Integrated ticketing for public transport

In a nutshell

SUMMARY
It is best practice to introduce integrated ticketing in the form of a smart system with the capability of identifying and charging for trips which use multiple modes of transport. If the public administration acts as a public transport operator (e.g. through a city-owned subsidiary company) it can implement the integrated ticketing itself. In cases where the municipality awards public transport services to private companies, the integrated ticketing solutions can be required in the tender.
Target group
Public administrations responsible for mobility and/or public transport in their territory
Applicability
This best practice is applicable to all public administrations responsible for public transport. However, below a certain critical mass of users and annual transactions, it can be challenging to recoup the initial investments in terms of the time and finances needed to implement a smart integrated ticketing system.
Environmental performance indicators
• Percentage of trips paid for by the integrated ticket (%) • Number of public transport users who would have used private motorised transportation in the absence of an integrated ticketing system (normalised by total population in the catchment area)
Benchmarks of excellence
• At least 75 % of trips are paid for by the integrated ticket

Description

A transport ticketing system is “integrated” if it allows travellers to pay for all legs of a journey on different public transport modes, typically including buses, trams, subways, light rail and in some cases even taxis, ferries, shared cars and bicycles. The environmental benefits of integrated ticketing schemes are primarily related to the increased ease and convenience of using public transport by eliminating the hassle of paying for each individual journey and thus contributing to wider modal shift strategies. Puhe et al. (2014) argue indeed that “the integration of tariffs, operators and modes is proved to have a positive impact on transport demand” (2014, p. 1). The benefits of a shift from private motorized transport to public transport are undisputed in terms of air quality, use of valuable urban space, noise reduction etc. (see section “Achieved environmental benefits” below for further information).

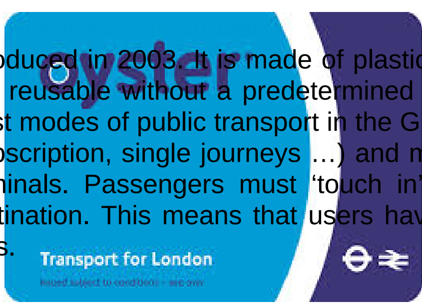
Integrated ticketing is not a radically new concept; it has existed in many cities for several decades. It comes in a variety of forms with varying technological requirements, covering different combinations of transport modes within specified zones and timeframes; each integrated ticketing scheme has its own set of advantages and disadvantages. Sometimes integrated ticketing is understood as some form of proof of payment (e.g. a paper ticket or a magnetic stripe card) for a lump sum, which allows travellers to use different public transport modes for a certain time. This approach is very easy to implement and therefore widely deployed. In Cologne, Germany, for example, a “1b” paper ticket allows people to use buses, trams and inter-urban trains within a certain geographical zone for up to 90 minutes. This low-tech approach is rather crude, however, because it penalises people, who only want to take rides that are just a little longer than the cheaper “1a” short-distance ticket. Generally speaking, the large increments between price steps are often perceived as unfair. Puhe et al. (2014, p. 9) conclude that “magnetic stripe cards are … technologically simple and cheap to produce. However, they are easy to copy and only able to save very little information.” Due to these and other disadvantages, such systems are not the avant-garde in the area of integrated ticketing.

Because best practices are to be based on a “frontrunner” approach (Schoenberger et al., 2014), this document is primarily based on a notion of integrated ticketing as a smart system with the capability of identifying and charging trips which use multiple modes. In most cases, the charging method is a deduction from a pre-paid amount. Different systems exist for the storage of pre-paid monies (or the remote information about the remaining amount): This can be recorded on a magnetic strip on the back of a paper ticket or on a central server, with which a chip inside a so-called “smart card” can communicate. For an overview of the different approaches see section 2.2 in Puhe et al. (2014). These different systems require different types of cards and different technical infrastructure. The most advanced systems also allow the use of smartphones for this purpose – for examples see Clarion (2014).

The practical usability of a product or service like public transport is not the only factor for its acceptance; it also has to have a positive “image” (Shove, 2010). It is therefore noteworthy that the introduction of an integrated ticketing system can boost the reputation of public transport as a modern and respectable way to move about. Pricing matters too – both in terms of actual money spent as well as in the subjectively perceived price. This is important because the use of integrated tickets is often rewarded with some form of discount. In the smarter versions of such systems the user can even rest assured to get retroactively and automatically charged the most advantageous fare (known as “capping”). This significant psychological effect eliminates the worry one would otherwise face of choosing the best ticket type out of an often confusing array of options. Such benefits seem at least as important as the actual economic savings because most travellers could not actually specify their exact saving.

The integration across various modes of public transport requires the coordination of various stakeholders, operators, authorities, financial service providers, telecommunication operators and suppliers (Puhe et al., 2014. p. 2-3), the exchange of data, automated financial transactions and so forth. It is therefore not surprising that various political, technical and managerial problems caused long delays in cases such as Sydney, Dublin or Stockholm. The Hungarian capital managed to tackle related issues and to replace the fragmented management structure of urban mobility with the establishment of the Budapest Transport Centre (Heves, 2012). Despite some undeniable challenges, a large number of cities have managed to introduce various forms of integrated ticketing. A reasonably comprehensive list (of transport smart cards) is maintained at Wikipedia (Wikipedia, 2014). It shows that not only large cities managed to establish such a system but also medium and smaller municipalities and even semi-rural authorities like counties.

Where the city itself acts as a public transport operator (e.g. through a city-owned subsidiary company) it can implement related initiatives itself. In cases where the municipality awards public transport services to private companies in a tendering process they can at least spearhead related efforts by stipulating integrated ticketing solutions into the tender document (RAL gGmbH, 2014). In a third case, where public transport is provided through multiple competing private companies, related coordination efforts can be particularly challenging. But even there, public administrations can bring these actors together and facilitate their cooperation as neutral broker.



A integrated ticketing for public transport is London’s Oyster card, which was introduced in 2003. It is made of plastic, the size of a credit card with an incorporated chip and is therefore rechargeable and reusable without a predetermined end. Oyster is supported by Transport for London (TfL) and can be used across most modes of public transport in the Greater London network. As a contactless smart card, it can hold various ticket types (subscription, single journeys …) and money can be added to the card via ticket machines, online or at some credit card terminals. Passengers must ‘touch in’ at the beginning of their journey and ‘touch out’ when they reach their final destination. This means that users have to hold their card near a card reader device at public transport entrances and exits.

Environmental benefits

Environmental benefits of integrated ticketing systems mostly accrue from the increased ease and convenience of using public transport, the reduction of queues, faster boarding times and, as a consequence, an overall increase of travel speed due to the reduced times needed for cash transactions, primarily on buses. Such systems therefore contribute to wider modal shift strategies. The benefits of a shift from private motorized transport to public transport are undisputed in terms of air quality, use of valuable urban space, noise reduction, lower levels of atmospheric pollutants and greenhouse gas emissions, greater biodiversity and improved mobility and access for citizens.

However, such effects are very difficult to trace in a direct chain of causes to a modal shift triggered by an integrated ticketing system. This would require precise knowledge about how many people made how many journeys by public transport instead of by car simply because of an integrated ticketing system. Nevertheless, related causal claims are widely considered plausible.

What could be called secondary effects are also being reported. These can result from the data about people's travel patterns (e.g. timing and sequencing of trips, travel origins and destinations) that many such systems allow to collect and therefore facilitate efficiency gains for the operator such as a better degree of capacity utilisation (Blaum, 2013) and others (Pelletier, Trépanier, & Morency, 2011).

In cases where such a system is implemented with reusable smart cards, additional environmental benefits stem from the reduction of paper usage. In the case of London, where currently 85% of all rail and bus trips are being paid for using an Oyster card, an estimated 1542 tons of paper are saved per year, equivalent to 38 heavy 40t trucks[1]. Also the reduced amount of rubbish from discarded paper tickets deserves mention in this context. The scale of such benefits is of course much less impressive for smaller systems in less populous areas.

[1] Own calculation based on the following data and assumptions: Number of trips per year on buses, underground, Dockland Light Railway, tramlink, overground and Emirates Air Line: 3820.7 million (Transport for London, 2013, p. 7). Plus 500 million estimated trips on eligible National Rail services within the London fare zones. Estimate of 60% return trip tickets (only one ticket for two trips). This results in a total number of trips per year of 4320.7 million. Assumed weight per paper ticket: 0,7 g.

Side effects

As with all initiatives to increase ridership numbers of public transport, integrated ticketing aims to attract new users from individual cars. However, there is no guarantee that an increase of public transport's attractiveness might not also induce cyclists and pedestrians to shift to public transport. Similar and even inverse unintended side effects have been reported from various modal shift strategies (Cachia Marsh & Ritzau-Kjaerulff, 2012). The absolute environmental effect is still mostly positive though. This phenomenon therefore underlines the importance of considering mobility as a complex system whose various elements have to be tackled in an integrated manner. The approach of *Sustainable Urban Mobility Planning* (www.mobility-plans.eu) provides such a holistic strategy that can help to avoid the cannibalisation across different sustainable modes of travel.

In almost all existing cases and presumably in all future applications of integrated ticketing, so-called smart cards will play a prominent role. At the most general technical level, an integrated circuit (chip) on board such a card can communicate with a card reader through some form of Near Field Communication (NFC) technology. The production of these chips, readers and cards requires material and energy resources. The cards themselves are typically made of plastic, generally polyvinyl chloride or other (often polyester-based) materials. A lifecycle assessment for these materials should be considered in principle but in practice is very time consuming and, considering the magnitude of mobility related resource usage, not hugely significant. In addition, smart cards from paper with a smaller environmental footprint are readily available on the market anyway and should be considered.

During the operation of a smart card-based integrated ticketing system, significant amounts of electricity are being consumed for the reader equipment, vending and top-up machines, website and central processing servers. However, their combined environmental impact is assumed to be marginal compared to the expected benefits of more and more frequent public transport usage. Quantitative data about these effects is very hard to come by.

Applicability

Integrated ticketing approaches have successfully been implemented in a variety of cities and regions, on every continent, from megacities to more peripheral areas, in highly developed as well as underdeveloped countries. This indicates a considerable degree of freedom from contextual constraints. It does not imply universal applicability and frictionless transferability however.

One potential obstacle to the implementation of an integrated ticketing system is the size of a public transport system. Below a certain critical mass of users and annual transactions it can be challenging to recoup the initial investments in terms of time and finances. Direct financial investments refer to the installation of the necessary technical infrastructure, which do not necessarily have to be borne by public authorities. In any case, these costs have decreased dramatically over the last one and a half decades, during which integrated ticketing systems have become more mainstream and the number of suppliers has increased.

Time investments are primarily related to the coordination efforts among the various actors that need to cooperate in an integrated ticketing system. Here, public authorities can play a particularly prominent role. In fact, Puhe et al. (2014, p. 45) argue that “strong governmental support has proved to be important for institutional coordination of integrated ticketing schemes in the Netherlands and the UK.” Under rigorous economic constraints (i.e. shortage of staff), such initiatives can obviously struggle to develop sufficient momentum. What can also hinder such activities are institutional and policy barriers within a public administration. In well organised administrations, however, these problems should not be insurmountable.

Regardless of the size of a public transport area, what can be a significant hurdle to the introduction of an integrated ticketing system is a highly disintegrated landscape of public transport operators. This increases the coordination effort and the risk of ending up with a non-comprehensive system. Nevertheless, examples exist where such challenges have been successfully overcome (Heves, 2012).

Locally specific factors can also include social and cultural barriers with regards to the willingness of various actors to engage in related discussions and cooperation agreements. Puhe et al. (2014, p. 9) refer to a similar problem as a “lack of political and entrepreneurial vision.” Likewise, the legal context and related liability issues, data protection regulations etc. also differ between countries but in few cases to such a degree that it would thwart integrated ticketing initiatives completely.

A strong factor that can boost the wider application of such systems is the wealth of experience from existing cases so that no one has to re-invent the wheel. The pioneer investment of cities such as London can now be avoided almost completely by follower cities.

Economics

Economic aspects of integrated ticketing can be differentiated into three basic categories as in the table below.

Table 4: Three basic categories which can differentiate aspects of integrated ticketing

Expenses	Savings	Revenues
• Research and development • Procurement of equipment • Marketing / customer support • Overhead and management • Maintenance	• Reduction of fare evasion • Staff savings (driver time / ticket offices) • Reduced managerial effort • Increased expertise in ICT which can be applied to other sectors (Cheung, 2006)	• Increased customer base • Increased usage intensity • Revenue from applications beyond transport • Sale of know-how and intellectual property (rare)

The price of e-ticketing technologies has steadily decreased in recent years. Early implementers, however, such as Hong Kong or London had significant research and development costs to bear. The total cost of the Oyster card from the initial scheme development until and including the forecast costs to the end of 2015 was £1.1 billion (TRANSFORuM, 2014). It is important to note, however, that due to the widespread use of similar systems nowadays, integrated ticketing solutions can be purchased “off the shelf” with close to no research and development costs. But even in London with its expensive early adopter situation “the business case was quite clear” argues Matthew Hudson, Head of Business Development at Transport for London (cited in Andrews, 2013). The old paper ticket system would not have been able to handle the amount of passengers. An extension of the gatelines would have solved this problem but this would have been even more expensive and less sustainable than this new technological solution.

In most other cities an onrush of public transport users is probably not the most pressing problem. Other business cases are therefore required and will always include a bundle of factors such as the following:

Most important among all revenue generating aspects is the plausible assumption that the convenience of such a system increases public transport ridership overall. This is seen as a combination of an increased customer base (non-users becoming users) and usage intensity (infrequent to regular usage). Fewer vending machine transactions mean reduced investment in such machines and in their maintenance. Bus drivers lose less time to fare collection; also their job satisfaction and retention might increase. Faster boarding can translate to faster trip times overall, i.e. same number of passengers moved in less (driver) time while customer satisfaction increases. Also the problem of fare evasion and irregular ticket usage can be reduced. London's public transport companies have seen their income losses due to such problems "cut from 4.5 percent in 2003 to 1.5 percent in 2007, which translates into additional proceeds of nearly € 47 million" (Blaum, 2013).

Another important advantage of smartcards plays out its strength in situations where public transport services are provided by multiple operators. Here, the data which is continually and automatically generated allows to control the distribution of revenue between the operators (ELTIS, 2013). In addition, the running of an integrated ticketing system can, in itself, be managed in all cases at lean costs. The cost of card sales can be optimised, taking into account the experience of various frontrunners (drop from 14% to 10% in London), "reducing commissions paid to agents for Oyster sales, lowering the number of cards that are issued, and a drive to encourage customer self-service" (ELTIS, 2013, p. 2).

Additional possibilities to even generate extra revenue are being used in some cases where the card's commercial potentials are being reaped. Hong Kong is a typical case where top-ups can be arranged in retail shops and through automated links to bank accounts. This application eventually led to a widening of the payment function to non-transport related services and products and generates some revenue through commissions. Such applications are said to have particular potential in touristic destinations (Puhe et al., 2014). Interestingly, London chose the opposite direction and updated its reading devices to accept contactless debit and credit cards for small amounts under £20 without PIN (Andrews, 2013).

Driving forces for implementation

The main motivation for the introduction of an integrated ticketing scheme is typically a robust business case that promises at least an acceptable return on investment within the foreseeable future. An increased revenue stream, avoided other investments and direct savings all play a role in such plans. But even if the outlook does not promise a significant profit, public authorities have still chosen this approach because of its non-monetary benefits to their citizens in terms of environmental advantages, quality of life and the sheer convenience for public transport users.

In fact, the main aim of the introduction of the AltoAdige Pass was "to incentive[ise] citizens, commuters, and leisure travellers to increase the use public transport and to attract new passengers … and that is what has actually happened" (Di Bartolo, 2013).

The situation in London is a bit more complex: As ridership numbers rose in the 1990s, the existing subway infrastructure dating back to 1850 was no longer fit for its purpose. In particular the gate lines were too small to handle the huge numbers of daily travellers. Station entrances could not be widened, though, because of the prohibitively high cost of real estate in London, which would have been required for such an approach. The Oyster card solved this problem in a different way by increasing the passenger throughput per time.

London's smart card also addressed another problem, the "lack of integration between the transport modes in the London public transport network" (TRANSFORuM, 2014, p. 130). The increased convenience of the system was expected to further attract more people to public transport, thus increasing the revenue stream. What also played a role was London's overall ambition to keep step in the race for global competitiveness with locations such as Singapore and Hong Kong who had introduced a similar system before. An analogous rationale is often also at play in most other cases where a city's reputation as an innovative home for modern citizens and businesses is seen as very important.

Reference organisations

Selection of widely used contactless smart cards in cities, metropolitan areas and larger areas (in chronological order of their introduction):

- Hong Kong's Octopus Card (1997)

- Singapore’s EZ-Link (2001)
- Tokyo’s Suica (2001)
- Navigo, Paris (2001)
- London's Oyster card (2003)
- Dutch OV-chipkaart (starting in 2005)
- Mi Muovo. Mobility integrated fare system in the Emilia-Romagna Region (2008)
- Stockholm's Access card (2008)
- Lagos’ ETC Card (2010)
- Dublin’s Leap Card (2011)

For a comprehensive list see List of smart cards (n.d.). Puhe et al. (2014) also provide an detailed overview of 12 integrated e-ticketing systems.

Integrated ticketing projects in regions and smaller cities (selection only):

- **AltoAdige Pass**. Italy.
  - Very interesting fee structure: “The more you ride the less you pay.”
  - Di Bartolo (2013)
- VSS-Mobilpass. Stuttgart, Germany
  - Interesting integration with CarSharing providers
  -
- **The Key**. North West England.
  - In the process of also introducing smartphone tickets.
  - Carreno (2012)
- **Maribor**, Slovenia.
  - Single ticket system between local bus services and to a cable car in the ski resort.
  - Toplak (2011)
- **oMnibus Card** in Brescia, Italy
  - Valid on buses, the local bike-sharing system and even for carparks.
  - CIVITAS (n.d.)
- **Resplusticket**. Sweden
  - Integrates regional trains, commuter trains, express busses, regional busses, local busses, underground, trolley across multiple provider companies.
  - Králí?ek (2010)

- **Urbana City Card**, Ljubljana, Slovenia.
    - Payment of city buses and funicular railway, public bike network and parking.
    - Category winner of MasterCard Transport Ticketing Awards 2014.
    - ELTIS (2014)
    - Mestna ob?ina Ljubljana (2014)

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