

THE INTEGRATION OF PASSENGER TRANSPORT AND INTEGRATION BARRIERS

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Abstract

The paper deals with the issue of supporting public passenger transport and its integration with the aim of ensuring the sustainable mobility of population. The paper points to the importance of public passenger transport and the reasons why the population prefers cars. Based on the analysis, it is arguable that public passenger transport without mutual integration is not capable enough to compete with individual motoring. Contribution proposes the process integration of public passenger transport as a key elements in increasing road safety. Contribution confirms the hypothesis that the integration of public passenger transport and achieving a higher use of public passenger transport of population can contribute to improving of road safety.

Keywords: transportation; behavior; safety; process; integration

1. Introduction

Transport strategy in European Union supports public transport against individual transport. The reason is using of public transport is possible to fulfil all the goals of the EU strategy in the field of road safety. This is particularly the stabilization of the increase in entitlements of road transport on infrastructure where dissemination is problematic especially inside in the territory of the town. Building of a new of expressway infrastructure for growing transport outputs is a long term problem, particularly in the context of an aging EU population. Support of public passenger transport brings lower fuel consumption. It is achieved by another strategic objective of EU transport and reducing dependence on oil as feedstock that is imported into the EU. Lower consumption of diesel fuel meets another strategic objective – the emission of harmful substances into the atmosphere [11, 33]. Based on the above it can be concluded, if residents use public transport to fulfil the strategic objectives of the EU transport policy. In this context it should be noted the necessary support public transport and in particular to support its competitiveness in relation to the individual automobile transport [25]. The aim of this paper is to identify the importance of public passenger transport and define method for creating effective integrated transport systems.

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2. Significance and problems of public transport

„Transportation is often referred to as the lifeblood of cities and regions; it provides the essential connection is constantly for moving population in this area that helps to shape the region” [30]. To support sustainable and habitable region is used private, public and non-motorized transport that is necessary for mutual and functional interconnection of these transport systems so as to create a balanced integrated systems. However today, in many regions, transport is characterized by high dominance of cars, i.e. is dependent on travel by cars [10]. Using of motor vehicles brings high comfort for the passenger in case of, if there is sufficient capacity transport infrastructure and sufficient space for parking private cars. Growth of individual motorized transport in cities, however, it causes reduction of driving speed and the irregular operation of public transport, what has an impact on passengers and public transport systems. Congestion prevents accessibility to target locations in particular those that are located in the city centres. Growth of individual motoring also causes other problems e.g. reduction of road safety, reduction of air pollution noise and global warming [1, 18].

While providers of public transport operate as key areas and places in the served territory, users of passenger cars receive a high quality of service in terms of availability and time. A passenger in passenger cars generally does not feel as a problem of occupation of land and emissions that are produced by the operation of passenger transport. Individual transport however causes a problem of static character. Parked vehicles are often a barrier to pedestrians, cyclists and the disabled. For these reasons, it is necessary to cause a change in the behaviour of human mobility. It is necessary to create activities aimed at reduce the need for cars and stimulate demand for travel through the use of public transport, increased use of bicycles and walking [21].

For providers of public passenger transport is too expensive to provide direct services between all points of the served territory, therefore it is necessary coordination individual transport modes to ensure transport serviceability of passengers in the use penetrations [28].

If we want to minimize transport time by public transport, which is greatly influenced by transfers, it is necessary to integrate public transport that aims to coordinate and promote the smooth carry passengers and provide comfortable services of high quality. Generally there are many definitions of integration of public passenger transport [2, 4-6]. We used the following definitions:

- Integration is an organizational process that includes elements of the public transport system (network and infrastructure, tariffs and tickets, information and marketing, etc.) and serves on various subjects using different modes of transport, communicate more effectively and closely. This results in an overall improvement in travel conditions for quality services [17],
- Integration of the method in which the elements are distributed in the public transport in moving chain [27].

Usually in the service of the urban public transport word "integration" is used for solutions that ensure continuity of services "door to door" [34]. Public transport provides an

attractive service chain in relation to a "door to door" system thanks to that integration is defined as the combination [20]:

- Various vehicles of public transport,
- Public and private transport,
- Transport policy with other policies related to land use planning and investment in infrastructure.

In the integration of transport it is possible to also build upon Mohring effect that was defined still in the 1972: "If more passengers use public transport the lower are the cost per passenger, which means better conditions for transport serviceability of short waiting time for passengers, denser network of routes and stops, this reduces the time to walk for passenger. For more passengers allow to plan of express connections, leading to a reduction of the distance travelled in the vehicle" [16]. At the present time a significant factor in promoting the integration of transport constitutes road safety and the impact of transport on the environment.

The current trend in Western Europe is the integration of transport whereby it is expected to increase the attractiveness of public passenger transport and the quality of transport serviceability [10]. Integration of public transport it is possible to build a system that for the passenger appears to be unified and provides passenger to transport harmonized timetables for the various modes of transport. The integration also plays a role in social policy. The importance of integrating transport creates an effective transport system that allows reducing the congestion of cars and also contributes to saving the environment [19]. In practice, especially in Eastern Europe, we often face integration that represents the integration of tariffs, services and information [22].

In practice, it is necessary to apply the more strategic form of integration that is directly relevant to strategy formulation: integration of various policy instruments improves performance of the overall strategy [12]. This integration may arise four general ways:

- (1) Integration between policy instruments covering different types of these instruments;
- (2) Integration between policy instruments including the use of infrastructure, governance, information and price;
- (3) Integration between transport measures and planned measures using designated territory;
- (4) Integration with other policy areas such as health and education.

Integration of types (1) - (3) draws from a broad range of different types of transport and land use policy instrument that is at the moment available. It is a fact that the combination of policy instruments is probable that will behave differently in relation to that objective, how would behave in the application of individual instruments.

In the integration of transport, it is necessary to define the essential characteristics such as: number of connections, lead lines, and the share of transport modes and daily operating time. In applying some instruments will also necessary to change the supply of transport, and thus costs for the users. The costs of installing and operating generate revenue that will also have a relevant impact on the instruments themselves but also by combining.

Each one of them will affect the extent and intensity, that is used as a policy instrument; changing fares, for example, may be different in amount of the fares-dependent the day periods and potential routes and areas. The number of possible combinations policy areas is very extensive. Carefully designed an integrated strategy, particularly types (1) - (3) should be able to achieve the objectives of one or several accepted policy instruments. Some of the above integration may give rise to a wider set of objectives: s the integration of transport and territory (type 3) can better increase the general set of development objectives [8]. The strategy is important to clarify the objective before unfolds the strategy because a combination of appropriate policy instruments for example, the efforts towards economic development will be different from those that best meet the environment and objectives regarding health.

The majority of approaches in the implementation of the integration strategy is focused on one of two types of principles: to look for synergies and the removal of obstacles [13, 14]. To look for synergies involves finding pairs or groups of policy instruments that will strengthen each other in achieving changes in the transport system. Examples are particularly apparent in the use of park and ride, as an aid in boosting rail and bus transport. Example of synergy is illustrated in Table 1 where Wegener tested synergy between the increase in operating costs for private vehicle, transit time of public passenger transport and Fares in public passenger transport [31].

Tab. 1. Evidence of increased synergies in operating cost of a car at a faster public transport services and for promotional fares for the Dortmund [31]

Tested strategy	Difference of the said variant 2021 (%)						
	Trips	Mean trip length	Percentage of public transport	Percentage of car trips	Car-km/inhabitant	Car ownership	CO ₂ emission
A Operating vehicle costs + 75%	-2.78	-14.77	+6.49	-3.61	-20.98	-6.24	-18.89
B Public transport time - 5%	0.00	+0.02	+1.15	-0.06	-0.12	-0.05	-0.04
C Fares of public transport - 50 %	+0.75	+2.49	+11.84	-0.42	-0.68	+1.95	+1.62
Total	-2.03	-12.26	+19.48	-4.09	-21.78	-4.34	-17.31
D Combination (A+B+C)	-2.00	-11.35	+26.68	-4.93	-23.03	-3.88	-17.43

The combination is illustrated in Table 1 and includes an increase in operating costs per car by 75%, increase potential through taxes on fuel or distance characterized by fees, reductions for public transport by 5% and similar measures; such as fares on public transport. It notes the strong synergy that is able to attract passengers of public transport where it is an increase of 35%, as the sum of the components. There is also no clear evidence of synergy total travel costs for a car per 1 km. The result is a modest indication of synergies in CO₂ emissions where the combination of instruments there is a reduction to just below 1% that is more than the sum of basic instruments. Here it is appropriate to ask ourselves whether it should discover the synergies in elements of the total fare and, if is so, only to a very limited extent and it in the performance of comprehensive policy indicators, such as indicators of CO₂. One possible answer is that such synergistic changes, for example using of public transport are balanced changes in other modes, and transport elements within the stable aggregate value, such as time of traveling.

Removing obstacles means identifying factors that prevent the implementation otherwise desirable policy instruments and where through other instruments need to be overcome. Key obstacles any strategies are often finance public acceptability and concerns that some members of society will be adversely affected. Integration can help to remove of obstacles in three directions [14]:

- May include measures to create additional elements of the strategy, but that are financially feasible. Increase parking fees, raise fares or road fees – all may be visible way to finance new infrastructure.
- Integration can contain a package of measures that are less acceptable in themselves, such as those that demonstrate a clear benefit. Again, an example can be found in the toll roads. Subjective research shows that probably will be much more acceptable if the revenue is used for investment in the context of public transport [7].
- Integration can include measures that induce undesirable effects. For example, road pricing could lead to higher operating vehicles off the toll areas.

3. The advancement integration of public passenger transport

The most important element of the decline in the number of passengers in public transport is to increase the quality of service [30]. A necessity of multiple transport and co-existence of more than one carrier is need for coordination, cooperation and mutual interaction, so as to ensure the image of one unified system without potential users confused or recording without interruption of provided services. To define the integration of transport, it is necessary to divide it into three levels: organizational, operational and the physical integration (Table 2).

Table 2. Three levels of intermodal integration [10]

Organizational integration	Operational integration	Physical integration
The contract between the carriers	Network structure	Access to equipment
The existence organizer of integration	Plan of transport service ability	Deployment equipment
	Transport timetables	Designing od station
	Transmission of information	Control vehicle motion
	Transport tickets	

3.1 Organizational integration

One of the conditions necessary for the development of integrated public transport system is that it must originate the authority responsible for organizing of integration of transport serviceability. The Organizer is necessary due to the fact that usually in the served area there are various administrative authorities in charge of transport serviceability. Usually urban transport serviceability is organized by city authorities, transport serviceability of the region providing regional authorities. E.g. in Slovakia Regional bus transport is performed by Region - Regional authority and regional rail services provided by government - the Ministry of Transport. The organizer of transport serviceability came from Hamburg in Germany from 1960.

Tab. 3. Transport accessibility in particular in Great Britain

Town/Village (outside Moray)	Population	Buses per day: Monday-Friday	Buses per day: Saturday	Buses per day: Sunday
(Aberdeen)	(220,420)	-	-	-
Aberlour	785	2 (+1 Thursday)	0	0
Burghead	1,640	15	14	0
Carron	<1000	1	0	0
Cullen	1,327	2	1	0
Dufftown	1,454	15	14	0
Elgin	25,678	-	-	-
Forres	9,174	15	12	0
(Inverness)	(51,832)	-	-	-
Keith	4,470	9 (+1 Tuesday)	7	0
Lossiemouth	6,803	39	36	8
Milltown of Rothiemay	<1000	1 Tuesday	0	0
Tomintoul	332; 363	1 (+1 Tuesday and Thursday)	0	0

The concept of an integrated organization still serves as a public authority that fully coordinated transport services and to the conservation of individual subjects as components companies that are actually responsible for supply of services. Disorganized transport serviceability leads to a significant reduce of transport serviceability, as shown by the experience of the United Kingdom. Liberalization in the UK in the 80s has led to the fragmentation of public passenger transport [26]. Mentioned fragmentation caused a reduction in public transport services. As an example, Table 3 includes municipalities with populations of more than 1,000 people who do not have daily transport links of regular transport service.

Further defines the organizational integration agreement between the parties that ensure the interest and liabilities related to the functionality of the integrated public transport system. Organizer of transport must be based on the expectations of passengers on public transport by Rivasplat must take into account the commercial interests of the carriers and carriers to be identified with the objectives of integration [28].

3.2 Operational integration

Operational integration is the coordination and planning of the transport system corresponding to the requirements passengers while minimizing of transfers in space and time. Operational integration consists of the layout of an integrated network, synchronized plans for of transport serviceability between different transport modes and routes of direct transport, integrated information on all services of general tariffs and compliant use of travel documents [35]. The necessity of transport serviceability plans also point to [3]. Division of integration refers to planning network without spatial gaps so that all routes, lines and modes of joint and coordinated in the most efficient manner that allows comfortable transfer to passengers. A clear hierarchy and structure of the system is required in combination with defined roles for each species. The hierarchy support services that are easy to remember, simple, with controlled routes where possible also be effectively covered reliable travel route [10]. Once the network is harmonized, the optimal operation of the system requires integration mappings: coordination and synchronization times of arrival and departure involved in routes and modes. Also aims to reduce the waiting, delays, transfers and total travel times.

As part of operational integration is necessarily communicating with passengers [23, 24]. The traditional view of integration of transport, passengers perceive transport as a negative experience due to time, cost, and of course it is a feeling subject to uncertainty [9]. For this reason, there must be an integrated information system. All necessary information about the entire transport system must be available regardless of the used method and of the operator responsible for the service. The way is a network introduced to the public, may significantly affect the efficiency of public transportation system [19].

Within the operational integration need to be addressed also travel documents. Setting up of integrated access system improves comfort by eliminating need to purchase of a ticket for each trip separately. The transport ticket and fare creates common system integration for those involved and contribute to improving transport that allows passengers to travel

comfortably between the lines by purchasing only one ticket for the whole service. Fare has an effect on passenger and also on operator. By introducing a common fare system can be avoided competitive bidding among carriers and aggregated revenues can be distributed in accordance a signed agreement.

The operational integration commit integration as a separate element of integration who details the operational integration as a separate element of integration [29, 32]. In integration of infrastructure is mainly about the arrangement of the combination of elements that constitute the integrity of the transport network. This concern especially to all elements that are: location of bus stops, stations and interchanges that ensure a comfortable transfer for passengers.

3.3 Physical (material) integration

The physical (material) integration or infrastructural integration relates mainly to physical changes, such as the integration of new roads, reorganization of transport sections and locations [15]. It refers to the construction of planned bus stops, stations and gateways, as well as their location and facilities, as well as actual draft. All of this involves coordinating of safe movement of vehicles in transit, without any conflicts between pedestrians and moving vehicles. Physical integration is trying to carefully plan the system by proposing a controlled station, comfortable walking paths and equipping stations aiming at accelerating and also the safe transfer, improving accessibility towards the inside and intermodal transport system for all groups of passengers, facilitating the movement of users and minimize discontinuities within the system.

3.4 Integration barriers

In the integration of transport can arise barriers that it is necessary to consider even before integration. The barrier is a barrier for implement policy instrument, or limits the way in which the instrument could be realized. In extreme cases, such obstacles can be overlooked and thus lead to less effective final strategy. Barriers can be grouped into four main categories [13]:

- Legal and institutional barriers – lack of legal powers to implement a particular instrument.
- Financial barriers – these include budget restrictions limiting the overall expenditure on the strategy, financial restrictions on specific instruments, and limitations on the flexibility with which revenues can be used to finance the full range of instruments.
- Political and cultural barriers – these involve lack of political or public acceptance of an instrument, restrictions imposed by pressure groups, and cultural attributes, such as attitudes to enforcement, which influence the effectiveness of instruments.
- Practical and technological barriers - while cities considered the most serious legal, financial and political barriers faced with the implementation of instruments of territorial and transport policy, also practical limitations may occur here. For example, in expanding of infrastructure public transport can be a barrier to existing network engineering.

Integrated strategies are particularly effective in overcoming the second and third type of barriers. The integration between authorities can help to reduce institutional barriers. This difference is usually more difficult to overcome the legal, institutional and technological barriers in the short term. It is often difficult to overcome such barriers what to some extent reduces the performance of the overall strategy. Approach is possible within the financial limit adapted to satisfy public opinion. Seeking synergies and resolution of obstacles is somewhat at odds with proposed integrated strategy.

In order to achieve the best integration of public transport that should quickly identify potential barriers is to choose the following procedure [29]:

- Phase 1: Diagnosis and evaluation of the current status of a public transportation system.
- Phase 2: Formulation of the concept of multi-criteria evaluation of ISUP as a problem in the position of the variants.
- Phase 3: Review and evaluation of methods of multi-criteria ranking of the options.
- Phase 4: Keeping computer equipment and methods selected of options position.
- Phase 5: Summary of computational experiments.

4. Conclusion

In modern cities individual transport leads to serious problems relating to the: traffic congestion on the roads and environmental pollution. With increasing of road transport performances at the corresponding capacity of the road network increases the probability of traffic accidents and reduce road safety. It is therefore extremely important to strive to change the behavior of people when traveling using several sustainable modes of transport: Public transport, bicycles, sidewalks, cars sharing and mutual agreements. This can be achieved by using the concept of managing transport demand. The aim is to support residents of the city to use public means of transport. On the importance of integrating transport have pointed experience from abroad. During a liberalized ensuring public transport in the UK led to reduced transport services area. Reduction of transport serviceability is causing transfer of passengers to individual motoring. The integration of transport is not a easy process, as is demonstrated process integration that referred to in this article. Is however important to overcome the greatest barrier to integration - the lack of funds in public funds [29].

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