Cost advice for the implementation of tram and bus systems

Road and Transportation Research Association of Germany (FGSV)
Task force 1.5.3 : Bus systems with high capacity

for the task force 1.5.3

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Centre of Traffic and Transport
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Please do not compare apples with pears!

To make it clear: this is not a cost comparison between a tram system and a normal bus service.

Within this cost comparison the focus is on two transport systems of comparable high quality: a tram system and a bus system.
Preconditions for comparing the cost of bus and tram

1. Each has its own right-of-way. The right-of-way has to be integrated into the urban environment.
FGSV AA1.5/AA1.6
Task force AK 1.5.3
Bus systems with high capacity

Preconditions

Introduction

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FGSV AA1.5/AA1.6
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Bus systems with high capacity

Introduction

Preconditions

Projection

Investment costs

Annual full costs

Variant comparison

Final results

urban integrated busway

urban integrated tram track

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We expect operating benefits as well as positive spin-off effects and emotional esteem on a comparable level with an integrated urban right-of-way system independent whether it is a bus or a tram.
Preconditions for comparing the cost of bus and tram

1. Each has its own **right-of-way**. The right-of-way has to be integrated into **the urban environment**.

2. Furthermore the deployment of vehicles of **identical capacity** will help to ensure that staff efficiency and service frequency are equal.
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Using vehicles with the same capacity, **staff efficiency** and **service frequency** are equal.
Preconditions for comparing the cost of bus and tram

1. Each has its own **right-of-way**. The right-of-way has to be integrated into **the urban environment**.

2. Furthermore the deployment of vehicles of **identical capacity** will help to ensure that staff efficiency and service frequency are equal.

3. The basis for the system cost comparison is provided by the construction of a **new** PT system. This is the only possible way in which to produce a uniform basis for the calculation of debt servicing.
Simplified projection for cost comparison

two lines (route length in total 20km)
5-min-frequency on both lines
3000 route circulations per year with 32 vehicles
trip speed: 20 km/h

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## Investment costs

<table>
<thead>
<tr>
<th>Cost centres</th>
<th>Bi-articulated bus running on right-of-way track</th>
<th>Tramway running on right-of-way track</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs of planning and building preparations</td>
<td>€15 million</td>
<td>€32 million</td>
</tr>
<tr>
<td>Land acquisition</td>
<td>€12 million</td>
<td>€12 million</td>
</tr>
<tr>
<td>Civil engineering work</td>
<td>€10-30 million</td>
<td>€30 million</td>
</tr>
<tr>
<td>PT right-of-way construction</td>
<td>€10 million</td>
<td>€28 million</td>
</tr>
<tr>
<td>Current supply for operations</td>
<td>-</td>
<td>€16 million</td>
</tr>
<tr>
<td>Costs of stopping points</td>
<td>€10 million</td>
<td>€10 million</td>
</tr>
<tr>
<td>Costs of restructuring the road space</td>
<td>€70-80 million</td>
<td>€80 million</td>
</tr>
<tr>
<td>Communication, information, retail systems</td>
<td>€16 million</td>
<td>€16 million</td>
</tr>
<tr>
<td>Traffic signal prioritisation</td>
<td>€12 million</td>
<td>€12 million</td>
</tr>
<tr>
<td>Investment expenditure on vehicles (No. 32)</td>
<td>€16 million</td>
<td>€80 million</td>
</tr>
<tr>
<td>Subtotal</td>
<td>ca. €170-200 million</td>
<td>ca. €320 million</td>
</tr>
<tr>
<td>Overall system costs</td>
<td>ca. €8.5 million/route-km</td>
<td>ca. €16 million/route-km</td>
</tr>
<tr>
<td>Maintenance and storage facility</td>
<td>€10 million</td>
<td>€25 million</td>
</tr>
<tr>
<td>Estimated capital expenditure on notional comparison system (20 km track length)</td>
<td>≤ €210 million</td>
<td>€345 million</td>
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</table>

1 Financial assistance for investments and special subsidies are not taken into account. Capacity per vehicle: 145 passengers.
### Investment costs

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Annual full cost of PT operation

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**Annual full costs**

**Variant comparison**

**Final results**

### Annual full cost of PT operation

**Variant comparison**

**Final results**

**Assumptions:**

- **Annual mileage:** 60,000 km
- **Operating hours:** 3,500 h
- **Driver costs:** 28 €/h
- **Interest rate:** 3%
- **Vehicle capacity:** 145 passengers

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<table>
<thead>
<tr>
<th>Vehicle category</th>
<th>Bi-articulated bus</th>
<th>Bi-articulated bus</th>
<th>Tramway</th>
<th>High-capacity bus</th>
<th>Tramway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle length</td>
<td>25.00m</td>
<td>25.00m</td>
<td>28.00m</td>
<td>20.00m</td>
<td>40.00m</td>
</tr>
<tr>
<td>Vehicle width</td>
<td>2.55m</td>
<td>2.55m</td>
<td>2.30m</td>
<td>2.55m</td>
<td>2.65m</td>
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<tr>
<td>Vehicle capacity</td>
<td>145 persons</td>
<td>145 persons</td>
<td>145 persons</td>
<td>120 persons</td>
<td>240 persons</td>
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<tr>
<td>Service frequency</td>
<td>5-min headway</td>
<td>5-min headway</td>
<td>5-min headway</td>
<td>4-min headway</td>
<td>8-min headway</td>
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<tr>
<td>No. vehicles</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>37</td>
<td>21</td>
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<td>Vehicle hallmark</td>
<td>diesel</td>
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<td>electric</td>
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<tr>
<td>Full costs of PT operation per vehicle unit</td>
<td>€6.29/km</td>
<td>€7.41/km</td>
<td>€9.40/km</td>
<td>€5.50/km</td>
<td>€12.90/km</td>
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<tr>
<td>Full costs of PT operation per seat-km</td>
<td>Ct4.34/km</td>
<td>Ct5.11/km</td>
<td>Ct6.48/km</td>
<td>Ct4.58/km</td>
<td>Ct5.37/km</td>
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</tbody>
</table>
Variant comparison at identical hourly demand

71%

120 [4 pers./ sqm]
4-min-headway

67%

145 [4 pers./ sqm]
5-min-headway

79%

145 [4 pers./ sqm]
5-min-headway

100%

145 [4 pers./ sqm]
5-min-headway

83%

240 [4 pers./ sqm]
8-min-headway

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Variant comparison at identical hourly demand

71%
120 [4 pers./ sqm]
4-min-headway

67%
145 [4 pers./ sqm]
5-min-headway

79%
145 [4 pers./ sqm]
5-min-headway

100%
145 [4 pers./ sqm]
5-min-headway

83%
240 [4 pers./ sqm]
8-min-headway
Results of the economic analysis for newly-created systems

The deployment of **diesel-powered** low emission high-capacity buses as BRT on an integrated urban busway is clearly superior in **business terms**.

For **electric drive systems** (bi-articulated trolleybus with overhead catenary), **cost parity** is theoretically possible by means of a doubling of headway and a correspondingly high transport capacity for tramway (> 240 persons).
System cost comparison is finished – but what about the benefits!

Is it possible for a high-capacity bus as BRT on an integrated urban busway, to achieve operating benefits as well as positive spin-off effects and emotional esteem like a tram?
Rouen, TEOR

Already at the planning stage several investors bought houses along the TEOR lines.

Facade to facade urban renewal

Re-design of city centre streets

Change of retailing character

Highly recommended in last satisfaction survey (2004)

Overall speed and regularity have clearly increased

source: local authorities and author's own survey; first picture by W. Kutil
Amsterdam, Zuidtangente

Patronage up to 99% higher than estimated
Schools, shopping centres etc. are built along the route

Source: local authorities and author's own survey; first and third picture by Stadsregio Amsterdam
Eindhoven, Phileas

Planning of a new north-south lane started, to connect Nuenen-West with the High Tech Campus in the south

Fully integrated bus lanes in new housing area Meerhoven and office site Flight Forum

source: local authorities and author’s own survey; second picture by Gemeente Eindhoven
Kent, Fastrack

A survey in Oct 2006 revealed that
- 26% of the passengers said they had a car available but chose to use Fastrack.
- 19% said they would previously have made the trip by car.

source: local authorities and author's own survey; pictures: PTI No.5/2007
Nantes, BusWay

Re-design of city streets and dismantling of an urban motorway

Strong political support, re-election of the mayor

30% of passengers previously would have made the trip by car.

Low number of accidents in 2006/07

- BusWay : 1.8/100,000km
- tram : 3.6/100,000km
- normal bus service: 5.1/100,000km

source: local authorities and author's own survey
What about the fare income?

„Does an integrated urban bus system appear to citizens as attractive as a tram? Will it be used more often, and does that lead to a rise in fares?“

pictures: Ch. Groneck / Comunidad Curitiba
<table>
<thead>
<tr>
<th>Variant</th>
<th>2001</th>
<th>2002</th>
<th>Phase II</th>
<th>2007</th>
<th>2008</th>
</tr>
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<tbody>
<tr>
<td>TEOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Zuidtangente</td>
<td>21,500</td>
<td>21,500</td>
<td>6,772 mio. pass per year</td>
<td>9,979</td>
<td></td>
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<tr>
<td>Phileas</td>
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<td></td>
<td>5,830</td>
<td>6,595</td>
<td>7,850</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>+13%</td>
<td>+19%</td>
<td></td>
<td></td>
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<tr>
<td>Fastrack</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>38,000</td>
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<tr>
<td></td>
<td>+22%</td>
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<tr>
<td>BusWay</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>16,000</td>
<td>25,000</td>
<td>28,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>+54%</td>
<td>+12%</td>
<td></td>
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</tr>
</tbody>
</table>

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The three major results ...

An integrated urban bus system has **economic advantages** compared to a low-capacity tram.

The external benefits of an integrated urban bus system are **similar** to a tram system.

It will always be difficult to convince politicians to transfer the **system idea** to the “flexible” bus. In comparison the tram has a legitimately and technically exceptional position.
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Hinweise zu Systemkosten von Busbahn und Straßenbahn bei Neueinführung

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