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Measure No.14: Integration of modes

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Passenger inter-modality schemes facilitate and streamline journeys that involve use of more than one mode.

Cities can minimise the complexity of combining different modes of transport, helping travellers to use alternatives to the car. Interventions that help to achieve this often focus on the point of transfer between modes.

14.1 Context and background

In effect, a large proportion of all trips include more than one mode. For instance, for able-bodied adults many trips will include a degree of walking; walking to the car or walking to the bus stop. Most of the source documents consulted in this review though have examined inter-modality as the facilitation of the use of two, non-walking, modes in a journey.

Where inter-modality is addressed successfully, then well integrated transport networks can be produced. This has led to high bus patronage in cities like Zurich where two-thirds of residents working in the city travel to work by public transport. Mees (2010, p.131).
Note: Whilst an important aspect of inter-modality is 'integrated ticketing' (Mees, 2010, p.137) this topic is reviewed in Measure 12: Public transport enhancements, whilst ticketing innovations implemented via new technologies such as mobile phones are covered in Measure 15 e-ticketing.

Key messages:

- The main benefit of Park and Ride (P&R) is to remove car trips out of a city centre, with the potential for economic (e.g. increased retail activity), and environmental benefits.
- The expense and convenience of the P&R site and the overall expense of the service are important factors for success.
- Reducing city centre parking capacity, or increasing the price to make it more expensive are factors that will increase the attractiveness of P&R.
- Improved access to public transport is seen to lead to improved 'customer satisfaction'. Transfer facilities such as cycle parking and cycle hire are also viewed positively - albeit with continuing debate over how effective they might be.
- Studies of improving access to stations suggest that such improvements can provide 'good value for money', better in fact than improving the rail service itself. This is an area of emerging evidence still, so this finding is at present based on a relatively limited number of sources.
- Measures to promote cycle-bus integration could be particularly beneficial for riders with low incomes, as well as increasing the area from which bus passengers can be drawn. Such schemes could offer positive returns for operators, although estimating costs is seen to be problematic.

Potential interventions

- Park and ride, where a car or bike is parked to ride a bus, train, tram etc.
- Cycles being taken onto buses (after being used for access, and/or for later travel)

14.2 Extent and Sources of Evidence

Although documents have been identified in relation to passenger inter-modality, studies documenting the before and after effects of a scheme are much rarer, (although 'before and after' behaviour was sometimes hinted at by answers to survey questions.) It is also the case that a large proportion of the evidence identified as relating to inter-modality concerns park and ride schemes.

13 studies were initially selected by the project for this measure, although not all proved helpful on further inspection, due to a lack of relevant empirical evidence. Those that were used were supplemented with documents from other sources. This review draws on 11 source documents in total. All except one are peer reviewed journal articles. For some studies the data has been collected by academics (Cherry & Townsend, 2012). For others the academic has studied data collected previously by other organisations (Givoni & Rietveld, 2007).

No meta-analyses, in the statistical sense, were consulted for the review. One review of a number of inter-modality schemes in Netherlands was useful as it included descriptive statistics relating to the different schemes. Most of the studies consulted used specific case studies, either small scale, such as specific metro stations, or national.

Studies consulted for this measure were from a variety of countries. However, 6 of the 11 were from European countries, and 4 of these were from the Netherlands. It is likely that there is a good body of evidence from the Netherlands because of the richness and diversity of the bike and public transport provision in that country.

The studies consulted were written within the last two decades and many within the last five years. Judging from the dates of the studies consulted, research into passenger inter-modality measures is ongoing. The types of intervention written about are also ongoing. Some of the studies consulted were written shortly after an intervention, such as the study on Park and Ride in Adelaide (Wiseman et al., 2012). Other studies were written long after a scheme had been first implemented (Parkhurst, 1995).

14.3 What the Evidence Claims

Passenger inter-modality is discussed in two contexts, park and ride, and access to rail and bus journeys.

14.3.1 Park and ride

Five items were studied that examined park and ride specifically. Of these, two investigated bus as the 'ride' vehicle, one looked at tram and two looked at rail.

Wiseman et al. (2012) suggest that park and rides have numerous benefits. One indicator of these benefits is park and ride's popularity. The schemes can be politically popular and can have economic benefits as in effect they can improve the access (including parking) to a city (Wiseman et al., 2012, Parkhurst, 1995). In 2003 in the Netherlands there were 386 park and rides and in 2007 in Great Britain there were over 130 (Parkhurst & Meek, 2014, p.188). As well as being popular with transport authorities park and ride can also be popular with users (Seik, 1997). Overall the evidence suggests that park and ride can achieve high patronage.

Wiseman et al. (2012) suggest a specific benefit of park and ride is that it may attract some new users to public transport. It can do this by raising awareness of public transport and by providing a step change: for example car drivers may change to park and ride and then change to public transport only (Clayton et al. 2014).

Perhaps park and ride's greatest strength is in displacing car trips out of a city centre. This may have city centre economic, ambience and local air quality benefits (although the latter was not investigated in the documents consulted). As Clayton et al.'s (2014) study suggests, reducing car parking and driving in a city centre can be particularly important in towns which need to provide good tourist access whilst preserving an attractive city centre ambience.

Park and ride can replace some car trips. Parkhurst (1995) found that in Oxford 56%

of park and ride commuters who had been commuting before the implementation of park and ride had previously used car, in York 70% had. Wiseman et al. (2012) found that 29.8% of park and ride users had previously used car. Specifically park and ride can reduce car trips in the city centres (Wiseman et al., 2012, Clayton et al., 2014).

Some types of park and ride scheme offer better effects on private vehicle kilometres travelled overall than others. Park and rides placed at different distances from the city centre can have different impacts (Mingardo, 2013). Remote schemes (which take the driver from a location near the origin of their trip) can lead to decreases in vehicle kilometres travelled.

However, some types of park and ride, such as periphery schemes, (which can be located at the edge of the destination town and take the driver for the last portion of the trip only) can actually increase car use (Wiseman et al. 2012). Park and Ride can lead to vehicular trips being made that otherwise would not have been taken (Mingardo, 2013, Clayton et al. 2014). Park and ride can also lead to increased car use by leading to modal shift away from public transport (Wiseman et al. 2012, Clayton et al., 2014) and bicycle (Mingardo, 2013). In effect this can mean an increase in car use (and thus an increase in emissions.) Thus Wiseman et al. (2012) found that the park and ride scheme in Adelaide had led to a car use increase of 4.7 car-km/person/day. So it is important to consider the benefits of decreasing car use in the city centre along with the effects on overall car travel (Wiseman et al. 2012).

Another caveat to apply to the benefits of park and ride is that it may reduce travel by active modes. Wiseman et al. (2012) suggest from their findings that the scheme they examined led to a reduction in walking.

Some studies suggest elements affecting patronage levels. Factors which led to increasingly successful implementations of the Singapore park and ride can be divided into those internal to the scheme and those external to it (Seik, 1997). Internal factors included extended parking hours, ongoing journeys on bus being included on one ticket, improved and more numerous car parks, higher financial incentives and improved publicising. External factors included increased charges for driving and parking in the central business district, factors which should be considered when considering implementing park and ride.

The expense and convenience of parking (Seik, 1997, Mingardo, 2013, Parkhurst, 1995) and overall expense (Wiseman et al., 2012, Seik, 1997,) in relation to other mode options, seem of particular importance to the patronage of park and ride. Other factors included the comfort (Mingardo, 2013) of the facilities.

Reflections on the evidence

None of the items on park and ride included a before and after survey. The studies consulted had been conducted after implementation. Often data collection was by survey. As discussed above a key survey question concerned the mode that had been used previously to using park and ride (Wiseman et al. 2012, Parkhurst, 1995, Mingardo, 2013). This is in effect a 'before and after' question: The 'after' data is the rider using the park and ride, and the 'before' is their stated previous mode. This is key because as discussed above switching from car only trips can be seen positively, but switching from bus or bicycle negatively. The strategy of surveying park and ride users about their previous mode and the location of their trip origin can reveal a lot about the success or otherwise of the scheme. This data can, without great complexity, give estimates to the total change in car travel caused by the park and ride, and associated CO_2 emissions.

Of course this data is limited to park and ride users only. It does not capture those who have left park and ride and their reasons for doing so, or non-park and ride users and the reasons why they have never used the scheme. However, Clayton et al. (2014) in effect conducted a park and ride user and non-user (people parking in the city centre) survey and through this were able to draw out different demographic profiles for users and non-users.

Seik (1997) offers evidence of another nature. This evidence is the 'real life' level of success (patronage) of a Singapore park and ride. This scheme was a failure at first but its success increased with successive altered reimplementation. Thus Seik (1997) is able to suggest reasons why the scheme became increasingly successful in terms of patronage.

A final method for investigating park and ride behaviour is that of observing behaviour rather than surveying. Mingardo (2013) reports observational research to see whether drivers were parking in park and ride car parks but then walking to their destination.

The nature of park and ride schemes (compared to national rail for instance) means that studies tend to be quite focused geographically, often studying the park and rides serving a specific city.

By surveying present users of park and ride, the data collected in the studies consulted do reflect real-world attitudes and behaviour. The statistical processes involved in the studies on park and ride tend to be reasonably transparent descriptive statistics. (Such as the percentage of people that had used car before park and ride.) Numbers of park and riders surveyed in the studies vary markedly. For instance, Seik's (1997) sample was n=122, Clayton et al. (2014) surveyed n=721.

The studies adopted different strategies in terms of the time of day that users were surveyed. Perhaps people travelling at different times of day and for different purposes could be better accounted for, by stratified sampling, if a way to do this could be found.

As discussed above, patronage of park and ride services can be influenced by external factors, such as the price of parking in the city centre (Seik, 1997), concessionary public transport fares for older people (Clayton et al. 2014) or public transport provision in areas surrounding the city (Parkhurst, 1995). The importance of these factors is understood through people's stated reasons for using/not using a park and ride. (Although it is possible that park and ride users might answer tactically if they perceive the ongoing provision of the park and ride is under threat.) The strength of surveying park and ride users (which most of the studies did) is that reasons for choosing that mode can be isolated. Such isolation would be difficult to achieve simply by looking at patronage levels.

Although inferences can be made from the above studies about the effects of park and ride on total levels of car travel in a city, an empirical study which measured this total, before and after park and ride implementation was not found. This would be a potential for a further study. Another study could look at park and ride schemes historically and globally looking for correlations between political, economic and transport conditions and patronage. This would involve some wisdom in drawing out the important factors.

The studies consulted have findings that are relevant in other countries/locations. However, the studies indicate that some country specific factors may have been present. For instance Seik (1997) records that in Singapore there were increasing population, income and car ownership combined with very limited geographical space. This led to charging for driving and parking in central urban areas, which increased the park and ride's popularity. In the case of England, there was a historical favouring of the scheme type and also a concessionary fare for older bus users (Clayton et al. 2014). These factors may support park and ride.

Levels of affluence in the local population may affect patronage of park and ride. This is because one of the main attractions for users of the scheme type is that it can be cheaper than parking in the city centre. Some of the park and ride schemes that Parkhurst (1995) and Clayton et al. (2014) studied had commenced 20 to 30 years earlier, this points to durability of the schemes.

The studies consulted suggest that important factors for high patronage are the expense and convenience of the associated parking site and the overall expense of the service. It is key to understand that the convenience of parking and expense of us-

ing park and ride matter in as far as they compare to other modes. Thus if parking in the city centre is made more expensive, park and ride becomes more attractive (see Seik, 1997).

14.3.2 Access to rail and bus journeys

The second group of studies examined for this measure relate to various forms of access to rail or bus journeys via other modes. (The distinction between these and park and ride are sometimes blurred.) These studies identified different aspects of access. A quick summary is useful:

Brons et al. (2009) and Givoni & Rietveld (2007) sought to understand how important the journey to the rail station is to overall satisfaction with the journey in the Netherlands. Givoni & Rietveld (2007) also discussed the importance of various factors for improving access to stations.

Martens (2007) examined a number of interventions introduced under the Dutch Bicycle Master Plan, aimed at improving bike/rail and bike/bus inter-modality.

Hagelin & Datz (2005) looked at facilities to take bikes on board buses, in Florida, U.S.

Chen et al. (2012) examined factors important to the popularity of bike use as an access/egress mode to metro journeys in Nanjing, China.

Cherry & Townsend (2012) examined Metro/bus interchange in Bangkok, Thailand and how this could be improved.

The studies above more often dealt with access to rail rather than to bus. They found that accessibility to and from railway stations is important and can influence customer satisfaction with the overall journey and hence rail patronage (Brons et al. 2009, Givoni & Rietveld, 2007). In addition to being important, accessibility to stations was considered by passengers to be one of the aspects of the Dutch railway needing most improvement (Brons et al. 2009, Givoni & Rietveld, 2007). Givoni & Rietveld (2007, p.362) found that passenger ratings of the access to Dutch railway stations averaged between 'insufficient' and 'sufficient'. Brons et al. (2009) suggest that improving accessibility can provide good value for money, both in terms of increased satisfaction and number of trips and can be more cost effective than improving the rail service itself.

The studies consulted differentiate between the access journey to/from a railway station and the actual transfer from one mode to another at the station. Brons et al. (2009) suggest that the access journey is more important than the transfer facilities at the station.

Some of the studies consulted examine the access of rail journeys, by public transport. Brons et al. (2009) found that connection between rail and other public transport had important and statistically significant effects on customer satisfaction with the rail journey. Without improvements being made, accessing rail by public transport can be problematic. Problems identified in rail/bus transfer in Bangkok included large distances between metro stops and bus stops, difficult boarding conditions for buses, lack of bus timetables and lack of personal security Cherry & Townsend (2012). These are all areas where important improvements could be made.

Some of the studies consulted dealt specifically with accessing rail by bike. Chen et al. (2012) suggest that using cycle to access rail was popular amongst those surveyed in Nanjing, China. However its popularity was variable according to the time sensitivity and purpose of the trip: Bicycle is more likely to be used when the trip is less time sensitive.

For cycle riders, in addition to the cycling access journey to a train station, there is also the task of parking the cycle. Brons et al. (2009) found that unguarded bicycle parking had positive and statistically significant impacts on rail user satisfaction. Martens (2007) also suggests better cycle parking can lead to improved satisfaction and may lead to increased rail use. Martens found improvements of quality and extent of bike parking (along with improvements to 'walking routes to train platforms') in five small stations led to an increase of satisfaction of rail users from 5.3 to 7.1, out of 10. The success of the

improvements was also attested to by increases in numbers of bikes parked at the stations. Martens reports that 11% of respondents said that better bicycle parking might lead them to travel more by bike and rail. The importance of improving cycle parking on overall trip satisfaction is however contested by Givoni & Rietveld (2007). Chen et al. (2012) report the finding that distance between bicycle parking and station may be an important factor.

Martens studied various other measures to improve bike/bus integration, some of these were more successful than others: An integrated group of measures aimed at facilitating bike-and-ride on a specific transport corridor, through improving the bus priority and adding bicycle parking, resulted in an increase of bus patronage. However, in other pilot schemes Martens (2007) found that facilities like bike lockers were not greatly used. The price for the user of bus/bike schemes should be considered: a pilot scheme to sell a 'bicycle-bus-bicycle' product, including bicycle lockers at the bus stops and a travel pass for the bus, was not popular due the price of the product, people preferring to cycle (only) to work and car dependency.

Provision for egress journeys by bike, from either train or bus to a non-home destination, can be beneficial. The two obvious options for how the egress journey can be made by cycle are either to have a second cycle which is left parked near the station, or to hire a cycle. PT-bicycles is an example of a bike hire scheme (Martens, 2007). During 2000 to 2004, this facility had been successful, with the number of participating stations rising from 4 to 72, number of users rising to 10,000 and trips rising to more than 100,000/year. Martens' survey data suggest that PT-bicycles had led to some modal shift. 15% of users had previously been using car.

An alternative to needing two cycles to complete a public transport trip is to take the cycle on board. Hagelin & Datz (2005) found that being able to take bikes on board buses had a number of specific benefits. They found that this facility could be particularly beneficial for riders with low incomes. People using the service tended to use it regularly and long term. The facility can attract new customers and can increase the area from which bus passengers can be drawn. Hagelin & Datz (2005, p.57) conclude that public transport companies can receive returns far greater than their investment through bike on board programs. However, the report also concedes that it is difficult to estimate the costs involved in providing such programs.

Reflections on the evidence

The studies on access to rail and bus journeys did draw on real life attitudes, often using surveys of users' satisfaction levels. Most of the studies on access to rail and bus journeys did not chart both before and after findings. However they did record patronage and customer satisfaction levels with various access facilities. Martens (2007) was an exception in measuring overall satisfaction with bike/rail journeys before and after a number of improvements were made to facilities. In effect Cherry & Townsend's (2012) study represents a 'before' study, highlighting priorities for change. Whilst Chen et al.'s (2012) study represents an 'after' study.

Most of the studies drew on surveys charting customer satisfaction, with their overall journey or with specific facilities. Martens (2007) however also drew on observational data collection of the number of cycles parked at stations. Martens also drew on patronage figures for a cycle hire scheme. The studies used a range of statistical tests ranging from simple descriptive statistics to Principle component analysis.

The occurrence of accessing rail and bus stations is less geographical focused than park and ride schemes. Thus the issue arises of how representative surveys conducted about access to rail and bus are. Some of the studies involved secondary analysis of national surveys (Givoni & Rietveld, 2007). Other researchers handed out surveys at two or three metro stations (Cherry & Townsend, 2012, Chen et al. 2012). The ability of these stations to represent more general patterns and conditions is questionable. However good sample sizes (n=1784 in total) were achieved.

In general it is hard from the studies to ascertain the link between attitudes to ac-

cess facilities and actual behaviour. It is difficult to isolate the accessibility factors from other external factors that may affect mode choice.

An absence within the studies consulted is economic study examining the economic cost/benefits of the schemes. However Brons et al. (2009) do suggest from their study that it is when the cost of improving accessibility to stations is considered that improving access to stations becomes desirable compared to improving other aspects of the rail service. The study suggested that accessibility improvements to smaller stations would be likely to be less costly than improving the travel-time reliability of trains, timetables or station quality.

One weakness with the source documents consulted are that they are not numerous or diverse enough to be representative of the different rail, road and cycling conditions in different countries. Three of the studies are from the Netherlands where cycling facilities are unusually good (Martens, 2007) and where there is a higher density of railway lines and stations than is average in the EU (Brons et al., 2009, Givoni & Rietveld, 2007). Other studies come from Thailand and China where conditions are likely to be different to EU countries.

14.4 Lessons for Successful Deployment of this measure

Key lessons emerging from the evidence include:

- Strong, supportive political will seems to be an important driver of (commercial) success for park and ride.
- The public popularity of park and ride is important; its attractiveness will depend on how it compares with the other modes available to access the city centre.
- Physical proximity is essential for effective inter-modality. The distances between train station/bus stop and bicycle parking or between train station and bus stop, should be small. One 'must have' for effective inter-modality is physical proximity. The evidence suggested that the distances between train station/bus stop and bicycle parking or between train station and bus stop, should be small.
- Whilst improvements to train and bus station accessibility can increase patronage this will also significantly depend on the quality of the bus and rail services. Low-quality, expensive, infrequent or poorly routed services and stations that are unattractive will limit potential increases. There is a case made for making investments here into stations that already have high levels of services, and where there are big local populations.
- It is important that efforts are made to inform user and non-user perceptions of accessibility to stations/stops and accessibility improvements. Car users in particular may have a negatively biased perception of the public transport accessibility to train stations.
- For both park and ride and access improvements, it is important to consider which mode trip makers will leave in order to use the improved public transport options. Where possible, pricing and incentives should be used to manage this carefully.

14.5 Additional benefits

As well as the evidence of economic and financial benefits of interventions discussed above, there are a number of additional benefits that are claimed for these policies:

- Improved access: P&R can improve access to a city. This can be particularly important in towns which need to provide good tourist access whilst preserving an attractive city centre. This may also help facilitate other changes such as pedestrianisation schemes – with potential benefits for businesses and for air quality in a city centre.
- Modal shift: P&R may attract some new users to public transport by raising awareness and by offering a high-quality service which may encourage car drivers to change to P&R and then change to public transport.
- Customer satisfaction: Accessibility to and from railway stations can

influence customer satisfaction with the overall journey and hence rail patronage.

- Increased patronage: Cycle facilities at stations and or related to bus travel may also lead to increased use of these modes by now facilitating a combined journey which previously would not be possible by public transport alone.

14.6 Summary

The evidence base for park and ride draws on studies from contrasting countries around the world. Studies often provide clear estimates of some of the impacts of the scheme, but there are gaps in the research concerning the perceptions of park and ride by non-users, and also before and after studies, in the strict sense. Park and ride schemes can be successful in achieving popularity and patronage where the right conditions are present.

The likely successes and drawbacks of park and ride should be considered before implementing. It is likely that the main benefits of the scheme will be to displace trips out of a city centre, which may have political, economic and ambience benefits. Some types of park and ride, such as remote park and ride can be more effective in reducing overall car travel levels than others.

The evidence relating to rail and bus interchange was often limited, although improved access was seen to lead to greater customer satisfaction, and additional data was emerging through simple usage studies. Transfer facilities such as cycle parking and cycle hire were viewed positively overall, though there was some debate about their effectiveness. More generally studying interchange facilities at rail stations was seen to be challenging, because of the variation in numbers of travellers, station facilities, and in the transport complexity of each location. Whilst the studies consulted did not deal with the economic cost/benefits of improving access in detail, claims are being made that improving accessibility to train stations can provide good value for money, better in fact than improving the rail service itself.

'Passenger inter-modality' covers a broad range of scheme types, and so drawing common conclusions across them is difficult. Two key principles of success do emerge though. Firstly, pricing and incentives are important, and influence which modes travellers switch from, and secondly, whilst it is critical that the interchange facilities are high-quality to be successful, the same is true for the journey segments they connect.

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Author information for the Evidence Measure Reviews

No.1	Electric Battery and Fuel Cell Vehicles	Hüging, H[1,a]	hanna.hueging@wupperinst.org
No.2	Cleaner Vehicles	Rudolph, F[1,a]	frederic.rudolph@wupperinst.org
No.3	Urban Freight	Ricci, M[2,b]	Miriam.Ricci@uwe.ac.uk
No.4	Access restrictions	Melia, S[2,b]	Steve.Melia@uwe.ac.uk
No.5	Roadspace reallocation	Clark, B[2,b]	Ben4.Clark@uwe.ac.uk
No.6	Environmental zones	Calvert, T[2,b]	Thomas2.Calvert@uwe.ac.uk
No.7	Congestion charges	Mingardo, G. & Streng, M [3,c]	mingardo@ese.eur.nl
No.8	Parking	Mingardo, G. & Streng, M [3,c]	mingardo@ese.eur.nl
No.9	Site-based travel plans	Bartle, C[2,b]	Caroline.Bartle@uwe.ac.uk
No.10	Personalised travel planning	Bartle, C[2,b]	Caroline.Bartle@uwe.ac.uk
No.11	Marketing and rewarding	Rudolph, F[1,a]	frederic.rudolph@wupperinst.org
No.12	Public transport enhancements	Shergold, I[2,b]	Ian2.shergold@uwe.ac.uk
No.13	New public transport systems	Clark, B[2,b]	Ben4.Clark@uwe.ac.uk
No.14	Integration of modes	Calvert, T[2,b]	Thomas2.Calvert@uwe.ac.uk
No.15	e-ticketing	Shergold, I[2,b]	Ian2.shergold@uwe.ac.uk
No.16	Traffic management	Clark, B[2,b]	Ben4.Clark@uwe.ac.uk
No.17	Travel information	Calvert, T[2,b]	Thomas2.Calvert@uwe.ac.uk
No.18	New models of car use	Calvert, T. & Chatterjee, K [2,b]	Thomas2.Calvert@uwe.ac.uk
No.19	Walking	Jain, J[2,b]	Juliet.Jain@uwe.ac.uk
No.20	Cycling	Parkin, J[2,b]	John.Parkin@uwe.ac.uk
No.21	Bike sharing	Ricci, M[2,b]	Miriam.Ricci@uwe.ac.uk
No.22	Inclusive urban design	Melia, S[2,b]	Steve.Melia@uwe.ac.uk

1	Wuppertal Institut für Klima, Umwelt und Energie GmbH	a	Wuppertal Institut, Döppersberg 19 42103 Wuppertal. Germany.
2	University of the West of England: Bristol	b	Centre for Transport and Society, University of the West of England, Frenchay Campus, Coldharbour Lane, Bristol BS16 1QY. UK
3	RHV Erasmus University Rotterdam	c	RHV BV, TAV Martijn Streng, P.O. Box 1738, 3000 DR Rotterdam, The Netherlands