A 1,85m narrow vehicle with the capacity of a standard bus: the bi-articulated minibus

1. Use-cases, advantages and perspectives of narrow buses

1.1. Desire for more narrow lanes in the context of traffic calming and urban greening

In many cities, it became popular to redesign urban streets towards less space for cars and more space for pedestrians, cyclists and green space. This leads to a conflict of goals concerning the distribution of public space: On one hand, public transport is desirable to ensure sustainable mobility and accessibility in these redesigned roads. On the other hand, traffic lanes used regularly by conventional public transport buses require significantly more width than lanes used by buses and trucks only occasionally. Due to this additional lane width for regular public transport buses, there is less space for green areas or sidewalks and car drivers are tempted to drive too fast. With more narrow buses, streets with regular public bus service could be designed as narrow as streets where no buses drive regularly.

1.2. Relocation of bus lines to more narrow parallel streets

In order to convert an urban main street into a pedestrian or calmed-traffic zone, the relocation of a bus line into the next parallel street is a considerable option, but often unfeasible because of insufficient lane width of that parallel street. More narrow buses would ease that problem.

1.3. New local bus lines through narrow roads

In historically grown urban environments a denser network of public transport would be desirable, but in the concerned area there are no sufficiently wide streets. Such additional lines could be served by more narrow buses.

Until now, plans to introduce or deviate bus services through residential areas often face opposition by residents because of the noise of combustion-driven buses, in particular when driving uphill or accelerating after stops. The upcoming change from combustion-driven to battery electric buses will solve this problem, leading to more use cases for narrow buses compared to the current situation.

1.4. Insufficient capacity of existing midibus services

Today, many downtown areas are served by midibus lines, but sometimes their capacity isn't sufficient. A bi-articulated minibus could serve these area with the same capacity as a rigid 12m standard bus.

1.5. Deviations in case of construction works or events in public space

Furthermore, urban public transport providers could use bi-articulated minibuses in a targeted way for deviations in case of construction works or events in public space. More narrow buses can use shorter and closer deviation routes that are unsuitable for standard buses and thus reduce inconvenience for passengers and improve the accessibility of the event itself.

1.6. Compatibility with contraflow bike lanes

In narrow one-way streets, the street width often allows either regular public bus service or a contraflow bike lane. This means, that in a one-way street with a bus line, you can't create a contraflow bike line or in a narrow street with a contraflow bike lane, you can't introduce a bus service. With bi-articulated minibuses both is possible.

2. Geometry solution

For the assessment of seat capacity and manoeuvrability of a conceivable bi-articulated minibus, a mechanical drawing of a Hess LighTram 25 DC[1] was downscaled by a linear factor of 72,8%. This leads to a width of 1,85 m (instead of 2,55 m) and a length of 18,0 m (instead of 24,7 m), making the bus as narrow as a passenger car and short enough to allow for operation without special permission. In those downscaled vehicle bodies, conventionally sized seats can be accommodated as shown in Figure 1:

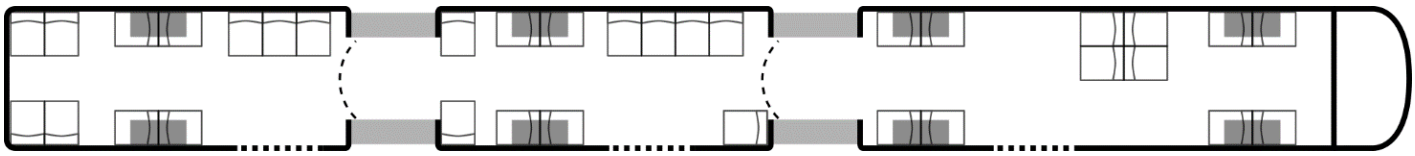

Figure 1: External geometry and possible seating for a bi-articulated minibus of 1,85 m width and 18 m length.

That way, a bi-articulated minibus accommodates 34 sitting passengers, roughly the same number as a conventional 12m rigid bus. The (outer) footprint is 33,3 m², this would be equivalent of a rigid bus of 2,55 m width and 13 m length. Considering losses, e.g. for outer walls, the passenger compartment will offer about the same area for standing passengers as a 12m rigid bus.

As shown in Figure 2, such a downsized bi-articulated bus would be sufficiently manoeuvrable for narrow urban streets:

Figure 2: Overlay of the tractrix curve of the car body of a 18 m long and 1,85 m wide bi-articulated minibus over two exemplary street crossings in Vienna: Bürgerspitalgasse / Liniengasse (left) and Liniengasse / Haydngasse (right). The tractrix curves are those of 24,7 m long and 2,55 wide existing bi-articulated bus[2], downsized by a linear factor of 72,8%.

3. Profitability aspects

The weight of a double-articulated minibus is distributed over four axles instead of two axles of a 12m rigid bus. As the stress on the road increases with the fourth power of axle load, in case of approximately the same total weight of the bus, the road is worn out by the bus eight times slower. Thus, the municipality will probably have to pay more to buy more expensive buses of more complicated design, but less for road maintenance.

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[1] Stadtbus Winterthur: Typenblatt SBW 401-411, Hess LighTram 25 DC: https://stadt.winterthur.ch/stadtbus/medien/praesentation-unseres-neuen-doppelgelenktrolleybusses/dokumente/typenblatt-401-411hess-lightram-25-dc_20220826_gech.pdf/@@download/file/Typenblatt 401-411Hess lighTram 25 DC.pdf; retrieved 30.6.2024

[2] Bau-, Umwelt- und Wirtschaftsdepartment des Kantons Luzern: Schleppkurven in Busbuchten, Doppelgelenkbus L=24,7 m: https://vif.lu.ch/-/media/VIF/Dokumente/download/fachordner/strassen/736_schleppkurven/7361151_doppelgelenkbus.pdf?rev=ed1a89cb2a5045f398667b75241ebf3d; retreived 30.6.2024