The advantages of multi-modal concessions, two analyses in the Netherlands

Gerald Hoekstra[a], Wijnand Veeneman[b*], **Niels van Oort**[c] and Rob Goverde[c]

[a] Trambaan 3, 8441BH Heerenveen, The Netherlands Gerald.Hoekstra@icloud.com
[b] Jaffalaan 5, 2628BX Delft, The Netherlands +31152787754 W.W.Veeneman@TUDelft.nl
[c] Stevinweg 1, 2628CN Delft, The Netherlands +31615908644 N.vanOort@TUDelft.nl

*Corresponding author

JEL classification: R41, L92, L98, H44, H77

Keywords: public transport, integration, governance, multi-modal, concessions

ABSTRACT

Public transport authorities are aiming for more integrated concessions, including bus, train services, to provide a better experience for travellers. This paper describes the analysis of the effect of multimodal concessions.
First, the Dutch Province of Limburg moved from uni-modal to a multimodal concession. The paper analyses effects of that choice had for network design, travel times (using weighted generalized travel time), travel costs, patronage (using smart card data analysis), and coordinative interactions between operator and authority (based on interviews).
Second, the paper analyses three different forms of coordination between bus and train services, using the STO model. It compares three regional concession in the Netherlands in Limburg, Fryslân, and Groningen. They represent one region with a multi-modal concession under net-cost, one region with multiple unimodal concessions under net-cost and one region with multiple unimodal concessions under mixed forms of contract.
The paper concludes that multi-modal concessions provide some real-world advantages to travellers and authorities. However, to what extent these advantages materialize is dependent on a number of key factors, including the type of contracts used, the number of transport authorities active in the concession area and the role that the transport authority wants to take up.

1. Introduction: multimodal concessions, good idea or not[1].

All across the world, Competitive Tendering (CT) of concessions is used as a model of governance for public transport service (PT) provision (Hensher and Stanley, 2008). A key question is what services to include in the concession, with various advantages and disadvantages for both smaller and large concessions, multi-modal and single-modal concessions. This paper aims at providing answers on how to move forward on that dilemma, with a focus the question of multi-modality.
In the Netherlands, the Passenger Transport Act 2000 (Wet Personenenvervoer 2000, 2001) directed the reorganisation of the Dutch regional PT system. Although CT of concessions has led to, in most places, more customer focus and more efficient operations (Beck, 2011; Mouwen & Rietveld, 2013), also some externalities are noticed. The push for

[1] This paper is based on the MSc Thesis: Gerald Hoekstra (2018) Push Back the Boundaries; The potential of multimodal concessions to make modal boundaries in public transport disappear.

defragmentation resulted in (more) unwanted boundaries at concession borders, both spatial as well as between modalities. Those borders are expressed in, for example, tariff variations and poor connections. Borders will always remain in a PT system where many operators are present, but some of them can be taken away or reduced. An often-proposed solution to let modal boundaries disappear is CT of multimodal concessions. In such a concession, the operator obtains the right to perform PT by both regional train and bus in a particular area. In theory, the borders between those modalities should, then, be taken away, resulting in an integrated PT system for passengers, while at the same time operations get more efficient, since no competition exists anymore between train and bus. A Public Transport Authority (PTA) only has to deal with one operator, which simplifies the current situation in most cases. However, also some expected drawbacks of multimodal concessions can be mentioned. For example, multimodal concessions are often larger and only larger operators are able to bid on them. Multimodal concessions seem to have potential in theory, but the real benefits and drawbacks are unclear yet. Therefore, the main question of this study is *What are the pros and cons of contracting out regional multimodal public transport concessions for travellers, authorities, and operators instead of regional unimodal concessions?* Thereby, the focus is on regional train and bus operations in a non-urban context.

Various forms of Public Transport (PT) should be better connected to each other, to better match the traveller's needs. Although this statement can be interpreted broadly, it gives an indication of the importance of alignment between different modalities, which is the topic of this research. More specifically, the alignment between regional train and bus is the main focus. In this chapter, the focus is on the research structure. The problem is made clear in this section by a problem description and thereafter summarised into the problem statement. Finally, the research goal that follows from the problem description and statement is mentioned.

The decentralisation in the Netherlands provided PTAs a lot of freedom to shape the concession contract with the operator (Veeneman & Van de Velde, 2014). Consequently, PT concessions differ in terms of size, number of modalities, and freedom for the operator to introduce (innovative) improvements to the system. After the introduction of the Passenger Transport Act 2000, most concessions were relatively small (Veeneman & Van de Velde, 2014). Initially, the national government pushed for modal, regional, and organisational defragmentation to simplify the various layers of government and increase efficiency. However, this resulted in many undesirable boundaries in the PT system: different identities, fares, and no smooth transfers (Veeneman, 2016).
The externalities of the boundaries in the system were noticed by the PTAs. As a solution, the PTAs took measures: regional cooperation became stronger, smaller PTAs merged, and integrated or multimodal concessions were tendered out (Veeneman, 2016). As can be seen in figure 1.1, the total number of concessions decreased from 61 in 2011 to 34 in 2018 (CROW, 2013; Veeneman & Van de Velde, 2014. In a multimodal concession, the contracted operator is responsible for different modalities in a region, often train and bus. Regional train services and bus lines are integrated in this way. Sometimes demand responsive systems are included as well (Veeneman, 2016).
In the PT sector, a lot of expected advantages of multimodal concessions over unimodal concessions go around. Since train and bus operations are provided by one operator, competition between these companies is not possible anymore. This should result in more

efficient operations, better passenger service and an improvement in the cost coverage ratio. Besides that, the interaction with only one operator should simplify the coordination task for the PTA. An expected benefit for travellers is a better integrated PT system, which translates among others in tariff integration. A regional integrated PT system focuses more on regional passengers instead of through travellers. Transfers from bus to regional train are promoted and improved. Since the average passenger travel distance by train in the Netherlands is 28.9 kilometre (UITP, 2016), probably more travellers are served better in their daily urban system. Also, network design is seen as an advantage, because different networks in a region can be better aligned with each other. Network design in a lot of regional concessions has hardly changed for decades: most buses simply traverse all villages passing by on their way to the city. A feeder network, in which buses feed a regional railway line, can be a way to decrease Travel Time (TT) for travellers and increase efficiency (Kuah & Perl, 1989).
Just like the expected advantages, some drawbacks of multimodal concessions are often mentioned in the sector. TT is redistributed when a feeder network is applied. For passengers who used to take a direct bus to their destination, TT might increase when such a system is applied, and a lot of passengers could be faced with extra transfers from bus to train. A second possible downside of multimodal concessions, in general, may be that only a few larger operators are able to bid on these large and often complex concessions. This might lead to reduced competition in the PT sector. Next, train and bus operations are different specialisations and are often separated within companies. In a multimodal concession, however, these different departments must work together. For example, traffic control of train and bus should be tuned to ensure interchanges in the system. This requires a different way of working. Finally, the focus on regional PT can be at the expense of integration between trains of different operators.
Below section 2 will discuss the research approach, section 3 will discuss current literature on coordination needs in public transport, section 4 discusses the analysis before and after situation in Limburg, going from uni-modal concessions to multi-modal, section 5 discusses 3 different cases of coordination between train and bus in the Netherlands and finally, section 6 draws up the conclusions.

2. The problem and approach: The effects of multi-modal concessions on travel and governance

PT should be operated as one system with smooth transitions at concession boundaries (Nes en al, 1988). Dutch PT is already relatively integrated (Van Oort et al. 2015), with a single smart card system (but with usability issues using it cross concessions and operators) and integrated travel planning across the system (with open access to various GTFS types allowing for many providers). This means boundaries are still popping up for travellers, such as different and unclear fares and no smooth transfers between different modes of transport. A multimodal concession could reduce the modal segregation by accommodating several modalities in a region at one operator but creates new coordination issues at other system boundaries. The difficulty is to evaluate in which cases the advantages of multimodal concessions outweigh the drawbacks.
This problem leads to the following question:
What are the pros and cons of contracting out regional multimodal public transport concessions for travellers, public transport authorities, and operators as opposed to regional unimodal concessions?

The paper takes two complementary approaches. First, multi-modal concessions could lead to better services for travellers, primarily because of the reduction of travel time by better coordinated transfers. This paper evaluates travel times changes in a single situation by analysing the effect of better integration, based on a real-world context. The Dutch province of Limburg moved in 2016 from a unimodal to multimodal concession. Based on timetable and smart card data, the effect of the overhaul of the network is analysed. The approach uses the timetables pre and post 2016 to evaluate differences in shortest travel time on the possible links in a central part of the province. This was done using Equation 1 to calculate generalised travel time (GTT).

$$GTT = \beta_1 T_{waiting} + \beta_2 T_{bus} + \beta_3 T_{train} + (\beta_4 T_{transfer} + P) \quad (1)$$

$T_{waiting}$	= waiting time for bus or train
T_{bus}	= in-vehicle time in the bus
T_{train}	= in-vehicle time in the train
$T_{transfer}$	= time between alighting and boarding at a transfer station
β_{1-4}	= coefficient of a TT element
P	= transfer penalty (per transfer)

GTT was weighted using smart-card data revealing the number of trips on these links is used to calculate the weighted generalized travel time (WGTT) for both situations, uni-modal and multi-modal. This provided a first glance on the possible benefits of the intermodal concession for travellers, in this particular case.
Second, multi-modal concessions could lead to easier coordination in the interaction between operator(s) and authorities. To evaluate that, the literature is used to take stock of the various coordination needs in concessions, building of the STO model. Using those coordinative needs within and between concessions, three cases were selected to evaluate key differences in coordinative power. The aforementioned multi-modal concession on Limburg is included (multimodal, obviously one operator), in addition of the concessions in Groningen (unimodal bus and train concession, different operators) and Fryslân (unimodal, but the same operator). This set up was chosen to see whether the effect of working with one operator could be distinguished from the effect of working under one contract. These cases all were operational all in 2018.
In these cases, interviews were carried out with both the transport authority as well as the operator. The focus was on the coordination between the different modes and the role of the operators and the authority in that coordination. Interviews put forward all aspects of coordination coming out of the literature study.
Based on these two steps, recommendations are made on the value of multi-modal concessions and on how to implement the in terms of governance.

3. Literature: The integration of modes in regional PT

Public transport is delivered more often in concessions that are regularly put on the market through CT. CT is an incentive for operators to get more customer (not necessairily traveller) focus in PT (Mouwen & Rietveld, 2013). The main expected effect is improving cost efficiency (Hensher & Wallis, 2005). Amongst others, Van Egmond et al. (2003), ECMT (2007), Beck (2011), Mouwen & Rietveld (2013), Veeneman & Van de Velde (2014), Mouwen & Van Ommeren (2016) show from experiences with CT in Western Europe the

expected efficiency improvements, and to some extent a better level of quality and customer satisfaction at lower costs when (some form of) competition is introduced (Van Egmond et al., 2003; Beck, 2011; Mouwen & Rietveld, 2013). Also, the critical role of the PTA is mentioned. However, downsides of CT are found as well. Negative results may occur for smaller operators and employees (Beck, 2011). Besides that, also in non- tendered regions, an increase in passenger satisfaction can be observed, due to the pressure in a competitive market on all operators to increase quality (Mouwen & Rietveld, 2013).
While the introduction of competition, more specifically CT, drove efficiency up, recently more and more awareness can be observed on the topic of integration. That has to do with the occurrence of boundaries in the PT system. In the Netherlands, the introduction of CT was accompanied with a push for modal, regional, and organisational defragmentation by the national government (Veeneman, 2016). Consequently, mostly unimodal concessions were tendered. Another development was, due to the introduction of CT, more focus of the operators on serving the contract. These two developments led to the negative externality of an increase in boundaries. Boundaries are inconvenient for travellers when changing from operator to operator or mode to mode. Examples of these externalities are different fares and no smooth transfers (Veeneman, 2016). The boundaries can be classified into two forms: spatial and modal (see Figure 1). Spatial boundaries can be observed between two regional (bus) concessions and modal boundaries occur in the interaction between train and bus.
“Through intermodal integration, [...] passengers perceive the transit system as one, unified, rather than fragmented system, and the offered services as “seamless” journeys with minimum interruption, independently of the number of modes or operators involved” (Saliara, 2014, p536). Integration is used when the coexistence of more than one mode or operator leads to cooperation issues (Saliara, 2014). The goal is to create a unified system of PT, which is clear to (potential) users. Intermodal integration can be divided into three levels: organisational, operational, and physical integration (Saliara, 2014). All levels consist of different elements and are necessary for the development of a well-integrated PT system where boundaries are not observed by the traveller. The three levels are partly dependent on each other. Organisational integration is the most basic version of integration. A PTA that coordinates PT in a region and arrangements between the PTA and operator(s) are prerequisite for operational and physical integration.

Organisational integration	Operational integration	Physical integration
- Existence of one or more independent public transport authorities - Arrangements between operators	- Network layout - Schedule - Information - Fares and tickets - Vehicle management	- Access to facilities - Location of facilities - Design of stations - Control of vehicle movements

Table 1 Three levels of PT intermodal integration (Saliara, 2014)

3.1 Organisational integration

The first level of intermodal integration is organisational integration. It “describes the special arrangements and contracts between the stakeholders ensuring their interest and commitment to the system’s performance” (Saliara, 2014). The existence of one or more independent PTA(s) to coordinate functions and operators and the arrangements between operators are part of organisational integration. Organisational integration is needed before operational and physical integration can take place at all.

Arrangements through a Public Transport Authority

In order to organise PT in a private environment, an autonomous umbrella PTA is needed. This PTA is responsible for PT in a region and ensures that different functions, responsibilities, and jurisdictions of all involved operators are unified (Saliara, 2014). It sets objectives for the intermodal PT system and balances commercial and passenger interests (Rivasplata, 2008; Saliara, 2014). The PTA coordinates the regional PT operator(s). In some cases, there may be several PTAs coordinating different modes of transport in a region. Arrangements between those authorities are needed then as well.

When referring to PTAs, often the concept of the 'Verkehrsverbund' is mentioned (Saliara, 2014; Pucher & Kurth, 1995). This concept originates in the mid-1960s in the region of Hamburg in Germany (Saliara, 2014). In that time, PT was highly uncoordinated, resulting in annoying, time- consuming, and expensive transfers (Pucher & Kurth, 1995). The role of the Verkehrsverbund is to stimulate both operational and physical integration of the services offered by the operator (Saliara, 2014). It has the mandate to fully coordinate the PT in the region, while preserving the existing operating companies (Pucher & Kurth, 1995). Timetables, fares, and stops are all aligned to smooth transfers from one mode to another. Furthermore, marketing and planning was the full responsibility of the PTA. The operators are responsible for executing the services by providing the vehicles, staff, work schedules, and maintenance (see table 2.4). Examples of more integrated organization, like the Verkehrsverbund in Hamburg, caused an increase in ridership and was consecutively conceived as successful. More extensive, higher quality, and better-integrated services were the main reasons for that (Pucher & Kurth, 1995). Because of the success in Hamburg, the general concept was imitated in other German cities and later also in countries like Switzerland and Austria. Also there, most regions saw an increase in ridership. An example of a current Verkehrsverbund is the Züricher Verkehrsverbund (ZVV) in Switzerland. It started in 1988 when the regional train network was decentralised. Since then, strong service standards were defined. These standards still form the basis of the regional PT planning (Petersen, 2009). In these standards, amongst others the times of operation, minimum headways, and geographic coverage are defined. Strategic planning is the responsibility of the ZVV. Tactical planning is (partly) delegated to the eight largest operators in the region.

In case of unimodal concession, the role we would expect of the authority is dependent on the remuneration in the contract. Obviously, in gross-cost contracts, the incentive for the operator to integrate services for the traveller is less than in case of net-costs contracts or incentive contracts. In gross-cost contracts, the authority is expected to be the key driver of integration. In case of net-cost contracts or other patronage related incentives, the role of the authority could be less strong, when operators cooperate to deliver better integrated services to the traveller. However, there is a risk with incentivised contracts. It could also drive operators to compete in concessions, leading to parallel services, rather than integrated services. In that case, again a strong role is expected of authorities to secure integrated design and operation of services.

Arrangements between operators

Although PTAs have the right to set service standards and minimum requirements, sometimes it can be desirable to let operators make mutual agreements. These agreements can enlighten the task of the PTA. Another argument is that the formulation and execution of regional transport planning are not done continuously in a privatised environment, which

allows operators to operate without (e.g. fare or timetable) coordination (Rivasplata, 2008). Therefore, PTAs can oblige operators to regulate specific topics themselves. Operators themselves can also make arrangements together on a voluntary basis. Sørensen & Longva (2010) call this partnership coordination. A characteristic is that the regulation is not enforceable directly. In the UK, for example, partnership coordination is used between bus operators to improve service quality on certain corridors (Sørensen & Longva, 2010). Arrangements between operators are always needed, not only in unimodal concessions. An example is the coordination between a bus operator and the national train operator.

Conclusion

In conclusion we see four possible organisational forms of coordination. Figure 1 shows the four forms and the role of the operators and authority.

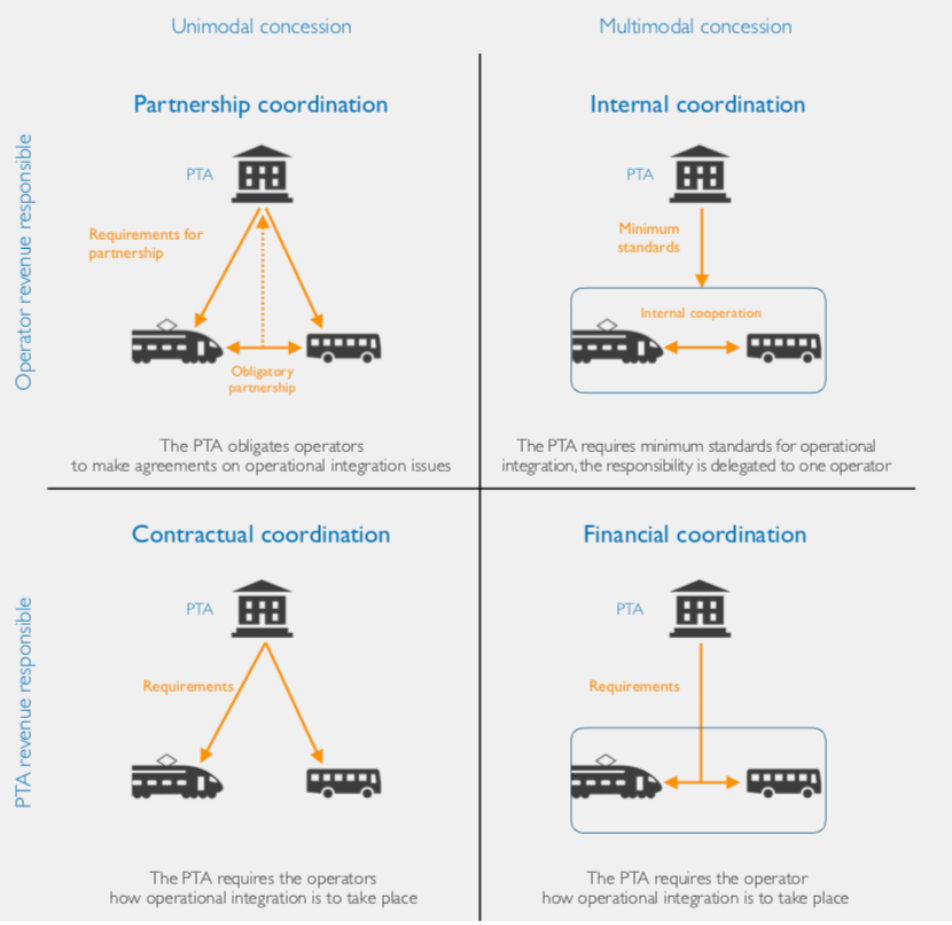

Figure 1 Four forms of organizational coordination

First, in *partnership coordination* the operators have uni-modal concessions with net cost contracts. Given the above, the authority would probably have to obligate the operators to coordinate the operational integration. In contractual coordination, the role of the authority is stronger and rather than provide an obligation to cooperate, the authority will have to set integration standards. In multi-modal concession, *internal coordination* is expected when the contract is incentivised for patronage. Here the authority might set minimum standards, but integration by the operator, both cost and revenue oriented integrations are expected. When this incentive lacks, again the role of the authority needs to be stronger. Cost oriented intergations are still expected, leading to a more efficient use of the different modes in the

network. However, revenue orientation is lacking and as such a focus on patronage and a good travel experience. This is where the authority again should step in with requirements.

3.2 Operational integration

Organisational integration can be used to achieve operational integration. Operational integration refers to the planning of the PT system with minimum interruption (Saliara, 2014). It relates directly to the supply of PT services for passengers. When operational integration is achieved, passengers experience a smooth PT system. Network layout, schedules, transfers, information, fares & tickets, and vehicle management (guaranteed transfers) could be synchronised over the whole network. The selected aspects built on the STO model (Van de Velde, 1999).

Network layout

Network integration is aimed to reduce wasteful duplication of services and improves the utilisation of transport resources (Ibrahim, 2003). From a travellers' perspective, travellers can reach more destinations when PT routes are connected (Chowdhury & Ceder, 2013). This increases the attractiveness of each service itself (NEA et al., 2003).
Switzerland is an international example of an integrated PT system, historically due to the integration of train and bus services (Buehler et al., 2013). The integration is mainly established by the different PTAs (Verkehrsverbünder). Petersen (2016) explores the case of the Weinland PT network in the north of Switzerland, which can be classified as a 'feeder network'. In 1988, when the Verkehrverbund was established, most of the current existing lines have been designed (Petersen, 2016). The basis of the network is the railway network. The bus network design is based on that. Bus lines aim to feed the train network. Bus lines parallel to the railway lines are prevented. Extra stations on the railway line can be opened to serve the towns located there.
Several advantages and disadvantages of feeder networks can be mentioned (Bracun, 2012). Most passengers will notice a TT reduction. For the operator, a feeder network is an efficient network to operate, because of economies of scale. In a feeder network, the smaller (bus) lines are shortened, while the railway line can take on more passengers. This increases the cost-coverage of such a network. The feeder network does however increase transfers for some passengers. Also, the investment and revenue risks for the operator become larger.

Schedule

Especially in regional PT, providing high-frequency services that can compete with private car (Nielsen, 2005) is a challenge. Through "coordination and synchronization of arrival and departure times of the involved lines and modes in order to reduce waiting, dwell, transfer and total traveling times" (Saliara, 2014, p538), quality of service for travellers can be improved (Nielsen & Lange, 2008).
An often-used principle in synchronised timetables is a pulse timetable. It can be described as a network operation in which arrivals and departures are synchronised at important stops or stations (Nielsen, 2005). This pattern can repeat itself at various intervals. It allows easy transfer from train to bus or vice versa, and from bus to bus. A pulse timetable is even more efficient when 'crossing points' serve as pulse point. These are stations where opposite trains meet each other (Petersen, 2009). In 1982, the Swiss Federal Railways (SBB) introduced pulse points in the railway system (Petersen, 2009).

Improving transfers is the central goal of a pulse timetable. Interchanges are an essential quality aspect for passengers since it has a significant impact on the reliability of the PT system (Lee et al., 2017). However, operators not always have an incentive to provide good interchanges. It can even make sense for them to offer bad interchanges (Potter, 2010), for example in cases where a bus operator wants to attract train passengers in the same region. Though, when the design boundary, the focus of optimization, is changed on a whole journey of the passenger, interchanges become important for operators as well and might help to generate passenger growth (Potter, 2010). For operators, a pulse timetable is less efficient to operate, since the dwell time of (some) vehicles can be high on transfer stations (Nielsen, 2005).
Transfer times, however, are not just determined by the schedules. Planning interchanges is a complex interaction between network, schedule, and physical integration (Saliara, 2014). Lee et al. (2014) mention five main variables for the reliability of transfers: distribution of arrival and departure times, walking time between the stops, planned transfer time, the frequency of lines, and the number of transferring passengers. Transfer integration is needed to reach a high level of reliability in a (multimodal) network.

Information
Next, all necessary travel information of the whole PT system, in particular interchanges, must be easily accessible. When all information cannot be reached quickly, for instance when the information is not provided at all, people will not even plan their journey (Terzis & Last, 2000). How information is provided to travellers will influence the way the system is used (Nielsen, 2005). For example, how a transfer point is depicted on a PT map can encourage or discourage travellers to transfer at the particular stop. When information integration is achieved, “the system is perceived as ‘one’, with a unified set of concepts and common language in the communication towards the users” (NEA et al., 2003, p15). A single brand for the PT system can be part of this.

Fares & tickets
An important aspect of operational integration for travellers is fare and ticket integration (NEA et al., 2003). Ticket integration is about the payment method for a trip. Fare or tariff integration refers to the price paid for a multimodal journey at one operator versus a multimodal trip with more than one operator (NEA et al., 2003). Often, fare and ticket integration go hand in hand, bit smart card systems allow for integrated tickets without integrated fares.
An Integrated Tariff System (ITS) eliminates the need to purchase a ticket for each trip, which makes it easier for passengers to transfer from one line or mode to another (Saliara, 2014). An ITS must satisfy two requirements to become integrated: no additional costs for transfers and all modes and services use the same ticketing system (Sharaby & Shiftan, 2012). Besides that, the availability of tickets is also a point of interest (NEA et al., 2003). Tickets can be valid for a short period or a whole season (Abrate et al., 2008), but can also be referred to special groups or trip purposes (Saliara, 2014). Introduction of an ITS has three desired contributions: shifting trips from private car or taxi to PT, creating new trips, and offering more options for travellers to travel faster (Sharaby & Shiftan, 2012).
For travellers, ITS only seems to have positive characteristics solely. Therefore, passenger growth can be expected when introducing an ITS. According to Abrate et al. (2009), an ITS has an expected positive impact on passenger demand of 2% in the short-run and 12% in

the long-run in the cases researched. The advantage for PTAs is that it avoids competition between operators on this subject (Saliara, 2014). Consequently, PTAs are often needed to regulate the fare system and to decide how to distribute the collected revenue.

Vehicle management

Vehicle management is about efficient real-time control of vehicles. Integrated traffic control ensures that passengers can travel seamlessly between all parts in a region (Nielsen, 2005). In a multi-modal concession it should control both bus and regional train. This is especially important in the case of disturbances and disruptions. At this stage, integration can be reached by providing guaranteed interchanges, adequate information, and/or remedial services (NEA et al., 2003). The situation becomes more complicated in the interaction between regional and ongoing IC trains of several operators. Proper arrangements between the operators are essential in this regard.

3.3 Physical integration

Thirdly, physical integration plays a role in establishing an integrated PT system (Saliara, 2014). This mainly has to do with the planning and design of stops, stations, and transfer centres (Miller, 2003). Physical integration aims to take away barriers. Mostly, physical integration are usually the responsibility of the PTA or municipality. This means even in multi-modal concessions, the role of the authority is probably substantial.

Access to facilities

PT facilities, such as transfer points, must be easily accessible to be able to compete with private car. Walking distances to stops must be short and attractive (Nielsen, 2005). The first aspect can partly be determined by the location (see below), but the second aspect can be achieved by safe and comfortable pedestrian routes (Nielsen, 2005). When a route is more attractive, passengers are willing to walk longer. Bike accessibility can increase the catchment area of PT. The same holds for park and ride facilities.

Location of facilities

The second aspect of physical integration, the location of facilities, refers to the establishment of transfer points. These must be located carefully (Miller, 2003). The largest transfer points should be on important locations where both land use (for example a city centre) and the PT network meet each other (Nielsen, 2005). Often, these are places with a lot of work concentrations, commercial activities, and local centres of activity (Nielsen, 2005).

Design of stations

Stations should be nodes in the PT system where transferring can be done easily. Barriers to transfer must be taken away as much as possible (Tarzis & Last, 2000). The physical design of stations can help to create a structured and pleasant place to stay station that overcomes the barrier to transfer. For example, in Singapore stations are continuously improved by refurbishing bus shelters, adding linkway from station entrances to bus shelters, and overhead bridges are added (Ibrahim, 2003). According to Nielsen (2005), the five most important issues of physical station design are creating short walking distances, the need for elevators and escalators, creating visibility between the main destinations to improve orientation and safety, accessibility needs for the disabled, and weather protection, light, and cleanness.

Control of vehicle movements
Controlling vehicle movements is the fourth aspect of physical integration. It is about the "coordination of vehicle movements for transfers to be safe without any conflicts between pedestrians and vehicle movement" (Saliara, 2014). This allows passengers to transfer safely from vehicle to vehicle and improves smooth operations at transfer stations.

3.4 Conclusion

What is the difference between a unimodal and a multimodal public transport concession?
A PT concession is a permit for an operator to run PT for a couple of years in a particular region. During that time, competitors are excluded. An operator is contracted (obtains the concession) when it has won the tendering process organised by the particular PTA. When only one mode is tendered, the concession can be classified as unimodal. A multimodal concession is a concession where two or more modes are contracted simultaneously. Regional train and bus are contracted together in a multimodal concession is a form of organisational integration, meant to simplify operational integration. Operational integration is about the alignment of regional train and bus network layout, schedule, information, fares & tickets, and vehicle management. However, operational integration is not limited to a multimodal concession.

Topic	Evaluation
Network layout (feeder network)	+ Average TT gain for passengers (Bracun, 2012) + High loading factor and cost recovery (Petersen, 2009; Buehler et al., 2013) + Financial compensation train-bus (Bracun, 2012) - On average more interchanges for passengers (Bracun, 2012) - Larger (revenue) risks (Bracun, 2012)
Schedule (pulse timetable)	+ Minimises waiting time for passengers (Nielsen, 2005; Bracun, 2012) + Fixed frequency all week long (Bracun, 2012) + More travel option for passengers (Bracun, 2012) - Complex interaction between network, schedule, and physical design (Saliara, 2014) - Passengers not able to avoid transfers (Saliara, 2014) - Stable and reliable running times needed (Nielsen, 2005; Lee et al., 2017) - Possible inefficient bus circuits (Nielsen, 2005)
Information	+ The system is perceived as one (NEA et al., 2003; Bracun, 2012) + Influences the attractiveness and the use of the network (Nielsen, 2005)
Fares & tickets (ITS)	+ Easier and cheaper transferring (Saliara, 2014) + More travel options to passengers (Sharaby & Shiftan, 2012) + No fare competition between operators (Saliara, 2014)
Vehicle management	+ Seamless trips between all parts in a region (Nielsen, 2005)

Table 2 Evaluation of different integration aspects

In literature, limited attention is paid on the different aspects of operational integration. The studies found are primarily based on case studies and focus on passenger growth or revenues. It is, therefore, difficult to determine the factors that influence the performance.

Furthermore, most sources only focus on one of the aspects of operational integration, mainly network and schedule. Generally speaking, the studies show positive results of an integrated system. Weaknesses are hardly mentioned. Table 2 provides an overview of the strengths and weaknesses of operational integration in a multimodal concession, from the factors obtained in literature. It functions as a starting point for the rest of the research.

4. Analysis 1: The quantitative evaluation of the effect on travel-time

To understand the differences between multiple uni-modal concession and a single multimodal concession, we analyse the effect of a new time-table as introduced at the Limburg concession, when the concession changed from uni-modal to multimodal. The uni-modal concession drove the new operator to integrate the design of the two modalities. They choose a pulse timetable and setting it up as a feeder network, with the railway line as a backbone. In addition, some buslines were sped up, with less stops. In addition, some buslines got higher frequencies. Lines were simplified focusing on the rail backbone, allowing for higher frequencies.

The analysis of the weighted generalised travel times (WGTT) showed how the pulse schedule and the tight connection in the multi-modal concession delivered on faster travel times, as Figure 2 shows. On specific links, the generalised TT of the new situation was performing worse, as making rail the backbone demanded the cancelation of the direct link between Roosteren and Echt. For travellers there, travel times increased slightly.

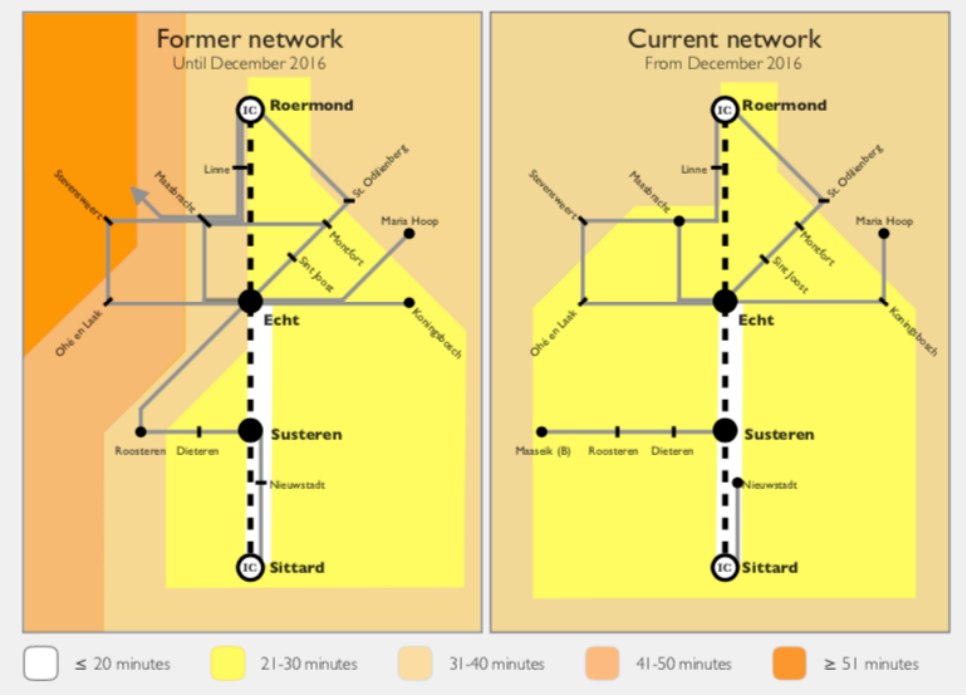

Figure 2 Schematic isochronic maps of non-generalised travel-times from Sittard station

A few advantages of the feeder network and pulse timetable can be mentioned. A remarkable improvement is the enhanced bus-bus and train-bus connections, mainly caused by the pulse timetable. Of the top ten links on which travel TT was reduced, gains ranged from more than 60 percent to 15 percent. Of those ten, 4 were the result of new direct lines, the other six of reduces transfer times, for which the improved coordination between train and bus was helpful. 80 percent of the travellers that could notice improvement only travelled

by bus, meaning the effect of a multi-modal concession was not relevant. Another 18 percent travelled multi-modal before and after. The last 2 percent were changed to multimodal trips. An analysis was made to evaluate the effect on costs for the passengers, showing short multimodal trips substantially cheaper and longer trips marginally more expensive.
The analysis of the case showed that passengers generally were better off in the multi-modal concession, however, with clear exceptions. TT was reduced mostly, however not for all links. Cost were almost identical, except for very short trips. Apparently, there was an advantage because of the integrated design and operation of the services by the new holder of the concession. They really could make an integral design, that made most of bus-train integration. This delivered better services, indeed, although with a few exceptions. In the next section we will look at the governance approaches that can make this work, and whether more integrative approaches can also be realized by strong authority coordination. However, we have to be precise: the new services were better for passengers but could also be realised by strong governmental coordination. To better understand the role of governance the next section looks at three different cases and the coordination by governments and operators.

5. Analysis 2: The qualitative evaluation of the effect on governance

The first case is the PT concession in the province of Limburg, a multimodal concession awarded to Arriva. It started in December 2016 and lasts for 15 years. The concession can be classified as large, with more than 200 buses and about 45 trains. Before December 2016, the PT network was split up into two concessions and included two regional railway lines. Already then, some changes towards an integrated PT system were made. According to former Veolia regional director Southern Limburg (Frank van Setten, personal communication, 16 October 2018), this was mainly the case around the decentralised railway lines. Concerning the rest of the network, the contract obliged the operator a minimum provision level by bus for each town, based on the number of inhabitants. Predefined frequencies and network layout were part of that. That was also the case around the non-decentralised railway lines. These two railway lines were decentralised in December 2016. From then on, one operator is responsible for virtually all PT in the province, except for some on- going IC trains.

Case	Case 1 Limburg	Case 2 Fryslân	Case 3 Groningen
PTA	Limburg Province	Fryslân Province	Groningen Province (train) OV-Bureau Groningen-Drenthe (bus)
Contract	Multimodal net-cost	Unimodal net-cost	Unimodal net-cost (train) Unimodal gross-cost (bus)
Coordination	Internal	Partnership	Partnership (train) Contractual (bus)
Network layout	Voluntary fixed internal cooperation	Voluntary ad-hoc internal cooperation*	Hardly cooperation
Schedule	Voluntary fixed internal cooperation	Voluntary fixed internal cooperation	Voluntary fixed external cooperation
Information	Voluntary fixed internal cooperation	Voluntary fixed internal cooperation*	Hardly cooperation
Fares & tickets	Required fixed internal cooperation	Hardly cooperation	Hardly cooperation
Vehicle management	Hardly cooperation	Hardly cooperation	Hardly cooperation

The province of Fryslân is the second case. The concession is unimodal, under a net-cost contract. The province was aiming to tender a multimodal concession starting in 2020, but due to economies of scale, the regional train concession was again tendered together with the province of Groningen and Niedersachsen (in Germany) (Provincie Fryslân et al., 2006). This regional train concession is currently awarded to Arriva and recently won again for the period 2020-2035. There are also two bus concessions, which are operated by Arriva as well. The railway lines are mainly located in the north of the province. Therefore, the focus is on this area with the corresponding bus concession 'Noord- en Zuidwest-Fryslân'.
The provinces of Groningen and Drenthe house of the largest PT concessions in the Netherlands regarding area size, representing the third case. This bus concession in tendered out by the cooperating provinces of Groningen and Drenthe. The concession was awarded from 2010 to 2016 and extended two times for two years to Qbuzz. Recently, the new concession starting in 2020 has again been awarded to Qbuzz. The rail concession in this area, granted to Arriva, is under the shared responsibility of the provinces of Fryslân and Groningen.
Since the coordination of regional train and bus services in Groningen is under the responsibility of different PTAs, a somewhat complicated situation arises. Two different coordination systems exist next to each other. The coordination mechanism of the train is closest to a theoretical net-cost contract with partnership coordination. In cooperation with Niedersachsen (D), the provinces of Groningen and Drenthe grant a concession for the shared regional train network. The operator itself is responsible for the tactical planning.
In order to achieve operational integration, cooperation between PTA, train, and bus operator is essential. Therefore, the involved stakeholders must be pushed to think in multimodal solutions. Especially in the case of Groningen, that is an issue. The division of the PTA for train and bus, there, causes a difference in interest between them on some levels. An organisation with one PTA having a strong development focus (often translated in a gross-cost contract) or a multimodal concession as in Limburg is more suitable to work on integration. Namely, one stakeholder has control over the whole PT chain, which gives more solution space. A typical example from the case of Limburg is the use of buses to serve the station Heerlen de Kissel, because an international extension of the railway line led to a time shortage in the train schedule. In such an organisation, there is a clear point of contact for all PT related issues and an incentive for one of the stakeholders to work on integration. An additional supporting condition in a multimodal concession is a culture in which train and bus staff meet each other, and some personnel is employable for both modalities. This may help to experience the PT system as a whole. Another valuable lesson concerns the passenger smart card data. Usually, all stakeholders only have overview of a part of the whole PT system. Sharing passenger data may help operators and/or PTAs to get a better overview of what is happening and how the current situation can be improved concerning integration.
The case studies indicate that there are two ways to ensure train-bus integration. The first way is creating a multimodal concession. Delegating all the tactical and operational planning tasks to one operator, with some minimum requirements, creates a financial incentive for the operator to integrate on all levels. The operator has more solution space, which creates opportunities for an integrated PT system. Network layout and timetable can be designed together for train and bus, and an integrated fare system will enhance this network. For passengers, there is a clear coherent PT identity and point of contact.
A second organisational structure that may support operational integration is a unimodal gross-cost contract. This is the 'Verkehrsverbund' model. In this type of contract, it is

primarily the function of the PTA to clearly demand how integration is to take place. The PTA must take a role as tactical planner and design the full network, determine the fares and tickets, and provide information to passengers. This type of contract is not fully encountered in the case studies but seems to be promising. Instead of the operator in a multimodal concession, the PTA now has the incentive to control the whole system. Most benefits in a multimodal concession can also be obtained in this configuration. However, it requires a totally different and sometimes discussed position of the PTA.
Both structures, however, will not necessarily lead to a better-integrated system. A lot of other factors play a role in that. Amongst others, unsuitable geographical structures, passenger flows to one major city, and overcrowded trains can inhibit network integration. Differences in vision on marketing can obstruct information integration. Integrated fares can be introduced when business cases are not influenced negatively, also a feeder network is introduced, and there is not too much uncertainty about the end of the concession. Generally speaking, the (financial) interests of PTA(s) and operator(s) must be aligned with each other as much as possible. That will lead to the best results on integration. The in-between situation, in which the operator is revenue responsible will, due to that, most often lead to a network that is not fully tuned between modes. Also, within a company, the division of a bus and train department can be strong.

6. Conclusions

A PT concession is the right to operate PT in a demarcated area and is usually obtained by an operator after winning a procurement procedure. Often, different concessions for separate modalities exist next to each other in the same district, but also an integrated or multimodal concession is possible. In a multimodal concession, both train and bus (and possibly other modalities) are tendered once. In theory, multimodal concessions would lead to better (operational) integration, because competition between train and bus operators has disappeared and internal coordination can be used. For passengers, an integrated PT system would mean a good aligned (feeder) network of train and bus, resulting in improved connections at pulse stations and lower TTs. Besides that, information would be tuned to each other, fares and tickets would be fully integrated, and vehicle management would be organised thoroughly. In that line of reasoning, it is assumed that operators benefit from a multimodal concession by having opportunities to operate more efficiently. PTAs would benefit from the incentives for the operator in the contract to perform well, which simplifies the coordination task.
The multi-modal concession can provide advantages. For travellers, they can simplify the delivery of shorter travel times, integrated network design, information, ticketing and fares. In addition, one operator can control the overall travel chain. And the operator can cross-subsidies bus and train, allowing for more optimised combinations of the two. There weaknesses as well, with potentially more transfers, dependency on the demand and supply context and investment risks.
Multi-modal concessions provide ease of implementation of pulsed schedules and feeder networks. This gives reduction in travel time and the potential to raise efficiencies by lowering overall costs and reducing ineffective competition between bus and train with uni-modal concessions. Key threats are the current organizational structures not allowing for multi-modal concessions, with different governmental layers responsible for different modes or concession periods not in sync. It also might be the case that infrastructural changes are needed, that hamper swift and simple implementation.

Acknowledgements:
The authors want to thank all interviewees, authorities, operators and experts, in providing their candid look at coordination practices in concession management in various types of concessions. A special thanks to Arriva, making the study possible.

Declarations of interest:
The research was carried out commissioned by Arriva. The researchers got total freedom in terms of defining and carrying out the research and developing the conclusions.

References

Abrate, G., Piacenza, M., & Vannoni, D. (2009). The impact of Integrated Tariff Systems on public transport demand: Evidence from Italy. *Regional Science and Urban Economics*, *39*(2), 120–127. https:// doi.org/10.1016/j.regsciurbeco.2008.05.014

Beck, A. (2011). Experiences with Competitive Tendering of Bus Services in Germany. *Transport Reviews*, *31*(3), 313–339. https://doi.org/10.1080/01441647.2010.511299

Bracun, M. (2012). Implementatie van het visgraatmodel in het Nederlandse openbaar vervoersysteem - een wetenschappelijke benadering. Breda, The Netherlands: NHTV

Buehler, R., Lukacs, K., & Zimmerman, M. (2013). Regional Coordination in Public Transportation: Lessons from Germany, Austria, and Switzerland. Retrieved from http://www.mautc.psu.edu/docs/VT-2013-04.pdf

Chowdhury, S., & Ceder, A. (2013). Definition of Planned and Unplanned Transfer of Public Transport Service and User Decisions to Use Routes with Transfers. *Journal of Public Transportation*, *16*(2), 1–20. https://doi.org/10.5038/2375-0901.16.2.1

CROW. (2013). Regionaal openbaar vervoer per 1 januari 2014. Retrieved from https://www.crow.nl/publicaties/poster-regionaal-openbaar-vervoer-per-1-januari-20

Egmond, P. van, Nijkamp, P., & Vindigni, G. (2003). A comparative analysis of the performance of urban public transport systems in Europe. *International Social Science Journal*, *55*(176), 235–247.

Hensher, D. A., & Stanley, J. (2008). Transacting under a performance-based contract: The role of negotiation and competitive tendering. *Transportation Research Part A: Policy and Practice*, *42*(9), 1143– 1151. https://doi.org/10.1016/j.tra.2008.05.004

Hensher, D. A., & Wallis, I. P. (2005). Competitive Tendering as a Contracting Mechanism for Subsidising Transport: The Bus Experience. *Journal of Transport Economics and Policy*, *39*, 27.

Ibrahim, M. F. (2003). Improvements and integration of a public transport system: the case of Singapore. *Cities*, *20*(3), 205–216. https://doi.org/10.1016/S0264-2751(03)00014-3

Lee, A., van Oort, N., & van Nes, R. (2014). Service Reliability in a Network Context: Impacts of Synchronizing Schedules in Long Headway Services. *Transportation Research Record: Journal of the Transportation Research Board*, *2417*(1), 18–26. https://doi.org/10.3141/2417-03

Miller, M. A. (2003). *Assessment of Service Integration Practices for Public Transportation: Review of the Literature*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.614.9449&rep=rep1&type=pdf

Mouwen, A., & Rietveld, P. (2013). Does competitive tendering improve customer satisfaction with public transport? A case study for the Netherlands. *Transportation*

Research Part A: Policy and Practice, *51*, 29–45. https://doi.org/10.1016/j.tra.2013.03.002

Mouwen, A., & van Ommeren, J. (2016). The effect of contract renewal and competitive tendering on public transport costs, subsidies and ridership. *Transportation Research Part A: Policy and Practice*, *87*, 78–89. https://doi.org/10.1016/j.tra.2016.03.003

NEA, OGM, TSU University of Oxford, TIS.pt, ISIS, & Erasmus University Rotterdam. (2003). Final report - Integration and regulatory structures in public transport. European Commission DG TREN. Retrieved from http://lnweb90.worldbank.org/eca/transport.nsf/3b8b3d27260832ec852569fa0059675f/1437053a57bf111e85256e2b0059356f/$FILE/INTEGRATION%20STUDY%20REPORT.pdf

Nes, R. van, Hamerslag, R., & Immers, L. H. (1988). *The design of public transport networks* (Vol. 1202). National Research Council, Transportation Research Board.

Nielsen, G. (2005). Public transport: planning the networks. Stavanger, Norway: HiTrans.

Nielsen, G., & Lange, T. (2008). *Network design for public transport success–theory and examples*. Oslo, Norway: Norwegian Ministry of Transport and Communications.

Oort, N. van, Brands, T., & de Romph, E. (2015). Short-term prediction of ridership on public transport with smart card data. *Transportation research record*, *2535*(1), 105-111.

Petersen, T. (2009). Network planning, Swiss style: Making public transport work in semi-rural areas. Melbourne, Australia: Australian Transport Research Forum. Retrieved from https://atrf.info/papers/2009/2009_petersen.pdf

Petersen, T. (2016). Watching the Swiss: A network approach to rural and exurban public transport. *Transport Policy*, *52*, 175–185. https://doi.org/10.1016/j.tranpol.2016.07.012

Potter, S. (2010). Transport integration - an impossible dream? Presented at the Universities Transport Studies Group Annual Concerence, University of Plymouth. Retrieved from http:// oro.open.ac.uk/19719/

Pucher, J., & Kurth, S. (1995). Verkehrsverbund: the success of regional public transport in Germany, Austria and Switzerland. *Transport Policy*, *2*(4), 279–291.

Rivasplata, C. (2008). Public Transport Integration In A Privatised Market: Recent Policy Lessons From Abroad. Retrieved from http://www.codatu.org/wp-content/uploads/Public-transport- integration-in-a-privated-market-recent-policy-lessons-from-abroad-Charles-RIVASPLATA.pdf

Saliara, K. (2014). Public Transport Integration: The Case Study of Thessaloniki, Greece. *Transportation Research Procedia*, *4*, 535–552. https://doi.org/10.1016/j.trpro.2014.11.041

Sharaby, N., & Shiftan, Y. (2012). The impact of fare integration on travel behavior and transit ridership. *Transport Policy*, *21*, 63–70. https://doi.org/10.1016/j.tranpol.2012.01.015

Sørensen, C. H., & Longva, F. (2011). Increased coordination in public transport—which mechanisms are available? *Transport Policy*, *18*(1), 117–125. https://doi.org/10.1016/j.tranpol. 2010.07.001

Terzis, G., & Last, A. (2000). GUIDE - Final Report. Retrieved from http://www.transport-research.info/sites/default/files/project/documents/guide.pdf

Veeneman, W. (2016). Public transport governance in the Netherlands: More recent developments. *Research in Transportation Economics*, *59*, 116–122. https://doi.org/10.1016/j.retrec.2016.07.011

Veeneman, W., & van de Velde, D. (2014). Developments in public transport governance in the Netherlands: A brief history and recent developments. *Research in Transportation Economics*, *48*, 41–47. https://doi.org/10.1016/j.retrec.2014.09.030

Wet Personenvervoer 2000 (2018). Retrieved from http://wetten.overheid.nl/BWBR0011470/2018-02-17