systems can be tailor-made to the needs in the region and are able to provide an attractive alternative to the car for trips between the city centre and the industrial locations (up to 10km) and on the industrial area itself.

Another important aspect that needs to be discussed is how a new bike sharing system should be implemented in relation to the existing PT-bicycle system. The PT-bicycle system is very successful in facilitating both commuting and business trips with regards to the last mile after having used the train and should therefore either be complemented or substituted and expanded when a new bike sharing system is implemented. Substitution and expansion of the system is preferred from the perspective of the user which prefers an easily accessible and user-friendly system: it is important to make sure users can access and return all available shared bicycles at all docking stations through accessing one single platform.

The preferred model of provision is dependent on the focus and aim of the system. In case the system is focused on a broad region and the costs of the system needs to be kept to a minimum so that a variety of people can make use of the system, the system should either be publicly owned and operated or publicly owned and operated by a contractor. When this is not the case, the system can be either third-party operated or vendor operated.

In conclusion, the decision on whether to implement a bike sharing system in Dutch cities is not straightforward. Due to the nature of the Dutch population, it remains unclear whether a shared vehicle system will be found to be attractive by a significant part of the population. In addition, as bicycle usage does not need to be stimulated as much as in foreign countries, and the focus lies more on decreasing traffic congestion and increasing the accessibility of urban regions, it is less likely that these problems can be solved through the implementation of a costly citywide bike sharing system. Systems introduced in smaller regions like industrial areas will however be able to tackle specific problems and thereby achieve the goals that were set with regards to traffic congestion and accessibility. The introduction of bike sharing systems at specific locations is therefore more likely to be effective as well as feasible. The decision on whether citywide bike sharing systems in Dutch cities are to be implemented should therefore not be taken lightly.

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