Impacts of Free PT, Tallinn - Evaluation Framework

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1. Background

The City of Tallinn, the capital of Estonia, will provide zero-fare public transport (ZFPT) for all its inhabitants on all public transport services that are operated by city-run operators, starting from January 1, 2013. This will make Tallinn with approximately 420,000 residents the largest city in the world that offers ZFPT services for all of its inhabitants. The main objectives of this policy measure are: to lead to modal shift from private car to public transport, to increase the mobility of unemployed and low income groups and, to increase the municipal income tax by providing a stimulus to register as a resident of Tallinn.

The share of public transport trips decreased dramatically during the last two decades. The current mode split is still favorable towards public transport with a market share of 40% followed by walking (30%) and private car (26%). During the same period, the motorization rate has more than doubled up to 425 cars per 1,000 residents in 2012. Public transport services in Tallinn are operated by two municipally-owned companies that run the service based on gross contracts. The two companies have recently been merged into a single company. Public transport fares were already reduced by 40% for Tallinn residents on 2003. This reduction had led to an increase of 30,000 in the number of registered residents. Moreover, 36% of the passengers are already exempted from paying public transport fare based on their socio-economic or occupational profiles. Additional 24% are entitled for special discounts.

Currently, the share of public transport operations costs that is covered in Tallinn by passenger fares is in the range of 30-40%. This share is also known as the farebox recovery rate. The ZFPT policy implies that almost all of the operations costs will be subsidizes. The additional subsidy amounts to an annual cost of 14.3 million euros. The City of Tallinn estimates that merging the two municipality-owned operators will result in annual savings of 10 million euros. Furthermore, the City expects that the additional taxes from newly registered residents will cover the remaining costs. The City is committed to sustain and further improve the standards of public transport level-of-service in terms of reliability and crowding. If the desired mode split impacts will be realized then additional resources will be required.

Public transport fares were identified as a primary problem area in Tallinn. On an annual municipal public transport satisfaction survey from 2010, 49% of the respondents were most unsatisfied with public transport fares followed by crowding

(29%) and frequency (21%). This led the City of Tallinn to propose a ZFPT policy on a popular referendum where it was supported by 75% of the voters with a participation rate of 20%. Following the referendum, the city council approved the measure.

A ZFPT policy is often discussed in the public debate with strong links to the attitudes towards public transport as public good vs. a commercial service. Arguments in favor of ZFPT include improving social inclusion, attracting people to public transport and hence reducing car traffic externalities and road infrastructure investments, saving fare collection and control costs and capitalizing on public transport economies of scale when extending system supply. In addition, shorter dwell time at stops due to smoother boarding may result in higher commercial speeds and even fleet operations savings (this is relevant only in the case of on-board validation). The main argument against ZFPT claim that this is a second-best pricing scheme as car travel is underpriced. Other arguments include the potential risk that it may become a substitute to walking and cycling rather than car trips, longer dwell times due to higher demand and the threat that it may lead to fewer investments in public transport in the long run.

The City of Tallinn appointed the authors, a research group from KTH – Royal Institute of Technology (Stockholm, Sweden), to evaluate the impacts of ZFPT. The case of Tallinn is a full-scale experiment that provides an unique opportunity to investigate the impacts of such policy. The empirical evaluation will take into consideration economic, social, mobility and level-of-service aspects. This will facilitate the overall cost-benefit assessment of the ZFPT policy measure. This document presents the evaluation framework proposed by the research group. We start by briefly reviewing previous studies on the impacts of ZFPT followed by stating the objectives of this evaluation. We then describe the proposed methodology and how we intend to carry out the analysis based on the available data sources. This document concludes with a description of the project process and the corresponding timeline.

2. Previous experience

The introduction of ZFPT in Tallinn will be the first of its kind in terms of its scale. Few smaller cities (Hasselt, Belgium; Templin, Germany and Aubagne, France) have a similar policy since the late 90s. There are few other cases of ZFPT policies directed toward specific user groups (e.g. students, youth, off-peak riders). Most of these experiences were not followed by a systematic evaluation.

When analyzing the mode split impacts of ZFPT policies, it is important to distinguish between *generation effects* and *substitution effects*. The former refers to trips that are now carried out by public transport that otherwise would not occur, while the latter refers to trips that without ZFPT were done by some other mode and switched to public transport modes. Generation effects can thus indicate greater mobility and access to opportunities but could also be the result of unnecessary trips. Substitution effects represent mode choice changes with the most desired effect been that of public transport substituting car trips.

A ZFPT pilot in Mercer county, New Jersey US took place as early as 1978 (Studenmund and Connor, 1982). Off-peak fares were abolished for 13 lines that used to have a differential fare for on-peak and off-peak periods under a one-year pilot. This resulted in 20% increase in ridership. Interestingly, two thirds of this increase was sustained after the pilot was over. The generation effect amounted to 17%. Half of the substitution effects were attributed to car and then other half to walking. A disproportionate share of the ridership increase was made by youth. The average off-peak load increased by 50% leading to an increase of 5-15% in the number of crowded buses and 25-45% increase in the share of late buses. No traffic volume reduction was observed. The analysis concluded that ZFPT could be a useful promotion technique but not a viable option for system-wide operations.

Perhaps the most well-known ZFPT scheme is the one introduced by Hasselt (c.a. 70,000 inhabitants), Belgium on 1996 (van Goeverden et al. 2006). The relatively small public transport system became then free to all users (not only for city residents). It was introduced together with substantial additions to the network supply (fleet size increased by fivefold). Ridership increased tenfold with 37% of the new trips attributed to new users. Only 16% of the substation effects are of trips switching from car to public transport.

The small city of Templin (c.a. 15,000 inhabitants), Germany introduced a ZFPT policy on 1997 (Storchmann 2003). Since then the local public transport system is universally free. The ridership increased by 1200% within 3 years with the vast majority of this increase reported to be among children and youth. This led to an increasing problem of vandalism. Most of the substitution effects were due to shift from soft modes – 30-40% from biking and 35-50% from walking. Only 10-20% of the substitution effects were associated with previous car trips. A cost-benefit analysis suggested that the ZFPT policy resulted in considerable safety benefits due to the undesired shift from the more dangerous soft modes.

Since 2009, all public transport services in the city of Aubagne and nearby municipalities (c.a. 100,000 inhabitants in total), France are free for all users. The main motivation was social and supported by the fact that user fares accounted for only 9% of the public transport system budget. No systematic analysis was carried out, but there are some indications that ridership doubled and more resources were allocated to increase system capacity. Survey data suggests that the generation effects amount to 20%. It was reported that it mostly affected short trips. However, most substitution effects are associated with car (63%) followed by walking (27%). Almost all users, more than 90%, are satisfied with the ZFPT policy.

A limited-scale ZFPT pilot study was carried out on the Leiden-The Hauge corridor, Holland during the year of 2004 (van Goeverden et al. 2006). The pilot involved two existing bus lines and one new line with the objective of testing the potential to reduce congestion from a parallel freeway. However, in retrospective the scale of the pilot was insufficient to address its objective and allow a significant congestion reduction. Nevertheless, ridership on the pilot bus corridor was tripled with 16% new trips. The large share of the substitution came from cars (45%) and public transport alternatives (30%) due to the relatively long-distance context. It was concluded that although the pilot was designed improperly, it led to better utilization of service capacity.

A ZFPT policy was introduced in 2004 by the Flemish council in Brussels, Belgium for students admitted to Flemish universities (Macharis et al. 2006, De Witte et al. 2006). The scheme details changed over the years with respect to registration fee and the reimbursement mechanism. The ZFPT applies only for parts of the public transport network that are administrated by Flemish operators. The main objective is to promote Flemish universities and Brussels's image among the Flemish community. The impacts of this scheme were analyzed based on a travel survey, mental map questions and in-depth interviews. New trips were generated by 26% of the students with 1.7 additional trips per week on average. The substitution effects were 60% from car, 15% from other public transport alternatives, 19% from walking and 5% from bike. The average reduction in car trips among students who have a car available amounted to 82 km per week per student. However, French students still use public transport more extensively than the Flemish students. This is presumably due to differences in their spatial distribution and mental maps. Moreover, the ZFPT scheme did not lead to greater variation in trip destinations. Flemish students reported a negative effect related to the loss of customer status and lower sense of respect. A stated-preference survey among commuters analyzed the potential mode switch of ZFPT (De Witte et al. 2008): only 10% said that they will definitively switch to public transport with another 42% saying they might switch.

All students in Holland are eligible to ZFPT in the entire country since 1991 (van Goeverden et al. 2006). The share of public transport increased from 11% to 21% during this period with the number of public transport trips per day increasing from 0.45 to 0.81per student. The substitution effects were distributed as follows: 52% bike, 34% car and 9% from walking. Average trip length increased by 15%. An increase in the crowding, especially around train weekend trips, led the national railway carrier to increase service frequency. Hence, other travellers benefited a more frequent service.

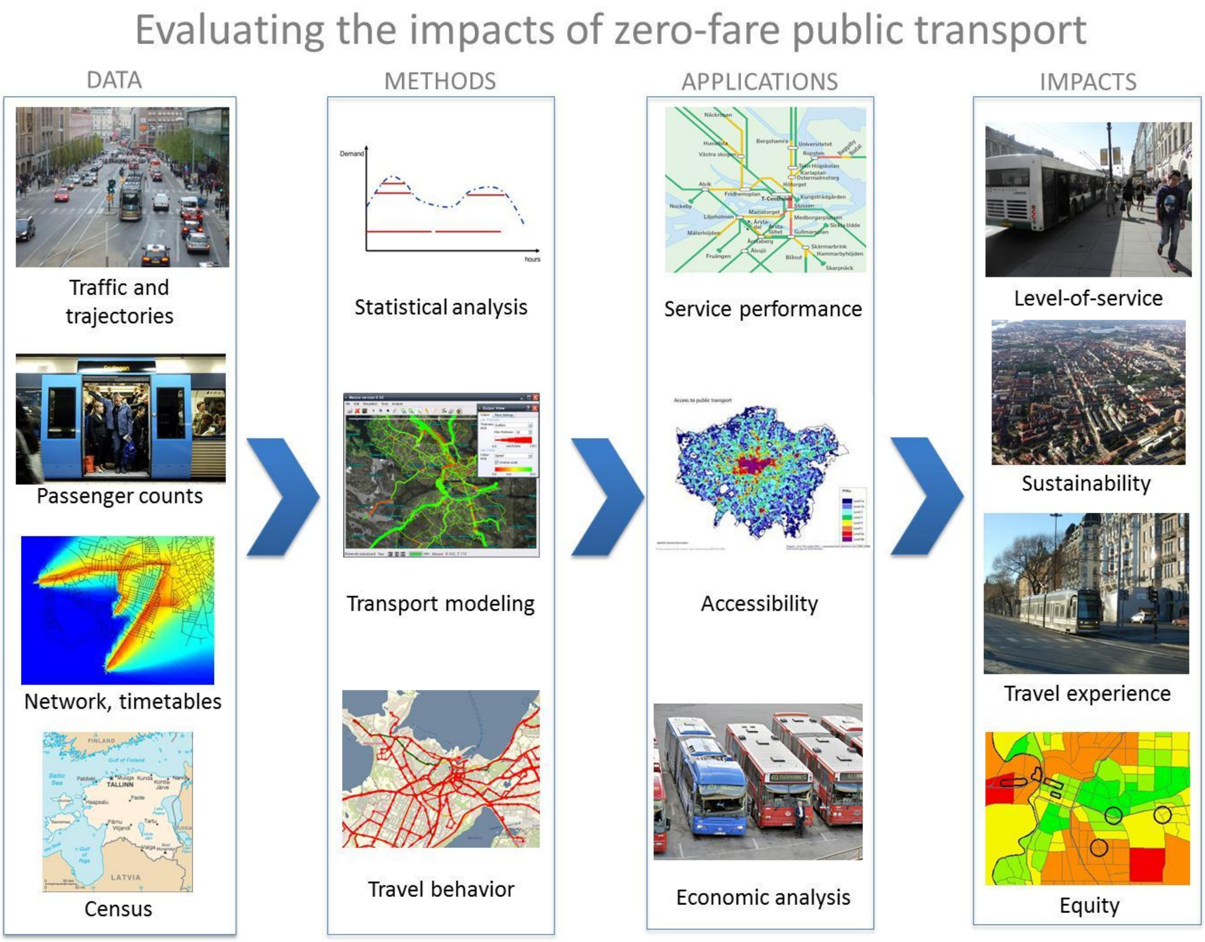
Starting from 2005, a ZFPT was introduces for youth in London, UK. The primary objective is to increase the opportunities for young people and promote the use of public transport. An analysis of health impacts was carried out based on interviews and focus groups (Jones et al. 2012). They have considered the level of activity, likelihood of injury, and cases of assaults. They found positive impacts with respect to access to after school activities, social inclusion and interactions. Buses became the default option for short trips. However, respondents reported that they would have cancel, pay or get a ride from their parents if ZFPT ceased to exist (and not walk). The assessment did not include any quantitative analysis.

3. Objectives

The primary question of the ZFPT evaluation is whether the benefits of zero-fare public transport policy exceed the costs? In order to be in a position to answer this question, the evaluation has to consider first the following questions: How do travel patterns and attitudes change? How will the transport system performance be affected? What are the impacts on disadvantaged groups?

4. Methodology

The evaluation will consist of a before and after analysis of various data sources on public transport performance and travel patterns. A series of measures will be defined and calculated in order to assess the impact of the ZFPT on the policy objectives.



4.1 Data

The evaluation of the ZFPT is facilitated by a large range of data sources. The following data sources are available for carrying out the evaluation:

- *GIS layers of the street and public transport networks* – The representation of the urban and public transport networks includes neighborhood zones, public transport stops, lanes and lines.
- *Automatic vehicle location (AVL) data* – Available for a sample of trips across the network. The raw data includes the arrival and departure times for each stop visit and the corresponding accumulated distance, dwell time and scheduled time. The AVL equipment is circulated over the service lines.

- *Automatic passenger counts (APC) data* - Available for a sample of service lines for each quartile. The equipment is circulated over the lines throughout the year in order to cover the entire network and allow year-over-year comparisons. The disaggregate data contains the number of boarding, alighting and on-board passengers for each round trip. Moreover, the data is proportionally generalized at the route level to generate an aggregate daily load profile.
- *Traffic counts* – the City of Tallinn carries out annual traffic counts on the main arterials.
- *Annual municipal satisfaction survey* – the City of Tallinn conducts an annual survey of face-to-face interviews with approximately 1500 inhabitants. Previous surveys (2002-2011) asked what is the most commonly used travel mode which gives an indication on mode split. In addition, respondents were asked to choose three aspects of public transport service that they are most dissatisfied with.

  Following the research group suggestions, the annual municipal satisfaction survey that will take place during the fall of 2012 and 2013 will include also a travel diary referring to yesterday trips (including start and end time, trip purpose and travel mode). Moreover, the survey will include questions referring to missed work opportunities, neighborhoods' attractiveness and residence registration. In addition, the list of dissatisfactory aspects was extended.
- *Socio-economic census data* – a range of socio-economic variables are available at various aggregation levels. The population by age groups is available at the district level. The following variables are available at the city level – income level, education level, household size and structure, density, employment status, land use mixture as well as land value. Car ownership is available only at the national level. The City of Tallinn has defined also 49 statistical areas (neighborhood level) for which some socio-economic variables might be available.
- *Periodical card analysis* – The number of public transport trips per day made by a periodical card holder is available from studies conducted on 2003 and 2011. In addition, the share of user groups is available from the current ID card.

4.2 Key performance indicators

The data sources described above will be processed, integrated and analyzed in order to compare the conditions before and after the introduction of ZFPT. In line with the policy objectives listed above, the evaluation considers a large range of measures or indicators. The key performance indicators refer to travel patterns, quality of service indicators and broader behavioral changes.

Indicator	Description	Data sources
Mode split	The share of trips carried out by each mode and substitution effects segmented by trip purpose, length and time-of-day.	Annual survey (travel diary), Periodical card analysis
Mobility	Generation effects by user group	Annual survey (travel diary)
Accessibility	Generalized travel cost index by geographical unit and user group (and as a hindrance for job opportunities)	APC, Annual survey (travel diary, work opportunities), Socio-economic census data, GIS layers, Periodical card analysis
Speed	Public transport speeds on bus lanes vs. mixed traffic across the network, car speeds on main corridors	AVL and Traffic counts
Reliability	Punctuality (share of on-time arrivals, schedule deviation) and Regularity (share of regular arrivals, headway deviation)	AVL
Comfort	Load profiles, likelihood of crowding conditions, denied boarding	APC
Operations efficiency	System capacity utilization (pass per veh-km)	APC
User satisfaction	The main problem areas (e.g. network design, information, cleanliness, vehicle comfort)	Annual survey (aspects ranking)

City attractiveness	Perception and preferences towards potential trip destinations and location choices	Annual survey (neighborhoods' attractiveness), GIS layers
Population registration	Number of registered residents and likelihood to register oneself	Annual survey, City records

4.3 Analysis periods

The evaluation will be based on different analysis periods with respect to different measures. The evaluation of public transport performance will consist of four analysis periods that exercise different conditions, as follows:

I. Before ZFPT; April 2012
II. Before ZFPT, after public transport package; October 2012
III. Immediately after ZFPT; January 2013
IV. After ZFPT; April 2013

The evaluation of the second period will allow assessing the impacts of network changes on public transport performance and separating their effect from the impact of ZFPT policy. The evaluation of the immediate effect will consist of ridership analysis and consider the need to adjust the supply. April and October are regarded as comparable in terms of traffic congestion and weather conditions in Tallinn.

Important parts of the evaluation are based on the annual municipal survey and hence require a different analysis span. Interviews take place each fall with results been available by December. Hence, the before and after analysis periods will refer to fall 2012 and fall 2013, respectively. Previous surveys will also be taken into account.

4.4 Synthesis

The impacts of the ZFPT policy will be evaluated by carrying out an extensive before-after comparison. The analysis of the various measures will be synthesized into three primary domains:

- *Transport system performance* – the impacts of the ZFPT policy measure on modal shift lie in the core of the evaluation. It will be analyzed for different user groups and trip attributes. A substantial reduction in car use may also result in environmental impacts. Temporal and spatial changes in ridership may also induce additional capacity needs. The level-of-service provided by the public transport system will be evaluated based on reliability, speed and crowding measures, as well as satisfaction with service attributes. The evaluation will take into account the changes that the City of Tallinn introduces to its public transport system prior to the ZFPT policy (such as dedicated transit lanes and signal priority).

- *Accessibility and equity* – one of the main objective of the ZFPT policy is to improve accessibility for low-mobility groups. The evaluation will consider changes in mobility patterns for different user groups. Equity implications will be investigated and in particular ZFPT impacts on social inclusion and opportunities for disadvantaged groups. Furthermore, impacts on location choice preferences and accessibility costs will be evaluated.
- *Economic and social aspects* – the ZFPT policy has long-term fiscal and economic implications. This includes urban economic aspects such as growth, labor market and land value. In addition, for the ZFPT to be successful it has to be financially sustainable. Sufficient funding for the public transport system is required to compensate for the lost fare revenues. The impact of the ZFPT on residents' registration is important in this context.

The evaluation of these three domains will facilitate the overall assessment of the ZFPT policy by comparing the benefits (e.g. increased accessibility, reduced traffic congestion, reduced fare collection costs) with the costs (e.g. lost revenues, increased capacity needs). This will allow us to draw conclusions on the ultimate ZFPT evaluation question and recommend further policy measures.

5. Project Timeline

Activity	2012						2013												2014	
	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
Survey design	■	■																		
Evaluation framework			■	■																
Before case analysis			■	■	■															
Network changes assessment					■	■														
Immediate effect evaluation							■	■												
After case analysis											■	■								
Travel patterns analysis				■	■	■	■										■	■	■	
Conclusions and recommendations												■	■					■	■	■

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