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An exploratory review of long-distance BRT combined with special use lanes and mobility hubs

English Summary

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Summary

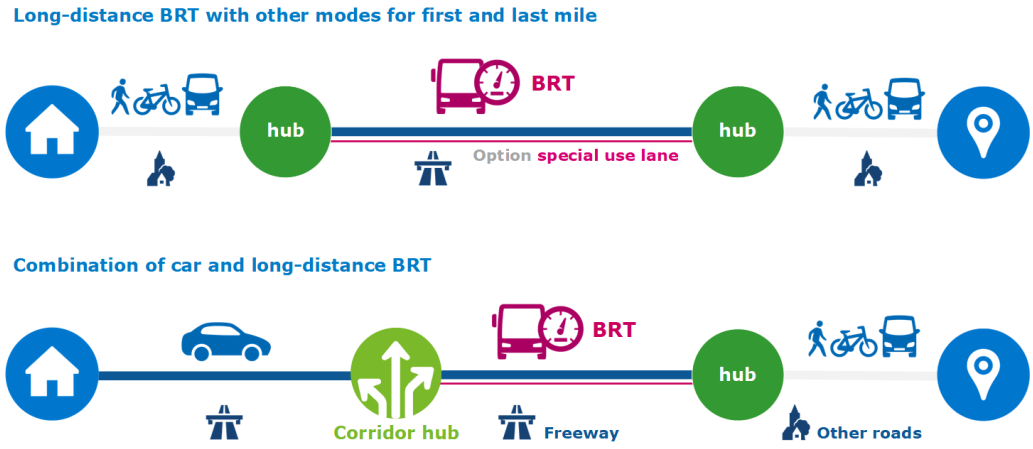
Long-distance Bus Rapid Transit (BRT) provides fast and reliable bus services between cities that often make use of freeways, as opposed to traditional BRT systems which operate within a city on exclusive bus lanes. These long-distance services can potentially provide an attractive alternative to the passenger car, and can thus help to relieve congestion on freeways and increase liveability within cities in the long-term. However, long-distance BRT is not a quick fix for congestion, since there are other important factors that contribute to a modal shift from car to bus. For example, complementary parking measures in city centres may be needed to decrease the attractiveness of the car and increase the relative attractiveness of the bus.

Special use lanes can help the bus to avoid congestion on the freeways, therefore increasing the operational speed and reliability of the service. But these are not always the only, or even the most cost-efficient solution to bypass congestion. Mobility hubs, and more specifically corridor hubs, provide a location where car drivers can transfer to the bus before reaching the most congested part of the freeway, being the ring roads. The parking policy within these corridor hubs must be tailored to the desired users, often commuters, to realize the intended effects.

Objective, scope and approach

The objective of this study was to explore the opportunities and possible effects of long-distance BRT services when combined with special use lanes on the freeways and a specific form of the mobility hub, namely the corridor hub, located along freeways. Two possible effects received specific attention; firstly the possible modal shift for (part of) the journey from car to bus, potentially leading to a reduction in congestion as a result of modal shift, and secondly improvements to the accessibility for existing public transport users due to a change in bus services.

Figure 1 **Typical use cases of long-distance BRT**



The focus of this study was on long-distance BRT services (between cities), as opposed to traditional BRT (within a city). Furthermore, even though this study identified possible effects of BRT combined with special use lanes and corridor hubs, the (cost) efficiency and feasibility of these policy measures were not part of the scope. The study was conducted through literature research and experts interviews.

These experts included researchers, representatives of public transport authorities, transit operating companies and road management authorities.

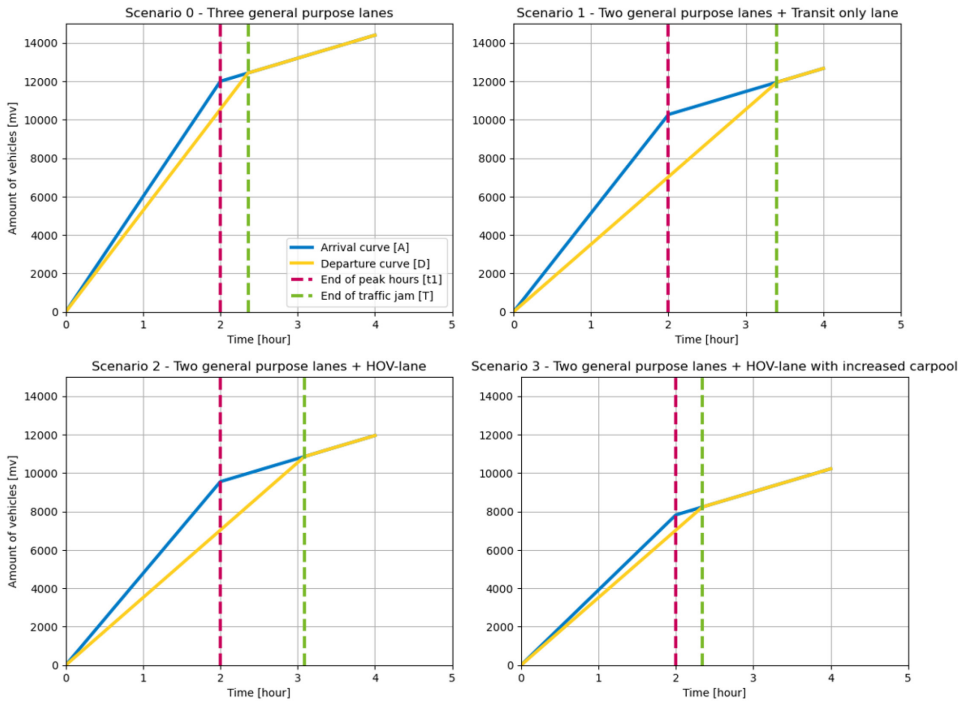
Potential for modal shift, with important sidenotes

Several societal benefits can be achieved when long-distance BRT is combined with special use lanes and corridor hubs, along with complementary parking policy at urban destinations (especially a reduction of parking availability at urban workplaces). Some evidence exists with regards to effects on congestion and liveability within cities, while effects on the accessibility of existing public transport users are unknown due to a lack of research. However, there are some important sidenotes. First of all, previous research by KiM (e.g. Witte & Visser, 2021) shows that modal shift from car to public transport is not easily achieved, and that even a small decrease in car usages results in much larger increase in demand for public transport. Furthermore, a high degree of modal shift is necessary when transforming a general purpose lane to a special use lane if the intention is to directly reduce congestion on freeways. In the short-term, this high degree of modal shift seems unfeasible, but in the long-term, and with complementary parking policy, the potential may be higher. This implies that long-distance BRT in itself is not necessarily unfeasible, but it does imply that the combination with special use lanes has its drawbacks.

Special use lanes offer speed and reliability, but at a price

Study of international cases demonstrates that special use lanes on freeways can improve the operational speed and reliability of long-distance BRT, which are two prerequisites for offering high-quality bus services. But special use lanes are not the only, let alone most cost-efficient, manner to improve speed and reliability. For instance, reliability can be enhanced, to a certain extent, using non-infrastructural measures. Examples are bus priority at intersections or adjusting the time schedule based on regular intervals instead of punctuality. Moreover, separate bus lanes may be a more efficient alternative to special use lanes, especially on freeways where there is a lot of interaction with traffic on on-ramps and off-ramps. Special use lanes which are solely used by BRT are not the most practical solution since it results in a less than optimal usage of the lane (or "empty-lane syndrome"). That is why, in many international cases, high-occupancy vehicles (i.e. carpoolers) or paying drivers (i.e. *high-occupancy toll lanes* or *express toll lanes*) are also admitted to the lane. Based on a simple mathematical model, Figure 2 demonstrates what the possible effect is on congestion of different kinds of special use lanes.

Figure 2 **Effects of transforming a general purpose to a special use lane on congestion**



Using a queuing-model, the effects of different types of special purpose lanes on congestion can be estimated. In the base scenario (0) all three lanes of a freeway are general purpose. If the intensity of vehicles on the freeway is higher than the capacity of the road, which can be the case during peak hour, a queue (i.e. congestion) arises. This queue is the difference between the amount of vehicles that have arrived (A) and departed (D), and can be used to determine the loss hours of vehicles (surface between A and D curves).

If one of three general purpose lanes is converted to a transit only lane with a high-frequency bus service (scenario 1), it is likely that the intensity on the freeway during peak hours will decrease, since a modal shift will occur from cars to the bus that can bypass congestion. However, the capacity will also decrease because one lane is withdrawn for the remaining cars. This results in a net increase in vehicle loss hours.

Only when a special purpose lane is also opened for carpoolers, and the relative amount of carpoolers increases due to the possibility of bypassing congestion (scenario 3), the trade-off between the decrease in intensity and capacity may result in a decrease in vehicle loss hours. And even then, the reductions in vehicle loss hours may be overestimated. For instance due to a latent traffic demand or suboptimal modal shift from car to bus.

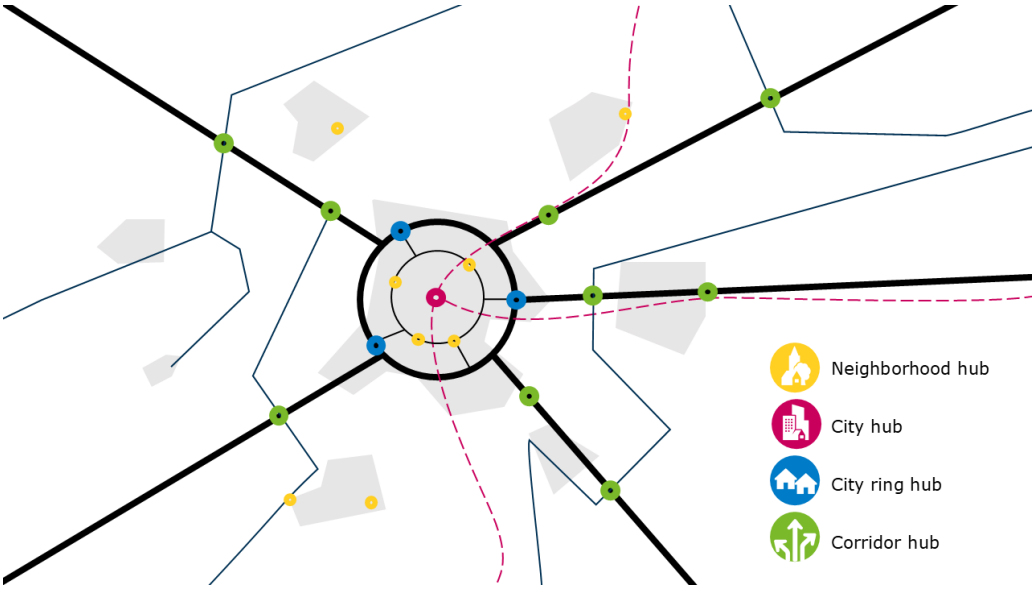
Important role for mobility hubs

Mobility hubs play an important role in creating the prerequisites for high quality long-distance BRT. Examples of these prerequisites are increasing comfort and perceived safety when waiting at the bus stop, but also facilitating a smooth transfer to first and last mile transport, or improving the clarity and recognizability of the BRT-system. Mobility hubs are also able to increase the potential of BRT by contributing to congestion reduction, and improvements in liveability in cities and accessibility. Corridor hubs can be particularly effective with regard to congestion reduction and liveability improvements. That is because they are situated at

strategic locations along freeways (see Figure 3), before urban ring roads. This allows them to offer a transfer possibility before car drivers reach the most congested part of the freeway, as opposed to the more traditional city ring hubs that are located on the ring road itself.

Without corridor hubs, long-distance BRT will not be effective in creating a significant modal shift from car to bus. What's more, in many cases BRT is the only feasible mode of transport for connecting corridor hubs with their intended destinations. Whether corridor hubs are actually used for their intended purpose, depends heavily on the parking policy at the hub and at the final destination of travelers. Without such complementary parking policies, corridor hubs may attract "unwanted" user groups (e.g. car drivers with a destination nearby the hub), or it may stimulate current bus passengers to complete a part of their journey by car. Trips using BRT are also likely to involve the use of other types of mobility hubs, such as neighborhood hubs (small hubs for passengers to board and get off the bus) and city hubs (largescale public transport stations in central locations).

Figure 3 **Corridor hubs, along with other hub types**



Update of previous findings

The current study was also used to update findings of a previous KiM study on BRT (Witte & Kansen, 2020). Firstly, the potential corridor capacity (i.e. the theoretical amount of passengers that a BRT-line can transport in a day) of long-distance BRT systems in the Netherlands was estimated to be around 9000 passengers per direction per day, which is somewhat lower than in the previous study. Secondly, other infrastructural (such as special use lanes) and non-infrastructural measures were identified to achieve and maintain a reliable bus service. Thirdly, full-electric buses were described as a way to minimize emissions and contribute to sustainability and liveability goals in the 2020 study. The current study also finds that full electric buses contribute to the perceived comfort of passengers, since they are able to accelerate more smoothly. Other measures to improve comfort found in this study are avoiding small roundabouts and sharp corners within the bus route. Some aspects of the previous KiM study were not part of the current study. When that is the case, the findings from 2020 are still relevant.

Governance and funding are important challenges

Whether long-distance BRT combined with special use lanes and corridor hubs are a feasible combination of policy measures does not just depend on its effectiveness (i.e. can the intended effects be achieved?), but also on the cost efficiency and practical barriers. Concerning these practical barriers, it is difficult to draw general conclusions. However, especially in the field of governance and funding there are some significant challenges. In the case of corridor hubs, this is related to the fact that the hub is often situated in a different municipality (i.e. a suburb) than the municipality where the benefits are reaped (i.e. a large city). The ratio between costs and expected effects is another area of uncertainty, but it is clear that each component (high quality buses, special use lanes and corridor hubs) requires significant funding. Therefore, additional studies are required to compared the costs and benefits, also taking into account other policy measures which may achieve similar effects. For example, to relieve congestion or increase liveability, behavioral or pricing measures may prove to be more cost efficient.

Call for ex-post evaluations

Studies into the possible effects of long-distance BRT in the Netherlands are currently limited to ex-ante evaluations. That is also because, strictly speaking, there are no examples of buses combined with special purpose lanes and corridor hubs along freeways within the Netherlands. Current high quality buses that resemble these systems are the Q-Link and Q-liner buses in the Groningen-Drenthe region, or the R-Net buses on the Haarlem-Amsterdam corridor. Even though in some cases these buses make use of hard shoulders to bypass congestion, or are connected to something similar to corridor hubs, there are no ex-post evaluations of the effectiveness of these systems in the field of modal shift, congestion reduction, or accessibility of existing public transport users. An ex-post evaluation that did in fact (try to) measure effects on congestion of high quality bus systems in the Netherlands, did not include the specific combination with special use lanes and/or corridor hubs.

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