

FARE COLLECTION SYSTEM IN INTEGRATED PUBLIC PASSENGER TRANSPORT SYSTEMS

Pavel Drdla¹, Josef Bulíček²

Summary: The paper deals with questions of fare collection systems in the frame of integrated public passenger transport system as well as with requirements and standards of fare collection systems. The relations between fare collection system and tariff system, information and sale (distribution) systems are also mentioned next to it. Brief proposal of application of these fare collection systems in the frame of integrated public passenger transport systems by fulfilment of all given conditions placed on these systems is mentioned in the conclusion part of this paper.

Key words: fare collection system; integrated public passenger transport system; standard for fare collection system; tariff system; information system; sale system.

INTRODUCTION

Public passenger mass transport is an indispensable public service for majority of citizens, ensuring transport service in area and thus accessibility of destinations of their trips. Ensuring of effective and economic transport service and the function of transport system for what the regions are responsible is the target. This system must cover as most transport needs of inhabitants as possible by controlled utilizing of adequate costs paid by the public finance. (1)

Integrated public passenger transport systems (ITrS) are an effective way of ensuring of public transport service as follows from especially foreign practical experiences. These systems are known as integrated transport systems in the Czech Republic, abroad they are known as transport associations or tariff associations as well. (2)

Well operated and suitable fare collection system (FCS) is also an integral part of ITrS. FCS is designed not only for passenger needs. Design of operation of FCS is not an easy task as follows from following text. It must be suitable for all passengers, ITrS and all integrated transport companies or operators involved in the ITrS. (3)

The aim of this paper is to point out individual problems connected with FCS and to recommend the solution applicable in the practical operation.

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1. REQUIREMENT OF INTEGRATED TRANSPORT SYSTEM ON FARE COLLECTION SYSTEM

It is possible that some serious changes in check-in of passenger travelling on single or short-term time tickets could be occurred by setting of ITrS into operation.

Important changes are able to be occurred due to:

- the changes in check-in technology,
- the introduction of transferable tickets (fare) in the regional bus transport service,
- the introduction of integrated transport documents with time-based or zone-based limits of validity.

The check-in passengers by technical devices equipped by possibility is required to stamp (mark, devaluate) ticket by necessary data. In the case if the technical equipment used by individual transport operators does not support all or some kind of data, it is not possible to base the fare system on these single tickets. Requirements of the rules for boarding and alighting of passengers, for ticket inspection and for issue of an integrated transport documents are able to be determined in the same way. It goes not about requirements on individual technical devices in the system only.

The requirements on interface between FCS and other systems have to be taken into account as well. Tariff, sale and information systems are examples what is mentioned under “other systems” (Fig. 1).

These requirements lead towards two main groups of standards in the field of FCS. (5, 6, 7)

Standards for FCS in ITrS

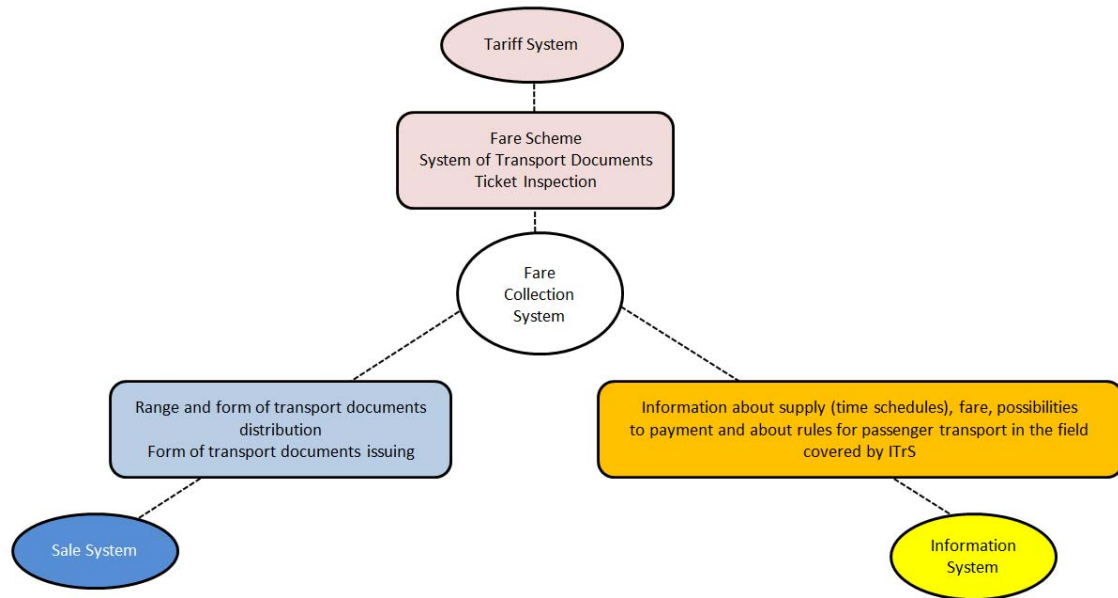
There are characteristics of technical devices as well as check-in of passengers (boarding and alighting of passengers, definition of place, time and way of transport document stamping or making) adjusted by these standards.

Interface Standards between FCS and Surrounding Systems

These standards adjust interconnection of FCS, sale, information and tariff systems. Individual interfaces are declared by the Fig. 1.

Both groups of standards are proposed in following text.

There is possible to analyse requirements of individual subjects of system, i.e. passengers, transport operators, system organiser and orders of transport services, in similar way for ability to specify requirements on FCS placed by surrounding systems.



Source: (4), Authors

Fig. 1 – Interface between FCS and surrounding systems

The needs (interests) of involved subjects are characterized by following:

1. Passengers

- the quick and easy check-in,
- the possibility to use public transport whenever and everywhere,
- the fair determination of price for using of public transport services.

2. Transport Operators

- to improve access of passengers to public transport, to allow development of fares based on “optimal” price for realized transport,
- to decrease of operational costs for unit of output,
- to decrease number of so called “stowaways”, to reduce abusing and falsifying of transport documents.

3. ITrS Organiser

- to ensure conditions for development of ITrS,
- strict clearing of revenues among transport operators, check of transport outputs,
- to collect statistical data about ITrS needed for optimal supply of services (movement of passengers, number of passengers in individual connections etc.),
- to improve access of passengers to public transport, to allow development of fares based on “optimal” price for realized transport.

4. Transport Service Orderers (state, municipalities and firms)

- to ensure conditions for development of ITrS,
- strict clearing of revenues among transport operators, check of transport outputs,

- to collect statistical data about ITrS needed for optimal supply of services (movement of passengers, number of passengers in individual connections etc.).

Tab. 1 – Standards for FCS in ITrS

	Standard ITrS 1	Standard ITrS 2
Sale of integrated transport document	In advance (ticket vending machine, newsstand, booking office at railway station or stop). By driver with surcharge (for sale in vehicle).	In advance (ticket vending machine, newsstand, booking office at railway station or stop). By driver in vehicle.
Stamping (marking) of integrated transport document (ticket)	Urban public transport and regional bus transport: by boarding of vehicle. Ticket validator is located in vehicle. Railway transport: before boarding of train. Ticket validator is located on platform or in vestibule of stop or station.	Integrated transport document purchased in advance: by boarding of vehicle. Integrated transport document sold by driver is marked by vending device.
Number of ticket validators	Urban public transport and regional bus service: equal to number of doors for boarding of passengers. Railway transport: at least one for every direction.	Equal to number of doors for boarding of passengers.
Boarding	by all doors	by the first door only
Alighting	by all doors	all doors, except first

Source: (4), Authors

The following requirements on FCS in ITrS should be determined by summarizing of aims of individual subjects:

- easy and quick way of payment for transport and check-in into system,
- ensuring of conditions for organisation and development of ITrS,
- ensuring of strict clearing of revenues among transport operators and check of transport outputs,
- collecting of statistical data about system (movement of passengers, number of passengers in individual connections etc.),
- improving access of passengers to public transport and allowing the development of fares based on “optimal” price for realized transport,
- decreasing of operational costs (print, distribution, sale of transport documents),

- high rate of system safety (protection against falsification of transport documents),
- reduction of “stowaways” number.

2. STANDARDS OF FARE COLLECTION SYSTEMS IN THE ITRS

Standards for FCS may be related to general standards for ITrS, which mark the character of transport supply ensured by ITrS and which are defined in following way: (4)

Standard ITrS 1 (IDS 1)

Standard is focused on the traffic outputs of urban public transport and on the outputs of services in suburban areas with character of urban public transport. This transport has network character and its supply is able to be considered as continuous.

Standard ITrS 2 (IDS 2)

The main part of transport output is to provide out of urban areas and their agglomerations. Supply is oriented on transport service in region. This transport has line character and follows community characteristics of a day.

Requirements on way of passenger check-in, related to these standards, are located in the table 1.

3. STANDARD OF INTERFACE BETWEEN FCS AND SURROUNDING SYSTEMS

3.1 Interface Tariff System – Fare Collection System

There is a lot of prerequisites for FCS resulting from the tariff system. This argument is also valid the in reverse way, but in lesser extent. (4) Following segments of tariff system have got serious relation to FCS:

Tariff Arrangement

The partition of area of interest depends on selected type of tariff with regard to ensuring of “optimal” revenues, financial acceptability and equity for passengers in known as tariff arrangement. The three types of tariff arrangements are used: the tariff based on combination of zone and time limits of validity; based on zones only; based on travelled distance (kilometres). In the case of zone-based tariff area of interest is divided to the number of tariff zones. One (the same) price for transport is valid in the area of one zone. In the case that the trip leads through more zones, the fare grows proportionately to the number and type of zones on the route. Data stamped to tickets by ticket validators have to be changed in accordance to accessing of individual zones. Ticket validators have to be interconnected with on-board computer due to this reason. Stamped validation data are changed by the computer.

Validity of tickets is limited by travel time in the case of time-based tariff arrangement. Ticket is valid from stamping of it (by first boarding of vehicle) to end of time period for what is bought. Simplicity of its use for passengers is an advantage of this type of tariff arrangement, especially for passenger who uses public transport in area of interest rarely.

The ticket inspection and distribution of tickets are also able to be seen as simple. It is necessary that the FCS must be equipped by the devices printing actual time. Connection

of ticket validators to on-board computer is also essential. The computer has to be connected to the time signal receiver for ensuring of the same time in all ITrS. The vehicles have to be also equipped by display of actual time for passengers.

The price of ticket is depended on the number of travelled kilometres in the case of kilometric (distance) tariff arrangement. This arrangement is sometimes named as line tariff as well. The price is determined for one kilometre. This kind of tariff is usually applied in the form of kilometrical band tariff with decreasing prices in practice (in regional bus service). Price is related to interval of travelled kilometres. FCS calculating price after marked (stamped) boarding stop and alighting stop is able to be seen as standard for this kind of tariff arrangement. The price is calculated by distance between marked stops. This FCS can work on principle known as check-in / check-out by passive or active registration of passengers.

Structure of Transport Documents

The definition of range of transport document kinds and declaration of their validity in relation to tariff arrangement is known as the structure of transport documents. The ticket, pass (season ticket) or other document permitting passenger to travel (and possibly to transport of luggage) in accordance to transport rules and tariff is able to be considered as transport document.

Solution of interface between structure of transport documents and FCS is able to be found between following extreme cases:

1. to unify check-in devices (FCS) by all involved transport operators,
2. to unify dimensions and content of transport documents (tickets) for their utilization in all kinds of technical devices used by all transport operators.

Tab. 2 – Check-in and Ticket Inspection Standards in ITrS

<p>Passenger is check-in by boarding of vehicle (integrated transport document is marked by passenger in ticket validator) or before boarding of vehicle. Boarding and alighting is possible by all doors. Boarding is able to be restricted to first door of vehicles in defined time periods or for a specified group of passengers.</p>	<p>Ticket inspection is organised by inspectors – employees of transport operator, organiser or specialized firm.</p>
<p>Passenger is checked-in by driver of vehicle. Boarding is realized by the first door of vehicle, alighting by all doors.</p>	<p>Ticket inspection is provided by driver of vehicle. Ticket inspection is organised by inspectors – employees of transport operator, organiser or specialized firm is considered as additional only and it is organized at random.</p>

Source: (4), Authors

In regard to possible differences between used types of FCS in the area of interest it is recommended to follow way of adjusting of ticket dimensions and of content in accordance to used types of FCS. It is possible that FCS will have to be changed especially by FCS not supporting using of transferable transport documents.

Ticket Inspection

Ticket inspection is a control of compliance of transport agreement, i.e. if the transport rules, contractual conditions of transport and tariff are complied. Practical implementation of complying of transport rules is based on control of legitimacy of travelling at place of control and time of control. Ticket inspection by railway operators, in urban public transport and regional bus transport is organized on the same legal base, but in different ways. These ways are influenced by type of utilized FCS.

Two relations between the ticket inspection and FCS mentioned in tab. 2 are able to be considered as standard.

3.2 Interface Information System – Fare Collection System

Modern FCS is not only a mere part of tariff subsystem of ITrS designated to vending or marking of transport documents. FCS has a new role – to collect data and information about transport system. FCS will become an important tool for controlling of ITrS as well.

The basic requirement for FCS in relation to information system is to collect the statistical data about subsystem characterized by transport output, payments for this output and by movement of passengers. The assumption is to ensure of data compatibility by all involved subjects.

These data can be divided into the following groups: (4)

1. data about realized outputs,
2. data about realized takings,
3. data about posterior transport demand (substituting of transport surveys).

Following extent of data can be considered as standard:

Ad 1) Data about realized outputs – monitoring of vehicle movement in area and of transport process (comparison of reality with plan). It can be proposed, that organizer cannot require dispatching of operation, for which transport operator is responsible. Possibly higher level of record is determined by transport operator. Off-line monitoring of vehicle output can be considered as standard. Monitoring is provided by record in the on-board computer unit.

Ad 2) Data about realized revenues – are depended on used tariff and kind of transport documents. An assignment of revenues to transport output can be considered as standard. This assignment is ensured by smart card, cash payment by driver or by vending of non-transferable ticket connected to place of boarding etc.

Ad 3) Data about posterior transport demand. These data are able to discover and evaluate how state-of-art transport supply is used and how is transport demand covered by supplied public transport. Passenger demand to travel by concrete supplied bus connections and trains can be considered as posterior demand. FCS are able to collect these data without ensuring of expensive transport surveys focused on vehicle capacity utilizing. These data assign numbers of boarding and alighting passengers to every connection and to every stop. This information can be used for:

- the evaluation of state-of-art and proposal of new transport solution,
- the increase/decrease of capacity by connection,

- the shortening/extension of connection,
- the change of route of connection,
- the decision making about merits of line connections.

Possibility to monitor of personified passenger, i.e. passenger whose selected personnel data are registered, is ideal. Observation of anonymous passenger and his registration by boarding is standard. This must be in accordance with valid (legal) conditions for registering, storing and manipulating with personal data.

3.3 Interface Sale System – Fare Collection System

An issuing (design and printing of integrated transport documents), distribution, way and forms of ticket sale are known as sale system.

The standards for sale of tickets are related to the general standards of ITrS and they are mentioned in the chapter 2.

The important standards in interface between FCS and for issuing of integrated transport documents are:

- the dimensional standards of transport documents,
- the standards for content and graphic design of integrated transport documents,
- the standards for protective elements of integrated transport documents.

Note:

There are often used the concepts like “uniform ticket” or “conjoint ticket”. It is often supposed about physical design of transport documents that the tickets issued by individual transport operator must have an unified design. It must be pointed out that uniform design could be mistake, it is not a priority. Unification of transport documents appearance is not necessary for establishing of the ITrS.

It is able that single as well as season transport documents can have various appearances related to the transport operator or to the distribution channel (sold by newsstand, by driver, by ticket-vending machine, or by distribution place of transport operator). The most important is that all tickets are issued by one tariff (tariff of ITrS) and that they are accepted by all involved transport operators. These principles may be also applied:

- the principle of content uniformity (obligatory data, eventually other data required by the system),
- the principle of design uniformity (same position of data on tickets, colour and graphical solution),
- the principle of application of transport documents protection standards.

4. PROPOSAL OF STEPS OF ORGANIZER FOR REACHING OF DESIGNED STANDARDS FOR FCS IN INTEGRATED TRANSPORT SYSTEM

The standards for FCS and its interface should be incorporated in operation and technical standards for control of ITrS.

Designing and applying of FCS standards and standards for interfaces between tariff, information and sale systems will be the most important operation-technical task of organizer in the field of ensuring of ITrS operation.

Following steps of organizer are able to be proposed for FCS: (4)

- ensuring of standards for passenger check-in by all transport operators involved in ITrS (see chapter 2),
- ensuring of dimensional standards for integrated transport documents by all transport operators involved in ITrS (see chapter 3),
- ensuring of standards for graphic design and content of integrated transport documents by all transport operators involved in ITrS (see chapter 3),
- ensuring of standards for protection elements of integrated transport documents by all transport operators involved in ITrS (see chapter 3),
- ensuring of content uniformity and compatibility of data provided by transport operators (see chapter 3).

Determined standards (not only) for FCS in ITrS should be declared by agreements in the operational documents of the ITrS. Applying of standards in whole system and by all transport operators is able to be ensured in this way.

It is recommended to make the controls by system organizer, if the standards are fulfilled by all of involved transport operators. Organizing of this control (control of complying of technical and operational standards of the ITrS) should be connected with ticket inspection or not. It is not necessary to make these controls by employees of organizer.

5. PROPOSAL OF PASSENGER CHECK-IN IN THE INTEGRATED TRANSPORT SYSTEM

5.1 The first Stage of Integration

There is recommended to integrate the public transport without urban (city) public transport systems in the first stage. In core it goes about acceptance of transport documents and coordination of tariffs based on distance (kilometric) tariff. The change of FCS is not necessary in this stage. It is necessary to equip the buses with the handy ticket validators for stamping of railway tickets, because there is a risk of multiple using of one ticket in the case without possibility to stamp the tickets. Establishing of integrated transport documents in the filed of season tickets is not presupposed in this first stage.

5.2 The second Stage of Integration – Incorporation of Urban Public Transport

If it is necessary or not to realize this second stage it is depended on the extent of application of FCS based on smart cards. The decision to skip of this stage is possible if FCS based on smart cards is applied by urban public transport as well. This can be connected with investment to the new FCS based on smart-cards.

Incorporation of urban (city) public transport systems (or municipal transport operators) is recommended in the second stage. The application requires following modifications of FCS:

- to unify dimensions of integrated transport documents,
- to modify of entrance slots of ticket validators for unified dimension of tickets in urban public transport,
- to add the software of ticket vending devices in the regional bus service and on railway by possibility to print text “+urban public transport” and by appropriate modification of tariff,
- to add the ticket validators also into regional buses (1 piece by driver),
- to modify of ticket vending machines.

The modification of ticket vending machines is the most difficult change in the field of FCS. The modification is focused not only on software, but also on hardware. The reason is to have the possibility to print also the name of destination stop chosen by passenger (except all of nowadays printed data). The price calculation must be related to the selected tariff as well. It is also possible to design two variants of solution differing by point of view of user as well as point of view of costs.

Variant 1

The ticket vending machines will be equipped by fixed (laminated) map with line scheme and names of communities (stops). The names of communities can be equipped by numerous codes – e.g. with three digits. The ticket vending machines will use the numeric keyboard.

The passenger will find his destination in the map and than he will type the code into the ticket vending machine. Naturally also other data must be entered like by nowadays (e.g. requirement for half price ticket).

The lower costs for hardware and software can be considered as advantage of this solution. Finding code of destination in the map is the second advantage, because it is independent on the work with ticket vending machine and the occupation times of ticket vending machine are shorter.

A disadvantage can be that this method looks a little bit older and maintenance of printed maps is also necessary.

Variant 2

A fully computerized solution is proposed in the second variant. The ticket vending machines will be equipped by bigger screen and by roll list of communities (eventually of stops as well). The passenger will select destination by roll list and confirm selected destination by the key “Enter”. All of other options are selected in the same way as before.

Higher flexibility is able to be considered as an advantage of the second variant. It is a modern solution and there is not necessary to equip the ticket vending machine by numeric keyboard.

Increased costs for hardware and software, longer time of occupation by passengers can be mentioned as disadvantages of this solution. The basic computer literacy of users is needed too. This can be also felt as a disadvantage.

The ticket vending machines have to be equipped by short, brief, understandable and clear manual how to buy tickets in both variants. The presumption for acceptance of this “self-service” distribution channel by passengers as well as essential help for passengers using system rarely (e.g. foreigners) is necessary.

5.3 Introduction of Season Time Tickets

Introduction of season time tickets is usually not directly connected to the change of FCS. This fact causes that the attempt can be occurred to start integration by these (long term) season tickets, without regard to possible obstacles in the future. Due to movement of main transport operators to use of smart cards it is recommended to skip this stage.

5.4 Recommended Final State

It is recommended to apply contactless smart cards prospectively. It is advanced application of information technology (e.g. information telematics systems). FCS connected with on-board (station) computers in combination with smart cards (especially in check-in/out systems) are also able to be used as important information source (as continuous transport survey). Check-in system based on smart cards is also able to allow collective check-in (out) by accessing (egressing) of station (or transport area) of capacity transport systems like underground or railway.

Appropriate moment for change of ITrS occurs on the end on life of currently used system. In the case of decision between modification of state-of-art (expensive) ticket vending machines and change of FCS, the change of FCS is recommended rather. Initial investment has return in lower operational costs and more simple cash economy.

CONCLUSION

A design and realisation of fare collection system (FCS) is a complicated thing as it has been mentioned in the paper.

Individual requirements placed on this system can be partially counteracted from the application point of view as well as from the point of view of parallel implementation of these requirements. Mentioned requirements are base for the design and application of FCS standards as well as standards for interface with surrounding (tariff, information and sale) systems. Special task is estimating of appropriate moment for involving of urban (city) public passenger transport systems into FCS of an integrated transport system (ITrS).

All of these facts have been pointed out in the paper and this is able to help with a decision about implementation as well as during the implementation process of FCS in ITrS.

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