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The impact of an integrated fare system on the public transport demand: A literature review

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Abstract

The main purpose of this paper is to investigate the impact of fare integration on the demand for public transport and the role of IT technologies and cash-free payments in this process. The paper presents the results of a critical literature review of studies conducted in this area so far. This approach enables the integration of theoretical and empirical findings, and perspectives of fragmented and interdisciplinary studies. Fare integration in cities is one of the factors that increase the demand for urban public transport services. This results from an improved image of public transport, easier promotion of services, more eligible passenger information, and easier use of services due to the uniform regulations and fares. In addition, for travelers, fare integration means cheaper services because they do not need to buy separate tickets corresponding to various organizers or carriers. The implementation of solutions from the field of fare integration is also related to costs; one can primarily mention the transaction costs and those related to the introduction of new solutions into the sales systems. The increase in the demand for public transport services due to the implementation of fare integration, results in external benefits that affect the sustainability of city transport systems and, thereby, justifies the funding of it by the public sector, which is accountable for ensuring efficient public transport.

Introduction

With the increasing size of cities, the transport system becomes increasingly important since it enables the choice of the place of residence, work, and education, as well as carrying out other activities related to the resident's life. Transport systems enable the spatial development of cities, creating the possibility of moving at the intended time between various places in the city. The size of demand for passenger transport in cities, including services of urban public transport, primarily results from the city size and its functional and spatial structure and, in particular, to what extent is required rationally. This is achieved by considering the effects in the form of travel necessities, travel origins, and arranged destinations. The spatial development of cities was formed over many decades. Hence, quick changes are not possible. Large cities have a multi-century history; over the years, they have developed with various intensities and changing factors that affect future city developments. Compact, intensive, and structured developments, which combine various functions in city districts, are favorable for the limitations of demand for transport and movements on foot. However, high congestion and infrastructure load exist, particularly during peak hours, namely, the morning travel to the city center and afternoon

hours in the opposite direction. Decentralization of functions, extensive development, monofunctional areas of cities, and urban sprawl result in an increased demand for transport.

Apart from the functional-spatial structure, the population, the location of places of residence, work, education, and other activities (also other factors) affect the demand for services. One can mention the transport offer, both in terms of the scope and the very high quality of provided services, and the prices of public transport services. Furthermore, the availability and possibility to use substitute goods, including the availability of personal cars, the amount of parking charges in cities, fuel prices, and the operating taxi systems or systems that enable short-term rental of means of transport, should be considered.

The pursuit of sustainable urban mobility means that the public transport services will need to adapt to residents' expectations and, in this way, they affect transport demand. Transport integration, including fare integration, should be mentioned among factors that improve public transport quality. The unification of service rules, and the creation of one price system, facilitates the promotion of services and reduces passenger fears of unintentional violation of fare rules. It is also important that a typical integrated ticket for combined networks is cheaper than the sum of separate tickets when moving and traveling, in which the networks are not integrated in terms of fares. Therefore, fare integration means facilitation during the use of the service and also a reduction of service prices for some passengers and performed rides, i.e., those that were previously carried out in transport networks of various entities or systems. Hence, the implementation of solutions from the field of fare integration affects the demand for public transport services.

The main research questions addressed in this study are:

- What is the impact of fare integration on public transport demand?
- What are the costs and benefits of fare integration in public transport?
- What is the role of IT technologies and cash-free payments in the process of fare integration in public transport?

To explore the research questions, a critical literature review on the impact of fare integration on public transport demand is conducted. The main purpose of the paper is to investigate the impact of fare integration on public transport demand and the role of IT technologies and cash-free payments in this process. In addition, the costs of fare integration are identified. This allows for evaluation projects in the field of fare integration from the point of view of costs incurred and benefits gained by the organizers and other entities who take decisions in this field. This is particularly important in a situation in which urban public transport is financed from public funds and, in numerous cases, shortages of funds occur, which result, for example, in an increase in service prices. On the implementation of a solution, similar to other changes, it is necessary to learn and estimate benefits and also related costs.

Methods and sources

Considering the subject and the aim of this study, a critical literature review of the research conducted so far is used. A literature review is a qualitative research method that enables the integration of theoretical and empirical results and perspectives of fragmented and interdisciplinary studies. Qualitative methods focus less on the frequency of the solutions or phenomena studied and more on the description, presentation, and development of theories and related good practices. Qualitative methods enable the answering of some basic questions – why and how a given phenomenon occurs – and understand and determine the motives of such actions and behavior (Shah & Corley, 2006). A literature review acting as a research method is a way of synthesizing research results to show evidence on a meta-level and to identify areas in which more research is needed (Snyder, 2019).

The results of research on the impact of fare integration on public transport are always limited to the specific geographical and socio-economic conditions in a given area resulting from multiple factors, e.g., traffic conditions, built environment, availability and quality of public transport, availability of private cars, socio-economics characteristics of inhabitants, their lifestyle, and habits and beliefs (Urbanek, 2021). In such cases, qualitative methods have significant potential since, by using data and examples of social processes, they can provide a significant amount of information and explanations for the formulated theories and allow the theory to be generalized to those elements of phenomena that are not subject to quantification and statistical generalization (Tranfield, Denyer & Smart, 2003; Bitektine, 2008).

The main purpose of this critical literature review is to synthesize previous research findings on the impact of fare integration on public transport and to provide a comprehensive framework for

theoretical and practical implications. New studies on the impact of fares and fare integration on transport demand are permanently conducted worldwide. This occurs because this issue is very important, not only from the theoretical point of view but also from the perspective of pricing strategies and transport policy in cities.

Literature review – results and discussion

Fare integration as a factor affecting the urban public transport demand

When attempting to determine the relationship between solutions from the field of fare integration in urban public transport and the size demand for such services, it is necessary to refer to factors that cause the need for moving in cities and, thereby, the demand for transport services and also to generally existing and known relations between the price of goods or services and the purchased amount. The size of demand, alongside the amount of purchased goods and services, is obviously affected not only by the price but also by other factors, which frequently occur or can occur parallel to price changes. Hence, to capture the relationships in the field of connections between the price and the amount of purchased goods and services, considerations are carried out assuming that other factors remain unchanged.

The distribution of demand, i.e., the position and shape of the demand curve, is the starting point for considering relations between demand and price. In general, apart from a few exceptions, both theory and practice show that if the price of a good or service is raised, then the users tend to reduce the demand and buy fewer goods or services. Conversely, if a good's price is reduced, then the quantity demanded by customers increases. The services of public transport are not an exception in this case; the aforementioned rule applies, which has been confirmed by many studies carried out on various continents and in numerous countries over a few decades (Goodwin, 1992; Trace, 1999; Dargay & Hanly, 2002; Wardman & Shires, 2003; Litman, 2004; 2021; Bitre, 2022). However, the sensitivity to price changes differs. Namely, the method for quantitative determination, how sensitive is the quantity of purchased goods, and services to price changes is the price elasticity of demand. In general, the demand is inelastic in terms of price when the price changes by, e.g., 1%, resulting in a smaller than 1% change in the quantity for which demand is declared. In turn, the demand is elastic if the shift in price by 1% results in a change of demand higher than 1%. At the same time, if the demand is inelastic in relation to price, the reduction of prices decreases, and the rise increases the obtained income (sales). When the demand is elastic to price, the price drop causes an increase, and the price rise leads to a decrease in the obtained income on sales, obviously assuming that other factors have not changed (Litman, 2021).

There are many studies that have investigated the relationship between public transport demand and fares (Bly, Webster & Pounds, 1980; Goodwin, 1992; Dargay & Hanly, 2002; Bresson et al., 2003; Wardman & Shires, 2003; Gnap, Konecny & Poliak, 2006; Paulley et al., 2006; Preston & Almutairi, 2014; Wardman, 2014; Fearnley et al., 2017; Dunkerlay et al., 2018; Urbanek, 2019; Khlodov et al., 2021). Results of studies on the price elasticity of public transport demand always refer to a specific mode of transport and particular cities, geographic areas, markets, and societies. The price elasticity of public transport demand is considered rather low. Holmgren (Holmgren, 2007) provided a useful meta-analysis of public transport demand that shows that the coefficient of price elasticity of demand for urban transport can range from −0.009 to −1.32, with an average value of around −0.38. Moreover, according to Fouquet (Fouquet, 2012), there is a declining trend in income and price elasticities of passenger transport demand, which result from economic and technological development.

There are many factors that affect the public transport demand and, thus, the price sensitivity of demand, i.e., demographic factors, trends, economic activity, income, built environment, geography and land use patterns, accessible substitutes, and demand management strategies in a given area (Litman, 2021). Moreover, the dynamic development of information and communication technologies (ICTs) influences transport demand, which has been proven during the COVID-19 pandemic. ICTs are predicted to be a key factor in reducing or limiting the growth of passenger traffic in cities (Gössling, 2018; Mouratidis & Peters, 2022).

Attention should be drawn to the fact that, for goods and services related to movements, the price elasticity differs depending on whether it is to be studied in a relatively short period of time after the price change, for example, a year to two years period, or whether later on, e.g., after two to five years. It is reported, in terms of an absolute value, that in the case of services of urban public transport, in particular buses and a longer period with a coefficient of price elasticity, it grows more than twice that found

in a short period of time, which indicates a higher price elasticity of demand. As a reaction to the changed price, it is possible to encounter situations in which this coefficient, after a few years, approaches the value of 1 or exceeds it, which means an elastic demand that has specific effects on the amount of income obtained in response to the change of prices. Hence, numerous papers have provided the effects of changes related to prices in urban public transport in a shorter and longer period of time. It is necessary to note that advanced econometric models and meta-analyses are applied, because numerous changes occur in cities and city transport systems that affect the transport behavior, not only the service price changes themselves.

Knowledge about the course of the demand curve and the price elasticity of demand itself is (and should be) the basis for price-related decisions; hence, there are many studies and data about the size of the price elasticity of demand. The measurement of price elasticity of demand in vast systems of urban public transport is relatively difficult. Price changes, excluding promotions, do not frequently occur in this case; this may be over a period of a few years or longer. Apart from this, not all systems of public transport are equipped with measuring devices to count passengers. Thus, the measurement of the number of passengers using services of urban public transport, applying a method of counting, will always be a measurement of a certain sample and related errors. Moreover, the study lasts for a specified time, which results in the necessity to make relevant calculations. The assumption fulfillment issue originates with the other conditions being unchanged because, besides a price change, the demand is already affected by other factors that influence the volume of transport.

The size of demand changes over time as a response to the price change and, thereby, the size of price elasticity, which results from the fact that, immediately after the change, on the one hand, it is difficult for consumers to change their habits and premises, from which the need for a specific good or service results, which favors the inelasticity of demand. However, the price change itself has a psychological effect that causes consumers to become willing to reduce the size of purchased goods or services, when the price has risen, to minimize the impact of price changes on their expenditure. It is also important that consumers have limited incomes, and the services of urban public transport are used by low-income passengers. As a result, short-term price increase results, where possible and favorable, in the choice of other methods of movement and in behavior consisting of a reduction of the number of rides. Buying goods or using services in the neighborhood of the place of residence, at walking distance, may be an example of reducing the use of urban public transport, or a total 'giving up' of part of the travel activity. Moreover, the use of IT services is possible; for example, remote work or education within a specified scope, remote handling of matters in offices and institutions and, to a larger extent, using the system of courier deliveries instead of going to points of sales. Longer-term further reduction of the number and/or distance of rides is possible, as well as changes in the ways of traveling. For example, for decisions about the place of residence, work, and education, alongside taking into consideration distances of travel and costs of transport, the result may be the obtaining of a driving license and buying a car, because using a car is competitive against the movements by public transport.

Various social groups respond to price changes in different ways. This is related to different situations in the field of obtained income. In general, the price elasticity is higher when the expenditure on specific goods or services consumes a significant part of income; it is also larger in the case of a higher level of fares. Hence, in the scenario of traveling longer distances when the fare degression is applied, we can refer to lower price elasticity because, in this case, the price paid for travel, converted to the covered distance, is lower. Rides with shorter distances generally feature a higher price elasticity because they can be easily replaced by walking. Such rides are also relatively expensive, e.g., in the case of a uniform fare. Lower price elasticity occurs in the case of commuting to work and school, which is carried out during peak hours.

In the situation of price changes, it is necessary to draw attention to the fact that their impact, in the case of increase or reduction, will not be symmetrical. In general, the situation of a price increase and, hence, expenditures is perceived as such, which is more arduous than if prices are lowered. This means a higher elasticity coefficient in the case of price rises and a lower one in the case of their reduction by the same percentage. In addition, people who become accustomed to higher expenditures related to the use of cars are not so sensitive to the reduction of the price of public transport services. Therefore, they will not be attracted to public transport due to a few percent (or a dozen or so) lowering in price. In this case, the non-price parameters of the service are important, in particular, its quality. Another factor causing a smaller response from the demand side

to price lowering may be the lack of information about the fact that, e.g., the price was reduced and also that, irrespective of the price, the attractiveness of a given good or service has increased. People who are potentially interested in using this service may obtain the information with a delay. Hence, the demand may grow only after a certain period of time. This may just occur in the case of fare integration; people using cars may only obtain information on this subject after some time, which results in increased demand later on.

In the case of extensive cities with low-rise development and unformed routes to be served by productive public transport systems, it is difficult to effectively provide services by public transport. In such cities, it is much easier to travel by car, and here the substitution of services is straightforward. Hence, the real possibility of 'giving up' public transport is not the same in various cities; it depends on the spatial development and infrastructure. In general, in suburban areas, in smaller towns and districts of cities with a lower population density, it is easier to carry out a substitution, and individual transport is a replacement for public transport. Therefore, the price elasticity of public transport services will be higher in smaller towns and those featuring a lower population density. Moreover, a saturation with cars, which over recent decades has been growing, has some influence.

The modal split in cities is affected by the implemented transport policy, within which various measures are used, for example:

- closing city centers for the traffic of private cars, charges for entering the city centers by cars, limitation of parking places, and introduction of parking charges in city centers;
- investments in the transport infrastructure, larger allocation of funds to the public transport infrastructure, without excessive expansion, especially in city centers, roads and streets for cars;
- development of public transport systems, in particular systems that ensure fast movements – metro, fast urban railways, and fast trams;
- high quality of public transport services.

In addition, the modal split is affected by passenger preferences, resulting, for example, from the previous experience and perception of the methods of movement, own assessments of the quality of public transport services, holding driving licenses, and actions for the city environment protection. Moreover, apart from this, the availability and the way of using various additional services have some effect, e.g., of short-term lease of cars, systems of city bikes, scooters, motor scooters, and other single-track vehicles. They may be used since such systems are complementary to public transport, increasing the demand for services via the facilitation of trips to stops, but they may also be competitive services used for commuting not to stops but from the origin to the destination. The scope of using cars and other transport modes in the form of a short-term lease is affected by spatial accessibility and fares.

In the case of fare integration, it is possible to refer to the following impacts on the demand and the size of demand for services of urban public transport:

- a shift in the demand curve to the right, which means an increase in demand for the service for reasons other than the service price;
- reduction of the service price for those who have used (or who are potentially interested in using) services of the urban public transport and, for example, in the situation of previously buying separate tickets that result in an altogether more expensive provided service, those who were not interested in these services. Consequently, there is a downward shift in the demand curve (a price decrease) and, thereby, an increase in the number of passengers using urban public transport.

The shift to the right in the demand curve (on the graph showing the relationship between price and demand) results from such factors as:

- availability of all lines (of various organizers and carriers) within the possessed season ticket;
- smaller fear of breaching the fare due to differences, which frequently exist in the case of separate fares at various organizers or carriers, greater certainty during the used service, easier gathering of fare information, and easier and, hence, more effective promotion of the pricing system.

The shift in the demand curve is related to the lowering of service price for a group of passengers using previous offers from different organizers or carriers, which did not offer an integrated ticket and resulted in a situation of necessity to purchase, when regularly using the services, of two season tickets. It was often related, e.g., to the purchase of a ticket for railway transport services when commuting from suburban areas, and later on to purchase a ticket for services of the urban public transport covering the area of the city or a group of cities. An integrated ticket is cheaper than the sum of separate tickets with corresponding entitlements; hence, the introduction of an integrated offer means a reduction in price (i.e., expenditures) paid by service users compared to the amount spent previously. Consequently, the price attractiveness of this service grows.

Attempting to assess the fare integration from the point of view of income on service sales, it is necessary to state that the shift in the demand curve to the right, due to greater ease of public transport use, image improvement, transparent price list, and clearer information, is favorable because it increases demand, which (at a given price) means an increase in the obtained income. At the same time, the factor of reducing the amounts spent by service users, in the case of previously using a network of other organizes/carriers, i.e., a shift in the demand curve with inelastic demand for services, results in the reduction of the obtained income. As a result, when the demand for integrated public transport services grows, the income effects depend on detailed solutions, primarily on the price level of the integrated tickets and the number of passengers using this offer. It is necessary to draw attention to the fact that benefits occur both in a shorter- and longer-time horizon.

Although there are an impressive number of studies on the price elasticity of public transport demand and relatively few studies are seen on the impact of fare integration on transport demand (Wardman & Hine, 2000; NEA, 2003; Matas, 2004; Cassone & Marchese, 2005; Marchese, 2006; Abrate, Piacenza & Vannoni, 2009; Booz & Company, 2009), most of the projects in the field of fare integration are not introduced separately, but they are combined with a wide range of other investments. Estimating the impact of fare integration on public transport demand is important from the point of view of the economic assessment of such undertakings.

IT technologies and cash-free payments in the processes of fare integration

The solutions in the area of fare integration are affected by many factors, including organizational changes as well as the development and application of modern ICT technologies in urban transport. The ICT technologies facilitate the implementation of one carrier of fares and, later on, processes of settlements between participating entities. However, they are not a necessary condition of fare integration. Fare integration systems have been functioning for decades and continue to operate, in which a paper ticket enabled movements using various means of transport of various entities and organizers.

The widespread use of cards with magnetic strips, instead of paper tickets, and then contactless cards with microchips, changed the ticket systems. It facilitated and accelerated fare payments. The next changes consisted of payments by means of payment cards and using mobile phones and smartphones, and also changes in the architecture of payment systems (UITP, 2020). Table 1 presents the evolution of payment methods.

Nonetheless, despite the implementation of modern solutions in many cities, solutions continue to be used, sometimes even at the same time, comprising tokens, paper tickets, cards with magnetic strips, electronic cards, and applications on mobile devices (UITP, 2020). In this context, it is necessary to state that the unification of carriers with information on the collected fare is an important factor, but it is not an indispensable condition. Apart from this, the

Table 1. Types of e-tickets in passenger transport (own study based on (UITP, 2020; Frączek & Urbanek, 2021))

	Form of ticket/ticket carrier	Type of ticket	Payment type
Traditional ticketing	Paper tickets	Single and season tickets	Cash/cashless
	Magnetic ticketing system	Single and season tickets	Cash/cashless
E-ticketing	Electronic tickets with a self-printed paper version (using OCR: bar codes or QR codes)	Single and season tickets	Cashless
	Contact-based (gold-plated chip) or contactless smart cards (RFID technology)	Single tickets, season tickets, pay as you go, best fare policy	Cashless/cash***
	Mobile ticketing based on SMS	Single tickets	Cashless
	Contactless bank cards	Single tickets, pay as you go fares, best fare policy	Cashless
	Mobile ticketing based on mobile payments, apps, or virtual smart cards (based on OCR* or NFC** technology). New concepts: Aggregated pay as you go (PAYG), account-based ticketing (ABT) and be-in be-out (BIBO)	Single tickets, season tickets, pay as you go, best fare policy	Cashless

* OCR (optical character recognition) – the passenger/user receives a special code (for example, a QR code) that contains all the necessary information.
** NFC (near field communication) – the information is saved in the phone's NFC memory.
*** Money or e-tickets can also be loaded onto a smart card using cash, but further use is digital and cashless.

implementation of modern systems for fares collection may be an effect of the progress in payment systems, of the pursuit to facilitate the tickets purchase and availability, and facilitating towards a broader extent price diversification. Hence, the implementation of new solutions is not always related to actions in the field of fare unification or the introduction of integrated tickets. The implementation of payment systems using payment cards may be an example – various carriers then use the same method of making payments; however, their fares may still remain separate.

Various solutions in the fare collection systems involve organizers and operators in different ways. Also, the costs differ but more important is that they are divided between the transport system participants in different ways. In the case of paper tickets and city systems of cards with magnetic strips and electronic cards, the total costs and obligations related to ticket printing and sales were ensured by the organizer or carrier. The situation with electronic cards is similar. Additionally, the organizer or carrier willing to ensure the respecting of tickets in other areas had to make arrangements and conclude relevant agreements. The costs and obligations are related in different ways in the case of payments by means of payment cards issued by banks, or using applications installed on electronic devices. In such cases, one can refer to the so-called open carriers, which enable paying not only in a given public transport system but also in other cities' means of transport or other purchased goods.

The issuing of a payment card, the problems when it is lost, duplicate issuing, and related costs are not on the carrier side and do not burden them. Likewise, in the case of mobile devices, their purchase, payments for the internet link maintenance, the application downloading and installation, and any other actions and risks are on the side of the person making the payment – i.e., the passenger. As a result, the development of payment systems by means of cards and via mobile applications contributes to the processes of methods unification, through which conditions are created to acquire data for settlements, and also part of the related costs and risk is transferred onto service users. The costs and risks are not additional since they are not identified in the context of payments for public transport services; hence, they are not an obstacle when using the systems of urban transport. Payment made by means of mobile devices ensures that passengers can easily make a relevant payment, without the need to proceed to points of sales, and also to learn sometimes complex price lists. Moreover, these organizers or operators can reduce the cost of sales, improve the effectiveness of the payment collection system, and also easily (and without significant expenditure) obtain knowledge about the choices and transport behavior of service users (Ferreira et al., 2017). Mobile apps usually comprise a part used for travel planning, in which possible connections are indicated, for a portion of which it is possible to obtain current information on any disturbances and real-time information about departure times of means of transport, and a part used to pay for traveling. They combine information from various organizers and carriers from the point of view of passengers planning a journey.

With the development of ICT, a possibility has appeared of more flexible fares, both in terms of price levels and differentiation. Hence, it is possible to refer to intelligent fares, in this case especially for solutions that minimize actions related to making a relevant payment that is good for service users, an automatic location of the travel start and, later on, of the travel end, waiting only for confirmation of this place determination and/or charging, in which for a larger number of travels within a given time period the fare is collected in a way most favorable for the passengers. Namely, in the case of a larger number of trips at prices of multi-ride tickets, hence, at an amount lower than the total of separate fares for each travel. Intelligent fares may be a measure for balancing the load of transport lines and shaping more uniform demand for services, so as to avoid overloads of the means of transport and of the network itself. Lower service prices outside the peak hours may be an example, but also, for instance, on less loaded connections that are alternatives to the basic ones. It should be added that the implementation of electronic fare collection systems, in particular using the applications on mobile devices, in many cases ensures a possibility to pay by means of a given application not only in one city but in many cities, and frequently also in various countries and for public transport services provided by multiple carriers.

Costs and benefits of the fare integration

The integration costs depend to a large degree on the provisions of the contract, in particular on the scope of duties and necessary work related to the solution implementation. It is possible to mention the costs of common ticket implementation; these could be the costs of the price change procedure itself, if necessary, but also the lost income related,

e.g., with the change of the fare system or the price level. Moreover, the reduction of revenue should be added due to the fact that the common tickets are sold at prices lower than the sum of separate tickets; the amount of revenue reduced because of this is easy to calculate and is one of the factors that affect decisions on integration or on refusing to participate in the project of a common ticket introduction. It is necessary to draw attention to the fact that the unification of the fare to some extent means 'giving up' the separate identity of entities and their own price strategies and, for entities, it is more difficult to obtain benefits resulting from price differentiation and their adaptation to the diversified usability of services for various social groups. It is also more difficult to consider the existence of diversified local conditions, related, for example, to residents' income or travel characteristics. The pricing policy simplification also affects the minimization of the cost of sales (Tomanek et al., 2004; Dydkowski, Tomanek & Urbanek, 2018).

Enterprises providing transport services of regional or national reach (i.e., bus or railway transport) most frequently apply a section-based fare. There are obviously exceptions related to transport in cities and the price adaptation to other carriers providing the transport services in a given area. Prices are diversified in terms of the rate for traveling on a specific section, and also distance ranges in various companies. The applied fares are degressive; ticket prices converted to vehicle-kilometer decrease with the increasing travel distance. Moreover, diversification between individual enterprises frequently occurs, and part of the enterprises has diversified prices on the transport lines too. This proves high flexibility and adaptation of prices to specific market conditions. Tickets are sold by vehicle drivers or increasingly often via applications available on mobile devices; the software supporting such sales allows the user to buy the ticket and determine its type and price (Tomanek et al., 2004; Dydkowski, Tomanek & Urbanek, 2018).

A flat fare, time-based fare and zonal-based fare are applied in urban transport. In regional transport, a distance-based fare is almost always used (Tomanek et al., 2004; Dydkowski, Tomanek & Urbanek, 2018). This results from the pricing simplification under conditions of urban public transport, in which the application of a distance-based fare would require the use of pretty complex electronic fare collection systems and is not justified by diversification of transport needs. The dissimilarity of fares systems for urban and regional transport is the basic, but not the only, barrier to fare integration. It complicates the designing of integrated tickets and may be the reason for the increased complexity of the settlement algorithms in integrated distribution solutions (Tomanek et al., 2004; Dydkowski, Tomanek & Urbanek, 2018).

Additionally, costs related to changes in IT systems that serve the sales may occur, as well as the information and promotion costs of a new solution. The information and promotion are important elements of the solution implementation because changes frequently occur in systems of sales and used tariff systems established for years, and the new solutions in the initial period may not be transparent, primarily due to the existing diversification of entitlements to concessionary rides used in different systems of the public transport.

The contract conclusion is also related to the transaction cost – preparation of a draft, procedures of arrangements and, later on, carrying out relevant settlements. The settlements can predict the necessity to carry out systematical studies providing the data necessary for settlements; a solution related to the deployment of appropriate automatic systems for passenger counting may also be predicted, which means specific expenditures. Moreover, the costs related to smaller elasticity in the field of transport offer changes that should be mentioned. The fare integration applies to common prices and tickets. However, each of the parties provides a specified scope of services, which may be subject to changes, but they require arrangements and coordination at the introduction. Such arrangements most frequently extend the process of change; hence, they can generate costs. Other factors, which can stop or cause risks in making decisions on integration projects, are fears of breaching regulations relating to competition protection on the markets, which generally ban the determination of prices and other conditions of sales or purchases. There are obviously exceptions referring to the non-application of provisions, when the buyer benefits, or if such arrangements contribute to the improvement in the service provision. However, the burden of proving the benefits is carried by the entities concluding such an agreement, which in practice may result in a reasonably lengthy procedure performed by the appropriate office. Related costs, if any, may be classified as the transaction costs of the concluded agreement.

The basic benefits are related to the improvement of the public transport quality in a given area. Easier information searching and the possibility of buying a common ticket for different systems means that the

offered services are more attractive; as a result, it is possible to expect an increase in the number of people using public transport services (Abrate, Piacenza & Vannoni, 2009; Zimmerman & Fang, 2015). This growth, as a result of assessments carried out in various countries and cities, occurs after the introduction of integration solutions. However, it is noticeable only after at least a few months and usually lasts a few years. In general, the increase in the demand is estimated at a few to 12% or even 15% (Puhe, Edelmann & Reichenbach, 2014), but longer-term, i.e., greater than 20 years, figures of 20+ or even 30+ percent are reported (NEA, 2003) (Table 2).

Table 2. Public transport demand impacts (NEA, 2003)

Area/City	Dates	Overall % change	Annual % change
Greater Manchester (bus only)	1999–2001	4%	2%
Hamburg	1967–2002	19%	0.5%
Stockholm	1973–2001	25%	0.8%
Vienna	1988–2001	24%	1.7%
Rome	1995–1997	6%	3%
Paris	1975–1993	33%	1.7%

In this period, other changes also occurred in the public transport system, both on the supply side and affecting demand. Therefore, it is challenging to separate fare integration from other factors that affect transport behaviors and, thereby, the modal split (PTUC, 2013). In addition, fare integration is frequently implemented parallel to a new fare collection system, like electronic cards, but also to a new price system. However, converting the previously provided data over a period of one year increased ranges between 0.5% and 3% p.a. (NEA, 2003). This corresponds with the data provided for Madrid. Matas (Matas, 2004) reported an increase in the demand related to the tariff system implementation by 2.2% year-on-year.

A study conducted by Abrate et al. (Abrate, Piacenza & Vannoni, 2009) showed the introduction of an integrated fare system can increase the number of passenger trips by 2.19% in the short-run and by 12.04% in the long run (Table 3). Moreover, according to extended models provided by Abrate et al. (Abrate, Piacenza & Vannoni, 2009), the estimated effect of integrated fare system introduction is around 6% in the short run and over 25% in the long run.

Table 3. Impact of integrated fare system: short-run and long-run elasticities (Abrate, Piacenza & Vannoni, 2009)

	Basic model		Extended model 2	
	Short-run	Long-run	Short-run	Long-run
Dintro	2.19%	12.04%	–	–
DsingDurb	–	–	6.75%	34.08%
DzoneDurb	–	–	6.66%	33.64%
DextDmix	–	–	5.05%	25.51%

Table 4 presents a review of studies on the impact of fare integration on public transport demand for different areas and cities.

The increase in the number of transported passengers is favorable in many dimensions. Firstly, it results in increased revenues for the provided services. Moreover, the fact that projects in the field of fare integration are undertaken by private carriers,

Table 4. Review of studies on the impact of fare integration on public transport demand

Author(s)	Studied area/city	Main results of the study
FitzRoy & Smith (1998)	Freiburg (Germany)	Introducing travel cards increased the number of bus trips per capita by 9.4% and 13.9%
Taylor & Carter (1998)	Maryland (USA)	Introduction of an integrated fare scheme created a 4% growth in ridership per annum (despite service cuts and an average fare increase).
Hirsh et al. (2000)	New York (USA)	Introducing an integrated fare system increased weekday ridership by more than 12% on the underground and by more than 40% on the bus.
NEA (2003)	Case studies of 8 European cities	Introduction of integrated fare schemes increased public transport demand from 4% to 33%.
Matas (2004)	Metropolitan area of Madrid (Spain)	Introducing integrated fares created an increase in bus and underground patronage in the short run of 3.4% and 5.3%, respectively, and in the long run of 7% and 15%.
Abrate, Piacenza & Vannoni (2009)	Panel data from 69 Italian public transport companies	Introducing an integrated fare scheme increased the number of passengers by 2.72% in the short run and 12.65% in the long run.
Sharaby and Shiftan (2012)	Haifa (Israel)	Introduction of an integrated fare system increased the number of passenger trips by 7.7%.

operating in deregulated and competitive markets, may enable the confirmation of possible benefits resulting from fare integration, increased demand and, hence, income (PTUC, 2013). At the same time, with the increasing number of transported passengers, premises appear to improve the transport offer, thereby it is possible to count on a further increase in the number of transported passengers. Apart from this, external benefits are obtained, related to a smaller negative impact per transported passenger as compared with traveling by cars, but also benefits related to the level of living and of social and economic development, obtained as a result of higher efficiency of the passenger transport system in cities. In the performed analyses of economic assessment of projects, the external benefits may be converted into monetary units, which enables their capture.

Conclusions

The multitude and complexity of changes occurring in cities and, thereby, in urban transport systems affect the complexity of studies on the force of impact and the share of individual factors, which affect the demand for transport services, including public transport services. Therefore, not only studies that evaluate demand and its changes via measurements of the number of people that use services are necessary, but also complex and advanced econometric models and meta-analyses. The situation is also complicated by the fact that the effects of demand change, depending on factors that cause them, which are spread over time and extend across 5–7 or more years. The very diversification of cities, in terms of spatial development, transport infrastructure, and economy, but also social aspects – i.e., the residents' lifestyle and the performed transport policy – means that it should be considered during the conducted comparative studies.

The integration, including fare integration, increases the demand for public transport services. This is the effect of an improved image of public transport as a result of the undertaking and implementing solutions from the field of integration, easier promotion, and integrated information, as well as common and uniform fare regulations, including the price list. The implementation of fare integration is frequently related to the introduction of new solutions in the field of ticket sales. Apart from a ticket valid in vehicles of various entities providing transport services, smart fares are implemented, calculating the fares in options favorable for passengers. In addition, the use of mobile devices facilitates fare payment, which also increases the ease of use of public transport services.

Fare integration for a portion of passengers, i.e., those who have used the services of various carriers that previously did not participate in the common fare solution, means a reduction of the amounts spent on the services. As a result, the demand for integrated services of public transport grows. Projects of fare integration are also related to costs. One can mention the transaction costs, if they are implemented in the formula of contracts concluded between various organizers and carriers. Moreover, it is possible to mention costs related to the implementation of changes or introduction of new solutions into the sales systems, primarily the costs of relevant changes in the existing applications or the development of new ones for ticket purchases. In addition, the promotion and information costs may be mentioned.

Irrespective of costs, fare integration causes a smaller revenue from ticket sales per passenger. This is related to the fact that tickets entitling travel in many networks are cheaper than the sum of separate ticket prices for individual networks, meaning smaller passenger expenditure. However, it turns out that the reduced profitability per passenger will be offset by the increase in profits on overall sales of services due to the growing demand for services. But it is necessary to draw attention to the fact that the reduction in profitability occurs immediately after the introduction of a new price list, while the increase in demand will be spread over a longer period of time. In addition, the unification of prices of various organizers/carriers reduces the possibility of adapting prices to a specific type of transport or specific local conditions. This applies, in particular, to the necessity of adapting price lists of carriers performing parts of transport in suburban conditions to prices in force in cities and city centers. Moreover, with the introduction of changes in price lists and in the situation of many partners, the time of arrangements is extended, which as a result also translates into effects on the income side.

The identification and estimation of integration costs and benefits are very important for entities undertaking and implementing such projects, so that they can be capable of predicting and planning relevant expenditures and changes in income. In addition, such solutions are correct for which the financial effects of integration are financed by public entities with the competence to ensure public transport. This stimulates not only the introduction of such systems but also their maintenance over a longer period of

time. Additionally, the transparency of the financing of public transport increases.

Fare integration, as a factor affecting the growth of demand for public transport services, is very important for the sustainable development of city transport systems, including the creation of friendly and accessible public transport services. This results in external benefits from a city point of view, which is crucial and justifies the financing of projects in this field from public funds.

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