Determining Fare Structures: Evidence and Recommendations from a Qualitative Survey among Transport Authorities

EMTA

European Metropolitan Transport Authorities

europe sustainable mobility metropolis transport authority

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New types of business models for urban mobility are being explored by bespoke new players looking at options to enter the transport market from other sectors, like the automotive industry, financial institutions, and IT-businesses. The volatility of this expanding market challenges local decision makers in larger cities to carefully weigh all stakes and decide on setting of public transport fares for different transport services and user groups, in an sustainable, affordable, equitable and attractive way. On the setting of fares lurks a variety of sometimes enigmatic structures that transport authorities use as reference for their fare setting policy.

Fare revenues are an important factor for PT financing for authorities and the operators. When the risk of fare revenues is all with the authorities like in gross cost contracts with less freedom to the operator, the fare structure for the long term strategy on financing becomes increasingly important. Driving the demand for public transport to maximize fare revenue by focusing on gradual increase of service offering quality and ensure transparency of fare adjustments is one of the major challenges to sustain a financial healthy fare policy. The progressive individualization of mobility offering by providing bundles of services targeting different customer groups at different prices will be less a political issue once the entrepreneurial freedom gains ground.

In an attempt to lift a tip of the veil of enigmatic fare structures Kyoto University in cooperation with Napier University in Edinburgh has launched an enquiry among mostly European cities among which were 16 EMTA members. In all 26 authorities from urban areas brought their data to this survey, not all cities with high maturity and some with a relatively low share of public transport. The outcomes are based on qualitative research not comparing the scope of the payment varieties but more an objective insight in what drives cities to use different fares and level of fares for regular users or incidental one-time travelers, as well as the validity of fare structures in case of facilitating intermodal transport and seamless transfer.

This report accounts for what are the particular values and properties that build the stem of the fare structure tree in the cities. It offers sometimes a number of parallels but many more times the rationale for the choice to define a certain fare basis are based on behind the scene political arguments. Although this makes benchmarking quite tough, some recurring factors behind the basis structure of fare setting are immanent and undeniable. The report highlights these as many cities are in the process of creating wider spatially integrated fare structures.

The report highlights that radial zonal fare structures are still dominant but that these must change due to changes in supply as well demand patterns. A second key finding of the report is contrasting trends in terms of planned changes: whereas some cities aim for more price differentiation wanting to exploit technological advances in fare collection, others aim for simplicity citing issues such as social welfare, user satisfaction as well as few economic benefits of more price differentiation. Interestingly both groups of cities often claim "fairness" as a key reason.

Summary

Fare systems consist of three interrelated elements: fare levels, fare structure as well as fare collection technology. This essay focuses on the fare structure which defines the factors or "dimensions" the fare depends on. These dimensions include spatial, temporal, operator, modal, loyalty and user group aspects. Any well-structured analysis on fare structure revisions should not be considered without these key factors. The survey is aimed to understand what fare structures revisions among EMTA members and other larger metropolitan areas are conducted or planned and conduct a qualitative survey. The keywords mentioned by many authorities in this context are "integration" and "equality".

Most cities currently have, at least in some parts, a zonal fare structure as a compromise between too simple flat fare and too complex distance-based structures. We observe contrasting trends in terms of planned changes: Some cities aim for more complexity wanting to exploit technological advances in fare collection. Others aim for simplicity, citing issues such as social welfare, user satisfaction as well as few economic benefits of more price differentiation. Both groups of cities claim "fairness" and we argue this term is overloaded in discussions. It can be agreed however that, if zonal structures remain, the type and shape of these will be changing. Radial structures tend to be increasingly replaced by structures that reflect the fact that large metropolitan areas have a polycentric layout. From this survey it is fair to argue that from the Oslo Åkershus region valuable lessons can be drawn for cities considering such changes..

Besides spatial aspects the focus of current revisions is more often inspired by user group aspects than by aspects of the fare structure. It is illustrated there are strong differences and few agreement in terms of user group discounts among cities and their authorities. Explaining these disparities is often hard, except that granting discounts appears to be, at least in parts, tied to national legislation.

Finally, as another innovative fare structure element "price capping" for Pay-As-You-Go transactions can be identified, as is practised in London. We argue that price capping is a prime example to utilise advanced fare collection possibilities that also satisfies simplicity requirements of users.

1 Introduction and keywords of the fare structure discussion

How to set an appropriate fare system has always been a hotly debated topic. Fares have a crucial influence on the attractiveness of public transport systems. They are often seen not only as an economic but a wider political issue that affects residents' accessibility, social inclusion, equity and with it their quality-of-life. Next to that fares are related to spatial equality and general economy including local policy issues such as land-value capture, income taxation and urban sprawl.

Recently a number of transport authorities within the EMTA network have considered to bring significant changes to their fare structure taking advantage of the possibilities enabled by the technological advancements of the collection systems. This 'shadow on the wall' has been the driver to produce this essay.

The first resounding keyword driving these changes has been *"fare integration"*. Whereas in some cases (like Japan) this means technological integration to assure that a single smart card can be used across operators, integration in European cities often means also that fares paid during an initial journey stage (i.e. the first vehicle boarded) are taken into account for the actual fare calculation, when the journey is continued by another bus or train connection that might even be offered by a different operator. This ambition to fare mode integration leads then to the review into more sophisticated fare structures and larger structures of fare validity. To give some examples of current changes, in Greater Copenhagen currently four fare structures have been employed, but the prospect is that these are to be integrated into a comprehensive single one. In Budapest an integrated e-ticketing system is opted so that users do not have to pay each time they board. Similarly, London is planning to introduce the "hopper bus fare" that allows free bus transfers within one hour's time. In Barcelona, Helsinki and Oslo the area over which a common fare structure is applied has been extended. Details of changes envisaged in these and other cities are discussed in Section 4.

A second keyword is *"fare structure equality"* and connected to this are "simplicity", transparency" and "fairness". Especially the possibility to introduce more price differentiation due to advanced payment systems appears to have triggered a discussion on how detailed a fare structure should be. In how far should prices be distance, time and user group specific? As will be discussed there appear to be clearly different trends. Whereas, e.g. Barcelona, Montreal and Stockholm stress the need for simplification, cities and city regions such as Amsterdam, Madrid and Prague see the need for more price differentiation.

This essay is organised as follows. In the following section the fare structure discussion is set into context by distinguishing terminology including "dimensions" of the fare structure. In Section 3 we summarise the survey we conducted. Sections 4 and 5 discuss our findings, first focusing on current fare structures and then on planned changes. In Section 6 we draw conclusions and provide recommendations.

2 Context and Scope of the Fare Structure Discussion

2.1 Fare Levels, Structures and Collection Technologies

The aim is to contribute to recent EMTA discussions by focusing on issues connected with fare structures. In this essay a strict distinction is made between fare levels, fare structure as well as fare collection technology. Whereas the fare level includes the specific amount of fare to be paid, the fare structure concerns the factors the fare depends on. Arguably most literature and research has been primarily discussing fare levels or specific aspects of the fare structure, e.g. whether fares should be time-of-day-dependent (peak pricing). Advanced fare collection methods, such as payment by smart cards, have allowed the operators to consider more complex fare structures as will be highlighted. This shows that the fare structure is related to fare technology. We suggest though that in many cases a general discussion on the fare structure should precede the one about the (more tactical) fare level and technology aspects.

Partly overlapping with the objectives of this one is a report by the Transit Cooperative Research Program (2003). The report makes a similar distinction as is made in here and discusses developments of all three aforementioned aspects in North American cities. Though thirteen years have passed and American cities tend to have simple, flat fare structures, some similarities can be observed since also the US report considers different forms of integration a well as equity. The TCRP further notes the urge of cities to keep fare structures simple, a conclusion that will be only partly replicated here. Noteworthy is further a recent comprehensive quantitative benchmarking study with the support of UITP on the future of urban mobility that derives some general imperatives for transport operators (van Audenhove et al, 2014). The authors suggest that transparency of fares is important but that also innovating fare structures and "bundles of (product) services" should be utilised to manage demand and maximise revenue. A more detailed discussion on fare structures is not included in the report.

The present essay aims to reflect on some opposing arguments cities need to face and weigh when implementing a fare structure. To the best of our knowledge, besides the above literature and some general overviews on fare structure advantages / disadvantages as in the books by Vuchic (2005) and Ceder (2007), existing literature dedicated to fare structures is sparse. Academic literature as early as Vickrey (1950) discusses social welfare optimisation, whereas later literature such as Zi et al (2008) focusses on optimisation of revenue under simplified assumptions or discusses in detail the impact of fare structures on route choice (Lo et, 2003 ; Constantin and Florian 2015). It is probably fair to say that none of the (modelling) literature is able to comprehend the wide range of objectives and conflicts public transport agencies face for the design of fare structures.

2.2 The Fare structure dimensions

The fare structure is defined by the fare variability with space (distance), mode, operator, time (temporal), "loyalty" and user group. In this section we discuss these dimensions as we suggest that distinguishing these explicitly when designing fare structures will help operators in designing the structure.

Spatial aspects primarily include first the decision on whether or not to charge users according to the distance travelled. If the answer is "no", one would introduce a (spatially) flat fare system. If the answer is yes, operators have to consider how detailed the distinction should be. A common approach is to adopt a zonal structure in which the fare is not strictly related with the travelled distanced but depends on the zones traversed by the travellers, whereas with purely distance based fares users are charged for each km travelled. The general dis-/advantages of these three spatial variables defining the baseline of the fare structures are well known and listed in Figure 1. We will discuss the trade-off transport authorities face among these aspects in Sections 4 and 5 to gain some understanding in what situations these dis-/advantages become more important. Generally, we note that the trade-offs are context specific and that operator, user and wider social welfare aspects can be distinguished. For example the fact that flat fares discourage short-distance trips can be desired if it means that these trips will be replaced by walking or cycling. If, however, sufficient slow mode infrastructure is not available, it might mean that some of the short distance trips will be instead made by car or not be made at all.

Figure 1 is a simplification in that specific spatial subgroups might be distinguished. Among distance based fare structures, one can further distinguish systems in which the marginal fares are constant or decreasing when the distance travelled increases. Zones might not be concentric. Zones could furthermore be "flexible" in terms that the spatial boundary whether one needs to pay the next fare level depends on a user's travel records. In other words, fare structures exist which adopt a mix of the zonal approach and the distance-based one. In Seoul for example subway fares are determined on the norm whether one has travelled less or more than 10km. Such a fare structure could hence also be classified a distance-based fare structure where fare increments only occur after a (fairly long) minimum distance travelled.

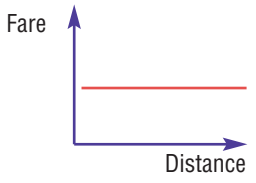
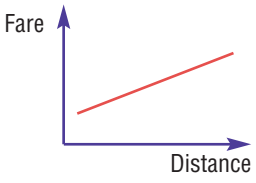
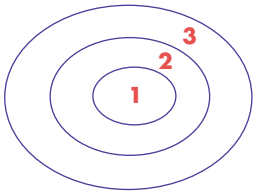
	Flat	**Distance-based**	**Zonal**
			
Advantages	Simple Cheap to implement Lowest level of fare abuse	Potential for revenue maximisation Travellers pay according to consumed service	Compromise solution between flat and distance-based ones
Disadvantages	Fare level increase has highest effect Discourages PT usage for short-distance trips	Potentially difficult fare calculation; not transparent for users Expensive to implement and control	transparent for users

Figure 1. Spatial fare structures and their dis-/advantages. Table adjusted from material in Vuchic (2005).

Modal integration or, its opposite, mode specific fares, consider whether the fare should differ between the various public transport modes that might be available in a city (including potentially new modes such as cycle sharing.) In other words, whether trips with the same origin and destination but made by different modes should have different prices. On the one side, one might argue against integration considering travel speed, operational costs and externalities; on the other side, modal fare integration will allow wider choices for customers and allow them to use the same ticket for alternative modes if one is delayed or out of service for some reason. Similar arguments apply for fare integration between different operators, i.e. whether a bus ticket is valid on all buses serving a stop independent of the operator. Integrated fares among travel (of the same modes) by different operators will often significantly increase user convenience. From an operational point of view, fare integration among operators raises only the question of revenue split.

Temporal aspects include the discussion on peak-hour fares as well as consideration of concessions or additional charges for e.g. night buses or services during festive periods. Objectives for temporally distinguished fares include congestion spreading or when there is slack capacity in the network but also to support leisure or shopping activities by giving discounts to travel at times when such activities peak out of social welfare concerns. Contrary, higher fares for periods with very low demand might be introduced to recover additional operational costs.

Day-passes etc. are clearly related to temporal aspects but we suggest to distinguish loyalty aspects which are discounts given to frequent users. These usually take the form of passes such as weekly, monthly or annual ones that include discounts compared to the fare of regular purchase of separate single tickets. We note that loyalty discounts might also take other forms, for example in the form of points that users might collect for travelling frequently (Nakamura et al, 2016). Also loyalty aspects might be person specific or not. An example for the former are non-transferable passes, an example for the latter are discounts for multiple tickets bought that are not necessarily person specific.

Further, Transport for London introduced a new form of loyalty discounts by introducing price-capping. The idea is that users do not have to calculate in the morning anymore whether it is worth purchasing a daily pass or better to buy tickets for single journeys, but instead travellers use their smart card and the card stops charging them once the daily limit has been reached. This scheme has been recently extended also to weekly price capping. The relation ship between fare structure and fare technology becomes also once more evident here, as this kind of fare structure is not feasible without advanced payment methods where the travel history of a traveller during a day or week can be stored.

Finally, user group aspects are related to all former aspects. E.g. the elderly and pensioners might get general discounts for travel after the peak period, or zonal discounts might be given for residents living in that specific part of the city. Recently, again partly because it has become easier implementable with newer fare collection technologies, in some cities the number of user groups with discounts have been increasing, by introducing discounts for the unemployed.

From the survey described in the following, it appears that spatial and user group aspects are currently the most discussed ones among the EMTA cities and therefore we focus on these. We suggest though that in particular also innovative forms of loyalty aspects are worth considering as we return to this in Section 6.

3 The survey: Motivation and Overview

A survey among EMTA members was carried out by the authors of this brief due to an overlap in interests with EMTA members. From an academic point of view, our motivation was to understand the spread in fare structures particularly in order to understand requirements in passenger flow modelling. Current software products often have limited capability in reflecting some of the fare structure dimensions discussed in previous section. Particularly modelling of complex spatial structures and loyalty aspects are difficult to model. The survey has been an effort to better understand which software advances are most urgently required.

Among EMTA partners, particularly two members had an interest in this work. Firstly Movia, due to the aforementioned current restructuring of fares in the Copenhagen region. As the revised fare structure in Copenhagen area covers a large geographical scope, there was particular interest in understanding how large the (integrated) fare region of other EMTA members proved to be. Secondly, CRTM Madrid shortly before conducted a survey on fare levels including, and in this aspect partially overlapping our survey, on fare discounts for specific user groups. In Madrid discounts for unemployed had been introduced in 2016 and there has been an interest in understanding which population groups obtain discounts in other cities. In order to better understand the spread of fare structures as well as their rationale we conducted a mainly qualitative survey among the EMTA cities. The essence of the six posed questions were as follows (the full questions included some further explanations we deemed helpful answering these are in the appendix).

Question 1: Some basic information such as number of operators in the city, whether there is an integrated fare structure and what type of payment system you mainly use.

Question 2: Description of the fare structure in the city/region.

Question 3: Reasons for choosing a particular fare structure.

Question 4: Previous changes in the fare structure and reasons for those.

Question 5: Plans for future structure changes.

Question 6: Specific question on size of integrated fare structure (less or more than 30km).

The survey was distributed among all EMTA metropolitan authorities in October 2015. We collected mostly completed surveys from 16 members: Stadsregio Amsterdam, ATM Barcelona, VBB Berlin, BKK Budapest, VOR (Vienna and Burgenland), HSL Helsinki,

[1] *See: https://tfl.gov.uk/fares-and-payments/oyster/using-oyster/price-capping*

TfL London, CRTM Madrid, AMT Montreal region, Movia (Copenhagen region), Ruter (Oslo region), Prague, Stockholm, Torino, Vilnius, and Warsaw. After obtaining initial answers to the questions we followed up with some cities to obtain additional information on some points that to us gave cause for further investigation. Results of the survey were presented at the EMTA Budapest general meeting in May 2016. We sent the presentation with our summary of the results to the participants asking them to correct any faulty data or misunderstanding. Also, in follow up we added a question specifically on how the effect of fare structure changes are modelled by the cities.

In addition to the aforementioned cities and regions we sent the survey to a number of further cities/operators to which had contacts via different roots. We obtained answers from: Athens, Gothenburg, Ljubljana (LPP, operator), Munich (MVG), Philadelphia (regional transp. authority), Skåne region as well as from Swiss rail. We selected these cities as they appeared to us interesting for a number reasons as will be outlined later. Finally, we had conversations with some operators and academics to obtain information about fare structures in cities such as Seoul, Santiago de Chile and cities in Japan.

In the following two sections we discuss some observations that appear important to us in order to derive some conclusions and recommendations.

4 Current Fare Structures

4.1 Basic fare structures

The main spatial fare structures of the cities are shown in Table 1 with the goal to categorise cities similar to the base typology shown in Figure 1. We limit Table 1 to fares for tickets purchased for single or multiple rides (Pay-As-You-Go ticket) as seasonal passes might have again different fare structures. We firstly note that many cities combine different fare structures in their city. As an example, in central Turin, the so-called "Formula" area, mostly a zonal system is applied. However, if one travels on interurban bus lines (within the central region) or uses the suburban rail network outside the central area the fare becomes distance-based. As another example, Berlin-Brandenburg is a largely zonal based fare structure, though there are also zone-independent short distance trip tickets. Such additional fare structure features are applied to overcome the issue of steep fare increases for short journeys across zone-boundaries.

We observe that most cities use, to some degree, a zonal based fare structure. This structure is seen by many as a compromise between "fairness", simplicity and the aim to avoid losing too much revenue when returns are compared to a flat fare system. The cities that do not use a zonal structure do so either because the fare collection technology is too basic or because advanced fare structures have become feasible and moving towards distance-based fares is seen as "fairer" or more equitable.

An example of the latter policy can be observed in Athens, who note that they want to change from a flat fare to a zonal based system once a smart card system has been introduced. With the currently "open fare structure" without control points they suggest that a zone-based structure is not enforceable. Berlin and Oslo also have open fare structures but do employ zonal fare structures. Berlin though hopes to moves to a closed fare system in order to be able to deploy also more complex fare structures.

A city that has "advanced" from a zonal fare structure is Amsterdam. At the time of full scale implementation of the national "OV-chipcard" in 2009 the fare structure changed to a distance-based one. This was part of a national strategy to establish a nationwide integrated fare structure. As part of this zones for specific regions were seen as outdated. Arguably distance-based fares are fairer as travellers pay according to the service they receive, but this had led to a discussion and protests of some citizens who suffered from the fare structure change (see Chapter 5).

Moreover noteworthy are "time limits", with this we mean in Table 1 whether the tickets have a limited time validity from the time of first boarding, of e.g. 1 hour. This can be regarded as an additional spatial fare limitation as the time limit determines the maximum distance one can travel. Especially in flat fare systems such an additional constraint is useful in order to avoid that people claim several journeys (possibly in opposing directions) are in fact a single journey. Note that Vilnius bases its fare structure solely on time limits with 30min and 60min tickets being available. This fare structure might be therefore seen as a mix between a zonal fare and a distance-based structure. It is zonal in the sense of the "flexible zones" noted in Section 1. Though this fare structure may have some potential for customer worry in case of delayed services, if one bases the fare relevant travel time on the scheduled travel time this appears to be a reasonable, simple to implement and understand, alternative. A time limit structure will be particularly useful if there is a relatively homogeneous network throughout the city, i.e. most destinations with similar distance can be reached within similar travel times. If that is not the case, customers in not-so-well served parts of the city might argue that they are doubly punished by a) lower service quality and b) higher fares.

Table 1. Spatial Fare structure among cities for pay-as-you-go tickets

City ; Structure used for pay-per-ride tickets	Flat fare	Zone-based (≤2hour)	+ time limits	Distance-based
Amsterdam	✔		✔	✔
Athens	✔		✔	
Barcelona		✔	✔	
Berlin Brandenburg		✔	✔	✔
Budapest	✔		✔	
East Austria		✔		✔
Helsinki		✔	✔	

London	bus	metro	(✔)1	rail
Madrid		✔		✔
Montreal region	✔	✔	✔	
Movia region		✔	✔	
Oslo		✔	✔	
Prague		✔	✔	
Stockholm		✔	✔	✔
Torino		✔	✔	✔
Vilnius			✔	
Warsaw		✔	✔	
Kyoto	bus, city center			metro; bus, suburb

[1] *for buses once the "hopper fare" is introduced.*

We further note that most cities have modal fare integration at least within the zone-based area. For distance-based fares Berlin approximates modal fare integration by defining a ticket valid for three bus stops also is valid for one metro stop. There is no modal fare integration though in London. Customers who travel by metro have to purchase a new ticket (get charged again on their Oyster card) if they continue their journey by bus or urban rail. Similarly in Japanese cities, such as Kyoto, modal (and to some degree operator) integration is not advanced, despite advanced fare collection technology in both London as well as Japanese cities. (In Japan nowadays also the same smart card can be used across the whole country.) This illustrates that fare collection technology integration and fare structure integration are not necessarily synchronised developments.

4.2 Spatial fare structures: Zone structure types

As many cities are aiming for wider spatial integration, we discuss in this section in more detail differences in zonal structures. As noted the idea of radial zones across a city centre as shown in Figure 1 is too simplistic. One might rather distinguish three general types of zonal fares of which the radial type is one. In addition there are radial fare structures with additional sectors (as in Barcelona) and areal fare structures that are not concentric such as Oslo. Berlin-Brandenburg in fact has a combination of radial and areal zones. Inside Berlin there are three radial zones whereas in the Brandenburg area around Berlin there are "honeycomb zones". It is important to note that areal zones such as in Oslo are important for regional integration of fare structures. In the Oslo case for example it was deemed important that travel in Åkershus county is not seen as a "suburb" of Oslo as a radial zonal fare structure generally implies.

Simple radial structures further have the disadvantage that long trips along the periphery of city centers are underpriced. In particular with improving public transport network coverage with more connections between suburbs at opposite corners of the city that avoid traversing the city centre therefore radial zones have limitations. Only for (large) regions that want to keep a fare structure focused on one central business district area therefore radial zones with sectors become (remain) attractive.

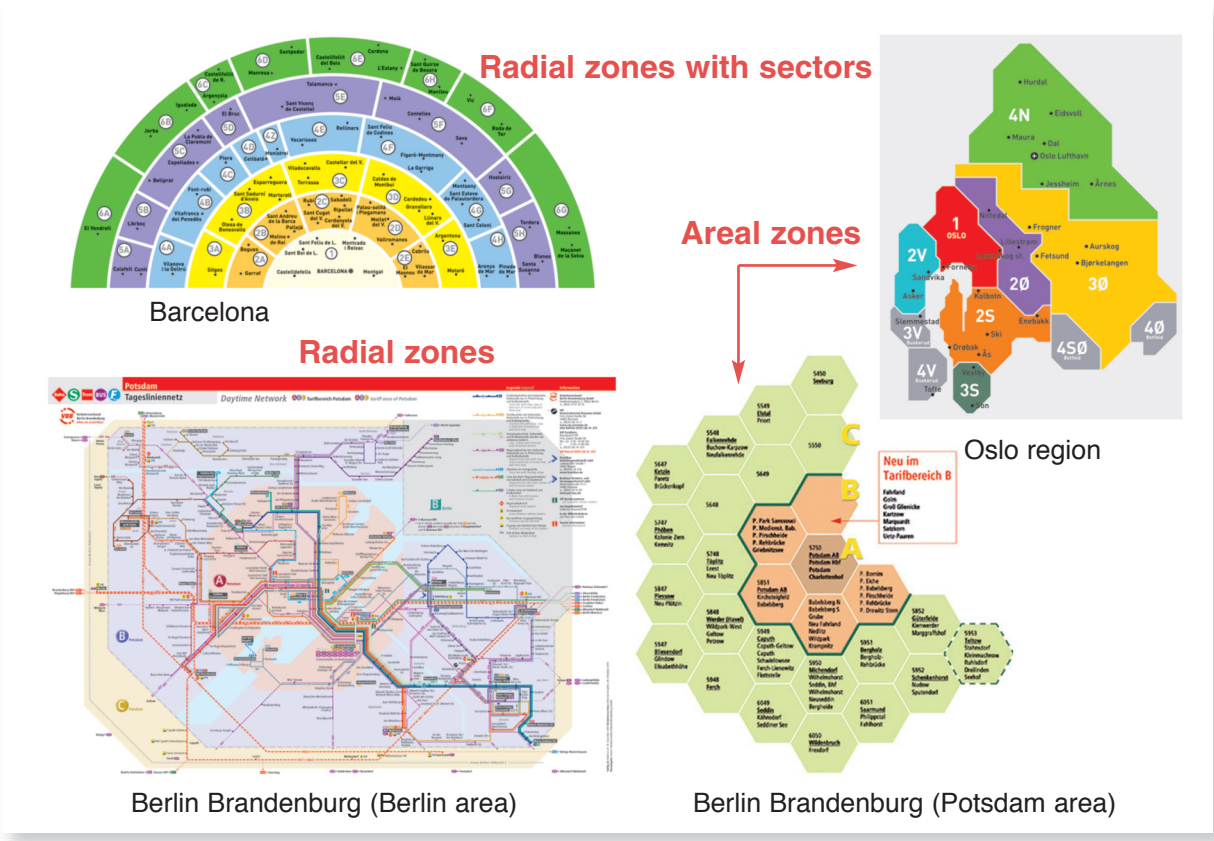


Figure 2. Three general zonal fare structures and examples

4.3 User group discounts

Besides spatial aspects, a number of cities have used advances in fare technology to increase their product range and provide discounts to specific user groups. Besides Madrid also Turin, Barcelona and Warsaw have discounts for unemployed. In many cities unemployed per se does not allow for discounts but instead discounts are given based on varying definitions of "risk of social exclusion". Having some kind of disabilities usually qualifies for discounts. Generally though, there appears to be little consensus on who should be included in this group nor on what the discount level should be. In some cities discount group regulations appear to be connected to national legislations on qualifications for social benefits whereas in others, such as Turin and Warsaw, one might rather refer to the group qualifying for discounts as "special interest groups". This leads to cases that in Turin for example also local police officers and war veterans automatically qualify for discounts.

In most cities young age or being in education as well as advanced age qualifies for discounts. The following three graphs illustrate that also here the rules are all but harmonised. In most cities (among those who replied to this question or for which we could obtain data) travelling up to age 6 qualifies for travelling free. The exceptions are Amsterdam and Oslo. Above this age large differences can be observed among the cities. In Stockholm, independent of whether a person is in education or not, even a 19 year old can obtain some reductions.

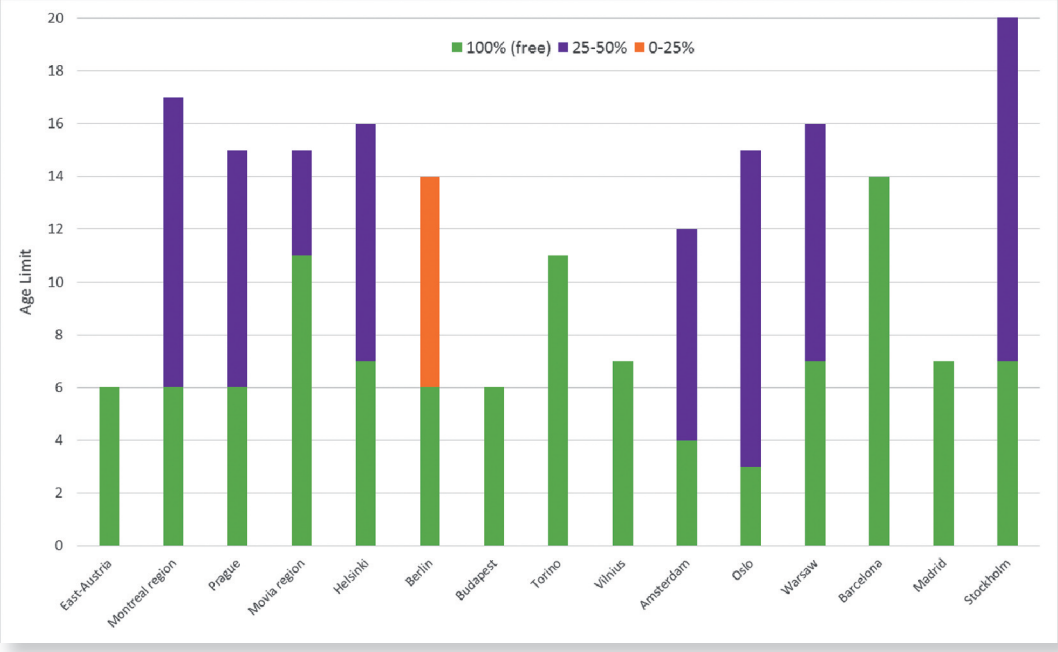


Figure 3. Differences in young-age discounts among cities

Figure 3 should clearly be seen in connection with seasonal tickets for educational discounts. In Oslo, for single tickets children under 6 might have to pay, resident children under age six can obtain free passes and also older children can obtain significant child benefits. Also in Amsterdam children up to age 12 can obtain children passes. Most generous appear to be city of Vilnius and the Eastern Austria (Vienna and Burgenland) in that students, even at a later age, can obtain very large benefits. In Montreal educational benefits appear to be lowest.

Similar large differences can be observed also for senior discounts. All cities have some discount for those aged over 70, although the percentage of discount varies significantly. It can be observed that in Eastern European cities single tickets for seniors tend to have higher discounts.

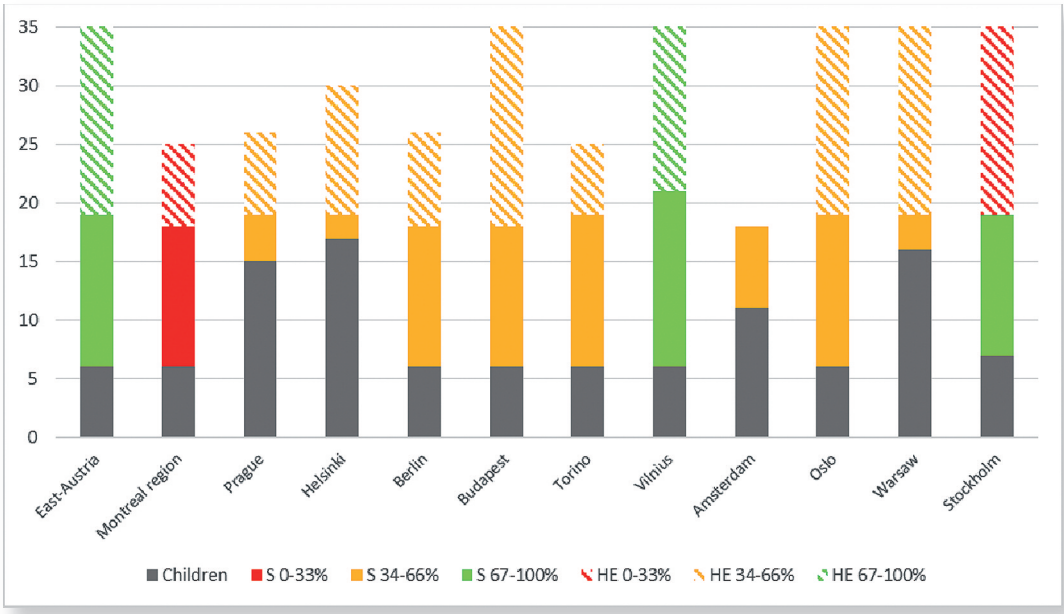


Figure 4. Differences in educational discounts (for season pass, S= elementary and grammar school, HE: higher education)

Although in general, we can account for these results, it's another thing to identify a common rationale for these discounted groups. One might assume that in cities where generally the price of public transport is higher the discount structure is more extensive. Remarkably, this seems not to be the case. Neither do we find much evidence for the assumption that in cities with strong congestion problems less discounts are granted; with the exception that in London senior discounts are in parts of the network time dependent as is nicely illustrated in the "London Oyster 60+ photo map" (see http://content.tfl.gov.uk/60-plus-photocard-new.pdf). With increasing discount schemes and increasing electronic ticketing introducing such time-dependent discounts might be one way forward. Finally, we should note that obviously fare discounts will decrease revenues which will have to be recovered. The Madrid research showed that in general operators on average, increased their fare by 3% over 2015. In how far user group discounts have led to general fare level increase is a causal link that cannot be ascertained.

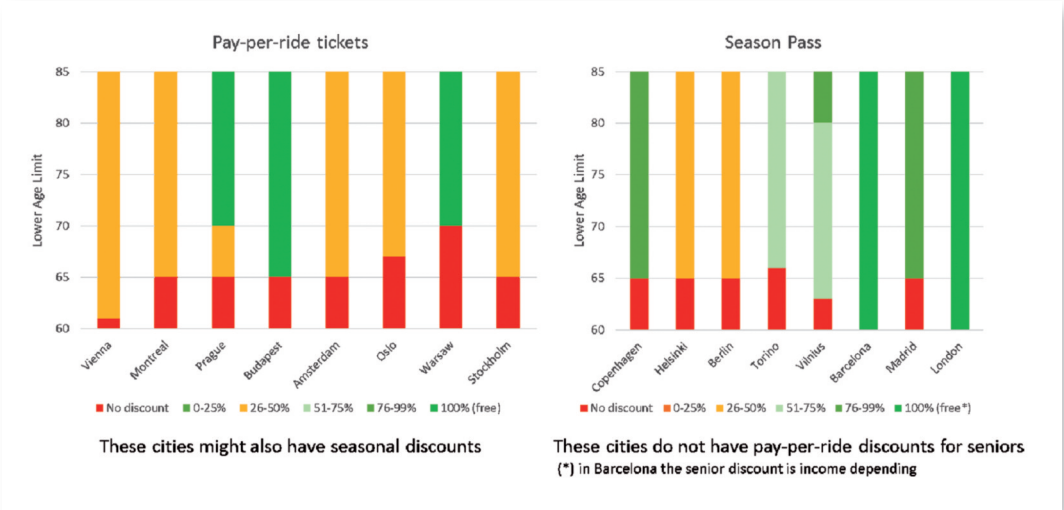


Figure 5. Differences in senior discounts

5 Overview on Planned changes and their Rationale

A key point of our survey was to understand whether there are planned changes in the fare structures. The responses showed that indeed most cities aim to introduce some, often major changes. In Table 2 responses involving those changes are synthesized as well as the main reasons for it.

In red highlighted are cities that are planning to implement some major changes in the spatial fare structure. A common trend is clearly the introduction of spatially larger, integrated fare structures. As an example Helsinki can be mentioned here. Since 1986 the major

metropolitan areas close to Helsinki have been integrated into a common fare structure which is currently being extended to include many more municipalities in the wider surrounding area. Similar effects can be seen in Barcelona where over time possibly all of Catalunya might be subjected to integration into a single fare structure. Prague's fare structure region has also been significantly increasing over time to such effect that the current fare structure based on radial zones appears to be outdated: travelling long distance journeys inside the zones are perceived to be underprized. The background to this is that the fare structure dates back to before the fall of the communist period. In post-communism the urbanized area has grown rapidly and the fare structure was kept in place in order to sustain an attractive service that could prize wise compete with fast growing car ownership. Nowadays more emphasis has to be given to revenue issues and rebalancing the expenses. Noteworthy for Prague is further that some aspects of the radial fare structure are disrupted by municipalities at the outskirts of Prague who pay subsidies in order for their city to be priced in a radial zone closer to Prague.

Similar arguments that the fare structure is partly outdated apply for Turin, though so far no major changes in the fare structure are envisaged. The operator's argument is also less based on increase in areal coverage as it's focused on increase in service quality of radial services. This means parts of the current structure is perceived as less adequate anymore as fast and long-distance journeys within some zones have become underprized.

A second group of cities emphasise that the fare structure needs to become simpler. Figure 1 showed the areal fare structure of Oslo that resulted from a fare structure reform published with the slogan "from 88 to 8" zones. We believe the Oslo experience leads to some transferable lessons as discussed in the following section. Stockholm is another strong example where simplification of the fare structure has been a major driver for revision. In fact, currently the introduction of a flat fare structure throughout the region is under discussion. Ljubljana also noted simplicity as an issue, emphasizing communication issues in that customers need to be able to understand the benefits of the different pricing options. Other cities have a very simple fare structure and for revenue reasons (rebalancing expenses and revenues) would like to change it but do not pursue this, again due to retain the level of simplicity. Athens mentioned that the flat fare structure is a result of both technological constraints as well as hesitation to introduce a more complex structure.

This ambivalence between retaining simplicity and reversely harvest new possibilities to introduce a more complex structure by applying electronic ticketing is apparent in various cities. Berlin notes that there is a desire to replace the currently open access system (no gated access) by a closed system. Together with electronic ticketing this could be used to increase revenues from a more complex and differentiated fare structure. Simplicity and the investment costs of introducing a closed system are used to argue to dispense of such a revision. Other cities or urban areas that want to utilise the additional possibilities of advanced ticketing are Barcelona, East-Austria, Madrid, Montreal and Philadelphia. East-Austria is in this list the region that appears to be most progressive and least concerned about losing simplicity aspects. Under discussion is that in future mobile-phone based tickets are based fully on distance travelled. The other cities/regions want to use smart card tickets mainly to expand their product range in terms of user group discounts. Noteworthy is further the initiative in some cities such as Madrid or Ljubljana to utilise the smart card for a far wider reaching integration of services including all modes of public transport such as e.g. cycle sharing, but also other citizen services such as parking, libraries and museums.

Table 2. Planned changes in the Fare Structures [2]

City	Future Changes	Main Reasons
Cities emphasising changes in the Spatial Fare Structures		
Berlin-Brandenburg	Zones will become smaller	Increase price fairness
East-Austria	Uniform tariff for bus and train	Optimize the price-performance ratio
Gothenburg	Flexible zones	Simplifying the current fare system
Helsinki	Increasing covering area; from zonal to combined zonal-distance based fare	More municipalities are interested to join
Copenhagen	Integration of 4 tariff structures into 1	Simplify for users
Munich	Possibly new tariff structure Revenue increase	Equality, Peak hour congestion;
Oslo	Increasing the area of coverage	Seamless travel, promotion of PT usage
Philadelphia	Integrating fare system Introduction of smart card technology	Equity concerns
Prague	Increasing number of zones rides not too low	Fairness of pricing long tangential
Stockholm	Possibly new tariff structure (flat fare)	Simplify for users; Revenue increase
Vilnius	Integrating fare system	Simplify for users
Cities emphasizing technology and changes in user group specific fare structure aspects		
Amsterdam	Possibly more complex system;	Cover the main share of operational
Athens	Introduction of smart card technology	Revenue increase
Barcelona	Introduction of smart card technology, extension of area	Simplify for users
Budapest	Developing an integrated e-ticket system	More transparent for travellers
Ljubljana	Introduction of online smart card	Integrate fare collection systems
Madrid	Ticket to be integrated with other citizen services; new discount tickets	Diversify fare system
Montreal	Discount tickets, Remove inconsistencies between local and integrated fare structures/tables	Increase ridership; Simplify for users
Torino	Some adjustments to the rules behind the fare system	More municipalities to join; Integrated system based on operators' ridership;

[1] *Some of these changes listed in the table need yet to be approved in the cities but are still under discussion within the councils and parliaments of public transport authorities*

6 Discussion and Recommendations

In this section we aim to advance and conclude previous findings by pointing out some lessons that are believed to be of general interest for cities considering fare structure changes. We acknowledge that most of the conclusions need to be considered within a larger political context where transport authorities set out and reflect the priorities of the societies they serve. Fare structures then can explain as well as justify different fare structures. Based on these priorities, trade-offs between different objectives and user groups and utilising opportunities enabled by the progress of the fare collection technology then fare structure changes can be implemented.

We divide this section into five subsections that all reflect general points that appear important to us. To some degree Sections 5.1 and 5.2 might though also be seen as subsections of 5.3. In 5.3 we highlight specifically the importance of simplicity and give some arguments against "traditional economics" that favours (complex) marginal cost pricing. The argument is continued in 5.4 where we elaborate on the term "fair". In 5.5 we then highlight some innovative fare structure solutions that appear worth considering by a larger group of cities than done currently.

6.1 Common feature: Pricing journeys, not trips

It can be observed that the introduction of the contactless smart card has been a trigger to examine enhancement of fare structures. In Barcelona and Madrid for example one clear reason for introducing smart cards has been the desire to enable the introduction of comprehensive tariff differentiation. In other cities, such as e.g. Helsinki, arguable the causality has been reversed; advanced payment technology had to be implemented regardless and is ex post facto proved a useful tool for fare structure changes. As we will point out there is a conflict between simplicity and using the features and properties of the smart card. However, what is clear is that smart cards allow "pricing journeys, not trips". Customers do not want to be charged according to how many transfers they make. This appears to be a common and important feature implemented by most of the cities. An exception among cities with advanced payment system is quite surprisingly London. Here customers have to pay for buses regardless if they have used the tube as a first stage of their journey. Having said this, buses are much lower priced than the London Metro, which might not be feasible with multi-modal fare integration. Our conclusion is that pricing of multi-stage journeys and not single trips or stages should be the leading principle in line with the concept of "Mobility-as-a-service", unless one has particularly strong reasons to keep a hierarchy in the transport system, in order to justify cheaper fares on a slower or inferior mode.

6.2 From urban to regional fares

Our survey highlights that in many cities wider areas are being integrated into the existing fare structure. Only very few cities (Ljubljana, Vilnius, Athens) have still only local fare

structures and do not mention plans to extend the fare much beyond the 30km border suggested. The regional fare structure is often due to political pressure and is the trigger for then even further and more substantial reaching fare structure changes. Municipalities at the fringe of the large cities have a strong desire to allow their citizens to travel with less cost into the CBD in order to promote local economy and attract residents.

Our key message is that expansion of the common fare structure zone is not as straightforward as some transport authorities might have believed. With larger integrated fare areas, today still rare, multi-centre structures will become more important. Regions do not have necessarily one centre so that ring zones are not a good option anymore. Instead areal zones as introduced in Oslo will become more important (see Figure 2). We suggest that the Oslo experience further offers a number of other potentially important lessons: Ruter concluded that there is no reason for complex, small zones in rural areas with low fare income. This makes the fare structure needlessly complex and unattractive without gaining much revenue. Ruter further concluded that a multi-centre fare structure should have the same fare for each zone. This will be perceived as fairer and allows for simple ticketing in that one can price tickets simply based on number of zones travelled. One should note though that in larger, more congested metropolitan areas there might be more reasons to protect travel into some of the most congested areas. Finally, important for the success of revisions in the zonal structure is to not break local communities into different zones. Otherwise this can lead to avoidable significant increases in expenditures for some households possibly followed by protests.

This last point is partly echoed by experiences in the Netherlands, where not a new zonal structure but a nationwide distance-based fare structure was introduced. This led to some significant price increases for some customers with following strong protests of harmed users. In reaction to this the zonal fare structure for seasonal tickets was in some cases re-instated. We suggest that, if changes in the fare structure are unavoidable, and in particular if more complex fare structures are introduced, distinguishing the fare structure for pay-as-you-go tickets from the basic structure for seasonal passes should at least be considered to avoid unfair impacts for daily users.

6.3 *"Simplify if you can afford it.."*

The above lessons might also be summarised by referring to the mantra we chose as header for this section. Simple fare structures such as flat fares are not optimal from the economic perspective where travellers should be charged according to their actual consumption of transport services (especially if there is limited transport capacity). Complex fare structures allow for revenue maximisation through such "marginal pricing", possibly also exploiting the captivity of some users to the public transportation network. Marginal pricing has become increasingly feasible through advanced fare structures, though truly charging according to operator and social costs remains elusive. This is not just a matter of technology but also due to price distortions in competing transport options as well as limited ways to assess the social impact of fares. Especially assessing the true impact of fares for socially disadvantaged groups remains difficult.

The traditional economic point of view neglects further that simplicity in itself appears to be important for customers. In how far simplicity creates demand appears difficult to quantify

as is also evident in the different opinions operators have regarding the importance of this topic. We suggest a general division as in Figure 6 is feasible. Whereas in the group of cities on the top of the figure the survey answers focus more on keywords such as simplification, the below group of cities are rather emphasising ideas connected with equity and to some degree revenue increase. That expanding the fare structure and fairness are located near the border line is to indicate that these are concepts noted by both group of cities. As discussed for example both Barcelona and Helsinki are increasing their fare structure area. While Barcelona is aiming to integrate the new areas without significant changes, Helsinki is revising the fare structure and will also utilise distance-based pricing in the future. Our conclusion is that simplification as a value itself should not be underestimated but suggests that further research is needed to be able to quantify how much revenue might be lost due to this. Therefore our motto "simplify, if you can afford it" remains valid. Note also, that this discussion will have to consider fare level issues. In cities with generally low public transport fares compared to income, it is not clear how many customers will even consider (small) increases in fares related to distance. Our on-going research from London suggests that for example zone-borders do not measurably affect trip distribution.

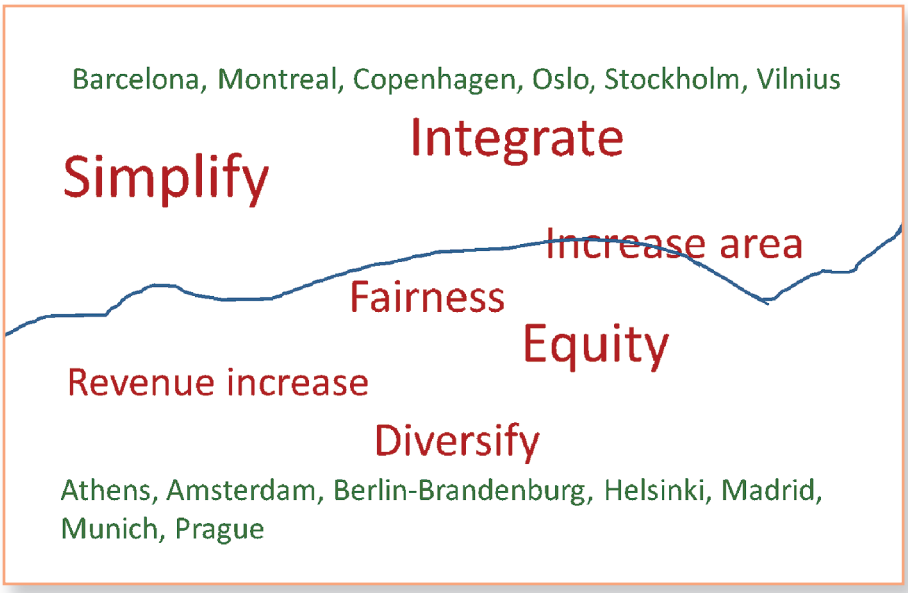


Figure 6. Rough classification showing two groups of cities with different emphasis in importance of fare structure objectives

6.4 The "Fair fares" conflict

Figure 6 puts fairness towards the centre of the graph to illustrate that fairness is claimed as an argument by both sides. In fact, all transport authorities want to price fair, but what a fair fare really is remains unclear. As noted in previous section from a purely short-term economic point of view more price differentiation is fair. Furthermore, from a long-term perspective, one might argue that environmental reasons and to avoid land-sprawl, complex, distance-depending fares are better and more fair. However, from a social-welfare perspective further arguments come into play that also favour simpler fare structures. Punishing population groups that cannot afford living in city centres by topping up the fare with additional charges for their travel to work and other opportunities often located more centrally, does introduce a double standard and therefore could reinforce social inequality. We suggest that this discussion on distinguishing short term, long term and social-welfare aspects of fare structures should be continued among transport authorities in a more organised way as the term "fair" appears to be overloaded.

6.5 Innovative fare structures

Our survey further showed that even cities that are closer to the cities mentioned at the bottom of Figure 6 do not intend to introduce what one might generally call, "first best pricing". In particular peak-hour pricing was (to our surprise) not much discussed in the answers. This is furthermore not just an issue for European cities but for example also in the highly congested metropolitan area of Tokyo there is no peak hour pricing. Part of the argument is again connected to social-welfare in that workers who have no flexibility in their choice of working hours should not be punished by having to pay higher fares. There are though some experiments in Tokyo with introducing route-specific public transport fares. The idea is to discourage users to transfer or travel via the busiest stations if they can reasonably be expected to do so. With advanced fare collection technologies such new advanced pricing structure might also be more introduced in other cities where transport networks provide sufficient routing options.

From the survey and literature we furthermore suggest that two fare structure elements are worth to be considered more widely. Firstly, the in Section 1.3 discussed concept of "flexible zones" as practised in Seoul. Such flat fare structures within a certain radius of the travellers first boarding point in the morning plus distance-based fares for longer trips is apparently also considered by Gothenburg.

Furthermore, we suggest that the in Section 1 introduced concept of "price-capping" as introduced in London is attractive for both users and operators in that it might generate also more revenue. It might allow users to be more willing to accept some complexities in the fare structure as an upper price limit is guaranteed. One possibility to consider also social-welfare issues would be to introduce different capping limits depending on income or place of residence. We suggest that despite the need to remain simplicity, a general lesson from our survey is that the technological advances in payment systems can still be utilised. If customers do not have to worry about being overcharged, fare structures can be a powerful tool to generate and manage public transport demand.

We refer in this context also once more back to our starting point of distinguishing the different dimensions of the fare structure. In the design of new fare structures we suggest that structuring the discussion into spatial, modal, operator, temporal, loyalty and user group aspects might be a starting point for authorities to consider appropriate revisions.

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8 Appendix A: Complete Survey questions

Question 1: For which city/region or operator will you answer this survey? Also could you provide some basic information such as: Number of operators in the city, whether there is an integrated fare structure and what type of payment system you mainly use (e.g. paper tickets, prepaid smart card etc.).

Question 2: Could you describe the fare structure in your city/region? (flat fare, distance-based fare, zonal, ..) We are mainly interested in the fare structure, not the absolute value of the fare. Also do you have peak-hour fares or other special features? Do you provide discounts for certain groups such as children, seniors, veterans etc.?

Question 3: Why did your city/region or organisation choose this fare structure? Are you aware of a structured discussion within your organisation on which system would be best? Or possibly your organisation could not choose the systemfreely but was constrained by regulations? Are there other objectives than to cover cost/make profit? (e.g. promotion of public transport usage in certain areas, equality concerns, etc…)

Question 4: Have there been any changes to the fare structure in the past? If yes, could you tell us why? (e.g. new main products, phasing out existing products, major changes in tariff zones, expansion of the covered area, etc.)

Question 5: Do you think changes should be made to the fare structure? If yes, what kind of change? Has or will your organisation utilise the introduction of electronic ticketing for changes inthe fare structure?

Question 6: Does the fare system integrate both local trips (e.g. 1-30 km) and regional trips (e.g. 31-99 km)? Please enter the approximate longest trip in kilometres you can carry out within the fare system.

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