Travel demand estimation of cable cars supplementing public transport

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Motivation

The process of urbanisation leads to the problem that public transport networks in many European cities have reached their capacity limit. This is particularly the case for city centres. Conventional public transport infrastructure (tram lines, bus lines) cannot be extended in high density city centres with narrow streets and limited space for additional transportation infrastructure. In many European cities with historical city centres capacity extension of mass transit requires systems to be build either below or above ground level. Mid-size towns like Graz (280,000 inhabitants) are too small to justify an underground system economically. However, a cable car could be a cost-effective and efficient alternative.

In recent years, South American cities as La Paz, Caracas or Rio de Janeiro have built urban cable cars to improve its public transport networks. Cable cars face ideal conditions in these **mountainous** cities. European cities like London, Lisbon or Koblenz have introduced cable cars for special events. However, their cable cars are not integrated into the public transport network. They merely function as point to point delivery at extraordinary event locations. No European city has so far experience in setting up a cable car system within their public transport network.

The research project “Ropeway” is funded by the Republic of Austria and examines the travel demand for an urban cable car as part of the public transport system in Graz, based on a transport model. In addition, the study analyses the contribution of an urban cable car system to strengthen intermodal passenger transport.

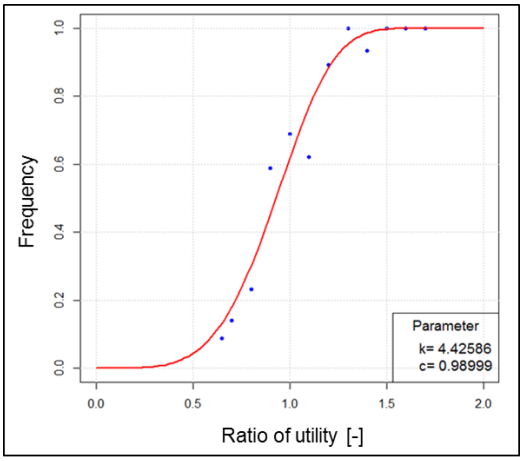
Methodology

The travel demand model is set up in three steps:

Firstly, a multistage mobility survey was conducted. Stated choice interviews were conducted with people who are affected by the cable car system; such as neighbouring residents and commuters. Each respondent had to select between hypothetical but realistic transport alternatives using personalised trip information. Inbound commuters – 117,000 daily - are relevant in Graz, so that they received a distinct set of choices with new Park&Ride options outside of the congested urbanized area and suitable public transport options including the cable car. An urban cable car could also have a touristic potential. More than 1,000,000 tourists visit Graz each year. Therefore a tourist survey was also conducted to analyse the mobility behaviour of this potential user group.

In the second step, the existing regional, multimodal transport model of greater Graz was enhanced. It is a macroscopic transport model for workdays using the tour-based, disaggregated, behaviour-oriented travel demand model VISEM. Based on the results of continuous travel diaries, the current mobility behaviour of the residents was updated

supplemented by an independent travel demand model for tourists. Besides these minor changes, the mode choice model had to be enhanced. So far, there was no separation between the different modes of public transport (train, tram, bus). Since cable cars have different characteristics than conventional public transport modes, a Nested Logit approach has been selected. Cable cars run continuously with little waiting time while frequency greatly affects the mode choice of trams and buses. Within the public transport nest we used a bimodal choice with a Weibull distribution. The parameters of the distribution function were estimated using the stated choice experiments of different behavioural groups (Fig. 1).



$$P_{CPT}(x_{i,j}) = 1 - e^{-(c*x_{i,j})\hat{}k}$$

With

P_{CPT}	Probabilty to select Conventional Public Transport to travel from origin *i* to destination j
c,k:	parameters to be estimated

Fig 1.: Empirical values of a stated choice experiment (blue) with different travel time ratios between bus/tram (conventional public transport) and cable car and an estimated Weibull distribution

Finally, different scenarios of cable car systems were simulated based on a forecasted city size, inhabitants and working opportunities. The year 2025 was selected with different cable car configurations differing with respect to the number and intervals of stations, gondola systems, and routes.

Results

Compared to the cable cars in South American cities, the routing was more complex due to the specification of routing on public property and the natural course of the river. The currently planned route of the cable car has a length of 11.9 km with 12 stations. The stations will be located on existing bridges as well as at the waterfront and there are connections to the other public transport services of the city. Possible systems were a detachable monocable gondola (MGD) with a travel speed of 6 m/s and a cabin capacity of maximum 10 persons or a detachable tricable gondola (TGD) with a travel speed of 7.5 m/s and a cabin capacity of 35 persons. The transport capacities of those systems can reach 4,000 (MGD) to 6,000 (TGD) people per hour and direction which is in line with high frequency tram lines.

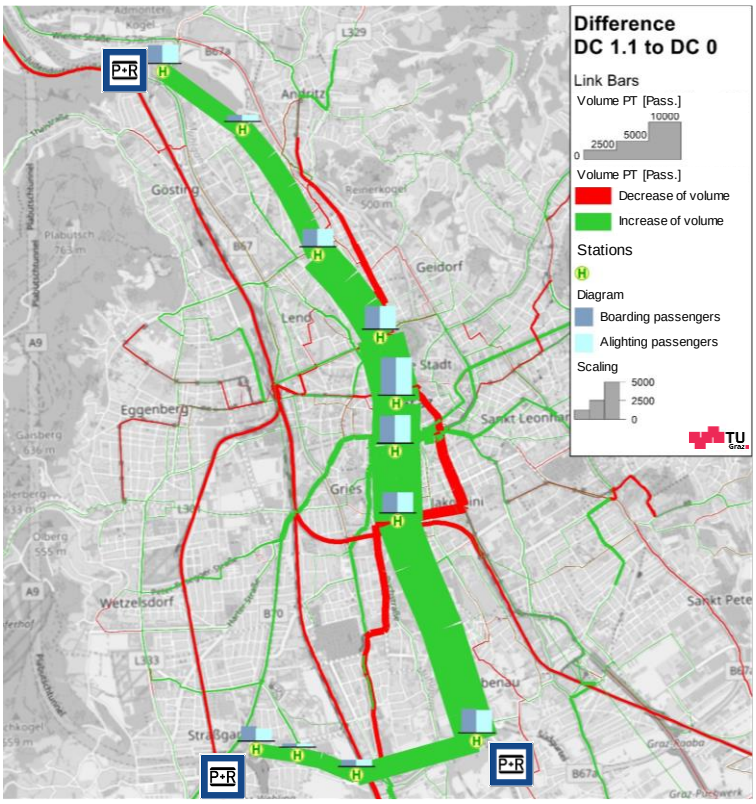


Fig 2.: Description of Increase (green) and decrease (red) of passenger volume in public transport (Design Case 1.1 compared to Design Case 0), number of passengers boarding/alighting at the stations of the cable car (Design Case 1.1) and Park&Ride facilities

The calculated travel demand of the cable car confirms a relevant potential of this new transport mode. The estimated demand ranges between 20,000 and 30,000 passengers per weekday depending on line length and number of stops. These passenger values are equivalent to an average tram line in Graz. Third of passengers are commuters and a sixth part are tourists. Tourists use the cable car for round trips as well as for hop on hop off activities. The modelling exercise also indicates that the cable car will only receive a substantial amount of passengers if journey time and fare structure are competitive to other public transport modes.

(962 words) The final presentation respectively full paper will include a literature review, the evaluation of the multistage mobility study and the estimation of the Nested Logit model as well as the calculated demand for the different design cases and further investigations of the system impact.