BKK Automated Fare Collection System

Feasibility pre-study

Budapest, 31 December 2011
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1. Executive Summary

In recent years, there were numerous proposals on reforming the fare system used in Budapest public transport. This should come as no surprise, as Budapest has the most outdated ticket system in Europe, with mechanical ticket punchers that are now museum items in the large European cities that Budapest aims to learn from when it comes to the organization of transport. This outdated technology blocks the introduction of ticket types that greatly differ from single-trip tickets and period passes, even though these alternative products are working well and are popular in other cities, and it also inhibits effective action against fare evasion and the counterfeiting of passes.

The foundation of the Centre for Budapest Transport (BKK) and the introduction of a new approach in the organization of transport, the time came for radically changing the system in Budapest. In the three Decisions passed at its 6 April 2011 session (601/2011, 602/2011, 603/2011), Assembly of the Municipality of Budapest called upon BKK to design and implement the new automated fare collection system. We reported on the progress of the project at the 31 August 2011 session of the Assembly of the Municipality of Budapest.

The main aims of the project are as follows:

1. Introducing a new fare system (ease of use, flexible rates, e.g. switching lines without buying a new ticket)
2. Making ticket and pass sales more comfortable and modern, and available in more locations through more channels (e.g. via mobile phone and Internet)
3. Reducing fare evasion by reorganizing controls and making them more systematic (e.g. by installing automatic gates in the metro network instead of relying on ticket inspectors).
4. Eliminating the counterfeiting of tickets and passes
5. Introducing a technological system that, apart from public transport tickets, also handles the collection and processing of payments for parking, Budapest's bike-sharing scheme (BuBi) and other transport services.
6. The ticket revenue processing centre of BKK needs to be connected to future the national ticket revenue processing system and the future National Integrated Card System.
7. Contributing to the sustainable financing of public transport and to improving the level of service it provides

The new system will bring numerous tangible changes for passengers: paper-based tickets and passes are expected to be replaced by electronic fare payments by 2014, and new elements are planned for the ticket system, most notably time-based tickets, a daily spending cap and pay-as-you-go payments using contactless bank cards. In another change, after the introduction of the nationwide system, students and pensioners will be able to use public transport and the concessions available to them through the National Integrated Card System.

The system will be simple and easy to comprehend for passengers, but it will be backed by one of the most complex payment processing and IT development projects in Hungary when it comes to the type and number of transactions and the complexity of the system; therefore, thorough preparation is particularly important.

The renewal of the fare system is one of our most important tasks, and the introduction of similar systems took several years even in Western European cities that had much more advanced technologies in place. The project requires the installation of new ticket validators on every vehicle, the installation of automatic gates on metro stations and manufacturing and distributing pass cards to hundreds of thousands of passengers. The switch from the old system to the new one will be successful if it is executed in accordance with a well thought-out and thoroughly planned structure, taking into account a variety of considerations. Therefore, the gradual introduction of the system will require several years, starting in 2014.

The present document recommends starting/continuing the preparations for the project, provides information regarding the system to be implemented, the possible schedule of implementation, the projected costs and longer-term operational cost savings, and proposes possible sources of financing.

The present study undertook the task of preparing a fresh, in-depth review of the current obsolete, inherently loss-making ticket system that is disadvantageous for a significant proportion of passengers, relying on a new, qualified expert team with knowledge based on prior experience, and drawing up a model for a future system based on the results.

The methodology is based on the fact that Budapest is starting with a clean sheet – as there was essentially no change or development in the ticket system or infrastructure in recent decades – and as such, what is under consideration is practically a "green field"
investment. Therefore, we felt we had an opportunity and an obligation to make a proposal for a **new fare system**. The fundamental principles of the new fare system were derived from the town policy principle that it is in Budapest's interest to motivate the largest possible number of people to use public transport services with regularity, as any increase in the number of people travelling by car causes loss of time at both the individual and the community level and contributes to environmental pollution, which can be significantly reduced by making public transport more attractive to citizens. There are several factors that contribute to the attractiveness of public transport: the size and structure of the network, the schedule, the ability to maintain the schedule and the condition of the vehicles. The fare structure and fare levels are similarly important factors, as is the availability of tickets and passes; in one word, the "fare system".

Within the framework of the review of the fare structure, the study proposes **maintaining the system of passes**, which is working well and is indispensable for those who use public transport on a regular, daily basis. We believe that it is advisable – as it is done today – to set the prices of weekly and bi-weekly passes such that it is worth for passengers to buy a month pass, and to give an incentive for buying one-year passes, which is beneficial for the service provider from the point of view of cash flow.

**Time-based tickets** are an ideal solution: during their validity, they offer unlimited line changes, which is beneficial for passengers that take short trips that require several line changes. In order to make public transport worth using for people who take several trips in one day, we recommend introducing a **fare cap** that maximizes the amount of money that can be spent on travel in a given period. This would automatically give the passenger a day pass in accordance with a predetermined fare structure after using a given number of time-based tickets, i.e. any further travel would be free after paying for a certain amount of travel time that day. In economic terms, this would mean the maximization of consumer surplus, and it would offer an assurance for people who are not regular passengers that reduces the weight of the decision taken when starting their first trip on public transport: they can start using public transport safe in the knowledge that the fare will switch to day pass mode whenever that is more beneficial for them. The validity period of time-based tickets requires further investigation in our opinion.

The above described product structure is designed to increase the number of people who use public transport with some regularity, encouraging occasional passengers to become regular users of the system, and to incentivize non-pass-using passengers to actually pay for
using the service. The above travel product range is expected to increase the number of people using public transport, saving time and money for the individuals involved and making the public transport system itself more sustainable through higher expected fare revenues.

Certain services in Budapest's public transport network (such as suburban railway lines) extend beyond the administrative boundaries of the city. The legal regulations regarding the fare structure applied to these services recently changed, making the introduction of time-based fares a legal obligation. This provides an opportunity to revise the fare structure that applies to the suburbs of Budapest in order to set up a ticket and fare system that is compatible with that of Budapest, and shared between the various service providers (the MÁV-START railway company and Volán coach services). With this aim, the present study proposes the introduction of a zonal fare system in Budapest suburbs, which requires further negotiations with the actors involved with a view to coming to a common agreement. A system of common regional fares is a long-standing issue that should be resolved by lawmakers in the interests of the travelling public.

However, the expanded and innovative product range is only one element of the proposed changes; the proposed technical solution also makes it possible to introduce radically new purchasing options as well: Internet distance sales and balance top-ups, and – depending on the results of further surveys – a radical expansion of the reseller network, e.g. using ATM machines.

The proposed automated fare collection system:

- is based on a server-based architecture
- uses contactless travel media
- is based on cards issued by the transport organizer
- ensures the verification of concession eligibility primarily through the National Integrated Card System
- is capable of mitigating counterfeiting
- enables value-added services and supports Internet distance selling
- makes it possible to introduce time-based tickets and a fare cap
BKK Automated Fare Collection System

- makes it possible to install automatic entry and exit gates at metro stations and operate them to a high standard
- ensures effective revenue protection

The proposed **server-based system based on contactless cards that also accepts contactless credit and debit cards** stores all travel-related information on a central server. The main advantage of this approach is that the **travel card used by the passenger (the travel media) only stores a limited amount of personal information; it has no value of its own.** Central data storage allows for **after-the-fact settlements** and the introduction of special, promotional travel products, even on an ad-hoc basis, and allows for the disabling of cards in case of theft or loss, minimizing the financial risk for users. In essence, the principle the system is based on is **similar to the operation of banking systems and credit cards.** The use of this principle of operation in a transport system is a technological novelty, because it means that all the ticket validators on vehicles and metro stations need to be constantly connected to the central server, and this was only made possible in recent years by the introduction of affordably priced advanced mobile data transmission technologies – which are still only available in major cities in Hungary. One of the most time-consuming tasks involved in the proposed solution is the replacement of mechanical ticket punchers with new validators; therefore, the introduction of new tickets is scheduled only for the second phase of the introduction of the new system. The examples of Chicago, Philadelphia and London have shown that automated fare collection systems can now be introduced in major cities in the proposed manner. A direct sharing of experiences is necessary with the above three cities – the results were announced in the calls for tender on the installation of the system in the two American cities in the autumn of 2011, so we only now get an opportunity to study the calls and the winning bids. We are already in contact with Transport for London, and Budapest needs to make use of the early experiences with the contactless bank card transit payment system that will be partially launched in time for the Olympic Games this summer.

The present study introduces the currently operating systems that are obsolete, fail to meet modern expectations and therefore need to be replaced. In all of these, the travel media stores the travel product and/or the passenger's balance. When the new system is introduced, the travel media can be paper tickets, magnetic stripe cards or cards using contactless technology. The study lists the drawbacks of each rejected alternative.
Overall, we believe that the new system to be introduced should not be based on technologies that are 15-20 years old. An automated fare collection system to be introduced in the near future at a cost of several billion HUF should ensure long-term sustainability, provide a basis for subsequent further development and make sure that invested resources are used efficiently. As the previous systems do not meet these criteria, we surveyed the modern technologies that are already in use in newly-introduced public transport projects in cities around the world.

The proposed system is a state-of-the-art solution in every aspect. **Contactless bank cards** offer new possibilities, but naturally passengers who do not have such cards will also be able to use the system with cards issued by BKK. Contactless bank cards (which are widely used in some countries and are expected to become widespread all over Europe in the next few years) will be **directly usable for travel**, which essentially makes the system globally interoperable and open. This means that anyone who has a compatible contactless bank card will be able to use the services immediately, **without any prior registration or product purchase**; payments will be charged to the card afterwards. This will make access and payments much more convenient for domestic and foreign tourists and businessmen. The use of contactless bank cards in public transport services requires the application of a special set of rules, which has been set up by major card companies in recent years. The principle of operation is explained in the present document.

Passengers who are granted **travel concessions** by the Hungarian state will be able to use public transport services directly with **personalized travel media** made out in their name; if all technical and operational details are worked out, this will be a **contactless card** issued within the framework of the **National Integrated Card System**. As we propose maintaining a system of personalized, non-transferable passes, **all pass holders need to be issued personalized cards**, i.e. cards with their name on it. Naturally, it will be possible – as it is possible now – to **use the service anonymously** using the appropriate travel medium, but not with every travel product.

The effectiveness of revenue protection will be ensured using **automatic entry and exit gates at every metro station**, which will replace human ticket inspectors. The installation of these automatic gates is one of the most costly elements in the proposed project. Limiting access to the front door on every vehicle in the surface transport network (e.g. trams) is not feasible, and therefore the system of controls will need to be revised. One of the main justifications for introducing the fare cap system is to motivate ticket users to become eligible...
for flat-rate travel in a given period as soon as possible, i.e. to validate their card at every ride. It should be noted that the installation of automatic gates requires every passenger, including those entitled to free travel (e.g. those over 65) to have electronic travel media, which will need to be provided to them.

We feel that it is especially important to inform Hungarian banks – with the cooperation of international card companies – about the special set of rules to be applied to the use of contactless bank cards in public transport.

The present study is not intended to provide detailed information about the various technologies and card and data transmission standards, especially because there is no widely adopted international or EU standard covering such systems as a whole. Therefore, we express preference for no particular industry standard over any other. The main aim when it comes to the design of the technological infrastructure is to set up a technologically open system in which the various components (such as the ticket validators) can operate as a closed system – a black box – but the specification of the data transmission and communication between components avoids dependence on any single supplier for the entirety or major elements of the system. One of the most important takeaways of the market research that was started in the autumn of 2011 with the involvement of numerous potential Hungarian and international suppliers was that the system proposed for introduction by BKK is a modern and feasible option.

Introduction was divided into several phases. In the first phase, pass holders in the various passenger categories would receive travel media. This would essentially eliminate the counterfeiting of passes, which causes BKV a lot of trouble and massive amounts of lost revenue. The installation of validators on vehicles will make it possible to introduce time-based tickets, and, finally, the system will be completed by the installation of automatic gates in the metro network and the acceptance of contactless bank cards. These latter phases are expected to take several years. According to optimistic estimates, the issuing of pass travel media and the launch of the related central system and validators can take place in late 2013 and early 2014, and the earliest possible date of the introduction of time-based tickets, pay-as-you-go payments and fare caps is the second half of 2014. This requires – considering the time necessary for the public procurement procedure – that the relevant call be published in July 2012 at the latest, as international experience shows that the planning and launching of a system of this type takes approximately one year from the signing of the contract with the supplier. The financing required for this phase is
estimated to be approximately 2.5 billion HUF\(^1\), which needs to be available by the start of the public procurement procedure, i.e. **June 2012** – possibly via a loan agreement – **if the proposed schedule is to be respected.** At the same time, an effort has to be made to ensure **financing for the entire project by the start of the first phase.**

Our primary **goal** is to implement the project as a **European Union project, with EU co-financing.** This requires the **support of the Hungarian Government, which has not yet been secured;** the Ministry of National Development has not responded to the project proposal submitted by BKK in spring 2011. Government support of the project is in the public interest: the system will significantly reduce abuse of the legally mandated travel concessions provided by the state to certain social groups (students, pensioners etc.) and the possibilities of fare evasion – these abuses are estimated to cause billions of forints of damage each year. The formalized feasibility study was prepared in accordance with the methodology required for EU co-financing and includes a cost-benefit analysis, i.e. a calculation of the return on investment.

As we currently do not have Government backing for starting the project, meeting the schedule described herein **requires** own capital or a **bank loan.** If own capital is available, the preparation of the first phase of the project can start virtually immediately. If a bank loan is to be used, we recommend initiating talks with the **European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD),** as financing the project through commercial banks would require a different approach than financing through the two above institutions set up for financing public projects of this type. In order to be able to start implementing the project with EIB or EBRD financing, but keep open the option of converting it into an EU project later, the methodology for the calculation of return on investment should be cleared with the banks, the National Development Agency, JASPERS, and, if necessary, EU institutions as well. Therefore, the structure and nature of the present study follows – wherever possible – the methodology prescribed for the feasibility studies of EU transport development projects (e.g. **review of alternatives**). To summarize: with a view

\(^1\) Net sum calculated at an exchange rate of 320 HUF/EUR. The estimated cost does not include the setting up of new BKK customer service points or the adaptation of existing ticket offices.
to the goal of EU co-financing, EU public procurement principles must be fully respected from the very beginning, irrespective of the financing used in the initial phase.

The pre-feasibility study contains, in addition to technical, transport and business analysis, a study on the implementation of a suburban fare system and a detailed legal opinion. The finalized pre-feasibility study, including the legal opinion, takes into account the legal amendments adopted by Parliament on 23 December 2011, which allow BKK to act as a transport organizer. The amendments empower BKK to collect the fares in Budapest public transport and take charge of the ticket sales system, thus allowing it to introduce and operate the planned automated fare collection system.

The project can only start if this research and analysis task can be completed. Therefore, there is an itemized list at the end of the pre-feasibility study that contains the tasks that are indispensable for compiling the final specifications of the system and starting the public procurement procedure.

Work needs to continue with the above mentioned steps, described in detail in the Action Plan chapter of the present study.
2. Antecedents and Methodology

In the three Decisions passed at its 4 April 2011 session (601/2011, 602/2011, 603/2011), the Assembly of the Municipality of Budapest called upon BKK to design and implement the automated fare collection system.

The Executive Board of BKK unanimously approved at its 20 June 2011 session (in Decision 68/2011) the work plan contained in the project plan Új tarifa- és jegyrendszer Budapesten (New fare and ticket system in Budapest), which was indispensable for the preparation of the present pre-feasibility study. In accordance with the fundamental principles therein, the first phase of the preparation of the new automated fare collection system in Budapest will be laying down the foundations of the future fare system, and the project plan stresses that BKK wishes to formulate technological requirements based on passenger needs and the features of services and sales. The approved plan allowed us to start looking for project participants with the required competencies – in finance, IT, quality assurance etc. After the selection of the project team, work started in early September.

During the autumn, the project team conducted discussions with major actors on the international market, a few Hungarian companies and experts of the two largest bank card companies, for the purposes of market research, each supplier once, in order to study international trends and the domestic situation. Contacts were also established with representatives of the Ministry of Public Administration and Justice (the ministry responsible for the National Integrated Card System) the Ministry of National Development, the Institute for Transport Sciences, MÁV-START and Volánbusz. Later, discussions continued with Transport for London and we were given access to information on the project of the New York Metropolitan Transportation Authority based on contactless bank cards.

Thus far, the dedicated project team reviewed the documentations of the two BKV calls for tender aimed at introducing an automated fare collection system. Both calls for tender were published in the 2000’s, but neither project was executed. Based on the review, it has been determined that numerous issues were examined in detail in preparation for these previous projects, but the overall approach was too technologically focused: the needs of the passengers, business needs and the need for revising the fare system were not sufficiently taken into account. The feasibility studies prepared at the time show that the intention was – in accordance with the state of technology at the time – to set up a system based on contactless cards where the travel product information is generally stored on the card itself.
Among the possible alternatives for financing the project, the model chosen was the BOT (build operate transfer) model of public-private partnership, where the supplier finances the system to be built, operates it for ten years and then, at the end of this operation period, hands over the ownership rights to BKV. There were plans for setting up a separate company that would operate the system, which was going to sell tickets and passes and collect all related revenue, handing back to BKV the sums remaining after deducting operation costs.

All offers submitted in 2006 contained sums over 60 billion HUF in total for investment (CAPEX) and operation (OPEX) for ten years, including of course the supplier's profit.

The participants were consortia made up of the most important international and Hungarian companies. The public procurement procedure was revoked or voided shortly before the publication of the results. The cancellation of the project damaged the reputation of BKV and the Municipality of Budapest as well, as each applicant consortium had spent hundreds of millions of forints on preparing their bids.

In retrospect, it is clear that no significant developments were carried out in the ticket and pass system of BKV, essentially because they were waiting for the introduction of a completely new system. Even the replacement of mechanical ticket punchers with time-stamp validators halted. Thus, the system that was in use when the call for tender was cancelled in 2006 had not been developed for years and its quality was already deteriorating. This system has remained in place ever since. The only significant development in recent years was the introduction of a computerized cash registration system in 2010. This system provides sales support, but offers no tangible benefits for passengers.

The most important thing we can learn from the 2006 BKV call for tender and its preparation is that in Budapest, where the current system is fully paper-based, the automated fare collection system should not be introduced based on primarily technological and IT considerations. A new framework needs to be set up; taking into account the public transport policy objectives of the Municipality of Budapest and the interests of passengers and the operator company, and the first step towards that new framework needs to be the drawing up of a new fare strategy and the related objectives.

Before high-level goals, expectations and guiding principles are laid down; the current system needs to be reviewed in detail, and the problems of said system need to be surveyed in detail. Based on the conclusions, a list of concrete goals and expectations can be
compiled and refined. Then and only then can technological solutions be reviewed and compared based on the goals set. Then a solution is chosen and proposed based on the option analysis, which is then described in detail. This is based primarily on the description of the processes related to the goals set, with the discussion of technological details being a secondary element.

This methodology allows for the discussion of the countless details that are not fully known at the time of the identification of goals and needs. The pre-feasibility study attempted – and, in most cases, managed – to provide answers to all arising detail questions. The complexity of the automated fare collection system requires the clarification of even the tiniest details before making any purchase commitments. Therefore, work on the preparation for the introduction of the ticket system needs to continue.

At the end of the pre-feasibility study, a proposal is made for the continuation of the work – taking into account the proposed schedule – with a view to starting the first phase of the introduction of the new system in late 2013 or early 2014.
3. The Current Ticket and Pass System in Budapest

In order to be able to review the various options based on goals using an appropriate methodology, we first need to have a good understanding of the baseline situation. This baseline is summed up a brief description of the current public transport network and associated fare system and the 2010 and (partial) 2011 revenue data. We present a description of the sales channels, validity periods and validation methods of tickets and passes and the ticket and pass control system. Based on this information, we present a detailed analysis of the problems of the present system, and draw the conclusions.

3.1. Introducing the current system

3.1.1. The public transport network of Budapest

In the $525 \text{ km}^2$ area of Budapest, there are 4,310 km of public roads, out of which 1,043 km are primary roads. In addition to the public roads, the capital has 1,159 km of public transport lines, operated by Budapesti Közlekedési Zrt. (BKV), owned by the Budapest Municipal Government, the legal predecessor of which was founded in 1968. BKV operates an inherited 186 km network of bus and suburban railway (HÉV) lines outside the administrative border of Budapest. BKV's network contains a total of 5000 stations (Table 1: Data on BKV lines leaving Budapest and Table 2: Data on BKV lines within Budapest).

<table>
<thead>
<tr>
<th></th>
<th>Bus</th>
<th>HÉV suburban railway</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bp.</td>
<td>Suburbs</td>
</tr>
<tr>
<td>No. of lines</td>
<td>237</td>
<td>45</td>
</tr>
<tr>
<td>Length of lines (km)</td>
<td>2,422.25</td>
<td>201.2</td>
</tr>
<tr>
<td>Length of network (km)</td>
<td>869.25</td>
<td>129</td>
</tr>
<tr>
<td>No. of stations</td>
<td>3,505</td>
<td>310</td>
</tr>
</tbody>
</table>

Table 1: Data on BKV lines leaving Budapest
The public transport network of Budapest, like those of other major cities, is hierarchically structured, with the high-speed rail network at the top.

In the following section, the branches of Budapest public transport are introduced in hierarchical order.

**High-speed rail** makes up the core of the network. The high-speed rail network is underdeveloped compared to other major cities, because the metro and suburban railway network is short, and the level of service at the latter (speed, level access, two-track infrastructure, not fully closed track) complies with high-speed rail requirements only partially.

Details of high-speed rail lines

- Metro lines (M1, M2, M3, with M4 under construction)
- Suburban railway lines (H5 and H7 fully meet high-speed rail criteria, H8 and H9 less so due to deployment shortcomings, H6 does not).

**Tram** lines are primarily designed to complement the high-speed rail network. The tram network is extensive, however, due to the favouring of car transport in the transport policy of the 1970s and 80s, the tram lines running above metro lines were eliminated, forcing passengers to switch lines more.

Examples for tram line types based on their role in the network:

- circular lines (4 and 6 on *Nagykörút*, 61 on *Budai körút*, 1 on Hungária körút, 3 on the outside circle on the Pest side),
- radial lines (18, 47, 49),
- lines serving access to the core network:
  - radial lines (14, 28, 37, 42, 50, 51) and
  - transversal lines (partially, 52)
Bus lines form a network that covers the entire area of Budapest. The network is mostly made up of exploratory lines and lines serving access to the core network in a radial or transversal direction, although it also contains lines that connect central locations, radial lines and transversal lines serving as core lines and transit lines (e.g. 7-173 family).

Trolleybus lines are designed to provide access to the city centre and the core network.

Other services of BKV outside of public services: the Sikló funicular railway, the Libegő chairlift and boats.

3.1.2. The fare system and the revenues it generates

The almost entirely unified fare system across various modes of transport is a great strength of Budapest public transport. The current fare system is based on a system introduced in 1966, which originally offered similar ticket systems in various modes of transport at differing fare levels. Ticket prices were fully unified in 1992 and pass prices were fully unified in 1997.

A cheaper travel option was introduced in the metro network in 1996, after the installation of time-stamp ticket validators at all metro stations. Metro section tickets cost 70% of the price of a regular single ticket and allow passengers to travel a distance of 3 stations. There are no surface section tickets, and the transfer ticket, introduced in 1999, now costs somewhat more than 1.5 times the price of a regular single ticket. In 1996, metro section transfer tickets were introduced, costing 10% more than a regular single ticket and valid for a distance of 5 stations, along with a metro transfer ticket that cost 60% more than a regular single ticket – both types of transfer ticket could be used when changing lines at Deák Ferenc tér.

However, in 2007 – after several altercations between ticket inspectors and passengers at the Deák Ferenc tér station that caused a public uproar – the unity of the fare system was broken by another change: the obligation to use a second ticket or a transfer ticket for metro transfers was abolished. Both types of metro transfer ticket were abolished at the same time. Thus, passengers travelling from the vicinity of a metro station to the vicinity of another metro station can travel significantly cheaper than other passengers.

Thus, the prices in the fare system in Budapest are not fully unified – they never were.

The two main categories of travel products are passes and tickets.
Passes enable the passenger to take an unlimited number of rides within a limited period of time. A photo pass certificate is required for passes. Thus, passes are personalized, non-transferable products\(^2\). Their validity is fixed, between two weeks and one calendar year.

Tickets enable the passenger to take one ride or possibly one trip with transfers, and they are transferable, i.e. they are not issued for a concrete person.

Travel cards, which are considered part of the “ticket” product group, are valid for an unlimited number of rides and they are not personalized, i.e. they are valid on their own, without a photo ID. Travel cards are valid for a period of 24 to 72 hours – there is no product between the 72-hour travel card and the 7-day travel card. The 7-day travel card is a transitional product between tickets and passes proper, as they are not considered passes and don’t require a photo ID, but they are personalized.

There are two main types of travel product: those that are only valid for travel on BKV’s vehicles and those that are valid for certain MÁV-START trains and certain suburban VOLÁNBUSZ lines within the administrative borders of Budapest in the framework of the three companies’ regional system of common fares. Within the ticket product group, there are single tickets, travel cards, HÉV tickets, conurbation tickets, group single tickets and tickets for services operating as market ventures (funicular railway, chairlift and boats). Within the pass product group, there are Budapest passes and conurbation bus and HÉV passes.

Travel products are described in detail in Chapter 3.2.

The system of common fares in Budapest started in 2005 with the introduction of optional Budapest unified passes sold with a 10% surcharge. This pass was valid for the Budapest sections of the suburban lines of MÁV-START and Volán in addition to local Budapest services of BKV Zrt. The Budapest pass was created in 2009 by merging this optional common fare product and the pass that was valid exclusively for local services. The selection of Budapest passes (bi-weekly, monthly, quarterly and yearly, with a photo) was expanded in 2010 by the Budapest travel cards (24-hour, 72-hour and 7-day).

\(^2\) The only exception is the annual pass without photo, the availability of which is limited (see Decision 74/2009. (XII. 10.) of the Assembly of the Municipality of Budapest).
The system of common fares currently does not extend to single trip tickets and regional tickets and passes. Outside of Budapest, the suburban services of the various operators (BKV, MÁV-START, Volán companies) apply identical km-zone-based fares, but the tickets are not interchangeable, i.e. passengers can't travel on a bus with a train ticket or vice versa.

The transformation of Budapest transport will see BKK, the transport organization body take over from BKV (the only operator in the city at this time) the tasks of drawing up the fare system, collecting fares and controlling passengers. The fare collection system will become operator-independent, and thus revenue risk will be borne by BKK. The involvement of private operators in Budapest bus transport will be possible based on gross cost contracts.

Figure 1: Share of revenue types based on BKV's expected 2011 revenues
BKK Automated Fare Collection System

BKV's expected 2011 fare revenue of HUF 50.2 billion is complemented by HUF 16.4 bn of consumer price subsidy from the national budget. The overwhelming majority of fare revenue, approximately HUF 48.9 bn is from local services. The revenue from conurbation services amount to HUF 1.3 bn, which is less than the revenue from penalties and other revenues (HUF 1.4 bn). According to available data, Budapest public transport is characterized by regular passengers who pay in advance, i.e. a high number of pass buyers. Accordingly, 78% of the HUF 38.2 bn of local fare revenue is from pass sales, with 19% (HUF 9.2 bn) coming from ticket sales and 3% (HUF 1.5 bn) from travel cards (24-hour, 72-hour and 7-day travel cards). Within conurbation revenue, HUF 775 million is from passes, which is a lower percentage at 61% (Figure 1:).


Government Decree 85/2007 (IV. 25). on travel reductions in public passenger transport fixes the groups that are entitled to fare reductions in domestic passenger public transport and the legal justification and rate of the reduction. The Decree lists the age-based concessions (Section 2), student concessions (Section 3), pensioners' concessions (Section 4), job seekers' concessions (Section 5), refugees' concessions (Section 6), and the travel concessions available based on profession or legal status (public servant or public official status, Section 7). The discounted rates are listed in the Annex.

Act LXXXVII of 2003 lists the compensations (consumer price subsidies) provided by the Hungarian State to the transport operator to compensate for the revenue loss caused by the travel concessions and free travel provided to certain groups. Decree 31/2007. (III. 13.) establishes the procedures for claiming the consumer price subsidy for free travel.

Decree 57/2009. (X. 20.) defines another set of persons (in addition to those listed in Decree 85/2007. (IV. 25.) who are entitled to travel concessions (essentially, people who are or used to be in a legal relationship with passenger public transport companies as employees, pensioners etc.) and lists the rate and validity period of these concessions.
The related Decree 324/2009. (XII. 29.). states that the travel concessions provided based on Decree 57/2009. (X. 20.) are tax-exempt in-kind benefits, and that the transport operators are not entitled to consumer price subsidies related to these concessions.

3.1.3. **Travel product sales channels**

Before the completion of the transformation of the transport institutions of Budapest, at the time of the writing of the present study, Budapest tickets and passes are essentially issued and sold by BKV. The current sales system of BKV was created by the interactions of three main sales channels. The current sales channels are as follows:

- Ticket offices operated by BKV,
  - 4 offices in Budapest and 4 HÉV offices near Budapest only accept cash payments,
  - all other ticket offices accept cash and bank cards
- ticket vending machines owned and operated by BKV,
- Direct sales to large employers
- Resellers
  - External resellers outside of BKV
  - Internal resellers within BKV

As of 2005, the sales channels of BKV are complemented by the following due to the sales of the former Budapest unified passes, currently known as Budapest passes and tickets:

- MÁV-START ticket offices
- VOLÁNBUSZ ticket offices
BKV's network of ticket offices is currently made up of 59 ticket offices with a total of 85 counters (Figure 2:). The ticket offices owned by BKV had machinery installed in 2011, but tickets are still shipped to the ticket offices pre-printed. This generates significant manufacturing, storage and distribution costs. Passengers need to visit a ticket office in person or have somebody do it for them, with only some large-scale employers buying tickets and passes centrally, to be distributed to employees as part of their *cafeteria* employee benefit system. Most BKV ticket offices are located at metro stations or transport hubs. The number of ticket offices and counters is not sufficiently adapted to sales volumes and trends, which is clearly demonstrated by the fact that the metro stations at railway stations have the same amount of counters (two, usually) as other metro stations. Pass certificates are only sold in the ticket offices of BKV. The passenger needs to have a passport-sized photo with them when buying one. BKV does not record personal data when a pass certificate is bought, not even in the case of passengers entitled to a concession.
There are currently only **257 ticket vending machines** of varying types and feature sets in and around Budapest, as follows (see Table 3):

- **152 J90 machines**, which only sell single tickets and only accept coins. Outdated, some machines are 18-20 years old, features not expandable.

- **The 105 JMS and PMS machines** are more modern (PC-based), but they are also outdated, aged between 12 and 15 years. Of them:
  - **JMS 15 machines** sell single tickets, metro section tickets, 24-hour travel cards and 72-hour travel cards, they are touchscreen-operated and only accept coins.
  - **PMS 15B machines** sell single tickets, metro section tickets, 24-hour travel cards and 72-hour travel cards, they are touchscreen-operated and accept coins, banknotes and bank cards.
  - **PMS 15B4 machines** sell single tickets, metro section tickets, 24-hour travel cards and 72-hour travel cards, they are touchscreen-operated and accept coins and banknotes.
  - **PMS 15MI machines** sell single tickets, metro section tickets, 24-hour travel cards and 72-hour travel cards, they are touchscreen-operated and accept coins, banknotes and bank cards and come with an attached info terminal module.

Ticket vending machines are very limited both in terms of number and location (in many cases, there are several machines in a single location, e.g. the 105 most modern machines are deployed in a total of 65 locations). Their operation is more expensive than even ATM
machines, spare parts supply is a problem and they are not attached to a remote monitoring system. A significant part of the operation risk is borne not by the external company that operates the machine but BKV itself (BKV has to order replacement main parts one by one as they are needed). The geographical distribution of vending machines has not changed in years, it did not keep up with changing needs, as is illustrated by the fact that there are districts in Budapest with a population of 80 thousand that have no ticket offices or ticket vending machines, while at the Deák Ferenc tér metro station, where the obligation to validate a new ticket when changing lines was abolished years ago, there are still vending machines on both sides of the white line that marks the border between the two metro lines.

Passes are not sold through vending machines, and the idea was not even entertained until the recent past. The machines were supplied to BKV in the 1990s by a company that is not in this market anymore.

The involvement of external resellers in sales started decades ago, when their primary task was selling tickets in locations where it would not have been economical for BKV to operate its own ticket office or keep it open after 8 PM.

External resellers started selling passes on 1 January 2008, in order to reduce the queues during the introduction of "sliding validity" 30-day passes. Since then, BKV reduced the number of reseller locations in several steps, especially the ones near BKV ticket offices. Until September 2009, 22 reseller locations were closed, and 15 more were closed in 2010 – all of them were located in the vicinity of BKV ticket offices. Until 15 September 2011, 10 reseller locations were closed, bringing the number of resellers located close to BKV ticket offices down from the original 60 to 13. External resellers are chosen by BKV via public procurement procedure; there is no unified commission rate or contract that any retail unit or network could easily join. Thus, increasing the number of external reseller locations would be difficult with this regime.

BKV has used internal resellers for decades. These are made up of the traffic management service staff of certain metro and HÉV stations and the drivers of 36 bus lines, 14 trolley bus lines and 1 tram line. Internal resellers sell single tickets and travel cards.

MÁV-START and VOLÁNBUSZ ticket offices have been selling Budapest passes (previously, Budapest unified passes) and tickets since 2005. These ticket offices used to sell pre-printed ready-made tickets and passes received from BKV. From the Summer of 2008, the on-site printing of full-price monthly passes started in MÁV ticket offices, followed
by the on-site printing of concession passes, and by now, after the gradual introduction of on-site printing in Volán ticket offices in 2009, all travel products sold within the framework of the system of common fares are printed on site in MÁV and Volán ticket offices, on their own security paper. The size and appearance of these passes is quite different from the ones issued by BKV.

Revenue and sales figures from 2010 and the first three quarters of 2011 are analysed for each sales channel based on data provided by the Controlling Department of BKV.

![Figure 3: Distribution of fare revenue by sales channels (see further details in next Figure)](image)

In 2010, 71% of all revenue from public service passenger transport services came in through BKV’s ticket offices. In 2011, the percentage was somewhat higher at 73%. External resellers provided 26% of the revenue in 2010, and 23% in 2011 (Figure 3). The minor shift is probably due to the 2011 changes to resellers located close to BKV ticket offices, which stopped resellers attracting sales away from ticket offices.
Among the sales channels that are responsible for the remaining 3-4% of fare revenue from public service passenger transport services, MÁV ticket offices have largest share, which increased somewhat, from 1.73% to 2.08%. The share of other sales channels is under 1%, but ticket vending machines, Volán ticket offices and internal resellers all increased their share in fare revenues from 2010 to 2011.

![Figure 4: Distribution of fare revenue among other sales channels](image)

![Figure 5: Share of various sales channels by revenue (1)](image)
BKV ticket offices and external resellers sell all three product types (tickets, travel cards and passes). The proportions are somewhat different, but the majority of turnover at both BKV ticket offices and external resellers comes from pass sales. Passes generated 82% of the turnover at BKV ticket offices and 61 / 66% at external resellers. Tickets accounted for 15 and 14% of turnover in BKV ticket offices and 35 and 31% at resellers. Only 3-4% of revenue comes from travel cards in both channels (Figure 5).

External resellers operating in premises owned by BKV paid a total of 641,350 HUF/month in rent in 2010, and 685,444 HUF/month between January and September in 2011.

![Figure 6: Share of various sales channels by revenue (2)](image)

Internal resellers and ticket vending machines do not sell passes, and most of their turnover comes from tickets as opposed to travel cards (Figure 6).
MÁV and Volán ticket offices sell Budapest passes and Budapest tickets, and more than 98% of revenue from these sales comes from selling passes (Volánbusz has been selling travel cards since 2011, when they became unified Budapest travel cards). See Figure 7.

![Share of various sales channels by revenue (3)](image)

Figure 7: Share of various sales channels by revenue (3)

Table 4: The sales system and associated costs

<table>
<thead>
<tr>
<th>Name</th>
<th>2010</th>
<th>01-09 2011</th>
<th>2010 ratio</th>
<th>2011 ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs not directly linked to sales channels</td>
<td>1 557 252 732</td>
<td>1 130 506 447</td>
<td>22%</td>
<td>21%</td>
</tr>
<tr>
<td>Cost of ticket office sales</td>
<td>1 025 677 275</td>
<td>838 088 178</td>
<td>15%</td>
<td>16%</td>
</tr>
<tr>
<td>Cost of reseller network sales</td>
<td>762 957 088</td>
<td>565 292 503</td>
<td>11%</td>
<td>11%</td>
</tr>
<tr>
<td>Costs related to ticket vending machines</td>
<td>195 196 940</td>
<td>136 433 401</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Costs related to ticket control and fining, of which:</td>
<td>3 437 064 811</td>
<td>2 601 550 056</td>
<td>49%</td>
<td>49%</td>
</tr>
<tr>
<td>HR costs related to BKV ticket inspectors and HEV ticket inspectors</td>
<td>1 695 319 264</td>
<td>1 264 439 523</td>
<td>24%</td>
<td>24%</td>
</tr>
<tr>
<td>Cost of security service (entry checks) and quality control, assistant ticket inspectors and public order officers</td>
<td>1 623 157 160</td>
<td>1 257 420 807</td>
<td>23%</td>
<td>24%</td>
</tr>
<tr>
<td>Fining costs</td>
<td>118 588 387</td>
<td>76 689 726</td>
<td>1.7%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Ticket validation costs</td>
<td>23 665 488</td>
<td>12 174 687</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7 001 814 254</strong></td>
<td><strong>5 286 045 272</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Table 4 shows the costs and cost distribution of travel media sales, ticket validation and control. These costs amounted to over 7 billion HUF in 2010. Most of this is from control and
fining costs, i.e. costs related to revenue protection (49%), followed by costs not directly associated with sales channels (22 and 21%).

Costs not directly associated with sales channels, ticket validation, ticket control or fining are as follows:

- manufacturing, disposal and distribution costs of travel media,
- IT costs,
- sales and marketing communication costs, advertising costs,
- the staff costs of the Sales Department related to staff working in areas other than sales channels, ticket validation, ticket control and fining, and
- the material costs related to the above described staff.

This does not include the operation costs of sales offices and the share of sales in overall higher-level management costs.

The share of the various sales channels in overall sales, ticket validation and ticket control costs is as follows:

- ticket office sales: 15-16%,
- reseller network: 11%,
- operation of ticket vending machines: 3%.
<table>
<thead>
<tr>
<th>Name</th>
<th>2010 cost</th>
<th>01-09 2011 cost</th>
<th>2010 associated revenue</th>
<th>01-09 2011 associated revenue</th>
<th>2010 cost-revenue ratio</th>
<th>2011 cost-revenue ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities not directly linked to sales channels</td>
<td>1 557 252 732</td>
<td>1 130 506 447</td>
<td>44 635 533 923</td>
<td>33 801 075 622</td>
<td>3,5%</td>
<td>3,3%</td>
</tr>
<tr>
<td>Ticket office sales</td>
<td>1 025 677 275</td>
<td>838 088 178</td>
<td>31 478 329 036</td>
<td>24 599 560 230</td>
<td>3,3%</td>
<td>3,4%</td>
</tr>
<tr>
<td>Reseller sales</td>
<td>762 957 008</td>
<td>565 292 503</td>
<td>11 832 943 847</td>
<td>8 035 227 831</td>
<td>6,4%</td>
<td>7,0%</td>
</tr>
<tr>
<td>Operation of ticket vending machine sales</td>
<td>195 196 940</td>
<td>136 433 401</td>
<td>318 731 520</td>
<td>261 351 280</td>
<td>61,2%</td>
<td>52,2%</td>
</tr>
<tr>
<td>Ticket control and fining, out of which:</td>
<td>3 437 064 811</td>
<td>2 601 550 056</td>
<td>44 635 533 923</td>
<td>33 801 075 622</td>
<td>7,7%</td>
<td>7,7%</td>
</tr>
<tr>
<td>BKV ticket inspectors and HEV ticket inspectors</td>
<td>1 695 319 264</td>
<td>1 264 439 523</td>
<td>44 635 533 923</td>
<td>33 801 075 622</td>
<td>3,8%</td>
<td>3,7%</td>
</tr>
<tr>
<td>Security service (entry checks) and quality control, assistant ticket inspectors and public order officers</td>
<td>1 587 538 764</td>
<td>1 218 297 006</td>
<td>44 635 533 923</td>
<td>33 801 075 622</td>
<td>3,6%</td>
<td>3,6%</td>
</tr>
<tr>
<td>Fining activity</td>
<td>118 588 387</td>
<td>79 689 726</td>
<td>44 635 533 923</td>
<td>33 801 075 622</td>
<td>0,3%</td>
<td>0,2%</td>
</tr>
<tr>
<td>Operation of validators</td>
<td>23 665 488</td>
<td>14 174 687</td>
<td>9 152 763 325</td>
<td>6 314 239 831</td>
<td>0,26%</td>
<td>0,22%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7 001 814 254</strong></td>
<td><strong>5 286 045 272</strong></td>
<td><strong>44 635 533 923</strong></td>
<td><strong>33 801 075 622</strong></td>
<td><strong>15,695</strong></td>
<td><strong>15,64%</strong></td>
</tr>
</tbody>
</table>

*Table 5: Costs of sales channels and activities, related fare revenues and revenue-cost ratios*
The costs of the various sales channels, the revenues generated by them and their ratios are described in Table 5. The costs associated with controls and fining related to sales and the costs associated to ticket validators and activities not directly related to sales channels are also presented, along with the revenues that justify these activities and the revenue-cost ratios. **The cost of the operation of the entire sales and controls system exceeds 15% of revenues.** The most expensive sales channel is that of the outdated ticket vending machines (costs amount to 52-61% of revenues), because they are expensive to maintain, spare part supply is problematic and they are not connected to a remote monitoring system. Sales through ticket offices appear to be very cheap based on these walled-off cost figures (3.3-3.4% of revenue), but this is deceptive as the operation costs of the premises are not included, amortisation is only included for five rooms and the total operation cost of the new cash management system has not yet materialized. It should also be noted that the costs of wholesale ticket sales (personal service) are not included in these calculations, and the costs that also affect other channels and are not directly connected to sales channels were not divided among sales channels.

Therefore, until such time as a precise breakdown of the central administrative costs of BKV becomes available, the calculated 15% cost ratio should be considered lower than the real figure. The situation will be cleared up by a new public service contract between the Budapest Municipal Government and the Centre for Budapest Transport that will come into force in May 2012, assigning transport organization tasks to BKK in accordance with the relevant strategic Decisions by the Assembly. This also means that BKK will need to rent at market prices the ticket offices owned by BKV that form an organic part of bus or metro stations, and therefore these costs will need to be determined by this time.

### 3.1.4. Validity period and validation methods of travel products

Currently, the validity of travel products – depending on their type – is set in advance at the time of purchase, or it starts before starting the journey or during the journey, at validation.

For travel card type products, the start of the validity period needs to be provided in advance down to the hour and minute. These products cover an unlimited number of trips within the predetermined validity period. The validity period is written on the travel medium by the cashier using a pen with a special ink or a stamp.

Full-price passes are only valid alongside a BKV pass certificate with a photo or a Volánbusz pass certificate with a photo, student passes are only valid alongside a student ID, and
pensioner passes are only valid alongside with a pensioner pass certificate if the user is under 65 years of age. When requesting a pensioner pass certificate and other pass certificate that enables the passenger to use concessions, the passenger must present the relevant official document to the cashier as proof. Before starting the trip, the number of the pass certificate must be written on the pass coupon. The end of the validity period is printed on the pre-printed pass coupon, or, in case of purchases in person, the customer tells the cashier the desired validity date, who enters it on the pass using a pen with a special ink or a stamp. Passes and travel cards need not be validated before or during a trip.

Ticket type products can be purchased before taking a trip. Every ride, i.e. every time the passenger boards a vehicle is considered a new "trip" in this context. The validity period of single tickets, discount coupon books and conurbation single tickets is one trip up to 60 minutes, and transfer tickets are valid for 90 minutes. The validity period of single tickets, discount coupon books and transfer tickets is 110 minutes on night services. No minute-based validity period is set for HÉV tickets, the only limitation is that the tickets are valid for one trip and must be used on the day of purchase. In surface travel, not many vehicles have time-stamp validators, and passengers have no way of knowing whether their vehicle will have one; therefore, the time limit has no practical relevance in this mode of transport.

On metro stations, passengers have to validate ticket type products at the validators placed at the edge of the restricted zone. The edge of the restricted zone is marked by a clearly recognizable 6-inch wide white line painted on the floor, or, in some cases, a physical barrier. On buses, trams, trolleybuses and HÉV trains, tickets have to be validated after boarding the vehicle, when it leaves the station.

Passengers need to show the ticket inspector their ticket or pass on request.

BKV uses two main types of ticket validators:

- Mechanical ticket validators (ticket punchers), which punch holes in the ticket when the user applies physical force. They are very outdated and belong in museums; the fact that they are still in use is a unique feature of Budapest public transport.

- Time-stamp validators, which print on the ticket lengthwise or across, and, in the former case, cut out a piece of the ticket as well. At the time of the writing of the present study, BKV uses the product of Protokon Kft. exclusively both on stations and on vehicles.
According to a 2009 survey, only 35% of the validators on vehicles are time-stamp validators, the rest are mechanical ticket punchers. All metro stations have time-stamp validators. Validators at metro stations are isolated; they are not connected to a network and offer no centralized data collection functionality. Up to now the machines received no central timing signal – this will be remedied in surface transport in the course of 2012 by the BKV FUTÁR project. Currently, they are connected to the on-board passenger information system, which means that an error in the passenger information system makes the validators dysfunctional as well – and this happens quite frequently. That said, the most frequent error is the printing of imprecise or completely erroneous times.

3.1.5. Revenue protection, control system

BKV operates a control system to protect its revenues. Controls are carried out by BKV employees and external workforce via subcontractor agreements.

BKV employs 475 ticket inspectors, who carry out random checks. Throughout the metro network, every day at almost every station during almost all the operation time, entry checks are carried out by mixed teams of ticket inspectors and security guards. These checks are preventive in nature; they are designed to incentivize the purchasing of tickets and passes.

There are no detailed statistics on the work of ticket inspectors broken down by lines, day and time of day going back years, and the data processing is quite crude by today’s IT standards. BKV does not compare ticket control data with passenger counts or other operation data or statistics, and the only information about whether systematic control on a single line over several weeks has a positive effect on ticket and pass purchases is anecdotal evidence from ticket inspectors.

The number of subcontractor security guards is 240, broken down as follows:

- metro entry controls
  - 194 people in non-stop service
  - 25 people in 16-hour shifts
- HÉV controls: 21 people on workdays in 12-hour shifts.

BKV also employed 46 assistant ticket inspectors via subcontracting agreement from July 2010 to the end of May 2011. A new subcontracting agreement saw 20 assistant ticket inspectors taking up work in December 2011, and the final headcount will be 50 after new
3.2. Problems of the current system

3.2.1. Travel media

The fundamental problem with current travel products is that travel media are paper-based. Paper-based travel media, apart from generating significant printing and disposal costs, do not support more flexible travel product structures, i.e. the introduction, elimination and modification of travel products.

Travel media record-keeping, distribution to points of sale and handling are significant logistical tasks.

As there is no centralized up-to-date electronic record of use, this system does not support collecting and processing passenger movement data suitable for network and schedule planning. Lost passes cannot be replaced as there is no electronic register.

The current system does not make it possible to install automatic gates at metro stations, because that would require at least magnetic stripe paper tickets and touch ticket validators. The use of simple time-stamp validators and automatic gates would mean that the gates would open whenever a piece of paper of the right size is placed in the machine. Paper-based travel media offers limited security features, and as a result, counterfeiting causes significant losses. In order to fight counterfeiting, security features were introduced in passes, but the goal is the complete elimination of the possibility of counterfeiting.

The most widespread counterfeiting method is the unauthorized modification of the validity date on the pass, which can now be done at home in such a high quality that ticket inspectors can barely tell that the pass was tempered with – if they can tell at all. In recent
years, BKV has been increasing the number and level of security elements on travel media, but it is difficult to identify counterfeit passes in daily practice. For instance, during controls at escalators, ticket inspectors have less than one second to check passes, and eligibility for, say, disability concessions is only checked in practice once: by the cashier when making out a pass certificate.

Today's fully paper-based ticket validation system, made up of ticket punchers and a small number of time-stamp validators, does not make it possible to change the current system that is based on vehicle boarding and thus essentially punishes those who change lines – apart from changing the fares, of course.

It is also a problem that ticket-type products are valid for the whole trip on buses that cross the administrative border of Budapest, i.e. BKV – for lack of appropriate technology and processes – partially finances the travel of ticket-using passengers travelling between the city and surrounding suburbs. This practice has been in place for decades, but it is unsustainable.

The conclusion is that travel media, especially passes, are affected by numerous security risks, and therefore the methods of issuing and controls need to be fully reviewed and entirely new, secure, personalized travel media need to be introduced without delay.

3.2.2. System of common fares with other Budapest public transport operators

Within the framework of the system of common fares, the travel cards and passes labelled "Budapest" are valid on the lines operated by MÁV-START and Volán companies. The various tickets are only valid on BKV lines. Although the name of the Budapest Card, (recommended for tourists, offering unlimited travel on public transport and numerous concessions in a given validity period) includes the word "Budapest", but it is only valid for travel on BKV lines, i.e. it cannot be used on MÁV-START and Volán vehicles.

In order to ensure complete integration, the development guidelines of the automated fare collection system of Budapest have to be coordinated with the ticket system used by MÁV-START and Volán – or a subsequent regional system of common fares. One of the fundamental preconditions is to ensure from the side of the fare system that the currently fragmented, competing suburban services (rail, bus, HÉV etc.) become available to passengers with a clearly communicated common fare system.
Currently, the drivers and ticket inspectors of Volán and the ticket inspectors of MÁV-START do not need any special equipment for checking Budapest passes and travel cards, as validity can be ascertained visually. The technical limitations and security risks this poses are discussed in detail in chapter 3.2.8.

One of the great advantages of the current ticket and pass system in Budapest is that Budapest passes and travel cards are accepted by MÁV-START and Volán bus companies. Naturally, Budapest intends to maintain this positive state of affairs, and, if possible, extend it to all travel products (i.e. tickets as well). This means that the sales, validation and control elements of any new system have to support this, while also making it possible for companies to financially settle each trip with each other. The current system does not support this, as data could only be registered manually, which would create many possibilities for abuse.

3.2.3. **Concessions**

Passengers need to show the documents specified in the relevant Government Decree to prove their eligibility when purchasing concession travel products.

Passengers often purchase student passes to use with expired student IDs or illicitly procure validation stickers for their student ID after they finish their studies, and purchase student passes that way, i.e. they use the concession illicitly.

Those who are entitled to free travel (e.g. those over 65) do not have to procure passes; their eligibility is checked on an ad hoc basis by checking their IDs. This is problematic in many regards, chiefly because – as noted above – ticket inspectors cannot demand IDs from passengers. This allows people near retirement age to easily evade controls and travel without paying for years when they are not yet eligible for free travel. Another problem is that because these passengers do not have travel media issued by BKV or any future transport organizer, there can be no system, not even a partial one, of automatic gates installed in the metro until special, named travel media is issued to those eligible.

Apart from the above, numerous abuse methods are in wide use, especially related to student and pensioner passes, mainly due to the fact that pass purchasers are not registered by BKV by name, and eligibility for concessions is not checked in any central database when pass certificates are issued – that is, the passenger’s data is not linked to the document proving their eligibility for a concession (or that document’s number) and the serial number of
the BKV pass certificate issued to them. Thus, when a pass certificate is issued, the
documents proving eligibility are often not requested or not checked, and thus counterfeit
documents are not identified. By fraudulently procuring a pass certificate and then buying
pass coupons on a regular – often monthly – basis, passengers commit fraud on an on-going
basis. The damage caused increases with the purchase of each new pass coupon. However,
the abuse – and the real fraud amount – is very difficult to prove: if a passenger is caught,
only the loss caused by one pass coupon can be proven, which is a sum lower than 20
thousand HUF, and as such, is only considered a minor infraction. Given the fact that the
fraud committed in previous months is impossible to prove (as BKV does not record personal
data), it is impossible to prove enough damage to give sufficient power to the law
enforcement authorities to prosecute the cases. Naturally, it is possible to improve security
within the framework of the current system, but the minimization of abuse of this type
requires an IT system that registers the names of passengers who buy passes, and no such
system is currently available to BKV.

The principle of operation and current practice of the ticket and pass system makes it
impossible to estimate with any precision the amount of loss BKV and the central budget are
subject to, but it is certainly at the billion-forint scale. A new, modern system that offers strict
data protection guarantees could provide a billion HUF in extra revenue as soon as the first
year or two by minimizing fraud and counterfeiting.

After the counterfeiting of full-price passes, the largest amount of direct damage is caused by
the various methods of abusing concessions; therefore, the relevant travel media and
processes need to be thoroughly revised.

3.2.4. Travel product sales channels

The problems with the current sales channels system – among other things – from the fact
that they rely on a physical network, and due to the nature of travel media, Internet or mobile
phone sales are not possible. Naturally, it would be possible to allow online orders and ship
the pass coupons by mail, but due to the above described problems with eliminating
concession fraud, the current system would only allow full-price passes to be sent by mail or
courier. This would increase the costs further, and products would need to be shipped as
registered mail or registered mail with acknowledgement of receipt, which would again
increase costs and make the process more inconvenient for passengers instead of making it
more convenient.
In ticket offices, even if there are several counters at the same location, they are almost never all open at the same time. At the same time, ticket offices are available in limited numbers and in a limited number of locations, and they are not available at night. When ticket offices are closed, buying tickets would require an unreasonable amount of effort – a long walk on foot – from the passengers if there is no vending machine at the location in question. This is exacerbated by the fact that BKV still does not have an intelligent GPS-based smartphone app that indicates the location of the nearest available ticket office or vending machine.

Resellers do not have access to the computer sales system used by BKV and make out receipts and invoices by hand. On top of that, the peculiar sales locations of some resellers are an embarrassment for the public transport company and Budapest as a whole.

For passengers, it is annoyance that the location of ticket offices – with the exception of the inconveniently located central ticket office in Akácfa utca – forces them to stand in line outdoors or in draughty areas of metro stations, often for long periods of time.

On buses, trams and trolleybuses where this is indicated by a sign, passengers can buy tickets from the driver. However, this is charged at a premium price (400 HUF instead of 320), and on vehicles that cross the administrative border of Budapest, the much cheaper conurbation tickets are not available for purchase. Passengers who wish to buy tickets on the spot need to have exact change, because drivers do not have change.

Ticket vending machines are old, and errors are frequent. There is no real-time central monitoring system, so errors are only discovered through daily inspections. This is slow and increases operation costs drastically, reducing revenue and eliciting entirely justified complaints from passengers. The range of products available from vending machines is severely limited as well. Improving the experience offered by the vending machines to an acceptable level and installing remote management functionality would require an investment in the hundreds of millions of forints, and replacing the most widespread (152 pc.) J-90 machines featuring mid-20th century technology would cost 1-1.5 bn HUF.

Only a small portion of ticket vending machines accept bank cards and banknotes. Generally, ticket vending machines that sell travel cards and even accept bank cards are located in the city centre, making them useful only for passengers who start their travel in the city centre. Those who arrive from peripheral areas and must therefore change lines have no chance to buy the product that would serve those best (e.g. a one-day travel card).
To sum up, the biggest problem with the current sales system is the use of travel media that rely on security paper and consequently the necessity of purchasing travel media in person, which affects regular and occasional travellers alike. Ticket vending machines are technically outdated and expensive to maintain; even if the current system were to be kept and no new machines were to be installed, much of the current stock needs to be refurbished or replaced at a cost of 1-1.5 billion HUF.

Although the in-person ticket and pass purchasing system can and should be improved to a certain extent, it is clear that a paper-based system cannot support new sales channels, such as the now ubiquitous Internet.

### 3.2.5. Territorial validity of travel products

Travel products can be categorized as: valid within the administrative borders of Budapest, outside the borders in suburbs, or for travel through the administrative border.

Within the administrative borders, any line (buses, trolleybuses, trams, metro and HÉV trains) can be used with any ticket or pass. The only exception to this rule is the metro section ticket. It was already emphasized in the description of the current fare system that one of the great strengths of the current Budapest fare system is that the fares are largely unified across service providers and services. In order to prevent a price competition among services within the system, the surface and metro fare systems need to be fully harmonized.

In accordance with Section 5 e) (5) of Act XXXIII of 2004, amended by Parliament on 23 December 2011, the setting of local public transport fares in Budapest falls within the remit of the Budapest Municipal Government, which is responsible for providing public transport services in the city.

BKV also provides services outside of Budapest (buses, HÉV), but the Budapest Municipal Government has no legal right to set fares on these line sections – this is a Government competence.

On buses, ticket-type travel products are valid for the entire line, including both Budapest and the suburbs; thus, passengers do not need to buy a supplementary conurbation ticket. As noted above, this practice needs to be changed. At the same time, Budapest passes, Budapest tickets and Budapest Cards are only valid within the administrative borders of Budapest; supplementary conurbation tickets are required for travel outside the border.
Conurbation local passes are valid on all buses within the administrative borders of the town indicated on the pass.

HÉV supplementary tickets – like conurbation bus tickets – are only valid for the section of line outside of Budapest. The two products are priced identically (based on km distance) regulated by national law. The two products are considered different travel products. On buses, single tickets are valid outside of Budapest as well, but on HÉV trains, they are only valid up to the administrative border.

As the system is not zone-based but kilometre-based, different vehicles travelling to the same endpoint via a different path offer different fares, with a typical example being the comparison between HÉV, which takes a detour towards Pomáz before reaching Szentendre, and Volán, which goes straight to Szentendre on a shorter route. This is not good: branches of public transport should not compete with each other; it is bad enough that they have to compete with cars.

Interestingly – even though there is no technical hurdle blocking this – BKV is not issuing combined Budapest and conurbation passes or combined Budapest and HÉV passes, forcing commuters to buy two pass coupons every month. The only exception is the annual all-line Budapest pass, which is valid on the entire length of all BKV lines, irrespective of administrative borders – but it costs almost twice as much as the annual Budapest pass. To make matters worse, if two pass coupons are used, the number of the pass certificate, the photo and both coupons are not visible at the same time on the same side, which makes controls more inconvenient. Conurbation passes and HÉV passes are only valid for travel between one given town and Budapest.

The concession system is different as well: There are no discount tickets within Budapest, but for services that cross the administrative border, 50% and 90% concession tickets are available to those eligible for concessions.

As the above information shows, the ticket and pass system becomes complicated when it comes to services that cross the city boundaries. The modernization of the ticket and pass system will need to involve the harmonization and simplification of the parameters of travel products.
3.2.6. Travel product validity periods

As shown above, the vehicles and stations of BKV feature a mix of hole-punch and time-stamp validators. In this mixed system, the more "primitive" method has to become the lowest common denominator: validation times cannot be taken into account except on the metro network, where every station has time-stamp validators.

It has already been discussed in chapter 3.1.2 that the validity time of tickets is only relevant on the metro network.

The validity of travel cards and passes is recorded in a very outdated manner, by stamping or writing the date on the coupon in ink. The validity of travel cards and passes is not recorded or verified electronically.

Passengers often fail to write the number of the pass certificate on the pass coupons even though this is compulsory, making passes transferable. Ticket inspectors at metro station entrances hardly ever raise this problem to passengers in practice, but ticket inspectors working above ground don't always issue fines for this reason, either. Entering the number on the pass coupon only takes seconds, but it is inconvenient for passengers to do, and there has been no improvement in the system, i.e. passengers still have to face this repeated minor inconvenience.

Tickets do not expire; tickets bought earlier can still be used after price raises. After replacing travel media, passengers will need to be given an opportunity to get a refund or replacement for their existing tickets.

Some groups abuse the system by collecting expired pass coupons, counterfeiting them in large quantities and reselling them at full price or cheaper.

3.2.7. Validation methods

Tickets that are valid for a single trip (single tickets, metro section tickets, transfer tickets) need to be validated in surface transport after boarding the vehicle, when the vehicle leaves the station. In the metro network, passengers have to validate their tickets using the time-stamp validators at the entrance. Otherwise, ticket inspectors have to issue a fine, even if the passenger has a ticket.

Ticket inspectors cannot disable either type of ticket validator (hole-puncher or time-stamp validator) temporarily on board the vehicles. Therefore, shrewd fare-evading passengers who
stand near the validators on purpose can validate their tickets whenever they see ticket inspectors show up. By the time the ticket inspectors reach them, they have a validated ticket and cannot be fined. Another well-known trick is to jam the hole in the validator, rendering the validator unusable – in this case, the ticket inspector can't fine the passenger and the passenger can get away without using a ticket. The transport service provider even suffers additional damage because other rule-abiding passengers cannot use the machine for the remainder of the day.

Tickets can be validated in two ways: using a mechanical hole-puncher or with a time-stamp validator.

Only one third of the outdated mechanical ticket validators were replaced in the last almost 20 years. The remaining two-thirds – thousands of machines – must be replaced. Without doubt, it would not make sense to purchase, install and use paper-stamping machines in the second decade of the 21st century, because the machine can be jammed by passengers even if it receives a central timing signal, provides data to a central unit on board the vehicle and can be disabled temporarily by ticket inspectors for the time of inspection.

Apart from sales, no other statistics can be compiled centrally; it is impossible to tell how many trips are taken with travel cards and passes, how many passengers actually use passes and where each ticket or travel card was used. These days, this information is essential for the planning of sales channels and the public transport network and the capacity management of the network.

It is clear that the current ticket validators, their mode of operation and the associated tickets are not suitable for effective control.

3.2.8. Revenue protection, controls

The ticket control system applied by BKV relies entirely on human resources.

Due to the necessity of quick entry, the large quantity of passengers and the nature of human workforce, the checks carried out at the entrance of most metro stations during most of the operation time are inefficient – and they also require great amounts of human resources. Control at the exit is done on a random basis much more rarely, and a single "caught" passenger can keep several ticket inspectors busy – thus, not every passenger is controlled. This "system" becomes more expensive every year while its effectiveness cannot improve, and it does not automatically provide passenger traffic data and cannot identify the
use of counterfeit (copied) passes based on near-simultaneous entry or exit at different points of the network.

In surface transport, many passengers stay close to the ticket validator with an unvalidated ticket (single ticket, transfer ticket or discount coupon book) and quickly validate it when a ticket inspector shows up. As discussed in chapter 3.2.7, ticket inspectors cannot temporarily disable on-board ticket validators one by one or all at once while they carry out controls. The FUTÁR system could theoretically allow the machines to be temporarily disabled centrally by the driver, but this should be possible for ticket inspectors to do – a feature that is not supported by the equipment currently in use, even with the FUTÁR system.

Another widespread method is to jam the slot of the ticket validator and hand over an unvalidated ticket when the ticket inspector shows up, citing the inoperability of the machine. As it is the obligation of the operator (BKV) to ensure that the ticket validators are in working order, fines cannot be issued in such cases.

The data of those who travel without valid travel media are recorded by hand, and as a result, the data is often difficult to read during the fining process and needs to be re-entered. On-the-spot fines can only be paid in cash, cards are not accepted. These issues can of course be remedied within the framework of the current system, but without a central database and personalized travel media, efficiency can only improve temporarily. Today, a modern portable inspector handheld device could be one small part of a larger system which makes fining easier and makes it possible to track and manage the work of ticket inspectors, while remaining easy to use so that a passenger can be controlled in a single second, eliminating the currently widespread methods of fraud and counterfeiting.

The weak sales system and the imprecise and not sufficiently systematic controls, both products of the use of paper-based travel media, weaken each other: apart from the users of annual passes, passengers hardly have any motivation to voluntarily validate a ticket for each ride. In practice, passengers are only forced to validate a ticket when they have no way of evading control, i.e. throughout most of the metro network. This is exacerbated by the fact that – due to the characteristics of the city and the transport network – a single trip that last less than one hour but requires two line changes can be unreasonably expensive for ticket users: three tickets, which at 2011 and 2012 prices is close to 1000 HUF.

The above makes it clear that controls in the metro network have to be automated to the greatest possible extent, which means that paper-based tickets and passes have no place in
the metro system. As travel media cannot be different in surface and underground public transport, the system to be used underground determines the travel media and system to be used everywhere.

3.3. Summary

The above chapters showed that travel media (pass certificates, pass coupons and tickets), the Budapest common fare system and the possible regional common fare system, the discounts mandated by the state or provided based on business policy, the current sales channels, the various anomalies regarding the spatial and temporal validity of various travel products and especially the ticket validation and control systems have entered a downward spiral in terms of technology, efficiency and finances. The system is unsustainable, and the fare system cannot be reformed because of the above discussed characteristics, even though this would be one of the most important preconditions for making public transport a more attractive transport option compared to using a private car.

There is no way of improving single components of the system without rebuilding the whole system from the ground up. As BKV prepared for an automated fare collection system project in the early 2000s, we have every reason to believe that this is the reason why, apart from the installation of machinery in ticket offices by 2010 and 2011, there has essentially been no development in the last 10 years in terms of fare structure, sales systems or control methods and organization, and the system has become unable to cope with ever more creative methods of abuse.
4. Goals and Expectations

One of the main aims and goals when setting up BKK was to preserve a very valuable trait of Budapest: namely that the proportion of public transport use is rather high compared to many Western European cities. One of the ways of doing that is making public transport in Budapest more customer-friendly.

This is necessary because in the last twenty years commerce, banks and all sorts of market-based service providers have improved their customer service hugely. Paying customers are more valued by companies than before, and they receive better service, care and attention. Apart from the developments at home, the borders have been opened up, and many citizens of Budapest have experiences with public transport in other major cities.

This changed passenger expectations significantly; much better, higher-quality service is expected from the company. Apart from the people who live in Budapest, we must not forget about those who commute to Budapest daily for work or study, or domestic and international tourists, many of whom also have experience with modern public transport. If they have a bad experience in Budapest public transport, that has effects well outside of BKK; therefore Budapest has to pay special attention to this.

When it comes to customer-friendliness, Budapest's public transport has barely improved in the last two decades, so passengers have every reason to expect concrete steps for improvement.

Customer friendly public transport requires several measures and developments. First and foremost, these measures have to provide incentives, i.e. people who use public transport need to receive benefits, while car users need to be incentivised to use public transport as much as possible.

The strategic aim of the present project is to contribute to this process and these aims through the introduction of a modern automated fare collection system. The automated fare collection system makes purchasing travel rights and furnishing proof significantly more comfortable and simpler for customers.

The automated fare collection system can improve current practice in many ways. These provide numerous added benefits to both passengers and the company responsible for
organizing public transport apart from making the service more customer friendly, and these benefits also serve the interests of Budapest and the Hungarian state.

1. As of today, passengers have to visit a point of sale in person to buy a ticket or a pass. This is unacceptable in the Internet age. Today, most banking customer service takes place online in Hungary, public utility companies are quickly switching to convenient electronic payments and more and more people make purchases using their mobile phones, so it is time to modernize BKV’s in-person sales system and start supporting distance services. The company also needs to set up new physical points of sale by extending its network of vending machines and resellers, and it needs to make it possible to use the widespread contactless bank cards as travel media.

The automated fare collection system needs to make it possible to introduce Internet distance sales and distance support, as well as the direct use of contactless bank cards.

2. Today, service providers make a great effort to provide value-added services. In public transport, a value-added service can be automatic pass purchases (when the passenger does not have to do anything to renew their pass, as this is done by the system automatically), automatic balance top-ups, personalized automatic notifications, electronic invoicing etc., which are all beneficial for customer satisfaction and sales revenue.

The automated fare collection system needs to make it possible to introduce value-added services.

3. Currently, planning fare policies, producing precise passenger flow data and analysing passenger habits are difficult, sometimes impossible tasks. One of the reasons is that the system of paper-based tickets and passes cannot collect and store such data (for instance, we have no way of knowing how many customers bought the single tickets sold, or how many tickets one passenger uses on average each year), therefore, the effects of price changes or new products on revenue can only be estimated. On top of that, the above circumstances also impede the precise post-hoc measuring of such effects, and thus, executive decisions cannot be sufficiently well-grounded.

The automated fare collection system needs to enable measuring and planning.
4. The introduction of an automated fare collection system does not simply make it possible to introduce a new fare system: it makes it necessary. Apart from the above, the current complicated system needs to be simplified for practical operational reasons as well. The pass system needs to be maintained for everyday users of the system, and time-based tickets need to be introduced for occasional travellers and regular travellers who do not travel every day. The current "boarding-based" ticket is not suitable for this purpose, as it punishes those who change lines twice or more times during a trip – that is to say, a significant portion of passengers. Time-based tickets allow passengers to reach their destination within a given time frame at a standard price irrespective of the current structure of the transport network.

The automated fare collection system needs to make it possible to maintain passes and introduce time-based tickets that encourage the use of public transport.

5. The paper-based system is a hurdle blocking the introduction of innovative products and fares that encourage use of the system. For instance, it provides no possibility of price capping (best value fare calculation). This feature limits the amount a passenger can spend in the course of a day using ticket-type products, making sure it is not more than the price of a one-day travel card. This means that if a passenger ends up travelling more than planned, and it would have been worth it for them to buy a one-day travel card, the system activates this option retroactively. This means that the passenger always pays the most advantageous fare, even if they are not using a monthly or annual pass.

The automated fare collection system needs to make it possible to introduce an innovative feature already used successfully in other major cities: the fare cap.

6. In order to drastically reduce the proportion of illicit users and increase revenues, controls need to become much more effective. In a paper-based system, this can only be achieved by increasing the number of ticket inspectors and involving the drivers of surface transport vehicles (front door only access). The drawback is that it is more difficult to identify the use of concessions by ineligible persons and the use of human workforce is less efficient at high passenger numbers. Due to the number of passengers, front door only access is not feasible on the on articulated buses serving main lines at peak times. In closed and closable systems (HÉV, metro) steps need to
be taken to switch from human controls to technological controls, which offer lower, more predictable and gradually decreasing costs.

The automated fare collection system needs to support automated passenger entry systems where possible (e.g. at metro stations).

7. The counterfeiting of paper-based passes and abuse of the state-mandated concession system causes losses in the billion forint range to the Budapest Municipal Government and the Hungarian state each year. The detection and elimination of counterfeiting and fraud is an on-going task that BKK, BKV and law enforcement authorities have no capacity for. Verifying eligibility for concessions is a mutual interest of Budapest and the Hungarian state; therefore, we wish to start verifying eligibility using state databases.

The automated fare collection system needs to be based on an IT technology that reduces counterfeiting damage, and regarding concession eligibility checks, it needs to be able to communicate with the National Integrated Card System that is currently being designed.

The project aims to make sure that the introduction of an automated fare collection system meets the above requirements in the interests of passengers and BKK, making it beneficial for society at large.

Another important goal is for the settlements centre of the future Budapest automated fare collection system to be connected to the systems of other operators within the transport alliance, and even the central systems of future transport alliances in other parts of the country, helping create a national transport settlement system and mechanism, clearing the way for the creation of new and innovative ticket combinations (e.g. “door to door” tickets).

In addition, the system should be technologically open so that the solutions and subsystems of various suppliers can coexist in it, reducing technological dependence and the dependence on a single supplier. This is necessary due to the features of the scheduling of the project and the public procurement strategy: if at least two or three potential suppliers are capable of expanding the existing system in the various stages and, once completed, developing the system further, then there will be real (price) competition during the public procurement process.
5. Option Analysis

The study discussed in the present document is aimed at describing the technical solutions that meet the goals and expectations (Chapter 0) set based on the current situation (described in Chapter 0). In this Chapter, the various possible options are discussed one by one, and a proposed solution or combination of solutions is chosen based on the established set of criteria.

Based on a review of international experience, we can conclude that no unified, standardized solutions have emerged with regard to completed or currently developed automated fare collection systems in major cities covering the totality of the operation of the system. Instead, what we have is competition between alternative models and quasi-standards.

Electronic ticket management systems are designed for decades, and such systems are used by hundreds of thousands of people a day for years and years; therefore, when choosing the system that matches the needs of Budapest best, the most technologically advanced system has to be chosen. On the other hand, the long life cycle and the high investment required also explain why

- there are several models in use around the world,
- and the modernization of systems is slow in this industry, but each change offers advantages that make the entire system more convenient, faster, more profitable or easier to operate.

The travel media that passengers use in public transport can be taken to represent each system. The following graph (Figure 8:) helps compare the various systems represented by travel media. Travel media are always devised and developed in accordance with the business and security demands and IT capabilities of the time.
Irrespective of how up-to-date the elements making up each system are, each of the systems can be a valid choice depending on the criteria taken into account when making a choice. The systems are not completely walled off; some of them overlap or complement each other. The remaining part of this chapter describes the main characteristics of each model and compares them based on various considerations.

5.1. Paper-based system

5.1.1. Internet distance sales, remote service, use of contactless bank cards

In the paper-based system, travel products are printed on security paper. Travel media and travel rights are not separated. After expiry or use, travel media cannot be reused; new media need to be purchased. Therefore, on-going manufacturing and distribution of both tickets and passes is necessary.

The Internet distance selling of paper-based tickets and passes is possible in one manner only: if the client pays for the product in advance and receives it by mail. Considering the delivery cost, a minimum order quantity would need to be set, as the delivery of one single
ticket would cost more than the ticket itself. Special ticket issuing terminals installed at public transport stations would offer a possible alternative delivery/pickup option. The widespread introduction of such a system would require the installation of hundreds of such machines all across Budapest. Outside of Budapest, at the national level, it would be unreasonable to install machines that sell Budapest tickets and passes. Vending machines selling other products (beverages, snacks) could be modified to print and dispense public transport products using security paper, but no such solution exists; therefore, it would need to be developed for this purpose, at a time scale and cost that is impossible to estimate.

The system cannot offer home printing and immediate use, because the security paper cannot be used outside of the closed sales system.

Online sales would require an investment into the transformation of the paper-based system that is presently in use in Budapest – the system that exists at the time of the writing of the present study is not suited to this.

**The paper-based system can only support online distance selling in a limited way, with difficulty.**

5.1.2. Introduction of value-added services

There is only one way the current system could support automatic pass purchases and the delivery of passes to the passenger: by expanding BKV's regular passenger database, connecting it to the financial system and setting up an online access system.

The introduction of value-added services such as automatic sales would require an investment into the transformation of the paper-based system that is presently in use in Budapest – the system that exists at the time of the writing of the present study is not suited to this.

5.1.3. Statistical measurement and planning

In the paper-based system, pass and travel card passengers do not use validator machines and therefore no data can be generated about their trip. Even sales data is unsuitable for analysis, because due to the above, it is impossible to tell where a given pass is being used. All we presently know is how many passes and travel cards were bought at each BKV ticket office at what times. When it comes to reseller networks, we have even less information.

Regarding ticket users, all we could possibly measure is how many tickets were validated at what time on which vehicle. It is important to note that neither the hole-puncher, nor the time-
stamp validator can tell whether the inserted piece of paper is a ticket or some other piece of paper, so any data gathered from them is by nature unreliable. The machines are also unable to tell apart single tickets and other products such as transfer tickets. The above described minimal measurements would require the replacement of thousands of ticket punchers with time-stamp validators and their integration in the FUTÀR system. The on-board and centralised components of the FUTÀR system would also need to be upgraded for receiving, relaying and processing this data. It would also require connecting the machines at metro stations to the network and sending the data to a central location. This would cost more than a billion forints in total.

As the machines cannot differentiate between different pieces of paper inserted in them, they cannot provide data for research into the use of different ticket-type products. Paper tickets are also unsuited to the analysis of travel chains (several rides making up a trip).

**Based on the above, we determine that the paper-based system does not support the generation of product usage statistics in its present state, and cannot be modified to support such a feature.**

### 5.1.4. Introduction of time-based tickets

With traditional paper tickets, time-based ticketing cannot be introduced immediately due to the widespread use of thousands of hole-puncher validators. The current boarding-based system could be replaced by a much more modern and passenger-friendly time-based system in the following manner:

- All ticket validators would need to be replaced by electronic machines where mechanical devices (hole-punchers) are currently installed. Currently, no funding is available for the purchasing and installation of the new devices.
- Using the validators currently in use, validation times could be printed a maximum of four times onto a paper ticket, on the first boarding and three successive line changes – and it would be up to the passenger to make sure that they put in a "clean" side of the ticket every time.

**Based on the above, we determine that the paper-based system in its present state does not support time-based tickets, and adding support for time-based tickets would cost billions of forints.**
5.1.5. **Possibility of introducing a fare cap**

This feature means, in other words, the conversion of one travel product type into another. In this system, if a passenger validates a (boarding-based or time-based) ticket so many times within a given period, such as one day, that the price reaches the price of a day ticket, then the passenger won’t be charged any more, and will be granted a day ticket automatically, allowing unlimited travel from that point.

In the paper-based ticket system the ticket itself is the travel media, which passengers need to buy in advance, and it is impossible to determine after the fact if a validated ticket was used by the same person multiple times, or different people.

**Based on the above, we determine that the paper-based system in its present state does not support the charging of the most advantageous fare, and cannot be modified to support such a feature.**

5.1.6. **Automatic gates at metro stations, effective revenue protection**

The installation and operation of automatic gates at the entries and exits of metro stations requires the communication of ticket validators and the gates. Currently, every metro station has time-stamp validators; each device works in isolation, without a network connection or remote monitoring. Generally, the systems made by companies that specialize in public transport automatic gates are capable of working with multiple types of ticket validators – even simultaneously – so this feature is taken as a given.

Chapter 3.2 describes how the slot of the current validators is easy to jam, making the devices unreliable. These devices are also incapable of differentiating between different pieces of paper inserted into them. In normal daily use, this would mean that the automatic gate would open whenever any piece of paper is inserted into the validator. The consequences of this need no further explanation.

In the light of the above – focusing on this as a purely theoretical proposition – it is clear that the current ticket validators are not suitable for validating pass coupons in the case of passengers who use paper tickets, and this would not be remedied by adding a unique QR code to each coupon that encodes the validity period and other data. This would need to be printed at the ticket office, which is not possible today, so it would require investment. Gates could have barcode readers installed. An obvious drawback of QR code readers is that they are not suitable for the unique identification of multi-use travel products (travel cards,
passes), as these could be copied with a simple black and white photocopier. The consequences of this need no further explanation.

Based on the above, we determine that the paper-based system does not support usage with automatic gates in its present state, and cannot be modified to support this functionality.

5.1.7. Anti-counterfeiting measures, verification of concession eligibility
Fight against the counterfeiting of travel media involves the use of new and more advanced anti-counterfeiting security features. The more security features are used, the more expensive tickets and passes are to manufacture. However, experience shows that the security features do not provide the expected protection against ticket and pass fraud. The best-known counterfeiting methods are: removing the ink, modifying the dates. The damage caused by these practices is estimated to be in the billion forint range each year.

Eligibility for concessions – in the lack of a central register – is determined by the inspection of documents. BKV has no way of checking if the person in question really is eligible as stated in the document shown.

The anti-counterfeiting protection of paper-based tickets and passes is not as effective as it should be, and eligibility for concessions cannot be adequately verified.

5.1.8. Summary
The result of the examination of the paper-based ticket and pass system based on the goals described in Chapter 0 is as follows:

- Travel media and the travel services to be purchased by nature cannot be separated from each other; therefore, convenient Internet distance selling is not possible.

- Ticket validators are mechanical and cannot be connected to a data network; therefore, they are not capable of reading contactless bank cards, preventing their direct use for travel.

- The system does not contain a register of personalized travel and purchasing information and paper-based travel products can only be purchased in person. Thus, no value-added services can be introduced in the area of sales.

- Due to the issues described in the previous paragraph, it is not possible to compile precise and up-to-date information adequate for executive reports and planning.
- The system cannot effectively support the introduction of time-based tickets, and a fare cap system is impossible to introduce in this environment.
- Paper-based travel media is blocking the installation of automatic gates at metro stations.
- The verification of eligibility for concession travel products is done by hand, and eligibility data is not stored in any centralized system, making it easy to abuse the system, even regularly. The current system cannot be joined up with the National Integrated Card System. During controls, passengers have to show the document proving their eligibility every time.
- Counterfeiting causes significant amounts of damage, and fighting it is a costly and constant task, which is not sufficiently effective.

Considering the above, we do not recommend further developing or maintaining the paper-based system fully or even partially.

5.2. Magnetic stripe card system

In magnetic stripe systems, the travel media is usually made of paper, equipped with a magnetic stripe and the size of a credit card. Its storage and operation principle is the same as with magnetic stripe bank cards. The card itself stores the travel product and/or the available balance available for travel. One advantage over paper tickets is that magnetic stripe tickets can be topped up, so they are reusable. Cards look identical; the products and/or balance are loaded on them when they are purchased. These tickets are by nature more easily damaged than plastic cards; experience shows that throughout the lifecycle of the system, a significant number of damaged, inoperable cards are to be expected. This technological trait generates customer complaints, as well.

International experience shows that this solution requires a smaller travel media distribution effort than paper tickets, but still, it requires on-going distribution

5.2.1. Internet distance sales, remote service, use of contactless bank cards

When it comes to remote sales, the situation with this solution is similar to paper-based systems: the data stored on the card cannot be updated without a magnetic card reader, therefore the possibilities of distance selling are limited to the mailing of electronically ordered cards.
The self-service sales system of cities that use a magnetic stripe system is made up of a large number of ticket vending machines. In Budapest, the installation of 500-1000 new machines could cost up to 10 billion HUF. Setting up a sales network outside of Budapest would be difficult and it would require significant investment, considering the cost of purchasing the necessary tools (vending machines, magnetic card readers) and the card distribution solution in question.

The magnetic stripe system can only support electronic sales to a limited extent, and the system does not support the use of contactless bank cards by default.

5.2.2. Introduction of value-added services

Due to the technological limitations described in the previous section, this system cannot offer a comfortable and satisfactory solution for automatic balance top-ups and pass renewals. Because of the expected high volume of travel media replacements, a lot of effort would be required from the operator (maintenance of the customer database) and the passengers (picking up and reregistering travel media regularly).

The magnetic stripe system is not capable of providing proper, comfortable value added services.

5.2.3. Statistical measurement and planning

One significant advantage of the magnetic stripe system is that it improves data collection compared to the paper-based solution. Every sale and validation is done using an electronic device, and therefore data can be collected and analysed. The reliability of the data is impaired by the expected high volume of card replacements.

Based on the above, we determine that the magnetic card system does not support the compilation of detailed product usage statistics.

5.2.4. Introduction of time-based tickets

Considering that travel products are stored on the card and the modified data is written back onto the card during every validation, it is possible to set up a data storage system that supports time-based tickets. However, in order to ensure reliable operation, the system has to provide precise clock synchronization and the precise recording of data onto the card without data damage. Most cities that use a magnetic stripe system use the "one card - one ride (boarding)" system.
Although magnetic stripe cards can support time-based tickets with some limitations, this technology is most widely used with a boarding-based model.

5.2.5. **Possibility of introducing a fare cap**

The introduction of the above discussed passenger friendly fare system – which also encourages people to use public transport – is not supported by magnetic stripe cards. Fare calculation is done in the card readers, which are not constantly connected to the central system. The calculations to sum up the day's (week's etc.) trips are done periodically in the central system, and the results would need to be recorded on the card to ensure correct operation. This is very difficult to achieve with magnetic stripe technology. Before the next trip, the card would need to be swiped and the travel product or balance would need to be updated.

The magnetic stripe system is not suitable for the introduction of a fare cap.

5.2.6. **Automatic gates at metro stations, effective revenue protection**

Automatic gate systems in conjunction with magnetic stripe cards have been in use around the world since the 1990s. These cards were the most advanced technology available for public transport at that time. Appropriate readers/validators can be installed on the gates, which make it possible for the gate to open automatically when the fare is paid. These devices are widely used for entry and exit controls.

The implementation requires the gate-mounted devices to be linked to a network, ensuring that for instance people cannot enter several times using the same pass card (this used to be a widespread fraud method).

The validation of the magnetic stripe cards requires physical contact, which causes wear on both the card and the mechanical parts in the reader. As a result of this setup, on-going maintenance is required, and attempts at jamming and other damage are to be expected. The damage caused by this can be mitigated by providing on-going monitoring and installing camera systems.

The relatively low speed of magnetic stripe processing needs to be taken into account when designing the gate system. This requires more gates to be installed than with the contactless technology, which, apart from increasing the costs, makes it difficult to install the system in some tight Budapest metro stations.
Based on the above, we determine that the magnetic card system can be used in conjunction with automatic gates, although at a higher cost and lower efficiency than more modern technologies.

5.2.7. Anti-counterfeiting measures, verification of concession eligibility

Cards can be protected against copying with simple tools, which makes it possible to introduce them for widespread use. However, due to the distributed nature of processing, successful fraud attempts can only be identified through controls carried out in person. Due to their characteristics (their limited storage capacity and susceptibility for damage), the cards are not suitable for storing data on concession eligibility, which can only be verified with the method used with paper tickets.

Magnetic stripes prevent most fraud, but are not capable of storing concession eligibility information.

5.2.8. Summary

The result of the examination of the magnetic stripe card system based on the goals described in Chapter 0 is as follows:

- Travel media is separated from travel rights, but the travel services purchased are stored on the travel media. The data is written onto the card using a specialized device. The storage capacity of the cards is insufficient for storing several different types of travel product, and therefore any given card can only store one type of travel product through its lifecycle.

- As the fare calculation is done by the card reader and the travel cards do not meet the specifications of international card companies, contactless bank cards are not supported by this system.

- The introduction of value-added services requires the conditions listed in the previous section to be met.

- It is possible to gain processable statistical travel information.

- The system can be adapted to support time-based tickets, but the introduction of a fare cap is not possible.

- The magnetic stripe technology supports the installation of automatic gates at metro stations.
• The storing of information necessary for the use of concession travel products on the magnetic card is not possible due to its limited storage capacity, and therefore the controlling of concession eligibility cannot be automated. The current system cannot be joined up with the National Integrated Card System.

• Magnetic stripe tickets can be protected against counterfeiting.

The system based on magnetic stripe travel media is undoubtedly more efficient and modern than the paper-based system, but this comparative advantage is due to the crudeness of the paper-based system.

**Overall, this model does not fully meet the specifications listed as goals, and therefore is not recommended even for partial introduction.**

### 5.3. Mobile phone based ticket system

The model is based on the presumption that mobile phones have reached a high rate of penetration (according to data from the National Media and Infocommunications Authority, the three Hungarian carriers had 11.642 million customers in November 2011), and the number of SIM cards issued has exceeded the population of Hungary for years. People carry their mobile phones with them everywhere, so it seems logical to use them in public transport.

There are numerous different public transport solutions built around mobile phones; the most important ones are the following:

• **SMS** – Passengers initiate a travel product purchase via SMS. The SMS needs to have a predefined structure and needs to contain all main parameters of the product to be purchased. If the purchase is successful, the travel product chosen is sent via SMS. The passenger can use the response SMS for validation and control. The message can contain a number string, a barcode or a QR code.

• **IVR-based solution** – Instead of sending an SMS, the passenger dials a phone number to initiate a travel product purchase. The call is received by a machine voice. The passenger uses the phone’s dial pad to start entering the name of the starting and ending stations of the trip. The system narrows down the list based on the passenger's entry, and eventually reads out the chosen station. Naturally, passengers can simply buy travel products directly as well. After confirming the travel product
chosen, the passenger receives an SMS or MMS as in the previous case. The usage of the system is the same as above, as well.

The advantage of the two systems is that passengers do not need to register in advance, so they can buy travel products anywhere at any time.

- **SIM toolkit** – an application to be installed on SIM cards based on an agreement with the mobile phone operators. The items related to public transport show up in the menu of the device as new menu items. The features of the SIM toolkit make purchases easier; the passenger receives the virtual travel product via a message as with other mobile phone options. The usage is the same as before, as well

- **Applications installed on the phone** – A very similar method to the SIM toolkit option, but more modern and flexible, based on installing the travel product features as a separate downloadable application. The data necessary for visual (photo, name) and IT (barcode or QR code) identification is downloaded onto the device in the course of a registration process. The purchased travel products can be stored on the phone or in a central system. The validation and control features are still based on barcode or QR code technology. Compared to the SIM toolkit solution, phone applications offer a lower level of security, and resist malicious attacks less.

These latter two solutions allow the personal identification of users, therefore allowing for more travel products and payment options to be offered.

- **NFC** – One of the countless available wireless communication protocols; its boom has been predicted by the parties involved for some time, but there are still no mature, widespread applications. The primary reason for this is that the parties that have a business interest in the technology have not been able to come to an agreement about the share each of them would receive as part of the model. On top of this, no unified NFC ecosystem is known.

However, NFC-based projects are on-going in many locations around the world. The first NFC pilot project started in 2005, and by 2009, 38 countries were experimenting with the technology. The largest and most important NFC projects are taking place in Europe and Asia; the below table summarizes some of them.
### Table 6: International NFC projects

<table>
<thead>
<tr>
<th>Location</th>
<th>Time</th>
<th>Industry</th>
<th>Participating companies</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanau (Germany)</td>
<td>2005</td>
<td>Transport</td>
<td>Nokia, Philips, T-Systems</td>
<td>146 people, 15 buses</td>
</tr>
<tr>
<td>Nice (France)</td>
<td>2010</td>
<td>Transport</td>
<td>4 mobile phone operators, 4 banks, 1 transport organizer</td>
<td>3000 people, 1000 merchants, 1500 information points</td>
</tr>
<tr>
<td>London (UK)</td>
<td>2008</td>
<td>Transport</td>
<td>O2, Barclay’s, Nokia, Visa, TfL</td>
<td>500 people</td>
</tr>
<tr>
<td>New York (USA)</td>
<td>2007</td>
<td>Transport</td>
<td>card company, bank, transport organizer</td>
<td></td>
</tr>
<tr>
<td>Barcelona (Spain)</td>
<td>2010</td>
<td>Commerce</td>
<td>mobile phone operator, bank, mobile phone manufacturer, chip card manufacturer</td>
<td>500 stores</td>
</tr>
<tr>
<td>Canada</td>
<td>2009</td>
<td>Commerce</td>
<td></td>
<td>325 people, 70 stores</td>
</tr>
<tr>
<td>Shanghai (China)</td>
<td>2008</td>
<td>Commerce</td>
<td>bank, card company, chip card manufacturer</td>
<td>800 people, 300 stores</td>
</tr>
</tbody>
</table>

Regarding the Hungarian situation: *Magyar Mobiltárca Egyesület* (Hungarian Mobile Wallet Association) was founded by six companies in June 2011, with the aim of promoting NFC-based mobile phone services.

The first nationwide "live" NFC-based payment system was that of three music festivals in 2011.

The gist of the NFC technology is that devices can establish connections very quickly without physical contact. Apart from the expected and customary IT security features,
business applications are aided by the fact that the communication distance is limited to a few centimetres, which contributes to strengthening public trust in the system, which is indispensable for widespread adoption.

NFC technology is not limited to mobile phones; there are NFC-capable watches and stickers as well. NFC can offer the same functionality as the contactless card systems discussed in Chapters 5.5 and 5.6; in this respect, this solution is less of a mobile phone based option and more of a contactless card based option – one of a range of options to be discussed in upcoming chapters.

The use of NFC-capable devices and mobile phones for non-transferable, personalized travel products (i.e. passes) needs to be studied in more detail. Regarding personalization, the legal and technical aspects of the use of concession travel products also need to be reviewed.

5.3.1. Internet distance sales, remote service, use of contactless bank cards

In mobile phone systems, the travel media and the travel product are separated, so passengers do not need to purchase new physical travel media before each trip; they only need to purchase the travel services they actually need.

Mobile phones by nature have some sort of data transmission capability (voice, SMS, Internet), which, depending on the implementation of the system, can allow the purchased travel products to be transmitted immediately to the telephone and the purchase requests to be transmitted to the central system. The sale of travel products can be implemented not only through personal computers connected to the Internet, but also through mobile phones.

Passengers can buy the travel products they need at any time, even at a bus station while waiting for the bus. As the phone also serves as the travel media, this alternative does not require ticket vending machines to be installed.

Two payment options can be envisaged for electronic purchases: card payment through a financial service provider, or carrier billing.

If the second option is chosen, there will be several problems to solve:

- In the lack of implementing regulations for Act CC of 2011 on the National Mobile Payment System, it was not possible to determine by the time of the completion of the present study if the future system will allow passengers to transfer money from their mobile account to the money account registered for them in the automated fare
collection system. Therefore, it is not possible to tell if the mobile phone option could offer pay-as-you-go (PAYG) products or only pay-in-advance (PIA) products.

- Another drawback is that foreign passengers who are unlikely to have a Hungarian phone number would in all likelihood be unable to use this service.

**Systems based around mobile phones support remote selling only partially, and the feasibility of personalized travel products is unclear. The use of contactless bank card technology is possible if NFC-capable mobile phones become widespread enough and the ecosystem of this technological solution is built up enough.**

5.3.2. **Introduction of value-added services**

Technically, the systems could support automatic orders, making the purchasing of travel products more comfortable and simpler. The display modes allowing the use of travel products (barcode, QR code) offer a low level of security, which makes them unsuitable for use with multiple-use travel products.

The mobile phone model does not support value-added services and there are numerous doubts about the feasibility of even the basic travel products.

5.3.3. **Statistical measurement and planning**

As the travel products are virtual and the validation is electronic, the collection of information can’t be a problem. The exact data that can be collected depends on the travel conditions in force at any given time.

5.3.4. **Introduction of time-based tickets**

As there will be automatic passenger entry at metro stations, all of the mobile phone purchase processes described at the start of this chapter will need to send the chosen virtual travel product to the mobile phone in a format that the chosen validator can read. It is technically possible to differentiate between the time of purchase and the time of validation. As the time of the start of the trip is known, the system can handle time-based tickets.

The above information demonstrates that the mobile phone option is capable of supporting the established goal of introducing time-based tickets.
5.3.5. Possibility of introducing a fare cap

The fare cap system can fundamentally operate in two ways.

If the travel products are recorded on the travel media, then new data needs to be written to the travel media at every boarding so that the information is available at the next use. This possibility is not supported by the mobile phone options, because the ticket validator is not able to communicate with the mobile phone (except for the NFC option).

If travel products are stored in a central system, then that is where the data collection and evaluation is carried out as well. If payments are not done by bank card but through carrier billing, other issues need to be taken into account, which affect the feasibility of the fee cap:

- If the fare cap is to be introduced without setting up money accounts for passengers in the central system, then the pricing of the travel products that substitute each other needs to be set so that they cost multiples of each other. For instance, the price of a day pass needs to be a multiple of the price of a single ticket. Otherwise, it would not be possible to charge the correct amounts.

- If the fare cap is not introduced, the passenger would need to manage the financial balance without payments made in advance, as the fees are added to the phone bill. This is essentially a form of current account credit.

It was determined previously that in the case of mobile phone sales, PIA products are the only option. Therefore, in cases where the passenger has already reached the fare cap and does not need to pay for the next trip, the system needs to be able to calculate in real time whether or not to charge the customer as soon as the purchase request comes in.

In the lack of implementing regulations for Act CC of 2011 on the National Mobile Payment System, it was not possible to determine by the time of the completion of the present study if the future system will allow passengers to transfer money from their mobile account to the money account registered for them in the automated fare collection system. To summarize: it is not possible to tell if the mobile phone option would provide the possibility of introducing a fare cap.
5.3.6. Automatic gates at metro stations, effective revenue protection

Mobile phone based solutions require the installation of validators equipped with barcode or QR code readers.

When it comes to travel product validation, all above options (with the exception of NFC) rely on the barcode or QR code technology that has obvious drawbacks in the area of counterfeiting, as discussed in the description of the paper-based model.

Due to technical considerations related to the portability and reading of travel products, only the NFC-based solution can integrate with metro station automatic gates and validators; the possibility of introducing an NFC system in the near future must be analysed in more detail.

5.3.7. Anti-counterfeiting measures, verification of concession eligibility

All of the mobile phone solutions discussed (with the exception of NFC) rely on barcode or QR code validation methods, which is practically the identical to the paper-based QR code solution discussed in 4.1. The barcodes or QR codes sent to the mobile phone are completely vulnerable to even the simplest counterfeiting techniques. A travel product or identifier can be copied in unlimited numbers by simply taking a photograph, allowing non-paying passengers to pass through the readers at the automatic gates. Only travel products that do not pose an excessive risk can be used with mobile phone solutions. For this reason, these systems can only support single tickets. Making it possible for passengers to buy day passes after providing extra data through a personalization process could possibly be considered.

Due to the above reasons, the only travel products that could be bought via mobile phone are single-use tickets. There are concession products in this category as well. In case of concession travel products, eligibility for the concession is assessed at the time and place of the purchase, and this information is contained in the information sent back to the phone, so control can be automatic. The system can use the database of the National Integrated Card System in order to verify the eligibility of passengers who registered their phone number in advance when a purchase is made.

If the above conditions are observed, mobile phone systems are counterfeiting-proof.
5.3.8. Additional considerations

In addition to the above, systems based around mobile phones have other, general risks:

- Mobile phones are active devices, which means that their batteries can run out, rendering the passenger unable to prove that they have paid for their ticket.

- Passengers could be subjected to extra costs, which could make this type of solution less popular: in case of SMS-based notifications, the cost of sending the SMS, the convenience charge, in case of IVR calls, the cost of the call.

- New generations of mobile phones and new operating systems come out every day, which makes it impossible to control the operating risks of the entire automated fare collection system. In other words: the operator of the system loses the ability to control the travel media.

- With some solutions (SMS, SIM toolkit), the efficiency of the model depends on the quality of the service provided by the carrier, and a business agreement with the carrier is required.

When starting a trip (with the exception of the NFC system), passengers don't just need to have their mobile phone with them: they also need to find the data necessary for validation in the phone's menu system. This can break the continuity of entry as passengers may get held up at gates, which could even cause accidents in case of exit control.

5.3.9. Summary

The result of the examination of the mobile phone systems based on the goals described in Chapter 0 is as follows:

- Buying travel services via Internet distance selling is possible.

- Among mobile phone solutions, only NFC can be expected to "convert" the NFC-capable mobile phone into a contactless bank card and allow its owner, the passenger to use the device as travel media. Technically, the technology is available, but NFC-capable mobile phones are not widespread enough, and, more importantly, the entire ecosystem is not standardized enough and widespread enough yet.

- Value-added services are only available with query features; transaction-type extra services are not supported – in traditional solutions (SMS, IVR), for security reasons, in NFC, because only PAYG travel products are available.
• It is possible to gain processable statistical travel information.
• The system supports the introduction of time-based tickets. No clear opinion can be formed on the feasibility of a fare cap due to the nascent new regulatory environment.
• New barcode or QR code readers would need to be installed at metro stations.
• Systems based around mobile phones are very vulnerable to counterfeiting; the codes used for identification (barcodes, QR codes) are very easy to copy, so these systems can only support travel product types that allow a single trip at full price.
• The data regarding eligibility for concession travel can be managed by virtualized travel products, the database of the National Integrated Card System can be used for verification.

Among the discussed solutions based around mobile phones, the NFC solution is the only one that deserves attention. The widespread use of this data transmission protocol has been introduced in various industries, but when it comes to mobile phones, it is not yet clear which solution will become widespread and usable in public transport; this is going to be determined by the clash of the interests of mobile phone manufacturers, mobile phone carriers international card companies and other major market actors and regulators.

None of the other possible solutions can be seriously considered due to the security problems with the technology used for the virtual display of the unique travel products (barcode, QR code). Based on the above, we recommend considering the option of making the passenger-facing elements of the new Budapest automated fare collection system NFC compatible so that the system can be made to work with NFC after the clarification of the details and a minor adjustment of the architecture once a standard becomes widely adopted.

5.4. Traditional contactless transport card system

Over the years, magnetic stripe travel media proved to be very successful – and very flawed as well. Their capacity is limited, they get damaged often, they generate on-going distribution costs, and the servicing of the ticket readers and the prevention of counterfeiting is becoming more and more difficult. Due to technological advances, credit card-sized devices made of plastic appeared in the late 1990s with a microprocessor and data storage and computation capacities. Later, radio frequency communication modules were added to these plastic
cards, which – in conjunction with a communication protocol – created the possibility for passengers to use public transport services with quick, secure contactless travel media.

Traditional models based around contactless travel cards were the first automatic ticket collection systems with a powerful central computer system. This setup, informally known as the electronic ticket system, became known as AFC (for automated fare collection), and proved to be a major step forward in the public transport industry. The first such system was launched in the second half of the 1990s.

In many of the world's major cities, public transport systems were already broken up by modes of transport, which were operated by different companies. At the city level, this model created a complicated, confusing and expensive fare system. Realizing that the passengers were the main victims of the problems, a passenger-friendly approach was used to solve the problem: complicated internal processes were hidden from the general public, and a single unified tool was created for passengers in the form of a plastic contactless chip card, which made fare unification possible as well.

Encouraged by the success of the first such projects, the leaders of more and more cities decided to modernize their own systems. The competition between the companies supplying solutions and devices and the differing needs of the various cities prevented a unified standard from emerging, leading to insular, technologically closed systems. This allowed supplier interests to prevail, making the systems supplier-dependant, to the detriment of the interests of customers (cities, transport organization companies). Eventually, realizing the risks this creates, some national governments and transport entities decided to set up national standards. This led to the creation of the British ITSO, the German VdV and the French Calypso.

However, integration did not go any further than this. Workgroups were set up by experts of these systems years ago, but they have yet to produce tangible results.

5.4.1. Internet distance sales, remote service, use of contactless bank cards

In this model, the travel products and the data necessary for the calculation of fares are still stored on the card. The main reason for that is the limited capacity for data transmission, especially in mobile network infrastructure in the broad sense of the term, as, when the model was designed and became widespread, mobile networks were not yet able to provide a continuous connection between moving vehicles and central systems.
As all data is (also) stored on the card, therefore, products bought over the Internet need to be recorded on the chip in the card. This requires an appropriate number of contactless reader-writers with adequate technical capabilities. Thus, the card cannot be used right away after making an online purchase, which is inconvenient for the passenger – although it is still an improvement compared to previous technologies.

Writing the product onto the card requires more time than a normal entry. In order to prevent longer queues at peak times, specialized devices need to be installed for recording products bought electronically onto the cards instead of having the automatic gates handle this task as well. This increases the cost of the project.

At a first glance, traditional cards and contactless bank cards seem to be near identical. If the ticket validator machines installed meet the requirements of card companies, there should be no major problems with the acceptance of contactless bank cards. However, closer inspection of the required preconditions reveals that the system designed for contactless bank cards differs radically from the system designed around traditional cards:

- Bank card acceptance requires close to real-time communication between the central system and the peripheral.
- In the traditional system, fare calculation is handled by the validator machine, while this is handled on the server side in the bank card system.

Internet distance selling can be supported with some compromises. Based on the above, it has been determined that contactless bank cards can only be integrated into systems based around traditional transport cards with major modifications that diverge from the principles of the model based around the traditional card.

5.4.2. Introduction of value-added services

The useful life of contactless cards can be orders of magnitude longer than that of paper media, offering years if continuous usage. The other requirement for product purchases and balance top-ups is the existence of a central system and the ability to handle these features, which has been implemented in numerous major cities.

Value-added services can be implemented with the limitations mentioned in the previous chapter (need to install separate travel product recording devices)
5.4.3. Statistical measurement and planning
As the system uses virtualized travel products by nature, and validation is electronic, collecting information is not a problem. The exact data that can be collected depends on the needs and the travel conditions in force at any given time.

5.4.4. Introduction of time-based tickets
The cards store not only travel products/financial balances but validation data as well, so this solution fully supports time-based tickets.

5.4.5. Possibility of introducing a fare cap
International experience shows that some type of fare capping is generally introduced along with contactless cards. The cards store, apart from travel product data, the financial balance and data on previous validations. An algorithm can rely on this data to manage the fare cap. The only difficulty stems from certain time periods to be used for the fare cap (e.g. one month), as so much travel can take place within these periods that their storage and calculation may slow down operation in the environment in question (metro station automatic gate/card reader/card).

The option discussed here offers a solution for introducing a (short-term) fare cap.

5.4.6. Automatic gates at metro stations, effective revenue protection
Ticket validators need to be capable of handling contactless cards. The automatic gates to be installed at metro stations also need to be equipped with similar readers. These cards can be read quicker than magnetic stripe cards, so fewer gates are necessary than in the magnetic card system.

The life of traditional cards is drastically higher than that of magnetic cards, as their use involves no physical contact, and there are no parts exposed to wear and scratches like a magnetic stripe. Naturally, the life of readers is longer, too, and their service needs are lower.

A sufficiently high entry capacity needs to be ensured, so the card reading/writing time needs to be minimized, which requires a simple product structure made up of few products.

Overall, this option meets the above goals – with some limitations.
5.4.7. Anti-counterfeiting measures, verification of concession eligibility

As the years went by, more and more concerns arose regarding the use of magnetic stripe cards. Magnetic stripes do not meet today’s security requirements, as the cards are easy to copy. The best proof of this is the fact that the finance industry is replacing magnetic stripe cards – using very similar technology – with chip cards en masse.

These security problems can be resolved by using contactless chip cards. This is a plastic card that contains a microprocessor, which makes the stored information impossible to extract with today’s IT tools except with a disproportionately great effort. Contactless communication technology is another result of technological development. By combining these two technologies in a commonplace, widespread credit card sized device, the public transport industry has managed to solve all the problems of magnetic stripe cards.

These cards are impossible to copy or manipulate with simple tools, although persons with great expertise and experience in the area occasionally manage to defeat the security features of the cards and modify the data or copy cards (for instance: cloning of Mifare Classic cards in 2008).

To prevent this, chip makers regularly introduce new and more secure products to the market. Therefore, it is especially important to give security considerations sufficient weight when choosing travel media, and it is important to add carefully and expertly chosen extra security features to the cards apart from the ones provided by the manufacturer as standard. In this case, the cards have adequate protection and are ready for use at the required security level.

The chips offer adequate capacity for storing concession eligibility information.

When it comes to security, the more information is stored on a card, the more vulnerable the system becomes. In this case, considering the entire architecture, the most difficult to protect element is the card itself – that is, the element that stores the most crucial information. This possible risk is exacerbated by the fact that card fraud can remain hidden for the longest time, as perpetrators are interested in keeping the fraud secret.

If extra security features are added, contactless cards can resist malignant attacks; they are capable of meeting expectations.
5.4.8. **Summary**

The result of the examination of the traditional contactless card system based on the goals described in Chapter 0 is as follows:

- Travel media is separated from travel rights, but the travel services purchased are stored on the travel media. Travel product data can be written to the cards using a specialized device.
- As fare calculation is done by the validator, and the travel cards do not meet the specifications of international card companies, contactless bank cards are not supported by the system.
- The introduction of value-added services requires the conditions listed in the previous section to be provided.
- It is possible to gain processable statistical travel information.
- The system supports the introduction of time-based tickets and fare caps.
- The installation of automatic gates at metro stations is supported by the system based around traditional contactless cards.
- The chips on the cards can store information regarding the use of concession travel products, allowing the automation of the control of concessions. The system can communicate with the National Integrated Card System (NEK) in order to verify concession eligibility, but the cards issued within the framework of the NEK system cannot be used as travel media.
- Contactless cards are protected against counterfeiting.

Systems based around traditional contactless cards meet most expectations. One great disadvantage of these systems is that no worldwide open standards emerged in this area, standardization reached national level at best. Therefore, transport organizers are very exposed to suppliers; in some cases, it is impossible to involve new suppliers in the on-going development of a system, eliminating the possibility of any real competition. The lack of standards also makes systems that use traditional contactless cards unable to meet interoperability requirements, even though this would be advantageous for passengers. In the light of the above, we can state that traditional contactless card systems do not offer an
optimal solution covering all aims, therefore, this option is not recommended for implementation.

5.5. Server-based system

Server-based systems also rely on contactless solutions on the travel media side, but their principle of operation is fundamentally different, and they work very differently in practice. The most important limitations of traditional card-based systems are as follows: the storage of travel products on the card, the necessity of regularly synchronizing the data stored on the card with the central system, the fact that the storage of travel products is physically tied to the card, the potential problems in ensuring the interoperability of systems, and the significant business and financial risks associated with a closed technology. Server-based systems are free of most of these limitations, offering an even more passenger-friendly, more secure, less supplier-dependent architecture that fully exploits available mobile communication possibilities, offers great flexibility in terms of possible parameters and supports media issued by third parties. In the following section, we review the extent to which such a system can meet our established goals.

5.5.1. Internet distance sales, remote service, use of contactless bank cards

Travel products or financial balances are only stored in the central system; travel media is only used for passenger identification and is not used for storing data on travel products.

As travel rights are stored on the central server, the possibility of checking eligibility during every ride needs to be ensured. This needs to be provided both at fixed locations (mostly at metro stations) and on board surface vehicles (buses, trolleybuses, trams).

This means that validators and control devices have to be capable of associating travel media and travel products immediately after purchase. Naturally, this holds for every purchase option, including Internet distance selling.

This requires high-quality, highly reliable, fast data transmission infrastructure. The risks associated with the use of mobile data transmission infrastructure need to be reduced through intelligence designed into the system.

The conditions required for supporting contactless bank cards described in the previous chapters are much easier to meet with this system: network infrastructure works optimally in this respect, and data is stored and calculations are done almost exclusively in a central
system. The special module that handles contactless bank cards as travel media needs to be attached to this central model.

The peripherals of the system can be adapted to accept contactless bank cards even without physical modifications, but further studies are necessary in order to determine whether and how the architecture can support this rather unconventional use of bank cards. This unconventionality springs from the fact that the verification of travel rights and the purchasing of travel products are both carried out using the card, but at different times.

**In essence, this model meets the needs of Internet distance selling, and can realistically support the use of bank cards.**

5.5.2. **Introduction of value-added services**

Due to the fact that all data is stored in the central system, passengers can access precise, up-to-the-minute information about their travels through a personalized Internet portal. Another benefit of the centralized nature of the system is that travel product purchases and financial balance top-ups can be automated. The parameters of these features can be set by the client without assistance through the Internet portal.

The server-based system supports value-added services.

5.5.3. **Statistical measurement and planning**

As the system uses virtualized travel products by nature, and validation is electronic, collecting travel information is not a problem. The exact data that can be collected depends on the needs and the travel conditions in force at any given time.

5.5.4. **Introduction of time-based tickets**

Central data collection and payment processing coupled with synchronized timing signals at every peripheral ensures support for all time-based products.

5.5.5. **Possibility of introducing a fare cap**

The central server stores, apart from travel product data, the financial balance, as well as data on previous validations. An algorithm can rely on this data to manage the fare cap.

The option discussed here offers a flexible solution for introducing the fare cap.
5.5.6. Automatic gates at metro stations, effective revenue protection

The gates at the entries and exits of metro stations need to be fitted with validators that can read contactless cards that also control the gates themselves. The validation process in this model is quicker than in the traditional card-based solution.

The system cannot be expected or guaranteed to be able to check for funds instantly when carrying out the validation, as all the data will be stored in the central system, while passengers can enter the network at a multitude of access points. There will be locations where the response time is a fraction of a second (e.g. at metro stations), but such speeds cannot be guaranteed in the case of many surface vehicles. The computational capacity of the central system needs to be set up so that the travel product and financial balance records stored in the central system prevent passengers from starting a trip when their account does not contain a sum sufficient for at least the cheapest travel product (a time-based ticket) or a corresponding travel product on their travel product account. Concrete fare calculation and charging the money account is subject to the design of the architecture, but these processes will generally take place daily, after the daily closing process.

Other tools can be used to make the system more robust, such as collecting deposits from passengers or instituting a scoring system based on the passenger's travel and payment habits.

**The server-based system and its components can ensure effective revenue protection.**

5.5.7. Anti-counterfeiting measures, verification of concession eligibility

The cards used in this model are technically identical to traditional transport cards. Their security level is higher because the system does not read or write travel-related data from and onto the cards. A card only contains fixed data that uniquely identifies the card itself, and this is all that is read off the card during validation. Due to the design of the system, counterfeiting possibilities are limited to the copying (cloning) of a card. If someone managed to clone a card, that could be quickly identified by the system's fraud detection intelligence feature.

Concession eligibility requires the personalization of travel media. The visual differentiation of concession travel media and the identification of the concession type on the card associated with the personalization of the medium are important tools for the verification of concession eligibility. This makes it possible to carry out targeted checks on people who travel with a
concession. Still, passenger data – including concession eligibility data – is stored in the central database. The validity of the card can be verified by connecting to the data holder organization that stores the concession data, if this is made possible. Eligibility for concessions needs to be checked when the card is issued, and, if possible, whenever a concession travel product is purchased.

**The server-based system can provide effective counterfeiting protection, and makes it possible to check concession eligibility, on a regular basis if required.**

### 5.5.8. Summary

The result of the examination of the server-based system based on the goals described in Chapter 0 is as follows:

- The travel media purchased is stored on a central server, allowing streamlined Internet purchases without any additional action by the passenger. If designed in a careful and goal-oriented manner, the system offers ideal opportunities for the full support of distance sales.
- The system has the basic capabilities required for supporting contactless bank cards. Among all the options discussed so far, this option offers the architecture best suited for adding the hardware and software tools required for supporting contactless bank cards.
- The system supports value-added services without any limitations.
- Up-to-date precise data is available all in one place for compiling statistics.
- The system supports the introduction of time-based tickets and fare caps.
- The system supports the installation of automatic gates at metro stations.
- The central system can store information regarding the use of concession travel products, allowing the automation of the control of concessions. The system can communicate with the National Integrated Card System (NEK) in order to verify concession eligibility, and arrangements can be made to support the use of cards issued within the framework of the NEK system as travel media.
- Contactless cards are protected against counterfeiting.
Overall, the model combines state-of-the-art technology with the ideal operating principles and processes as identified based on past experience. Like other solutions, this option cannot be guaranteed to meet every possible goal, but the server-based operating principle and the standard communication protocols used for communication between subsystems ensure the best possibilities for adding support for contactless bank cards as travel media.

The server-based system offers the best guarantees of a modern and sustainable ticket system in Budapest public transport – or even other transport services – for the next several decades; therefore, this alternative is recommended for adoption.

5.6. System based on contactless bank cards

A system based fully on contactless bank cards would essentially be a special version of the established server-based system with contactless travel media.

The usage model of bank cards is fundamentally server-based, with the cards storing only basic data (name of owner, card number, expiry, CVV/CVC code, sometimes a photo, PIN code, signature etc.); the balance associated with the card and the transactions carried out with the card are stored on the central server of the issuer. In order to further improve security, a special set of industry rules is applied (PCI DSS), regulating the entire lifecycle of the card, covering production, use and disposal. These rules are compulsory for all actors in the bank card ecosystem.

Bank cards are among the most successful and widespread products in the financial sector (according to June 2011 data from the National Bank of Hungary, 8.85 million cards have been issued in Hungary, and more than 188 thousand points of sale accept cards). In recent decades, this area became a global, standardized, reliable, large turnover business. Thanks in part to the procedure to be followed when using a card (online balance check, PIN code request, printing of slip, requesting signature etc.) and in part to the price policy of card companies and banks (minimum charges, high interchange fees etc.), bank cards so far have not been able to break the dominance of cash in the commerce of small-value items that require quick payment ("micropayments").

International card companies and financial service providers have long been dreaming about entering this market segment. After several years of preparation, in the mid-2000s EMVCo, co-owned by large card companies (American Express, JCB, MasterCard, Visa), published
the technical specifications of contactless technology as part of the EMV standard that prescribes unified global processes and technical standards.

Contactless technology is being introduced in the world of bank cards based on the specification and the attached set of rules, and new rules and regulations are being devised to make accepting contactless bank cards more attractive for potential business partners (abolishing minimum charges, introducing an offline acceptance procedure without immediately verifying that sufficient funds are available on the account etc.).

The two main keys to the success of contactless bank cards are the quick growth of the number of such cards and a large network of merchants that accept them. Card issuers and the decisionmakers at international card companies are determined to carry this recent trend forward. As of the end of 2011, numerous financial institutions issue contactless bank cards, stickers and wristwatches in Hungary. Some banks offer this service as a complementary payment option, while other banks have decided to offer them to all members of certain target groups. At the same time, major card accepting companies/banks have started to replace and upgrade POS terminals to support contactless technology.

It is important to note that card companies and card issuers both indicated that they consider public transport service providers some of their most important partners in introducing contactless bank cards into widespread everyday use. Obviously, at least one product type is needed that is bought by large numbers of people with great regularity and that was not available by bank card thus far. The direct use of contactless bank cards in public transport (e.g. for crossing automatic gates at a metro station) cannot be executed following the normal merchant rules, i.e. the PIN code cannot be requested (above a certain spending limit). Consequently, the use of the card and the payment transaction need to take place at different times. The special demands of public transport have motivated card companies to draw up a set of rules specifically on the use of contactless bank cards in public transport, in cooperation with the world's largest public transport service providers and transport organizers.

This model is advantageous for both the financial sector and public transport providers:

- The most important elements of the public transport ticket system (purchase, validation, control, entry) are thus standardized at the international level to an extent that is rare not only in transport but in general as well. In this model, anyone who has
a contactless bank card can directly use public transport services without any prior registration procedure.

- In the light of the needs of transport (very quick operation) and the characteristics of the transactions in question (low sums per transaction), the rule system relies on a risk-sharing model. The model is being implemented locally in the Hungarian market in the framework of an agreement between financial and transport service providers and card companies. These negotiations are expected to take place in Hungary in the near future.

- Bank card owners who wish to use their card directly in public transport do not need to get travel media from transport providers (transport organizers).

- It is possible to have a financial service provider handle the activities related to travel media partially or even fully (manufacturing, emission etc.).

- Apart from the tasks related to the issuing and managing of cards, it is possible to have a financial service provider carry out financial sub-operations (managing of money accounts, complex financial operations such as automatic top-ups, direct debit etc.) on behalf of the transport service provider – after all, financial service providers are specialized in this field and better equipped for the task. This way, public transport companies can focus on their areas of specialization.

5.6.1. **Internet distance sales, remote service, use of contactless bank cards**

Contactless bank cards are issued by a bank, which also manages the account attached to each card. Today, virtually all banks provide electronic access to their clients. This electronic channel allows customers to provide sufficient funds.

By nature, contactless bank cards can only be used for purchasing PAYG products.

As contactless bank cards are limited to PAYG travel products, they do not support distance sales or distance services. Naturally, the system accepts contactless bank cards directly, but only with regard to the above groups of travel products.

5.6.2. **Introduction of value-added services**

Among value-added services, **automatic top-ups are not compatible with this model**. 

*Query transactions can be carried out* in the manner described under the previous model. This requires the transport organizer to set up and operate a multi-functional personalized
website for customers. In addition, the possible rules for storing the card numbers – which serve as unique identifiers in this case – need to be studied separately.

5.6.3. Statistical measurement and planning
As the system uses virtualized (PAYG) travel products by nature, and validation is electronic, collecting travel information is not a problem. The exact data that can be collected depends on the needs and the travel conditions in force at any given time. In accordance with the contents of Chapter 5.6.2, the rules and regulations on handling bank card numbers need to be observed during statistical measurements.

5.6.4. Introduction of time-based tickets
Central data collection and payment processing coupled with synchronized timing signals at every periphery ensures support for all time-based products. As in the case of a server-based system that uses contactless cards, a purely bank card-based system also requires the transport organizer responsible for the ticket system to set up a central system, which converts card usage data into travel products and charges the price of said travel products.

A purely bank card-based system is capable of handling time-based tickets, but, in accordance with the contents of Chapters 5.6.1 and 5.6.7, only for PAYG tickets.

5.6.5. Possibility of introducing a fare cap
As described in Chapter 5.6.4, the transport organizer converts card usage data into travel products on its central server. An algorithm can be set up on the central server that enables the conversion of one travel product into another, for instance, applying a fare cap for a given period.

The option discussed here offers a flexible solution for introducing the fare cap.

5.6.6. Automatic gates at metro stations, effective revenue protection
As described in Chapter 5.6.4, on top of putting into place the entire architecture, certified reader devices capable of reading contactless bank cards need to be installed on metro automatic gates. Entry through the metro gates with contactless bank cards will still be automated.

The acceptance and application of the special transport model drawn up by card companies – described as part of the description of the model – essentially relieves the public transport service provider from the potential risk involved in fare collection.
The model is essentially based on the installation of special card reader terminals without a PIN entry keyboard on all surface vehicles and metro gates. Every terminal is directly connected to the central server of the transport organizer. By default, terminals accept any valid contactless bank card automatically, even if it was never used in the system before, and allow the trip to commence (e.g. the automatic gate opens in the metro). This "zero sum transaction" is registered by the central system, and a few minutes later an authorization request is sent to the acquirer bank. The request is sent through the card company systems to the system of the bank that issued the card, which communicates to the central system of the transport organizer if the card can be accepted or not.

If the answer is negative, i.e. the card cannot be accepted (e.g. due to insufficient funds), then the central system of the transport organizer updates the black list of all readers (terminals) in the system with this information. The passenger who used the card, e.g. on the metro, can finish the trip, but cannot start a new trip; the card will be rejected by the reader. In this case, the transport organizer loses the revenue that would have resulted from the sale of the travel product in question (generally, the price of the time-based ticket). The only exception is if the passenger happens to meet ticket inspectors on this ride. This risk borne by the transport organizer can only be evaluated in the light of whether the accepting or issuing bank assumes financial risk, and if so, to what extent (see below).

If the answer is positive, then, in accordance with global card company regulations, a combination of a sum and a time window opens (e.g. 14 days of 5000 forints), within which the transport organizer allows the use of the card for travel without further authorization requests. This is what is called "chargeback protection", which means that the risk under this limit is borne by the issuing bank. In accordance with the contents of the previous Chapters, the central system processes card usage transactions and converts them into travel products, and records the sums that have aggregated but have not yet been settled with the financial service provider.

If the passenger is at a point where they would exceed the authorized limit with the next ride, then the charges collected thus far are sent to the bank to be settled. After the successful settlement, the time and sum window of chargeback protection opens again. The same happens if the passenger reaches the time limit first.

Based on the above, we can establish that the (purely) bank card-based system supports the use of automatic gates in the metro network. Effective revenue
protection depends on the risk sharing agreement between the transport organizer, the card issuers and the card companies. The agreement and the exact rules on the use of contactless bank cards in public transport need to be studied in exhaustive detail separately.

5.6.7. Anti-counterfeiting measures, verification of concession eligibility

In the case of bank cards, the security risks associated with the medium are shared between the card company, the issuing and acquirer banks and the card holder. Naturally, it is also in the transport organizer's interest to make sure that bank cards are used in a secure environment, and therefore, transport organizers need to have a certificate proving that the audits required by card companies and carried out by independent companies take place regularly. In practice, this means a PCI DSS audit of the entire "ticket system" operated by the transport organizer.

If bank cards are used in public transport as travel media, they can only provide access to PAYG products. For PIA products, the transport organizer that operates the ticket system cannot ensure the reuse or redeeming of travel products associated with bank cards that expire within the validity period of the travel product. The transport organizer has no control over the rules on the transferability of cards, and as a result, personalized travel products like passes or concession tickets and concession passes cannot be bought with the cards.

Consequently, there are essentially no counterfeiting-related risks to consider; concession eligibility verification does not arise as an issue in purely bank card-based systems.

5.6.8. Summary

The result of the examination of contactless bank card system based on the goals described in Chapter 0 is as follows:

- In the case of PAYG products purchased with contactless bank cards, by nature no in-person or electronic pre-purchasing is necessary – this is the central element and great advantage of the system.
- The system handles contactless bank cards, so evidently this solution fully meets this goal.
The system can provide a personalized Internet query interface as a value-added service.

Up-to-date precise data is available all in one place for compiling statistics.

The system supports the introduction of time-based tickets and fare caps.

The installation of automatic gates at metro stations is supported by the system based around traditional contactless cards.

Concession travel products cannot be purchased with a contactless bank card.

The transport organizer has no tasks in the area of counterfeiting prevention.

The acceptance of contactless bank cards as travel media is not capable of handling the entire range of travel products, as it only supports PAYG-type products. This solution offers an ideal solution for managing all the purchase-related processes; therefore, the system based around contactless bank cards is recommended for implementation as a complementary part of another system.

5.7. Comparison of alternative solutions

Here, we score the various solutions based on a detailed discussion of the goals listed in Chapter 3. Scores are awarded based on the extent to which the solution meets the criteria (full circle for best compliance, empty circle for worst). Background shading was used to indicate the best choice with regard to each aspect.
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<th>Aspect</th>
<th>Paper-based</th>
<th>Mobile(^3)</th>
<th>Magnetic stripe</th>
<th>Traditional transport card</th>
<th>Server-based system</th>
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<td>Sales channels</td>
<td></td>
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<td>📊</td>
<td>📊</td>
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</tr>
<tr>
<td>Investment and operation costs(^5)</td>
<td>📊</td>
<td>📊</td>
<td>📊</td>
<td>📊</td>
<td>📊</td>
<td>📊</td>
</tr>
<tr>
<td>Time necessary for implementation(^6)</td>
<td>📊</td>
<td>📊</td>
<td>📊</td>
<td>📊</td>
<td>📊</td>
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</tr>
<tr>
<td>Maturity of technology</td>
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<tr>
<td>Necessary network capacity(^8)</td>
<td>📊</td>
<td>📊</td>
<td>📊</td>
<td>📊</td>
<td>📊</td>
<td>📊</td>
</tr>
</tbody>
</table>

Table 7: Scoring of options

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\(^3\) “Mobile” covers all mobile phone alternatives discussed in the relevant Chapter except for NFC. NFC was categorized here as a server-based system.

\(^4\) This aspect involves a comparison of the protection offered by various types of travel media against fare evasion at automatic gates (generally installed at metro stations).

\(^5\) This does not reflect the actual investment costs; the comparison only involves the costs that differ most between models.

\(^6\) The time necessary for installing automatic gates is not included in the comparison.

\(^7\) As this infrastructure is in place already, this aspect cannot be evaluated.

\(^8\) No network connection needed for validation.
5.8. The option recommended for implementation

Based on the goals laid down in Chapter 0, in Chapter 0 we assessed paper-based, magnetic stripe, mobile phone, traditional (contactless) transport card, server-based and contactless bank card systems.

Considering the extent to which they fulfil the goals and the available experience and possibilities, we have determined that the sustainability of the fully paper-based system in place at the time of the writing of this study is limited, and its replacement is fundamentally important for economic and social reasons. None of the systems under review meet the goals fully on their own. Therefore, various systems will need to be employed in combination, which works optimally if the systems in questions are as close as possible to each other in terms of architecture, allowing for almost complete integration, and if they strengthen and complement each other.

Among the systems under review, the server-based contactless card system is the only one that meets these requirements, as complemented by the capability of accepting contactless bank cards.

However, we believe that when designing and implementing the system proposed as the final system in this project, NFC should be considered as a possible accepted medium, as NFC technology is available, but the payment ecosystem that is indispensable for its daily use has not yet been established. Therefore, NFC cannot be fully relied upon at the time of the writing of the present study.

Based on the information collected and analysed so far, we propose the introduction of a new electronic ticket and pass system in Budapest that:

- has a server-based architecture;
- is contactless for users;
- is based on cards issued by the transport organizer;
- makes it possible to use contactless bank cards directly;
- ensures the verification of concession eligibility primarily through the National Integrated Card System;
- is capable of mitigating counterfeiting;
• enables value-added services and supports Internet distance selling;
• makes it possible to introduce time-based tickets and a fare cap;
• makes it possible to install automatic entry and exit gates at metro stations and operate them to a high standard; and
• ensures the effective protection of revenues.

These conditions are met by a server-based system that accepts self-issued contactless cards and contactless bank cards.

If new, as yet unknown considerations emerge in the future, which may affect the choice of model, some elements of this choice may be refined or modified. The subsequent Chapters of the pre-feasibility study discuss the proposed solution.
6. Operational Model of the Proposed System

The operational model of the new automated fare collection system of Budapest is made up of physical and logical components and the description of processes. The fundamental pillar of the system is the range of travel products to be offered to passengers and the structure of this product range. The following Chapter discusses in detail the issues surrounding the travel media (sometimes simply called "cards" for brevity), the possibilities of acquiring the travel media, the purchasing of travel products, the method of validation of travel media, the possibilities for checking passengers' right to travel, the range of statistical data to be collected about the operation of the entire system, the legislative environment that determines the possibilities and limitations of operation, the organizational operational model, the basic IT system and its principle of operation and the peripherals to be used on a daily basis by passengers, with a separate subchapter on data security.

6.1. The proposed new fare system

The future automated fare collection system will be fundamentally determined by the fare system. The introduction of time-based tickets and other innovative products is one of the primary goals and expectations. The following subchapter describes this in more detail.

The proposal on the fare system is a framework that will need to be fleshed out with concrete products and their pricing. The present study – except for some instances where this is unavoidable – does not name concrete products. We also do not discuss details of the parameters of products, or pricing. The details need to be established based on analyses outside of the present study, in accordance with the principles and goals laid down in the fare strategy and municipal policy objectives.

6.1.1. Fare strategy

One of the core issues in socially, economically and environmentally sustainable transport policy is controlling the balance of public transport and car use. One of the methods (but not the only method) of managing the balance of the two competing motorized modes of transport is controlling the usage costs of these modes of transport. At the same time, the revenue from usage fees is one of the most important sources of transport financing.
There are various costs and concessions (e.g. travel concessions) attached to each mode of transport, and many of them are controlled not by the Budapest Municipal Government but the state. Fare strategy is one of the tools available for achieving transport policy objectives.

The considerations to bear in mind when setting the fare strategy are the following:

- simple, transparent fare strategy,
- fare structure independent of mode of transport within Budapest
- no fare penalty for switching lines
- the fare structure should encourage regular use,
- a discount should be provided when purchasing a large number of tickets
- passes for longer periods should be cheaper,
- fare revenue should contribute to covering some of the costs of public transport,
- some social policy objectives need to be taken into account as well when setting public transport concessions, such as:
  - the state-mandated system of travel concessions is taken as a given; no proposal is made for their simplification – which would be justified from the point of view of transport – as this is not the subject of the present study
  - state-mandated concessions must be implemented in the local public transport of Budapest,
  - the Budapest Municipal Government can prescribe further concessions; however, it should be noted that the Municipal Government receives no state funding to cover the costs of these extra concessions,
  - discounts can also be provided as part of business policy to serve commercial interests,
  - the various fare payment systems need to be interoperable,
  - between different branches of transport (public transport, parking, road tolls),
  - and between various areas (Budapest and the suburbs),
  - the fare payment system needs to provide data about the usage habits in public transport services.
Is there a “fair” fare system?

The idea that the fare system needs to be fair, i.e. entirely proportional to usage often comes up. In urban transport, this is impossible to implement for reasons of both principle and practice.

The reason of principle is that environmental and town policy reasons require as many people to use public transport as possible. One of the best incentives is the fare system, and especially prepaid products that offer unlimited travel for a longer period (a month or even a year), in other words, passes. Passes are financially beneficial for the individual, as when the passenger multiplies the number of rides they take with the price of a single ticket, they get a significantly higher number than the price of the pass. The price of time-based tickets will need to be set so that the pass conserves this advantage. This product is useful for the transport organizer and its owner, the Budapest Municipal Government, as it is sold in rather high quantities and it is paid in advance, which contributes significantly to liquidity in the financing of public transport.

In practice, if distance-based or time-based tickets are used, tickets of differing validity cannot be used in surface transport. The reason is simple: in urban transport, even if boarding is restricted to the front door, the driver cannot be expected to keep track of what distance or time each passenger chose for their trip and make sure that they abide by it. Similarly, it would not be possible to control passengers by “checking them in and out” of vehicles, because anyone could check out at the first stop and then stay on the vehicle (see Chapter 6.1.4). If there were several types of time-based tickets, again, the temptation to always buy the shortest one would be very high. If passengers regularly abused the system in the above ways, that would hurt pass sales very significantly, eliminating one of the main pillars of the financing of public transport through fares.

The following fare strategy principles are proposed for the introduction of an automated fare collection system:

- **Prepaid passes, i.e. bi-weekly, monthly, quarterly and annual passes remain in place**, and even an expansion of the pass product range is possible. The revenue from pass sales currently makes up the large majority of fare revenue. This pre-paid revenue is very important for liquidity. Therefore, maintaining the preference for pre-payment as opposed to post-payment is important. Passes are some of the best
incapacities for the choice of travel mode: people who already own a pass are more likely to use public transport.

- **Time-based tickets will be introduced**, offering an unlimited number of line changes within a predetermined time period and zone. At the same time, the current "boarding-based" ticket system (of single tickets and transfer tickets) will be abolished.

- **The new fare system needs to be able to increase revenue**. This can be achieved through more efficient, partially automated controls and payments, the elimination of counterfeiting and the limitation of other abuses, as well as through attracting new passengers with a better fare system and new, modern payment options. **Budapest will remain a single unified fare zone**. Budapest is a single unified fare zone in the current fare system. If Budapest was divided into multiple zones, and the intention was to achieve the same total revenue as today, there could be two alternative fare options:
  
  a) making travel across the entire area significantly more expensive than it is today, and making travel in each zone significantly cheaper than today, or
  
  b) making travel across the entire area cost the same as today, and making travel in each zone significantly cheaper – this would cause revenue loss.

Option a) punishes the inhabitants of peripheral districts, reducing the use of public transport in these areas, i.e. pushing people towards using their cars, which is opposed to town policy objectives. The revenue loss generated by option b) is not permissible.

- **The fare system needs to offer appropriate products and solutions both to people who travel with some regularity and people who use public transport only occasionally**. In order to attract occasional travellers, fare products are needed that do not need to be purchased in advance, but subtract the fare from a balance stored on an account (**pay-as-you-go, hereinafter: PAYG**).

- The principle of best value (price capping) will be introduced, as illustrated by a practical example.
(In this example, the time-based ticket is valid for one hour, and a day pass costs as much as three one-hour tickets. One-hour tickets are valid for rides or trips (series of rides) started within one hour, with the last ride possibly ending after the time limit.)

Gergely is a 29-year-old economist. He lives in South Pest. This month, he did not buy a Budapest transport pass, but – as he occasionally uses public transport – he has a card issued by BKK. One weekday morning Gergely decides not to take the car to work. While he is having breakfast, he logs in to BKK's website on his mobile phone. He checks his balance and tops it up using his bank card with the value of 2-3 day passes. A bit of a reserve could come in handy any time, he thinks.

After breakfast, he is on his way. Two line changes and about one hour later, he reaches his workplace in central Buda. When he starts his trip and when he changes lines, he holds up his card to the on-board validator, which is registered by the system.

Late in the morning, he finds out that he needs to go to a meeting with a business partner a few tram stops away. On the tram, he validates his card again. The meeting lasts longer than planned: more than an hour. After the meeting, Gergely returns to his workplace.

During the day, he sets up an after-work pub meeting with some friends. His friends insist on going to their favourite place in the city centre, which is close to Gergely's workplace, but the 20-minute trip still includes a line change.

Gergely has a good time in the pub with his friends he hasn't seen in a while, and decides to head home at around 8:30. After one line change, he gets home in little more than half an hour.

How much did Gergely pay for using public transport?

He started one-hour trips in the morning, shortly before noon, early in the afternoon, late in the afternoon and in the evening, so he is supposed to pay for five one-hour tickets. However, that would cost a lot more than a one-day pass. In the morning, Gergely didn't know that he would need to go to a meeting to another firm's office and wasn't sure he would go to the pub in the evening, so he didn't buy a day pass in the morning – he topped up his balance instead.

However, thanks to the fare system instituted by BKK, Gergely isn't paying for 5 one-hour tickets, but a much cheaper day pass. How is that possible? The ticket system registered
every card validation in the central computer along with the time when it took place. The figure below shows Gergely "buying" his third one-hour ticket after the business meeting by boarding a tram and validating his card. However, this took him up to the daily spending cap, which is the same as the price of a day pass. From that time, the system does not charge Gergely for his travel; he automatically receives a day pass, which grants him unlimited travel until dawn the next day. The price of the day pass is subtracted from Gergely’s balance at a well-known time at dawn, after the daily closing of the system.

- **Prepaid pass-type products and the principle of best value need to be coordinated** in order to incentivise passengers to prefer bi-weekly, monthly etc. passes in the interest of the sustainability of the system of public transport. In practice, this means that – as described above – passengers receive a day pass after buying a certain number of time-based tickets, and, applying the same principle, they are "awarded" a week pass after buying a certain number of days passes in a calendar week. However, **products with validity longer than a week will only be available pre-purchased.**

Without this proviso, pass-type products would cease to make sense, i.e. they would not be bought by anyone. This would result in a sharp decline in fare revenue, which would not even be compensated by introducing front-door boarding or on-board ticket inspectors on every vehicle. This could lead to the collapse of one of the most important pillars of the financing of public transport, fare revenue.

### 6.1.2. Characteristics of the proposed fare system

The new fare system to be used with electronic travel media is described below.

**Zone system in the suburbs of Budapest**

A territorial zone system is proposed for introduction in the suburbs of Budapest. This means that the access points of public transport services, i.e. the stops and stations would be grouped into zones. Travel to stops and stations in the same zone would cost the same.

Within the territory of Budapest, every station and the services between them up to the last station within the administrative borders will belong to the same zone. Outside of Budapest, in the suburban area, 5km wide concentric circular zones are recommended for the towns
served by BKV (Figure 9:). The stations at each town in the vicinity of Budapest will end up in the same ring-shaped zone.

Figure 9: Ring-shaped zones in the suburbs of Budapest and BKV services

9 The zone codes introduced in document [BKSZ 2009,a] are used for marking the towns in the vicinity of Budapest served by BKV
The recommended zone system of 'Budapest plus concentric ring-shaped zones around Budapest' is similar to the system in the conurbation bus services operated by BKV. The towns covered by the 5 km version of the conurbation bus pass belong to the first ring and the town at a 10 km distance (Törökbálint, code R-02 in Figure 9) is in the second ring. The system of ring-shaped zones will be expanded to suburban railway (HÉV) lines as well, establishing a total of six 5 km rings around Budapest.

**Zonal fares**

Outside of Budapest, the pricing of both tickets and passes is based on the number of zones covered. Inside the zone of Budapest, a flat rate is charged. Within Budapest, passes are flat-rate, while time-based tickets offer unlimited line changes within the validity period. Ticket users have to pay for another ticket if their trip exceeds the time limit. A daily price cap is recommended for introduction in Budapest for ticket users.

For travel that crosses the boundary of Budapest or takes place entirely outside of Budapest, a conurbation fee is (also) paid, depending on the number of zones covered. The pricing of zone-based tickets and passes for travel outside Budapest is proportional to the number of zones covered, charged in accordance with the conurbation fare decree in force (n*5km).

**Travel product types**

The travel products used in the final stage of the introduction of an automated fare collection system are introduced below.

Travel products are valid for one or more zones. Each travel product belongs to one of two groups in terms of payment: paid in advance (PIA) and pay-as-you-go (PAYG).

**Within Budapest** (zone 0) **time-based tickets will be introduced**, with a time limit between 30 and 60 minutes between the first and the last boarding. Decisions on the time limit are outside the remit of the present study, but the figure needs to be easy to remember and easy to communicate to passengers. If the ticket is valid (for the last boarding) for 60 minutes, then essentially the entire city can be covered with one ticket. Prices need to be set

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10 Territorial zone code introduced in document [BKSZ 2009,a]
accordingly. We do not propose introducing a currently non-existent concession version of the ticket, as the state-mandated travel concession system is taken to be a given and no financial compensation can be realistically expected from the Budapest Municipal Government. Thus, temporal validity should not be calculated from the start of the trip, as the passenger cannot control the travel time of the vehicle, i.e. a passenger could become a fare evader through no fault of their own. There is another reason why validity cannot be based on the termination of the trip: if that were the case, a mandatory "checkout" would need to be introduced when getting off a vehicle, and such a system would be easy to abuse and very inconvenient, especially in urban public transport.

When using time-based tickets in a pay-as-you-go system, no further fees are charged after reaching the daily fare cap. Based on initial experience after the introduction of the automated fare collection system, the fare cap could be extended to other periods as well (3-day and/or weekly passes), eliminating the sale of prepaid travel products for such periods.

**Suburban zone-based travel products should also offer** – after the amendment of transport laws – **time-based access**, to be introduced based on a unified urban and suburban fare system covering the services provided by BKV, MÁV-START and Volán companies.

The fare system **includes both personalized and non-personalized travel media. Concession travel products**, including free travel, will only be accessible with **personalized travel media**, mainly with **NEK cards** and also with concession travel media issued by BKK.

By default, **full-price passes** will only be available for holders of a **personalized card issued by BKK authorizing full-price travel**. We propose the optional introduction of anonymous travel media and associated passes at a surcharge.

As per current plans, the system will only accept contactless bank cards directly for full-price pay-as-you-go travel products. "Direct use" means the direct logical contact between the card and readers/validators on board vehicles or on metro automatic gates. "Indirect use" means the use of bank card for payment during purchases made at ticket vending machines, ticket offices etc.

Whether a particular travel product is only valid for use by one person depends on whether it is used with personalized or anonymous travel media.
- **Full-price tickets** can be used in any zone both with anonymous and personalized travel media or directly with a contactless bank card. The daily fare cap applies to travel with full-price pay-as-you-go tickets using any of the above travel media. Anonymous BKK cards and the associated travel products are transferable, while personalized travel media and bank cards are not.

- **Concession** (conurbation) **tickets** for zones 1-6 and full-price and concession (local and conurbation) **passes** for zone 0 (Budapest) and zones 1-6 will only be available with personalized travel media. As the travel media is attached to one person, the travel products associated with the travel media are non-transferable as well.

- If full-price passes are introduced for use with anonymous travel media, they need to be sold at a premium compared to non-transferable passes that are used with personalized travel media.
### Table 8: Basic travel product types in the automated fare collection system (final state) and their association with travel media

<table>
<thead>
<tr>
<th>Local transport in Budapest</th>
<th>Outside of Budapest (into and within suburbs)</th>
<th>BKK card</th>
<th>NEK</th>
<th>Smart paper</th>
<th>Contactless EMV bankcard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 0. (Bp)</td>
<td>Zone 1-6 (6 km per zone)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Tickets</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x minute time-based ticket</td>
<td>zone 1-6 single ticket</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>-</td>
<td>zone 1-6 single ticket 50% disc</td>
<td>+</td>
<td>#</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>-</td>
<td>zone 1-6 single ticket 90% disc</td>
<td>+</td>
<td>#</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Travel cards</strong></td>
<td></td>
<td></td>
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<tr>
<td>Discount group student ticket</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24-hr Budapest travel card</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>24-hr group ticket</td>
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<td>+</td>
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</tr>
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<td>72-hr Budapest travel card</td>
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<td>7-day Budapest travel card</td>
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<td></td>
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<tr>
<td>Ticket associated with events 1-10 days</td>
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<td>(+)</td>
<td></td>
<td></td>
<td>+</td>
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<tr>
<td>Combined ticket, 1-10 days</td>
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<td>(+)</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>14-day Budapest pass</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Monthly Budapest pass</td>
<td>Zone 1-6 pass</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Monthly Budapest pass for students</td>
<td>Zone 1-6 pass for students</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Monthly Budapest pass for pensioners</td>
<td>Zone 1 pass for pensioners</td>
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<td></td>
</tr>
<tr>
<td>Monthly Budapest pass for parents with small children</td>
<td>-</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicycle pass (monthly)</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Annual Budapest pass</td>
<td>Annual 6-zone pass</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Annual Budapest pass for students</td>
<td>Annual 6-zone pass for students</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Annual Budapest pass for pensioners</td>
<td>Annual 6-zone pass for pensioners</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- PIA paid in advance
- PAYG pay-as-you-go
- + travel media - travel product link
- (+) available on card holder's request, but other media is preferred
- + surcharge compared to similar product associated with a personalized card (e.g. +50%)
- # only possible in case of eligibility for unlimited discount trips
- travel product not usable with this travel media

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**Table Notes:**
- BKK Automated Fare Collection System
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**Paid-in-advance (PIA) travel products**

In case of PIA travel products, as with current travel products, tickets or passes are bought before starting the ride. The current paper media will be replaced by electronic travel media. PIA travel products will be available for holders of BKK cards, NEK cards and smart paper. Travel media are discussed in more detail in Chapter 6.2.

**6.1.2.1. Time-based tickets**

Tickets are valid for a limited time period, with no limitation on the number of rides (line changes) taken in that period. The last boarding needs to take place within the validity period; the last ride can continue after the validity period ends.

This is a PIA travel product for a single trip (possibly made up of several rides), available with personalized (BKK card, NEK card) or anonymous travel media (BKK card) or smart paper. The passenger needs to possess the necessary travel media when buying this product.

**6.1.2.2. Flat-rate travel cards and passes**

Travel products that offer an unlimited number of rides over a given period are called flat-rate products. This product group includes travel cards and passes.

There are no products between single-trip time-based tickets and travel cards.

PIA pass-type products are available with personalized travel media, designed for regular travellers and passengers eligible for a concession. Travel media is attached to a natural person, allowing for information to be provided based on personal travel habits. Travel products involving a concession mandated by the state or the municipal government can only be used in conjunction with personalized travel media.

**Pay-as-you-go travel products (PAYG)**

The new electronic system will allow payment for certain travel products after the fact, i.e. after completing the trip. The products involved are the time-based ticket and the day pass associated with a daily fare cap.

In PAYG travel, the fare is calculated after the fact. Travel is started without buying a travel product in advance, simply by validating the travel media. The fare is calculated and collected based on a daily summary of travel media validations.
Pay-as-you-go tickets have the same validity as PIA tickets, and also offer unlimited boardings. This travel product can be used for line changes as well, with the last boarding taking place within the validity period; the last ride can continue after the validity period ends.

PAYG products are available with anonymous travel media as well, but passengers need to be motivated to register their media so that information can be provided to them based on their individual travel habits. Travel products can be paid after travel from an account associated with personalized travel media and topped up beforehand or from a bank account specified in advance if the passenger uses services that are not covered (spatially) by their PIA travel product or if the PIA travel product's validity has expired or not yet started. The following example illustrates the former case.

Gergely has a valid one-month Budapest pass. Saturday morning he decides to visit Szentendre with a friend and have lunch there. Gergely doesn't want to mess around with out-of-city fares, but he's sure a couple of hundred HUF will cover the trip on the HÉV there and back. He uses his computer to check the balance of his public transport card: he remembered correctly, he still has 1500 HUF. This balance will not be used inside Budapest, and he has a valid month pass.

Gergely sets off in the morning. He boards HÉV at Batthyány tér. Before boarding, he touches his card to the validator. BKK's system records the time and place of the start of the ride. In Szentendre, when the train arrives at the end of the line, he touches his card to the validator at the station. The central system of BKK records the time and place of arrival. In the afternoon, he takes the HÉV train back to Budapest.

Early the next morning, the central system of BKK sums up his travels taken on the previous day. Travel within Budapest is not charged as Gergely has a valid month pass. Accordingly, the system calculates that two supplementary tickets need to be charged for travel between the administrative border or Budapest and Szentendre, which are debited to the account associated with Gergely's BKK card. The next morning, Gergely can log in to check his account over the Internet and view his exact travel data, the fare calculation and the charges applied to his account.

The association of travel products and travel media is described in Table 8.

Depending on technical possibilities, the introduction of a daily fare cap may mean that in a PAYG setup, day passes will be valid for a calendar day, not 24 hours.
The travel products of other BKV services (funicular railway, chairlift and boat) need to be integrated into the system, the details of which are yet to be drawn up.

### 6.1.3. Fare policy principles

The present document makes no proposals on the fares to be applied as part of the new fare system, as we have no up-to-date ticket usage data. The last usage survey was commissioned by BKV in 2004, and the part of this survey that covers ticket use is suitable for the present task only to a limited extent; regardless, the validation and analysis of this data is planned after the completion of the present study. In addition, new ticket usage surveys will need to be carried out as part of the preparation, and after the introduction of the automated fare collection system, the fare system will need to be fine-tuned in the light of the usage data generated by the system.

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Table 9: Fare policy principles

Table 9 summarizes the fare policy principles that need to be taken into account when setting the prices of various travel products.
The application of a quantity discount means applying a lower fee for products with a longer validity period than the price of multiple products with shorter validity that cover the same period or number of trips.

When drawing up the range and pricing of travel products, the concessions laid down in the Government Decree on travel concessions and in the Budapest fare Decree must be applied.

The fare system must be capable of managing the deposit attached to the travel media. The amount of the deposit needs to be determined simultaneously with the pricing of travel products usable with travel media, in accordance with the fare levels.

6.1.4. Use of travel media (validation)

The nature of the fare system and the use of travel media mutually determine each other. If the fare system is based on flat rates, then travel media only need to be validated on boarding a vehicle – fares can be calculated and charged based on this one validation. Therefore, on transport services that do not leave Budapest, it is sufficient to validate the media on boarding.

Outside of Budapest, we do not recommend introducing a fare system that requires validation of the media at the end of the ride (“check-out”). There is one technical and financial reason and one practical reason for this position. Installing and maintaining validators in close to 5000 surface stations and stops would be unrealistic, pointless and unsustainable, so validators would need to be installed on the vehicles themselves. However, this would make fare evasion easy by checking out well before actually leaving the vehicle.

On metro stations, validators need to be installed as part of the automatic gates. In a flat-rate system, travel media need not be validated on exit, except if metro section tickets are kept in the PAYG system; in this case, optional exit validation will be necessary.

If the M2 metro line is connected to the H8/H9 HÉV lines or any other metro line is extended across the city boundaries, travel media validation on exiting will become necessary throughout the metro network. This is because a trip started in the metro network outside of Budapest can end at any point of the metro network in the city, i.e. the passenger can cross the zone boundary.
On transport services that leave the territory of Budapest, as the fare of passengers that cross the administrative border is not a flat rate but is determined by the starting point and endpoint of the ride, there are two possible options for validation and fare calculation:

a) choose the destination (zone) when starting the ride (boarding the vehicle) on the validator using a button (check-in; CI) during validation, or

b) validate the travel media when starting the ride (boarding the vehicle) and when ending the ride (getting off the vehicle) (check in, check out; CICO).

Option a (CI) is recommended for introduction on buses that leave the territory of Budapest, as the validators will be installed on vehicles. At the same time, the introduction of front-door-only boarding is recommended on all lines that cross the administrative border of Budapest. Whether the destination zone should be entered by the passenger or the driver is an issue that needs to be analysed further. This solution is essentially an electronic version of the system currently used on long-distance Volán buses.

On HÉV lines, option b (CICO) is recommended, because the expensive and time-consuming installation of validators on hundreds of vehicles which are ripe for replacement is not advisable. Instead, we recommend the installation of validators on the platforms, which are much fewer in number.

Irrespective of any subsequent metro line extensions, the introduction of the CICO system (see below) at metro automatic gates from day 1 deserves consideration, as this could provide BKK with very valuable real-time passenger flow data, contributing to significant improvements in scheduling, capacity planning and thus the overall quality of service in the metro network.

This solution would doubtless be somewhat less convenient for passengers, as it could slow down exiting the stations to an extent. As the transport network develops, it will eventually become necessary to introduce CICO in any case.

6.1.5. Summary

The proposed automated fare collection system is the framework which, due to the logical and architectural features, can offer the largest possible range of travel products and their combinations, both as PIA and PAYG products.
The framework of current state travel concessions and Budapest travel concessions and the possibilities provided by the technological solutions and technical structure of the proposed automated fare collection system should be fully exploited in order to provide the widest, most flexible range of travel products and payment options.

The proposal unifies BKV’s current city+suburb fare system further by setting up a zonal fare system, and if the relevant companies so decide, it can be extended to the suburban services of MÁV-START and Volán companies to form a unified city+suburb fare system.

6.2. Types of travel media

When the automated fare collection system is introduced, the current paper-based travel media will be replaced by travel media that use contactless technology (plastic cards) and contactless bank cards. Some of the travel products associated with the automated fare collection system will be available through NFC-capable mobile phones as well.

The introduction of an automated fare collection system in Budapest is essentially a green field investment, as – unlike in most Western European and North American cities – there is no cheap and reliable travel media and associated framework in the current system that would be worth keeping, even if limited to the simplest travel products. This raises the following question: would it make sense to introduce – apart from the direct use of contactless bank cards, ideal for occasional travellers – a form of travel media that is different from and cheaper than plastic cards, and assume the ancillary burdens (operation of distribution system, security issues)? The following need to be taken into account when making a decision:

1. The entire system is based around the concept of top-up travel media, but occasional travellers need to have access to time-based tickets as well. Therefore, the introduction of paper-based tickets that offer better security than current tickets and support contactless technology (smart paper) needs to be considered.

2. One of the preconditions of using plastic cards for everything is for the manufacturing costs not to be disproportional to the associated travel product. The smallest travel product unit in the fare system described in Chapter 6.1 of the present study is the time-based ticket. Considering the fact that the present study does not intend to decide the exact validity period or price of time-based tickets, it is not possible to determine the value ratio of time-based tickets and plastic cards at the time of the writing of the present study.
The cost of a plastic card may be as high as two thirds or three quarters of the price of current single tickets (320 HUF), which would be an unacceptably high cost ratio. The exact price and validity of time-based tickets and the range of products on offer need to be determined before deciding whether to make available a single time-based ticket separately – and if so, on what media.

3. There are fully paperless systems in place abroad where occasional travellers receive redeemable plastic tokens or plastic cards, but this solution – although it appears to be environmentally advantageous – is costly. The high costs would mean that passengers would need to pay a non-refundable fee and a refundable deposit for the media on top of the price of the time-based ticket, which would be a disproportionate burden for occasional travellers. Thus, the above again shows that the price of time-based tickets (and thus, the length of their validity) needs to be determined before finalizing the architecture of the system and the types of travel media to be used in it.

4. One of the most salient characteristics of paper tickets – apart from the relatively low price – is the fact that the paper is easily damaged, so their life is short.

5. The cost of smart paper needs to be paid again at every purchase, while plastic cards last five years, with an unlimited number of top-ups.

6. The combined use of plastic cards and smart paper causes extra ancillary costs: vending machines have to be capable of selling both, which increases investment and operation costs.

7. If the server-based system recommended for introduction is used in conjunction with a zone-based fare system in the suburban areas, vending machines and resellers would need to store tickets separately by travel product and combination (e.g. ticket for zones 0 and 1, ticket for zones 2 and 3, tickets for zones 0-6) in order to ensure immediate usability, which would raise logistical costs in the distribution network to an unreasonable level.

8. The technology of contactless bank cards is available. Two major card companies have started spreading the technology and will intensify their efforts in the next few years. Considering the fact that Hungarian (and foreign) card-issuing banks are in the initial stages of this process, and bank card penetration is low in Hungary, we cannot rely exclusively on contactless bank cards even for the lowest travel product unit.
In the light of the above, we need to discuss, apart from the travel media that fully serve the established goals (BKK-issued plastic cards, contactless bank cards, NEK cards), a type of travel media designed specifically for occasional travellers: a special card-sized piece of paper that supports contactless technology, known as smart paper.

Travel media can be categorized as follows:

1) BKK cards

2) Third party cards
   - Cards issued within the framework of the National Integrated Card System (NEK cards)
   - Contactless bank cards

3) Smart paper

4) NFC-capable mobile phones

In the following sections, each type of travel media is introduced in detail.

6.2.1. Travel media issued by BKK

Travel media issued by BKK and identified by a unique serial number is called the BKK card. The cards are owned by BKK even when they are in the possession of passengers. Cards expire after 5 years. The different types of BKK cards will be visually differentiated.

There will be three main types of cards:

- BKK cards personalized by at least a photo and the card holder’s name for purchasing full-price travel products (hereinafter: full-price BKK cards),
- personalized BKK cards for purchasing concession travel products (hereinafter: concession BKK cards),
- non-personalized BKK cards for purchasing a limited set of travel products (e.g. day passes and week passes, hereinafter: anonymous BKK cards)

Full-price BKK cards will be available for order through BKK customer service, the website and the telephone customer service. Apart from these channels, anonymous BKK cards can be sold through ticket vending machines and the reseller network.
Access to concession BKK cards will be largely limited to BKK customer service offices as eligibility for the concession will have to be proven by producing the relevant documents. The type and expiry of the concession will be recorded in BKK's back office system.

If and when eligibility can be checked via a central database (e.g. NEK), cards will also be available through the website and the customer service phone line. In this case, eligibility for the concession will be registered in the back office systems of the third party.

Eligibility, whether it is registered in the system of BKK or a third party, will be verified at every travel product purchase. This means that if a student buys a student pass each month, BKK checks their student status each month.

When the automated fare collection system is introduced, those who can use public transport for free will also need to get a concession BKK card, mainly because of the automatic gates in the metro network and the automation of ticket controls.

Both full-price and concession BKK cards contain the holder’s name and photo, and thus neither are transferable. Anonymous BKK cards do not contain the card holder’s personal data, making them transferable. Both PAYG and PIA products are available with all cards. If a card is associated with both a PIA product (valid at the time and place of validation) and available funds for PAYG payments, the system will use the PIA product.

Staying with Gergely's example: he has a valid monthly Budapest pass, as well as 1500 HUF on his account from two months ago. If he only travels within Budapest during the validity of the pass, BKK will not charge fees against his balance.

The use of BKK cards allows for the compilation of precise, up-to-date statistics on the number of passengers using concession travel products.

All types of BKK cards can be registered in BKK's system. After registration, the card holder will have access to detailed information on card transactions through BKK's website, and can carry out transactions (e.g. purchase travel products).

### 6.2.2. Smart paper

Occasional travellers who have no BKK or NEK card will have the option of using a paper-based electronic ticket based on smart paper technology.

The smart paper ticket is owned by BKK, possessed by the passenger. Smart paper tickets are not personalized: they can be transferred freely within their period of validity. Smart
paper tickets have unique identifiers. Smart paper tickets are valid within the territorial validity of the travel product purchased, until its expiry (e.g. 60 minutes).

Smart paper tickets can be bought through BKK customer service, BKK ticket offices and ticket vending machines and resellers. Smart paper tickets cannot be registered in BKK's online system. Smart paper tickets are disposable; new products cannot be loaded onto them.

6.2.3. Third party cards
The automated fare collection system can function with BKK-issued cards only, but – in accordance with goals and expectations – there are several options for supporting cards issued by third parties. These options are described below.

6.2.3.1. NEK card
The cards issued within the framework of the NEK system that is to be set up in the near future will be registered and will have unique serial numbers, and they can substitute concession BKK cards.

NEK cards will be issued by the Central Office for Administrative and Electronic Public Services (hereinafter: KEK KH). NEK cards will be personalized cards with a photo, which are planned to be suitable for proving concession eligibility (e.g. student or pensioner status), and they will have contactless technology.

If a card holder wishes to use the card for – concession or full-price – public transport, they have to inform BKK. NEK cards will only function as transport cards after registration in BKK’s back office system.

NEK cards will support a range of PAYG and PIA products; payments can be made via bank card or through the balance registered in BKK’s system. Discount eligibility is automatically checked through the central card registration system of KEK KH at the time of the purchase of a travel product in accordance with a set of rules.

The use of NEK cards allows for the compilation of precise, up-to-date statistics on the number of passengers using concession travel products.

NEK cards can be registered in BKK’s system. After registration, the card holder will have access to detailed information on card transactions through BKK’s website, and can carry out transactions (e.g. purchase travel products, see Chapter 6.6).
6.2.3.2. **Contactless bank cards**

Cards issued by any bank in accordance with Visa and MasterCard joint regulations (EMV) can be used as travel media in the automated fare collection system, provided that they support contactless payment (payWave/Paypass). Contactless bank cards do not need to be registered in BKK's back office system; they can be used without registration for purchasing PAYG products.

Contactless bank cards can be registered in BKK's system. After registration, the card holder will have access to detailed information on card transactions through BKK's website, and will be able to carry out transactions.

Among the operation models of automated fare collection systems, there are mixed models as well, where the transport card is not issued or registered by the transport organizer but a financial institution commissioned by the transport organizer. The two parties issue co-branded EMV-compatible contactless cards. The financial institution is responsible for handling card issuing and management, while the transport organizer handles tasks related to transport. The advantage of this setup is that the transport organizer's system need not be prepared for the issuing a special "own" card, which has implications in areas such as security, while financial institutions have years and years of experience and established processes, allowing them to manage the issuing of a new type of card routinely. The potential disadvantage is that the transport organizer is at the mercy of third party with regard to a critical activity.

6.2.4. **NFC-capable mobile phones**

Mobile phones with NFC capabilities can serve as an alternative to both BKK cards and contactless bank cards. At the moment, few such handsets are sold, but they are expected to become widespread in the near future. The type of travel media accepted and the specifics will be determined based on the particulars of the use of NFC-capable mobile phones.

6.3. **Sales channels**

Apart from providing passengers with general information, sales channels provide services related to travel media and travel product purchases.

Starting out from the presupposition that BKK will take over the managing of fares and the operation of the ticket system from BKV before the introduction of an automated fare
collection system, we presented some of the activities handled at the time of the writing of this study as BKK tasks.

**BKK customer service**

BKK customer service offices are offices of BKK open to the general public, where passengers can request information about the services offered by BKK, and have many issues dealt with, ranging from requesting travel media to complaints.

**BKK ticket and pass offices**

BKK ticket and pass offices are offices of BKK open to the general public, where customers can purchase travel products to be loaded onto existing travel media, and can top up their balance.

**Services available through BKK's Internet portal**

Electronic services are available through the Internet site of BKK. The BKK Internet portal allows registered customers to query personal travel data and to initiate certain transactions.

**Ticket vending machines**

Automated devices operated by BKK which allow customers to purchase certain travel products, top up their balance and carry out other operations (e.g. view their current balance) using cash, BKK cards or bank cards. The accepted payment options are indicated on each ticket vending machine. Time-based tickets are issued by vending machines on BKK cards or smart paper.

**BKK telephone customer service**

BKK's 24-hour telephone customer service, which allows customers to request general information and information on travel media and to initiate certain transactions.

The telephone customer service can be operated internally by BKK or it can be outsourced to a third party.

**ATM (cash dispenser)**

Customers who own both a bank card and a BKK/NEK card will be able to purchase PIA travel products and top up their balance at ATMs operated by banks that cooperate with BKK in this regard. This sales channel offers the significant advantage that the ATM network of
any Hungarian bank is capable of offering nationwide coverage instantly. This sales channel has worked reliably for years for numerous products and services.

**Reseller network**

This covers natural and legal persons outside of BKK that sell certain travel products for a commission based on a consignment or agency contract. MÁV and Volán ticket offices are part of the reseller network as well.

6.4. Requesting travel media

6.4.1. Persons eligible to request travel media and purchase travel products

Any natural person over the age of 18 is eligible to request a BKK card and purchase travel products for themselves or third parties. Natural persons over the age of 14 but under the age of 18 can request BKK cards and buy travel products for themselves only. Children under the age of 14 are considered legally incompetent; therefore, only third parties (e.g. their parents) can request BKK cards and purchase travel products for them.

The transport organizer needs to provide the legally mandated concessions. It is the task and responsibility of the transport organizer to check eligibility for the concessions. This is first done when the passenger eligible for a concession decides to purchase a concession travel product. The purchasing of the concession travel product is conditional on possessing the appropriate travel media.

It needs to be studied if the various bodies providing concessions (Hungarian state, Budapest Municipal Government etc.) have up-to-date databases that could allow BKK to carry out online queries in databases to verify eligibility. The NEK system is expected to support this. However, further analysis is needed to determine if the NEK system will support verifying every state-mandated concession type. As this cannot be definitively settled at the time of the writing of the present study, the possibilities for acquiring concession travel products need to be adapted to the current methods of proving concession eligibility. A method for a stricter, regular control can be set up after compiling a registry of eligible persons. As the BKK automated fare collection system and the contactless card that can be used for certifying concession eligibility does not exist yet, until they are introduced, BKK has to issue travel media that enables eligible people to use a concession.
Special concession BKK cards can only be requested in person, and the documents entitling the person in question to the concession need to be shown.

In the case of contactless travel media compatible with the BKK system issued by a third party (e.g. NEK card), the holder of the travel media is entitled to purchasing concession travel products in accordance with the media and to using them directly for travel. Thus, in this case, BKK does not provide travel media to the person eligible for a concession, and may make the use of the media in question compulsory.

6.4.2. Procedure for requesting travel media

This chapter covers the process of requesting travel media issued by BKK.

Cards attached to the NEK system suitable for use in the system and contactless bank cards are issued by third parties in accordance with their own regulations; therefore, the first part of the chapter covers the initial steps necessary for the regular use of such media.

In the case of smart paper, the acquiring of travel media and the purchasing of travel products is not separated; therefore, the use of smart paper tickets is covered in Chapter 6.6.

The main steps of requesting a BKK card:

a) Providing customer and card data

The data necessary for requesting a BKK card are as follows:

- Data of the person requesting the BKK card (name, address, ID number, postal address etc.). In case of anonymous cards, no personal data is recorded.
- Card data (card type, concession status, time of requesting etc.)

Recording of data:

- BKK customer service: based on a data sheet filled in by the customer, the customer service staff enters the data in BKK’s back office system.
- BKK telephone customer service: the data provided by the customer is entered into the back office system of BKK by the telephone operator.
- BKK Internet portal: the client enters the data and sends it to BKK electronically.

Photo on the card (except for anonymous BKK cards)
Photos to be put on the BKK card can be made at the customer service, or they can be provided by the customer in the form of a standard passport sized photo.

- If the telephone customer service is used, the customer needs to send the photo to BKK’s email address.
- If a card is requested online, the customer needs to attach a standard digital photo.

b) Payment of card fees

After providing identification and card data, the customer needs to pay the card fee and, in case of anonymous cards, the deposit (the system itself needs to be capable of handling deposits for all card types).

Payment options:

- BKK customer service: cash or bank card via POS terminal.
- BKK phone customer service: by bank card over the telephone.
- BKK Internet portal: through BKK’s payment page using a bank card.

The data of the card requests entered through BKK’s online portal and its telephone customer service will be entered into BKK’s back office system after BKK employees carry out the necessary checks (data correctness, photo, payment of card fee etc.).

c) Opening of customer account in BKK’s back office system

Based on customer and card data, the customer’s account is opened in BKK’s back office system.

The customer account is made up of two parts:

- the tracking of the travel products purchased by the customer,
- the tracking of the money balance on the customer’s BKK account

Customers can pay money to their BKK account in the following ways:

- in person at the BKK customer service in cash
d) Card manufacturing

Personalized BKK cards will be manufactured based on the card data in BKK's back office system by BKK or a third party on BKK's behalf.

When the automated fare collection system is being introduced, cards should definitely be manufactured centrally in large numbers internally or with an external partner. The possibility, conditions and costs of manufacturing personalized cards on the spot at customer service offices need to be studied further.

In the case of anonymous BKK cards, pre-made inactive cards will be stored at BKK customer service locations.

e) Handing over cards

The way customers can receive their cards will depend on the method used for requesting them.

- BKK customer service: anonymous cards activated by a BKK employee are handed over on the spot as soon as they are purchased. In the case of personalized cards, a few days will be necessary for manufacturing, depending on the arrangement chosen.
- BKK telephone customer service: the customer can choose between visiting a BKK customer service office in person or having the card mailed to the address provided by them.
- BKK online customer service: the customer can choose between visiting a BKK customer service office in person or having the card mailed to the address provided by them.

f) Card activation

Cards need to be activated before they can be used for travel product purchases and travel.
• BKK customer service: a BKK employee activates the card before handing it over.

• Cards sent by mail will need to be activated through the telephone customer service or the online portal.

After activation, the BKK card is ready for travel product purchases.

\textit{g) Card returns}

Expired and disabled cards and cards that became unusable for any reason can be returned at any BKK customer service office. If an active card is returned, a customer service employee disables the card.

When a card is returned, the following steps need to be taken:

• Expired or disabled cards and cards that became unusable: if the customer wishes to request another card, they can do so at a BKK customer service office, through the telephone customer service or BKK’s Internet portal. The request process is the same as when requesting a new card, with one difference: the new card will be associated with a customer who is already present in the system of BKK. The travel products and balance on the customer’s previous card will be available to the customer with the new card.

• Active BKK cards: if the customer does not wish to use public transport with a BKK card in the future, the card is disabled by a BKK employee. The balance associated with the card and the sum of the deposit is returned – in case of a personalized card, to the card owner (after identification), in case of an anonymous card, to the person handing it in.

\textit{h) Disabling of cards}

If a BKK card is lost, the card can be disabled through the BKK customer service, the telephone customer service or the Internet portal. After disabling, the card is placed on a black list, and is not accepted for use in public transport anymore.

Disabling is carried out using established banking procedures.
Steps to take for using NEK cards

The various cards that are part of the NEK system are issued by the relevant Government bodies. In order to be able to use a contactless NEK card in BKK's automated fare collection system, the card needs to be registered in BKK's back office system. As the NEK card in itself is not usable for payment, travel product purchases and balance management are handled in the same way as with full-price BKK cards.

Supposing that the state-mandated concession eligibility can be electronically verified through the relevant database of the provider of the concession (the Hungarian State), the NEK card can be registered in BKK's back office system through the customer service, the Internet portal or the telephone customer service. In this case it is fundamentally important for the database to be up-to-date.

a) NEK card data registered in BKK’s back office system

- Data on the NEK card holder (address, ID number, postal address etc.)
- Card data (type, type of concession, date of registration etc.)

Recording of data:

- BKK customer service: based on a data sheet filled in by the NEK card holder, the customer service staff enters the data in BKK's back office system.
- BKK telephone customer service: the data provided by the customer is entered into the back office system of BKK by the telephone operator.
- BKK Internet portal: the client enters the data and sends it to BKK electronically.

b) Opening of customer account in BKK’s back office system associated with a NEK card

Based on customer and card data, the customer's account is opened in BKK's back office system.

The customer account is made up of two parts:

- the tracking of the travel products purchased by the customer,
- the tracking of the money balance on the customer's BKK account

Customers can pay money to their BKK account in the following ways:

- in person at the BKK customer service in cash
- at a post office via check
- by bank transfer.

After the customer account is opened, the NEK card can be used for purchasing travel products.

c) Card activation

Cards need to be activated before they can be used for travel product purchases and travel.

- BKK customer service: a BKK employee activates the card when registering it in BKK's back office system.
- After entering data through BKK's telephone customer service or Internet portal, the NEK card is activated when the data has been confirmed by NEK's system.

After activation, the BKK card is ready for travel product purchases.

d) Card returns

Expired and disabled NEK cards and NEK cards that became unusable for any other reason are replaced in accordance with NEK rules. The final decisions on how to handle NEK cards in BKK's system can be made once the rules of the future NEK system are known.

When a NEK card is returned, the following steps need to be taken:

- Expired and disabled NEK cards and NEK cards that became unusable for any other reason: if the customer wishes to request a new NEK card, they can do so in accordance with NEK rules. The new NEK card will be associated with the customer who is already registered in BKK's system. This is carried out in accordance with the contents of a) with the addition that the travel products and financial balance present on the customer's account will be available to the customer after the new card is activated.
• Active NEK cards: if the customer does not wish to use Budapest public transport with the NEK card in the future, the card is disabled in accordance with NEK rules. The money balance associated with the NEK card will be paid to the card holder after identification.

e) Disabling of cards

If a NEK card is lost, the card can be disabled in accordance with the rules to be set up by NEK. After disabling, the card is placed on a black list, and is not accepted for use in public transport anymore. Disabling is carried out using established banking procedures.

6.5. Travel media registration

BKK cards, NEK cards and contactless bank cards can all be registered on BKK's online portal, allowing the card holder to access data on the card or cards associated with their username.

Registration is optional, and allows customers to access BKK's Internet portal and ancillary services.

• BKK customer service: the customer service staff enters the necessary data in BKK's back office system.

• BKK telephone customer service: the data required for registration is provided by the customer and entered into BKK's back office system by the telephone operator.

• BKK Internet portal: the client enters the data required for registration and sends it to BKK electronically.

Detailed information on the services available through BKK's Internet self-service portal is available in Chapter 6.9.

6.6. Travel product purchases

There are separate purchase procedures for pay-in-advance (PIA) and pay-as-you-go (PAYG) travel products (see Chapter 6.1). The system needs to be able to limit travel product purchases in accordance with certain parameters (e.g. check whether the customer has unpaid public transport fines). This Chapter discusses the travel product purchasing procedures associated with each type of travel media.
Available travel products by travel media:

- BKK card: PIA and PAYG
- NEK card: PIA and PAYG
- Contactless bank card: PAYG
- Smart paper: PIA

6.6.1. BKK and NEK cards

The travel product purchasing process is very similar for BKK and NEK cards, therefore, they are discussed together, noting the differences.

**Purchasing of PIA travel products with BKK and NEK cards**

PIA travel products are available for holders of BKK and NEK cards through the following sales channels:

- BKK customer service
- BKK ticket and pass offices
- BKK telephone customer service
- BKK Internet portal
- Ticket vending machines
- ATMs

The main steps of PIA travel product purchases are as follows (except ATM):

- the customer indicates which travel product they would like to buy for which BKK/NEK card:
  - At a BKK customer service office, at a BKK ticket office, at a vending machine by touching the card on a compatible reader
  - Through BKK’s telephone customer service by providing the card's number (in case of personalized cards, BKK requests other data as well).
o Through BKK’s Internet portal, by choosing the card from the list of cards associated with the customer's user ID in the menu

- the customer pays for the travel product:
  o BKK customer service, BKK ticket office: in cash, through a POS terminal by card or by charging it on the balance kept with BKK and associated with the card
  o Through BKK’s telephone customer service: by bank card or by charging it on the balance kept with BKK and associated with the card
  o Through BKK’s Internet payment portal: by bank card or by charging it on the balance kept with BKK and associated with the card
  o At a ticket vending machine: by cash, bank card or by charging it on the balance kept with BKK and associated with the card

- after successful payment, the chosen travel product is registered to the customer account associated with the BKK/NEK card in BKK’s back office system;
- after the product is registered, the customer can use Budapest public transport with their BKK/NEK card.

**Purchasing of PAYG travel products with BKK and NEK cards**

PAYG travel products can be purchased using BKK and NEK cards if the money account associated with the card contains sufficient funds.

The main steps of PAYG travel product purchases are as follows:

- the customer touches the card on the validator when starting the trip or changing lines in the surface network
- the time(s) of starting the ride(s) are recorded in BKK's back office system
- BKK’s back office system associates the rides with travel products in accordance with the fare system and the calculation rules
- the price of the travel product is charged to the client's money account registered with BKK and associated with the card
Purchase of PIA travel products through ATM

A contract between BKK and banks is proposed on providing travel product sales through the ATM network of banks. To buy travel products from selected ATMs, customers will need to have a bank card accepted by the ATM in question.

The steps of a PIA travel product purchase are as follows:

- the customer inserts the bank card in the ATM and enters the PIN code
- the customer chooses the BKK travel product purchase option in the ATM's menu
- the customer chooses the desired travel product
- the customer enters the number of their BKK/NEK card
- the central system of the ATM's operator – after detecting a BKK purchase request – connects to BKK’s back office system, which confirms whether the travel product in question is available with the card in question. In accordance with predetermined control rules, the two systems reject or authorize the purchase.
- After a successful check and authorization, the travel product is purchased and charged to the bank account.

After the successful purchase, the customer will be able to use Budapest public transport services in accordance with the validity of the travel product purchased.

6.6.2. Contactless bank cards

Contactless bank cards issued by any bank can be used for PAYG travel. With this combination of product and travel media, the passenger does not need to inform BKK in advance that they would like to use their bank card in public transport, and they do not need to purchase a product: the travel product purchasing process starts by touching the contactless bank card on a reader on the vehicle or the station when starting the ride.

In the view of the above, the steps of PAYG travel product purchase are as follows:

- the customer touches the card on the validator when starting the trip or changing lines in the surface network
- the time(s) of starting the ride(s) are recorded in BKK’s back office system
• BKK's back office system associates the rides with travel products in accordance with the fare system and the calculation rules

• BKK settles the transaction with the acquirer bank, charging the customer's contactless bank card; the fee of the trip is charged to the bank account associated with the customer's bank card.

6.6.3. Smart paper and anonymous BKK cards

BKK's product range contains two types of anonymous travel media. Single-use smart paper tickets and anonymous BKK cards can only be bought along with travel products. While smart paper tickets cannot be used for subsequent travel product purchases, anonymous BKK cards have this feature, implemented as described in a). This chapter discusses the process of purchasing smart paper tickets and anonymous BKK cards. The following sales channels offer travel products for smart paper and anonymous BKK cards:

• BKK customer service,
• BKK ticket and pass offices,
• ticket vending machines,
• reseller network,
• drivers on selected lines (this option is to be reviewed in a specific impact study)

Two alternatives are available for the sale of smart paper and anonymous BKK card travel products.

In the first case, it is BKK's task to associate the travel media and the travel product, before handing over the travel media to the point of sale. After this, the point of sale sells the travel media to customers along with the associated travel products, which are ready to use.

In the second case, points of sale purchase inactive travel media for reselling. Directly before selling, points of sale need to activate the travel media using a device connected to BKK's central system, and associate the selected travel product with it. After this, the travel media is ready to use.

The advantage of the first solution is that sales can be carried out quicker. At the point of sale, the passenger receives the travel media, to which a travel product had already been attached previously, pays and is ready to use the travel media. In this case, each piece of
travel media needs to have a concrete travel product or products associated with it. In a 7-zone system, this would require quite high administrative overhead; therefore, this could only work in practice if the range of travel media/travel product combinations available through this sales channel is restricted. As the activation of travel media and travel products is carried out beforehand in the back office system, it is important for point of sale employees to be able to tell apart the travel media holding different travel products during storage and sale, e.g. zone 0 (Budapest) tickets need to be visually different from zone 1 tickets. The forced limitation of the product range on offer may be inconvenient and confusing for passengers (e.g. anonymous BKK cards and tickets for zones 0, 1, 2 and 3 are not available). The task would also require major logistical and administrative efforts and significant expenditures from BKK and the point of sale. The point of sale would not need to have special devices or a data connection to BKK's back office system; the advantage of this is that setting up a point of sale would not involve investment costs; at the same time, this solution does not offer BKK up-to-the-minute statistical data, which significantly increases the chances of fraud in a system like this. Ticket vending machines would need to be able to handle several types of product, which means that several storage compartments would be needed in the housing, and certain products or product combinations could run out more often, raising the operation costs of vending machines.

In the second case, each sale is made up of more steps, but BKK only needs to hand over one travel media type to points of sale for resale, as the travel products are associated with the travel media during the sale using a device at the point of sale. The passenger can decide what travel product or combination of travel products to buy, and the products are associated with the travel media on the spot at the point of sale. This means that the passenger can essentially choose any travel product or combination of travel products, which is – unlike the previous scenario – the entire product range is available. This solution significantly simplifies the administrative and logistical tasks associated with sales, but it requires the installation of specialized devices at points of sale. The devices need to have a fast data connection to BKK's back office system, which means that investment and operation costs arise on top of having to ship travel media to the point of sale (this latter cost is present in the first option as well). One advantage of this solution is that if travel media were to be stolen from the points of sale, they could not be used for travel, as no travel product would be associated with them. Another advantage is that this solution can provide up-to-the-minute data for sales statistics and anti-fraud systems, however, the time between
the sale of the travel media and the time when it is ready for use depends on the data communication network, as information regarding the sale needs to be immediately pushed to all (several thousand) ticket validators in the system. This solution requires special on-board devices and procedures if on-board sales by vehicle drivers are to be implemented.

Customers can pay for the smart paper tickets and anonymous BKK cards and associated travel products with the payment methods supported by the point of sale: cash or bank card via POS terminal.

6.7. Travel product validation

If a customer has suitable travel media and an appropriate travel product, they can use Budapest public transport services.

Validation systems may vary by vehicle, with some only requiring a validation when starting the ride (check-in) and others also requiring validation at the end of the ride (check-out). The details are available in Chapter 6.1.4.

The passenger needs to touch their travel media on the validator when starting their ride so that BKK’s back office system can record the start of the ride.

- When a passenger uses a PIA travel product valid for the fare zone in question, the trip requires no financial transaction. If a passenger has several types of PIA travel products and available balance on their travel media, then the system will use the one that is most beneficial for the passenger (e.g. if they have a single ticket for the zone in question as well as a pass, then their travel will be "charged" on the pass). This applies to all types of travel media.

- When a passenger pays for their travel in a PAYG system, settlement depends on the type of travel media:
  - if a BKK or NEK card is used, fees are charged on the balance kept with BKK and associated with the card
  - if a contactless bank card is used – and here public transport diverges from the model generally used with bank cards – the card use and the product purchase take place at different times. Travel is billed after the fact by debiting the bank account the bank card belongs to. This is described in detail in Chapter 5.6.
Several validation methods are available depending on technical possibilities and passenger traffic considerations:

- automatic gate entry and exit (gates have integrated ticket validators)
- on-board validation
- validation on platform
- validation by ticket inspectors

In the following, travel media validation is reviewed by vehicle type.

**a) Metro network**

We recommend the use of automatic gates at all metro stations. The goal of the gates is to implement automatic validation (check-in) and to minimize fare evasion. If necessary, exit control (check-out) can also be introduced. An exact mechanism for this is proposed in Chapter 6.1.4.

In a check-in system, every passenger needs to validate their travel media by default.

Check-in procedure:

- gates are closed by default, entry requires the gates to open
- the passenger reaches the gate and touches the travel media on the validator integrated into the gate
- After checks are carried out in BKK's back office system, if the travel media is deemed valid by the system, the gate opens and the passenger can pass through. After the passenger passes through, the gate closes. If the travel media is not valid, the gate does not open and the validator emits light and sound signals.

In case of check-out, the central system records the time the journey was completed. The process of passing through the gate – in case of checking of travel rights – is identical to the above.

**b) Bus, trolleybus, tram**

The above vehicles are divided into two groups:

- vehicles with front-door boarding
- vehicles with boarding through all doors
1) Front-door boarding

Front-door boarding can be applied on buses and trolleybuses – and it is already used on several bus lines. This possibility will be available after the introduction of the new automated fare collection system as well. In front-door boarding, only the validator mounted at the front door for boarding passengers needs to be active; as passengers cannot board at other doors, the validators at other doors can be deactivated when this boarding regime is used. It is recommended to have an active spare validator near the front door.

In case of front-door boarding, all passengers need to validate their travel media when they board.

Check-in procedure:

- passengers touch their travel media on the validator mounted near the driver's cabin;
- after carrying out checks through BKK's back office system, the validator signals to the passenger and/or driver that the travel media was found to be valid and the passenger can board. If the travel media is not valid, the validator gives a negative signal.
- After validation, the ride is recorded in BKK's back office system.

If the passenger does not possess travel media, they may be able to buy it at the driver depending on the final system setup; in this case, the driver validates the media as part of the purchase before handing it over to the passenger.

On bus lines that cross the administrative border or Budapest or other zone borders proposed in the present study, the passenger's destination needs to be known before the fare can be calculated. On these lines, the check-in is complemented by choosing the destination fare zone on the validator before validating the travel media. On these vehicles, the validators mounted on the front door need to feature a touchscreen or buttons so that the passenger or driver can pick the destination (the detailed rules are to be determined later). The necessary travel product and fare can be determined based on the vehicle’s current position and the destination. This also means that the operator needs to ensure that every vehicle serving lines that cross zone boundaries has validators with a zone choice option. This can be achieved by either installing such validators on all vehicles used in Budapest.
public transport at least at the front door, or by assigning a dedicated fleet to lines that cross zone boundaries.

2) All-door boarding

On bus and trolleybus lines inside Budapest where front-door boarding cannot be introduced or the transport organizer or transport service provider decides not to introduce it, passengers can use all doors for boarding, as is the general practice today. On vehicles serving these lines, at least one validator needs to be installed at each door, or, in the case of trams, each door pair.

Surface tram stations cannot be closed off with automatic gates due to their layout (low, narrow platform, access from several directions, including from the rails etc.). Arguably, it is technically conceivable to close tram stations off with a 5 to 7 foot tall fence and gates, but this solution is not recommended, as securing the necessary permissions would be difficult and it would raise aesthetic and operational concerns that would make such a project impossible to complete. If the installation of gates of this type was part of the model and the return on investment calculations, then the failure to build the gates could threaten the financial return on the project and possibly its financing. Consequently, a decision to install gates at surface stations would involve risks that are too great for the project.

In case of boarding at all doors, in order to speed up passenger flow, only PAYG passengers and smart paper users will need to validate their travel media. This way, however, full statistics will not be available on the travel habits of PIA travel product users. It is up to the operator of the system to decide whether to temporarily or permanently expand on-board validation to PIA travel product users (with appropriate communication and passenger incentives) based on early experience.

The check-in procedure is identical to the one described in the previous section, except for situations when the travel media is not valid and the validator gives a negative signal; in such cases, the driver cannot prevent the boarding of unauthorized passengers on large, one or two-carriage trams. Therefore, in case of boarding at all doors, maintaining random ticket checks with ticket inspectors is essential. At the same time, the use of automatic gates at metro stations and front-door boarding on some vehicles allow ticket inspectors to concentrate on efficient revenue protection on vehicles with boarding at all doors.
c) HÉV suburban railway

BKV operates four HÉV lines as an organic part of Budapest public transport.

The entire length of the Csepel HÉV (H7) line lies within the administrative borders of Budapest, therefore, validation on this line is the same as on tram lines, as stations cannot be closed off. At peak times, HÉV trains are made up of six carriages and carry hundreds of passengers, making front-door boarding per train or per carriage physically unmanageable. The possibility of installing the validators on the platforms of the (only) six stations instead of the trains should be considered (this would be a divergence from the validation process used on trams, of course).

The Szentendre HÉV (H5) handles significant traffic between Szentendre and Budapest, with an especially high percentage of passengers using the section within Budapest – so high that there are complementary trains that only travel this section of the line. It should be noted that passengers who travel within Budapest use both the trains of the Budapest-Szentendre service and the complementary Békásmegyer service. The H5 line has two underground stations, which can feasibly be closed off with gates, but the other surface stations – except for the final station in Szentendre and possibly the station in Békásmegyer – should be examined one by one.

Apart from the Szentendre HÉV, the Gödöllő (H8), Csömör (H9) and Ráckeve (H6) HÉV lines cross the administrative border of Budapest as well. Fares are different in Budapest and outside Budapest. In most surface HÉV stations, the platforms – due to their physical layout – cannot be closed off with gates. If only some of the stations are closed off, then some passengers will simply exit the trains at other stations and continue their travel on buses or trams, evading fare payment.

For the above reasons, the utilization of an internationally widely adopted method is recommended. This involves requiring passengers to validate their travel media on the platforms at the start and end of the ride. If a passenger fails to validate at the end of the ride, a fine is charged on the account associated with their travel media. Validators need to be installed at the front and back of HÉV platforms, so that passengers cannot commit fraud at stations along the way by quickly getting off, validating and getting back on the train.

In order to ensure a passenger-friendliness and appropriate revenue protection, the details of the above method need to be studied further.
d) Suburban trains

As part of the system of common fares in Budapest, passengers will be able to travel on certain suburban trains with travel media and travel products issued by BKK or NEK.

In order to use suburban trains, passengers will need to have a card issued by BKK or NEK and a PIA travel product that is valid on suburban trains.

PAYG travel will not be possible on these lines, as the high number of stations and their layout do not make it possible to install validators or automatic gates on the platforms, and PAYG travel requires check-in and, in some cases, check-out for registering the start and end of travel in BKK's system for fare calculation.

The validity of the travel products used by passengers will be checked by MÁV ticket inspectors as before, with the devices provided to them.

Further negotiations are necessary with MÁV-START on the setup of the electronic system and the cooperation within the regional system of common fares.

e) Suburban Volán lines

A front-door boarding policy is already in force on suburban Volán services; therefore, validation (and travel media and travel product sales) can be carried out in the same manner as on Budapest buses with front-door-only boarding.

This requires the installation of sale and validation devices and data connections on all vehicles of every Volán company serving Budapest suburban lines. If a suburban common fare system were to be set up, then this system could be used for selling and validating the resulting travel products as well.

6.8. Travel product control procedure

The control system, also called the revenue protection system, will rely on both human resources and automatic gate systems.

The new validation processes will serve the primary aims of more efficient control, reducing fare evasion and eliminating pass counterfeiting and concession abuse. Ticket and pass control will still be needed, but, after introducing automatic gates at the metro network – which currently uses up a lot of the ticket inspector workforce – most ticket inspectors can be
moved to surface lines and targeted random checks, for instance among passengers using concession travel media in the metro system.

Control methods

- On lines where front-door boarding is introduced, ticket and pass control will be the task of drivers.

- At metro and HÉV stations that can be gated, the gates handle control automatically, with staff having the option of opening the accessibility gates when needed (for people with a disability, wheelchair users, people with pushchairs, people with small children, or people with suitcases).

- On surface vehicles, random checks will still be necessary where front-door boarding is not possible, with technical conditions permitting significantly more effective controls than before (ticket inspectors will be able to temporarily disable on-board validators).

Inspector handheld devices

Ticket inspectors need to be equipped with portable devices. Inspector handheld devices need to be able to look up the identification data stored on the travel media in the database stored in the device (or, if a data connection is available, in the central database) and tell the ticket inspector if the passenger has the right to travel on public transport. Specifically, they need to be able to:

- identify the travel media and its user,
- determine if a concession is available to the passenger,
- check the validity of PIA travel products,
- check the use of PAYG travel products,
- automate fining for illicit travellers,
- record the data necessary for fining, and
- collect fines by bank card.
Steps of travel product control by ticket inspectors on board vehicles:

- after boarding, ticket inspectors disable on-board validators;
- ticket inspectors ask passengers to swipe their travel media at the inspector's device;
- ticket inspectors read the travel media and the validity of the associated travel product using their handheld devices. They determine whether the passenger is travelling illicitly or not.

If a passenger refuses to touch their travel media on the device, have no travel media or there is no travel product associated with it, the ticket inspector issues a fine.

Camera systems will need to be installed on surface vehicles and near the gates at closed-off metro and HÉV stations in order to prevent incidents and protect passengers and infrastructure.

There are several technological options for controls. The validations carried out by the passenger can be accessed from the central system or the vehicle's on-board system (on buses, trolleybuses, trams), which can be checked by swiping each passenger's travel media at the ticket inspector's reader. Those who failed to validate can then be fined. If necessary (for instance, in case of communication error), it is possible to read (collect) the card numbers of passengers on the vehicle on the ticket inspector's device, and then compile a list of illicit travellers in the central system later and fine the balances associated with the relevant travel media as necessary.

Ticket inspectors have the right to ask passengers for their travel media of any type to prove their travel rights, just as they have the right to ask for paper tickets and passes. Passengers are required to have travel media; this is a precondition for using public transport (both legally and technically), and passengers have to allow ticket inspectors to read their travel media during inspections.

In order to maintain the legality of controls with regard to contactless bank cards, inspectors need to observe certain rules.

- Controls cannot violate banking secrecy. Simply making sure that the bank card in question was used for a check-in within the validity period does not reveal banking secrets to the ticket inspector. This does not reveal the name of the bank card holder or whether the person using the card is the card holder.
• If the bank card produced by the passenger does not enable them to travel legally, the procedure is then separated from the card (which is given back to the passenger by the ticket inspector), and the passenger is identified using normal identity documents. The ticket inspector writes an inspection report, based on which a fine is issued. This way, no banking secrets are revealed to the ticket inspector (the ticket inspector does not compare the personal data of the passenger with the personal data on the card); the personal identification of illicit travellers is carried out and the fine documents are filled in as today.

• The ticket inspector does not withhold the bank cards of illicit passengers to force the passenger to hand over identification documents in return for the card. The identification of the passenger needs to be achieved by other means.

6.9. BKK’s self-service Internet portal

Two types of online services will be available as part of the automated fare collection system. The first category includes all features that do not require the user to be identified. These features mainly provide basic public information on the fares in Budapest public transport, on travel product purchases, on the standard contractual terms, on the way the ticket system works etc. This also includes information on requesting and using travel media.

The second category includes features aimed at individual users. As the data covers their personal travel and fare payments, the use of these features must require identification.

The following general considerations and requirements need to be met when setting up the online services.

• Apart from the version for use on traditional desktop computers, there need to be versions optimized for the small screens of smartphones and tablets in order to make the features usable with the most widespread devices.

• In order to allow the system to work efficiently and speed up information flow, a one-way communication service needs to be set up that delivers SMS messages to mobile phones or delivers information via a custom application.

• The self-service portal needs to be available in foreign languages as well as Hungarian.

• When it comes to data security, in order to securely handle regular payment traffic, the security level has to be on par with that of Internet banking.
• For customer identification, single authentication is sufficient

• The website needs to be able to serve large customers as well (employers who buy travel products in bulk for their employees)

The following considerations and requirements need to be met when setting up the online services.

The system needs to be designed so that inexperienced Internet users can find their way around it easily and quickly so that everyone can get what they need as quickly as possible.

**Comprehensibility**

• The language needs to be simple and free of jargon

• Supplementary explanations need to be as brief and to the point as possible

• Names (of features and concepts) should be the names used by the general public

**Ergonomic (optimal layout, clear structure, simple processes), image**

• The layout needs to be clean, with little data

• The menus need to be simple and clear

• In longer processes (e.g. travel media requests), the completed and remaining steps should be indicated.

**Functionality**

The introduction of the automated fare collection system is planned with only basic functionality, then, based on the experiences of the next 6-12 months and customer feedback, a decision can be made about further developments.

• General information (accessible to everyone)
  
  o Description of travel products (passes, tickets, special products)

  o Information on concessions

  o Types, requesting and use of travel media
- Price table
- Information for large customers (request forms)
- Standard contractual terms
- Frequently asked questions

- Travel media requests

- Features available to registered users after customer identification
  - Viewing of customer balance
  - Viewing data on completed travel
  - Viewing product status (type, validity, payment status)
  - Product purchases and balance top-ups
  - Setting up automatic travel product purchases (balance top-ups, pass purchases)
  - Managing payment modes (transfer, bank card)
  - Payment of fines
  - Modification of personal data

### 6.10. Centralized reporting

The operation of the automated fare collection system generates large amounts of data, and analysing that data can be very useful in preparing subsequent executive decisions, in product development, in the modification of services and in setting fare policy. The electronic logging of public transport processes brings radical changes to business planning and technical operation, offering much more precise and detailed data than is available today, including the introduction of new measurements that are not yet used in daily practice.

Reports are planned on the following topics after introduction:

- Sales reports
  - travel media sales data
  - sales data of individual travel products (ticket, pass etc.)
  - travel product purchases by persons eligible for a concession
- sales data of sales channels (e.g. BKK customer service, BKK Internet self-service etc.)

- Customer reports
  - number of customers in Budapest public transport
  - number of people travelling with a discount / for free
  - customer categories by usage intensity
  - number and type of travel per customer

- Usage report
  - passenger flow data
  - usage of sales channels
  - effect of the introduction of new products
  - frequency of use of various vehicle types
  - gate abuse
  - vehicle capacity utilization

- Operation reports
  - uptime of the entirety of the automated fare collection system and system components
  - planned and unplanned downtime

The most important function of operation reports will be to allow us to measure the performance of the contractual undertakings of supplier partners.

6.11. Legal environment

The review of the legislative environment serves the purpose of making sure that the automated fare collection system model proposed in the present study is compatible with the legislation currently in force.
6.11.1. Preconditions

Parliament adopted amendments to Act XXXIII of 2004 and Act CLXXXIII of 2005 on 23 December 2011. These amendments introduced a new model in the organizational and management structure of Hungarian public transport: the introduction of a transport organizer company that organizes and manages local public transport. BKV used to be the only actor in Budapest's local public transport; it will become a – non-exclusive – transport service provider offering scheduled local and suburban passenger transportation. BKK as the transport organizer will sign public service contracts with BKV and other transport service providers for the provision of local and some suburban scheduled passenger transportation services, paying a fee to the transport service providers in return. In order for BKK to become a transport organizer, the Budapest Municipal Government needs to assign this task to BKK via municipal decree, entrusting it with the task of organizing local public transport services, operating the ticket sales system and collecting ticket revenue. BKK can only start operating the ticket system as its own after these conditions are met.

6.11.2. Regulations on free and concession travel, operation of the ticket system

One fundamental task of the ticket and fare system is to make the legally mandated travel concessions available. The groups entitled to travel concessions are listed in the following legal acts: Government Decree 85/2007. (IV. 25.) Korm. lists those who can travel free of charge or with a discount, and lists the discount rates as well. Act LXXXVII of 2003 fixes the consumer price subsidy provided to the transport service provider in connection with the free or discounted travel of members of these groups. Decree 31/2007. (III. 13.) GKM establishes the procedures for claiming the consumer price subsidy. Decree 57/2009. (X. 20.) KHEM defines another set of persons (in addition to those listed in Decree 85/2007. (IV. 25.) Korm.) who are entitled to travel concessions (essentially, people who are or were in a legal relationship with passenger public transport companies as employees, pensioners etc.) and lists the rate and validity period of these concessions. The related Decree 324/2009. (XII. 29.) Korm. states that the travel discounts provided based on Decree 57/2009. (X. 20.) KHEM are tax-exempt in-kind benefits, and that the transport operators are not entitled to consumer price subsidies related to these discounts.

It is BKK's primary objective to make sure that concession eligibility can be proven by NEK cards in as many cases as possible. If a NEK card cannot be used to prove eligibility for some type of travel concession, BKK will issue personalized cards for this purpose. As this
generates costs for BKK, BKK intends to charge one-time and/or yearly card fees. The current legal regulations do not contain provisions on such cards or the fees charged in connection with them. Therefore, initiating an amendment to Government Decree 85/2007. (IV. 25.) Korm. is proposed, inserting in the Decree a provision stating that the concessions listed in Annex 1 refer to the concrete travel fees, and if an electronic ticket or pass system is introduced, administrative fees can be collected from persons eligible for discounts in order to cover the costs of making the necessary travel media available and maintaining their validity, or, if the lawmaker does not wish to burden those eligible for concessions with the administrative fees, compensation for these costs should be included in the consumer price subsidy. Pursuant to Decree 57/2009. (X. 20.) KHEM, a card fee can already be collected from persons eligible for a travel concession based on the legal regulations currently in force.

BKK, the operator of the automated fare collection system, needs to receive information about the existence or termination of student legal statuses, as travel concessions are attached to them. In accordance with the Act on public education, all children of compulsory schooling age have a student status, and may maintain their student status after reaching the age limit as well. Further discussions are needed to allow the automated fare collection system to receive data from the relevant national registry systems regarding the persons in public and higher education for the purpose of checking their student status.

In accordance with the Civil Code currently in force, it is legal for BKK to allow persons over 14 but under 18 to purchase concession travel cards, or, if they are not students, full-price travel cards.

6.11.3. Legal issues surrounding the cards used in the automated fare collection system

Regarding the travel media to be issued by BKK and used in the automated fare collection system, a free choice can be made as to whether the cards remain the property of BKK or become property of the purchasing customer. In both cases, BKK has the right to collect one-time card issuing fees, annual administrative fees, fees associated with extraordinary events (disabling, replacement), and a deposit (to compensate for the travel fee in certain situations where the automated fare collection system allows travel without advance payment). In order to avoid the charge of abuse of dominant position, the fees have to be proportional to the costs of the activities that are cited as the reason for collecting the fee (e.g. annual administration fee).
Regarding the possibility of introducing a deposit as proposed in Chapter 6.1.1 in connection with the fare strategy, the sums collected as deposit are legally categorized as collateral (Civil Code, Section 270), i.e. a financial collateral arrangement paid in advance to secure a claim. The handling of collateral is not considered a financial service by Act CXII of 1996 on Credit Institutions and Financial Enterprises (hereinafter: Act on Credit Institutions), therefore, BKK can carry out this activity. The Act on Credit Institutions requires no reporting or authorisation in connection with collateral. The regulations on the automated fare collection system need to be drafted so that the deposits not used up by the passenger are paid back to the passenger when the card is returned.

Regarding media issued by a third party, BKK has the right to decide what media can be used in the automated fare collection system and what media cannot. Therefore, if BKK – with predetermined technical, economic and legal preconditions – allows third-party media to be used in the automated fare collection system, then the third party issuers wishing to join the system and their media can only be rejected for technical or legal reasons; otherwise, a competition control procedure may be filed against BKK citing discriminatory action. Regarding third party media integrated into the automated fare collection system, media need to be disabled in the ticket system when disabled by their original issuers.

If a third party contactless bank card that is authorized for use in the automated fare collection system is non-transferable as per the card user agreement, then the card has to be non-transferable in the ticket system as well. However, even though the standard contractual terms of the automated fare collection system will contain the non-transferability clause, the verification of the identity of the user as the owner of the bank card cannot be a part of the control protocol. The reason is that by verifying the identity of the passenger and whether the bank card in question was issued in their name, ticket inspectors would become privy to banking secrets illegitimately as per Section 50 of the Act on Credit Institutions.

Third party media used for PAYG travel in the automated fare collection system is also the proof of the right to travel, i.e. the passenger can be legally required to hand the card over to the ticket inspector for inspection (the ticket inspector can only make sure that the fare was paid).

Regarding the number formats to be used on cards issued by BKK, there is no authority or organization whose prior permission is necessary for the use of certain number formats. BKK needs to make sure that the identifiers cannot be confused with unique identifiers used by
other systems. When planning the BKK ticket system, the use of number formats similar to the financial account numbers generated as per Decree 18/2009. (VIII. 6.) MNB needs to be avoided.

The proposal to make domestic local and long-distance public transport services interoperable by unifying the conditions of use, the proof of eligibility and the media also arose. This would require the format of the identification number of travel media to be regulated by law. If BKK’s ticket system is launched before this future Act is adopted, then the characteristics of the BKK system, which will be the system with the greatest number of users, will need to be taken into account during the preparation of the Act.

According to the feasibility study adopted in December 2011, the National Integrated Card System will be introduced gradually from 2012. The first to be introduced – in February 2012 according to the plans – will be contactless student IDs. The NEK system is being developed by the Central Office for Administrative and Electronic Public Services (hereinafter: KEK KH). Further negotiations are necessary with KEK KH in order to make sure that there is no overlapping between the identification number ranges of the cards to be issued by BKK and the identification numbers of NEK cards and that the automated fare collection system can recognize and handle NEK cards. The reason is that e.g. student IDs will be usable for personal identification; therefore, if a student ID holder buys a student pass, they will be able to prove their student status within the framework of the ticket system with their student ID.

Pursuant to Act CXXXVI of 2007 on the Prevention and Combating of Money Laundering and Terrorist Financing, no more than 3.6 million HUF may be added to the accounts associated with a BKK-issued card, but a lower limit can also be instituted.

In connection with personalized cards issued by BKK, the passenger needs to be identified when issuing the card and during controls as well. This way, it is possible to check that the passenger using the card is the owner of the card, and if a card is lost, stolen etc., the balance can be transferred to the replacement card. For identification – recorded in the back office system – data should be used that does not change during a person's life, such as birth name, time and place of birth, and mother's birth name; other personal data might change. The cards would bear a photo, a name and a card number.

In the course of the operation of the ticket system and the controls, BKK will handle passengers' personal data, which is made possible by Act CXII of 2011 on Informational Self-Determination and Freedom of Information, in force from 1 January 2012 and Act XXXIII of
2004, amended on 23 December 2011. In general, data handling is possible with the passenger’s permission (the permission needs to be included in the standard contractual terms of the ticket system), but pursuant to Section 6 (1) of the Act, if securing the consent of the affected person is impossible or disproportionately costly and the handling of the data is necessary in order to enforce the valid interests of the data handler (in this case, for the operation of the ticket system, the checking of the right to travel and the collection of fines), and the interests in question are proportionate to the limitation of the protection of personal data, then the data can be handled. Pursuant to Section 6 (5) of the Act, if the personal data is recorded with the consent of the person in question, then BKK can continue to handle the data even if the passenger subsequently expressly retracts their consent. The details of the handling of the data need to be discussed with the Hungarian National Authority for Data Protection and Freedom of Information before the ticket system is launched. BKK also needs to get itself registered in the data protection registry, without which the handling of the data of the automated fare collection system cannot start.

In case of PAYG travel, the validator cannot immediately provide a receipt or invoice on the amount of money charged to the account. However, this is not legally required, as according to Act CXXVII on Value Added Tax (VAT Act), service providers are exempted from the invoicing obligation if payment is made immediately in cash or using a cash-substitute payment instrument, in which case a receipt is to be issued. However, Section 167 c) of the VAT Act grants an exemption from the obligation to issue a receipt in connection with goods sold by way of vending machines or in connection with services registered by an automated apparatus – and the electronic validator devices to be installed in Budapest fall into this category.

6.11.4. Contracts between the transport organizer and transport service providers

In connection with the introduction of the automated fare collection system, various legal relationships will be set up between the transport organizer (BKK) and the transport service providers (BKV and other future bus operators).

The introduction of the automated fare collection system is divided into three project parts, clearly separated legally, as follows: the central software of the automated fare collection system, with the associated Internet and other travel product purchase options; the issuing of BKK travel media for use in the framework of the automated fare collection system, and the
installation of validators on vehicles, the installation of gates (and validators) at metro stations and some selected surface platforms.

Three of the four legal relationships related to the first project part (the central software of the automated fare collection system) need to be prepared and signed in parallel: the new standard contractual terms of BKK, the labour law takeover of ticket inspectors and the renting of existing BKV ticket offices. These three contracts need to enter into force by the starting date of the operation of the automated fare collection system by BKK at the latest. However, they can also enter into force earlier; according to current plans, these contracts will be signed by the time the Decree that names BKK as the transport organizer enters into force on 1 May 2012, before the automated fare collection system is launched. The fourth contract, the new public service contract between BKK and BKV must come into effect by the time BKK becomes the transport organizer.

Regarding the second project part (the installation of validators on vehicles), issues like the authorization of the installation of validators, the regulation of how, with what schedule, with what concrete conditions the devices are installed on vehicles and how they are maintained should be regulated in the new public service contracts signed between BKK and BKV and any other transport service providers. Vehicles and validators are legally considered a main item and its accessory; therefore, validators can remain in the ownership of BKK.

Regarding the third project part (the installation of gates), a rental contract will be signed between BKK and BKV for renting part of the stations operated by BKV. In this context, the legal ownership, asset management and utilization status of metro and HÉV stations currently used by BKV need to be reviewed. Furthermore, the contracts signed between BKV and NSN Trafficom Kft. need to be reviewed in order to determine if the communication between the validators integrated in the gates and the central system is in any way affected by the contractual rights granted to NSN Trafficom Kft.

Pursuant to the provisions of Act LXXXI of 1996 on Corporate Tax and Dividend Tax (the Corporate Tax Act), BKK and BKV are considered related undertakings, and thus the pricing of transactions between the two needs to follow transfer pricing and documentation obligations. The contracts need to apply prices that two independent companies would have agreed on in identical (similar) circumstances, and the prices in each contract need to be supported by the documentation prescribed by Decree 22/2009. (X. 16.) PM on the obligation to keep records relating to the determination of fair market value.
6.11.5.  **Summary**

Based on the above, it has been determined that the legislation in force on 2 January 2012 contains no provisions that would inhibit or prevent the implementation and operation of a ticket system following the model proposed in the present study.

Based on the results of the legal overview, a detailed legal work plan needs to be drawn up, attaching an implementation deadline to each task in order to continue the legal preparation for the introduction of the automated fare collection system.

6.12.  **Organizational operational model**

The operational model introduced in the previous subchapter makes it possible to achieve the objectives set for the electronic ticket and pass system. However, the daily operation of the system requires coordinated teamwork by experts of various specializations. The following chapter names the organizational units to be set up and lists their responsibilities.

6.12.1.  **General expectations connected to the operative business model**

With highly integrated systems with a strong IT element, it is especially important to provide coordinated leadership for the people working at the various endpoints of the system to ensure the highest possible efficiency in the system and reduce losses due to incorrect usage to a minimum.

The planned automated fare collection system will be used by millions of passengers on a daily basis, and it will handle tens of billions of forints each year; that is, one of the most important pillars of Budapest transport financing will depend on this technological system and the group of experts operating and developing it. Here, weak responsibilities, series of errors and other anomalies that can be tolerated without particularly grave consequences at other organizational units can have direct and very serious effects: they can inconvenience large groups of passengers, and they can cause losses of many millions of forints for BKK and the city of Budapest. Therefore, providing technical and human resources on an on-going basis must be a priority.

Future operators can be divided into groups based on various aspects of their role:

- location of work (centre, points of sale, vehicles)
- type of work (user of the system, support)
• qualifications (technical, economical, sales)
• new position or expansion of existing role.

This grouping shows that many different expectations can be drawn up regarding the qualifications, skills and abilities of the employees working in the system. Precisely establishing and consistently requiring these expectations is one of the most crucial preconditions of successful operation. The most important ones are:

• banking and financial knowledge,
• hardware and software operation qualifications with solid IT skills,
• ability to use foreign languages at the level required by the position,
• ability to handle workload and multi-shift work schedule,
• customer-focused attitude, friendly and polite behaviour, appropriate physical appearance.

Naturally, not all employees at the future organizational units will need to meet all of the above expectations, but the organization needs to project this overall image to the outside world.

It is very important to know that employees can only work to the required standard in each position if the material preconditions are provided. For instance: maintenance work requires tools and vehicles, operators need to be able to participate in trainings or have access to books on the subject to keep their knowledge up to date etc.

The operative model suggests that entirely new positions will be created (e.g. telephone customer service, sales support, central system organization), and the expectations regarding the quality of work will change in numerous areas (e.g.: points of sale, ticket inspectors) and there will be areas where new tasks will be added to the job description (e.g.: IT, finance).

6.12.2. Organizational model necessary for the operation of the system

After a general description, this Chapter discusses the positions that are required by the system described in the section on the model of operation. A brief description of the task, the expectations and the material and other preconditions is attached to each position.
The present Chapter does not name concrete organizational units. The pre-feasibility study is not intended to establish the hierarchy of the units in question or to propose a concrete organizational model.

**Central coordination/Business affairs**

Complex systems can work successfully if there is an operative team that has both high-level overview of the entire operative environment and in-depth knowledge of the various subsystems. This is especially important in the initial phase, but as the environment that the system is installed in continuously expands and changes, it is important to have a unit where this knowledge is concentrated and optimal answers can be provided to any questions and problems that may emerge. Experience shows that if a system of this size has no dedicated organizational unit, then no other unit will take ownership of these complex tasks, and questions will be answered inefficiently, late and incorrectly.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Required special knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Drawing up of development plans and specifications</td>
<td>• System-oriented approach</td>
</tr>
<tr>
<td>• Cooperation with sales, marketing and IT department,</td>
<td>• Excellent organizational skills</td>
</tr>
<tr>
<td>• Representing the interests of the automated fare collection system in on-going projects,</td>
<td>• IT skills</td>
</tr>
<tr>
<td>• Monitoring of international trends,</td>
<td>• Knowledge of financial processes</td>
</tr>
<tr>
<td>• Supporting users of the system,</td>
<td></td>
</tr>
<tr>
<td>• Coordination and execution of tests,</td>
<td></td>
</tr>
</tbody>
</table>

**Card unit**

The current paper-based tickets and passes will be largely replaced by contactless plastic and paper cards. If a decision is made to centralize the processing of card requests, then all such requests will be handled by this unit; if not, then the unit will only be responsible for processing the requests arriving through the central request system.
If necessary, cards need to be personalized by recording data on their external surface with a suitable device before they are released. It is possible that – as a result of decisions taken at a later date – this unit will also be responsible for personalizing the card chips.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Required special knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring of card stocks, ensuring adequate supply</td>
<td>• Good computer skills</td>
</tr>
<tr>
<td>Supplying sales network with cards</td>
<td>• Precise work</td>
</tr>
<tr>
<td>Manufacturing centrally requested cards, sending them to requesters</td>
<td></td>
</tr>
<tr>
<td>Verification of concession eligibility in case of concession card requests</td>
<td></td>
</tr>
<tr>
<td>Analysing and responding to complaints</td>
<td></td>
</tr>
</tbody>
</table>

This work requires specialized office workstations, with appropriate access to the central system, software for personalizing cards and connection to a specialized printer.

In normal operation, the total monthly number of card requests is estimated to be around twenty thousand based on current sales data.

Instead of setting up a separate card unit, a feasible option could be to assign card requests to a dedicated customer service centre, reinforced in terms of staff number and resources. (Due to mailing issues, further division would not be beneficial.)

The mass launch before the automated fare collection system comes live requires the manufacturing of cards for approx. 600,000 paying passengers. Travel media needs to be made for everyone who currently uses public transport services free without travel media. This is expected to require hundreds of thousands of cards as well, unless these citizens will receive compatible cards from the NEK system. The introduction of the system – which will need to be supported by a large-scale communication campaign – will require extra capacities already in the first phase.
IT employees will ensure that the hardware and software IT components required by the automated fare collection system are functional and capable of carrying out their tasks, with the performance indicators fixed in advance in SLAs.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Required special knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Maintenance and operation of hardware infrastructure</td>
<td>• Excellent organizational skills</td>
</tr>
<tr>
<td>• Maintenance, updating, operation of basic software infrastructure</td>
<td>• Solid software, hardware and IT network communication skills</td>
</tr>
<tr>
<td>(operating system, database program etc.)</td>
<td>• Professional experience with similarly complex systems with</td>
</tr>
<tr>
<td></td>
<td>massive traffic</td>
</tr>
<tr>
<td>• Maintenance of application infrastructure, learning of operation,</td>
<td>• Ability to grasp business aspects of systems</td>
</tr>
<tr>
<td>operation</td>
<td></td>
</tr>
<tr>
<td>• Designing, monitoring, maintenance of network infrastructure</td>
<td></td>
</tr>
<tr>
<td>• Setting up and maintaining a secure hardware and software</td>
<td></td>
</tr>
<tr>
<td>environment</td>
<td></td>
</tr>
<tr>
<td>• Maintaining contact with IT suppliers</td>
<td></td>
</tr>
<tr>
<td>• Maintaining contact with maintenance staff, managing error reports</td>
<td></td>
</tr>
<tr>
<td>• Managing and enforcing SLAs</td>
<td></td>
</tr>
<tr>
<td>• Processing of business needs (system planning)</td>
<td></td>
</tr>
<tr>
<td>• Ensuring operability of office infrastructure, providing help to</td>
<td></td>
</tr>
<tr>
<td>users in case of technical problems</td>
<td></td>
</tr>
</tbody>
</table>

Maintenance

The physical devices passengers are in contact with will be crucial parts of the system. Automatic gates, ticket validators and ticket vending machines all require regular maintenance just like any other mechanical device. These devices are not purely mechanical, as they are controlled by software.
International experience shows that software control can be handled centrally for all the above devices, as these physical devices have a network connection, which allows central monitoring and updating.

These devices can only perform their functions to the full if they are flawless in both respects. Therefore, it is important to centrally manage error reports.

A dedicated specialized group of mechanics for each type of device is recommended:

- The malfunctions of different devices have different consequences (e.g. failure of an automatic gate can lead to groups of passengers having to wait, while the failure of a ticket validator "only" causes revenue loss).
- On-board ticket validators are best repaired at vehicle depots, while automatic gates and ticket vending machines need to be repaired on the spot.

In addition, ticket vending machines contain cash as well; therefore, maintenance jobs cannot be handled all together: they need to be split up. Apart from ticket vending machines, cash handling and transportation tasks also arise in connection with ticket offices and customer service centres; therefore, these issues are discussed in detail at the relevant chapter.

Based on the above, the tasks and expectations regarding experts who repair mechanical devices are as follows:

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning of device maintenance knowledge</td>
<td>Appropriate qualifications</td>
</tr>
<tr>
<td>Use of monitoring systems</td>
<td>Willingness to work in multiple shifts</td>
</tr>
<tr>
<td>Carrying out maintenance, repair and cleaning works</td>
<td></td>
</tr>
<tr>
<td>Refilling of plastic and paper cards as they run out</td>
<td></td>
</tr>
</tbody>
</table>

(Currently, BKV handles ticket validators internally, while ticket vending machines are maintained by a third party.)
Partner sales

Because of the virtualization of tickets and passes, the role of the reseller network needs to be reconsidered. The operation of the existing network mostly involves distribution and settlement tasks. In the new system, the shipping of physical products will take a back seat to the sale of IT-based standard packages.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Drawing up and pricing of packages</td>
<td>• Economics qualifications</td>
</tr>
<tr>
<td>• Drawing up of reseller sales processes</td>
<td>• Business-oriented attitude</td>
</tr>
<tr>
<td>• Identification of important potential partners, sending offers</td>
<td></td>
</tr>
<tr>
<td>• Measuring the performance of the reseller network</td>
<td></td>
</tr>
<tr>
<td>• Sourcing of tools necessary for the operation of the network; organization of installation and training</td>
<td></td>
</tr>
<tr>
<td>• Shipping of physical products to resellers</td>
<td></td>
</tr>
<tr>
<td>• Cooperation with other units (IT, finance, central coordination)</td>
<td></td>
</tr>
</tbody>
</table>

BKK customer service centres, BKK ticket offices

The maintenance of a sales network based on personal contact is justified despite the fact that there will be plenty of other convenient and fast sales channels. Passengers' purchasing habits cannot be changed overnight, and cash payments are not supported by electronic channels. It is also likely that concession purchases will only be possible in person, which also justifies the sustaining of the physical sales network.

Current sales statistics suggest (9-10 out of the 55 ticket offices sell half of all pass certificates) that points of sale should be differentiated in terms of the breadth and depth of the available service portfolio. Experience shows that new pass certificates are generally bought at major transit hubs. In the new model, customer service sites need to be made able to provide personalized travel media, with ticket offices selling tickets and passes.
### Tasks
- Providing personalized travel cards (BKK customer service)
- Registration of external cards in central system (BKK customer service)
- Handling of issues related to disabled cards (BKK customer service)
- Disabling of lost and stolen cards
- Sales of anonymous BKK cards and smart paper
- Sale of travel products
- Top-up of money balance on travel cards
- Recording of other financial transactions (BKK customer service)
- Handling of banknotes and coins
- Monitoring of card stocks, requesting stock
- Processing of card orders arriving through electronic channels (at BKK customer service – optional)
- Handling of fine payments
- Handling of passenger complaints (BKK customer service)

### Expectations
- IT skills
- Knowledge of foreign language (at team level)
- Cash handling certification
- Willingness to work in multiple shifts
- Customer-centric approach, problem solving ability
- Confident handling of stressful situations

The task requires an office workstation with appropriate software and hardware (card reader, printer, POS terminal) infrastructure.

In addition, strengthening the corporate image requires clean, modern offices, with consciously chosen, unified interiors that adhere to the company's image strategy. Passengers' interests need to be taken into account when choosing the locations of BKK customer service offices.
Currently, there are ticket offices in 59 locations in and around Budapest. Information on sales data and the planned changes regarding sales networks make it likely that the number of ticket offices will be reduced significantly. Exact recommendations can only be provided after further calculations.

**BKK telephone customer service**

The requesting, sales, personalized information providing, complaint handling and travel media-related processes and data associated with the automated fare collection system will be available centrally and instantly. This makes it possible to provide customers with a feature-rich live-voice telephone customer service. This is important because this is the cheapest channel to run among all customer service options that require human staff (BKK customer service, ticket offices).

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Card disabling, product transfer from card to card</td>
<td>• IT skills</td>
</tr>
<tr>
<td>• Recording of financial transactions, sale of travel products</td>
<td>• Knowledge of foreign language (at team level)</td>
</tr>
<tr>
<td>• Recording of technical complaints and forwarding them to those</td>
<td>• Willingness to work in multiple shifts</td>
</tr>
<tr>
<td>responsible for the area in question</td>
<td>• Customer-centric approach, problem solving ability</td>
</tr>
<tr>
<td>• Answering general questions on schedules and other passenger</td>
<td>• Confident handling of stressful situations</td>
</tr>
<tr>
<td>information</td>
<td></td>
</tr>
</tbody>
</table>

**Ticket inspectors**

Ticket inspection will still be needed after the introduction of the automated fare collection system. However, the inspections will be largely transferred to new locations, as the installation of automatic gates in all metro stations and some HÉV stations will allow us to concentrate on controls on surface vehicles.
### Tasks

- Controlling passengers
- Fining illicit travellers
- Collection of fines on the spot via bank card transactions
- Centralized management of overdue fines

<table>
<thead>
<tr>
<th>Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Polite but firm attitude</td>
</tr>
<tr>
<td>• Managing stressful situations</td>
</tr>
<tr>
<td>• Foreign language knowledge sufficient for the task</td>
</tr>
<tr>
<td>• Ability to handle great workloads</td>
</tr>
<tr>
<td>• Willingness to work in multiple shifts</td>
</tr>
</tbody>
</table>

Ticket inspectors need to be supplied with portable reader devices

A CCTV system installed on vehicles could improve security and cleanliness, and ticket inspectors may be equipped with sound recording devices as well. The effectiveness of ticket inspectors' work would be improved if ticket inspectors had wider legal powers than presently.

In the new system, ticket controls will be recorded in the central system just like ticket and pass validations, making it possible to prescribe and easily control the effective work efficiency of ticket inspectors.

#### 6.12.3. Process assignment: internal and outsourced processes

Modern economic actors exhibit intense specialization, and therefore, certain tasks are often outsourced. The principle is to have each actor in the system do the task they are best at.

**Advantages of outsourcing:**

- The company does not need to invest in equipment for the task or keep up with market trends and technologies in the specialized area.
- Cost reductions, or avoidance of cost increases.
- Claimable, plannable fixed monthly cost.
- Payroll reduction.
- No problems and extra costs associated with arranging substitutions.
- Easy enforcement of performance through contracts and SLAs, which even makes it possible to radically improve the level of service.
Based on these considerations, it is conceivable to outsource part or all of the daily operation of the system after the implementation of the project.

There are two possible options for full outsourcing: either the owner sets up a subsidiary company for this purpose or contracts these operative tasks out to an independent third party. It is important to emphasise in both cases that technical tasks related to transport issues, management, decision-making and all associated revenue will remain with the owner.

It is also possible to outsource only certain subtasks. The following activities can be considered for outsourcing:

- Installation, maintenance and repair of ticket vending machines
  The current network of ticket vending machines is being managed by an external company. Their contract covers cash handling as well as maintenance and repair. In general, third parties helped increase sales; they eliminated numerous possibilities for abuse that resulted from software and hardware problems.
  If a decision is made to keep outsourcing tasks related to ticket vending machines, separating cash handling from maintenance would be advisable. Currently, this is not possible due to the physical design of the machines. The complexity of the combination of the two tasks can in itself reduce the effectiveness of competition, resulting in worse contract terms (this does not necessarily mean that the same company will end up carrying out the two tasks in practice).

- Installation, maintenance and repair of ticket validator machines
  Ticket validators will be installed on surface vehicles (buses, trolleybuses, trams) and at stations (metro, HÉV), in high numbers (approx. 10,000 in total). At the same time, by the time the automated fare collection system is introduced, several competing companies are expected to be operating the buses.
  If we assume that ticket validators will be purchased within the framework of the automated fare collection system project, and they will be owned by BKK, then the maintenance of these devices will be the task of the owner. Whether to outsource this task or hire internal staff is still to be decided.

- Cash transportation
Cash transportation tasks will be required at BKK customer service offices, ticket offices, ticket vending machines and, in case of on-board sales, at depots. The company that handles cash transportation tasks for BKK customer service offices and ticket offices can also be contracted to handle these tasks at ticket vending machines.

- **Maintenance of automatic gates**
  Automatic gates are valuable, modern mechanical/IT devices. In order to ensure their longevity, an expert, well-equipped team needs to be hired for maintenance and repair tasks. Gate manufacturers offer warranty repairs for the first few years after installation.

- **Telephone customer service**
  Telephone customer service may be outsourced with a view to cost rationalization. Fluctuation is above average in this job, and extra costs arise from having to train new workforce. There are specialized service providers working in the area of telephone customer service, which can offer the same service to passengers at a lower specific cost.

**6.13. IT architecture of the future system**

The goals of flexibility, cost-effectiveness and supplier independence dictate a modular system. This also ensures flexible expandability, and reduces investment and operation costs.

The main elements of the system will be:

- **central system**
  - customer database
  - fare engine
  - settlement module

- **travel media (cards)**

- **self-service machines (ticket vending machines and ATMs)**

- **validators**

- **automatic gates**
BKK Automated Fare Collection System

- inspector handheld devices
- Internet self-service portal
- mobile phone application
- communication over wired and mobile networks

6.13.1. Central system

In the IT design of the proposed server-based system, the central system plays a much more prominent role than in card-based systems. The structure and operation of this system is quite similar to the mature models that have been used successfully for years in the financial and telecommunications industries.

The central system is at the core of the entire automated fare collection system. By nature of the structure, the other elements in the system (e.g. validators) have a smaller role to play, which reduces their initial cost and makes their maintenance simpler and cheaper. This setup also increases flexibility in supporting value-added services and the fare structure. With card-based systems, it takes several days to install updates in all system components in order to support the introduction of new products or change fares. There are similar difficulties with returning money to customers' accounts in case of error, for instance. These problems do not arise with server-based systems; here, updates can be carried out in the central system alone. This model offers much more robust support for features customers have come to expect such as electronic purchasing channels and customer self-service.

Naturally, the central system needs to offer more functions in this setup. Some of these functions are:

- registry of passenger data (data of personalized and concession cards)
- registry of travel media in use (validity, expiry, type etc.)
- association of passenger data and travel media
- registration of travel products and available balance for each travel media
- handling of travel product purchases and payments
- fare calculation based on rides (PIA products, PAYG travel, daily fare cap calculations)
BKK Automated Fare Collection System

- registry of completed travel (which travel media was validated when at which validator)
- service and support of sales channels (customer service, ticket offices, vending machines, electronic channels)
- reporting, serving of monitoring queries
- financial accounts

This list of the most important functionalities shows that the operation of the entire ticket system relies heavily on the speed and uptime of the central system. In public transport, the move from earlier system types towards server-based systems is a recent phenomenon. The primary reason for this is the development of the telecommunications industry and contactless card technology in recent years, as well as the fact that passengers have embraced electronic channels. We can safely say that today, every system component and process is available for setting up a server-based public transport ticket system.

The design of the architecture has to place special emphasis on reliability. As public transport in Budapest operates 365 days a year, 24 hours a day, 24/7 ceaseless operation needs to be ensured, with planned maintenance.

When it comes to travel records on surface vehicles, the system needs to be prepared for delayed data synchronization due to communication failures. Among other things, this requires validators and ticket control devices to be able to store travel and control data and send it in for central processing when connection is restored.

The central system needs to be able to handle both PIA and PAYG travel products. This includes product purchases, balance top-ups, fare calculations and the handling of validations and travel fare settlements.

The card is associated with a virtual account in both systems, which keeps track of the travel products associated with the card and the available money balance. In case of PIA products, this means a travel product registry account, while a money account is needed for PAYG travel to manage the balance available for travel.

The registration and calculation of rides is an especially central task, as it is one of the most important elements of financial calculations and record-keeping. Different procedures need to be followed when it comes to PIA and PAYG product use.
In case of PIA travel products, the validity period starts with the first validation, and new rides (line changes) only need to be recorded, without attaching a new travel product to them. If the ticket has expired since the first validation, the central system needs to validate a new ticket. Naturally, only the rides (validations) are included that take place on vehicles with an identical fare (e.g. the use of the Libegő chairlift after starting a trip on a bus does not qualify as a free mid-trip line change, and travel outside of Budapest is handled separately as well).

The system also needs to keep track of areas of validity (inside Budapest and in the appropriate zones) when it comes to passes and pass validations. When a passenger does not possess an appropriate travel product for the ride they are trying to take, they need to be notified of this fact.

In case of PAYG travel, the free available balance needs to be reduced by the calculated travel cost when the passenger starts the ride. In a further step, the automatic fare cap needs to be checked, calculated and registered. If the passenger is eligible for a new travel product based on their previous travel within a given period (e.g. time-based tickets are converted to a day pass when the fare cap is reached), the new product needs to be activated on their account, and fare calculations and balances need to be updated accordingly. Settlements with banks in connection to the use of contactless bank cards in accordance with card company rules and value limits is an especially important task. The operation of this system is described in chapter 5.6.

We intend to make their travel history and fare calculations available to passengers via electronic means. This feature needs to enable passengers to view data on the start of their rides, the travel product validations and the related fare calculations.

6.13.2. Travel media

One of the central issues in the system is the management of the media, calculations and travel products.

We recommend the introduction of a system based around contactless travel media due to their speed, flexibility and convenience. This technology and architecture is currently the most advanced solution in public transport systems.

The common feature in possible technologies is communication using the NFC standard (ISO 14443), which permits the reading of travel media from a maximum distance of 8-10
NFC-based travel media are already in widespread use in cities with an advanced public transport system (Oyster cards in London etc.).

The speed of the transactions carried out with the cards is crucial to the successful introduction of the automated fare collection system. Cards have to be able to communicate reliably within 200 milliseconds. In order to ensure unimpeded passenger flow, validation can take no more than 500 milliseconds at gates and no more than 1 second at other locations.

The available technologies support the use of various tools as travel media:

- paper cards (smart paper)
- plastic cards (similar to bank cards)
- contactless bank cards (e.g. Mastercard Maestro PayPass and Visa payWave cards)
- NFC capable mobile phones
- other NFC capable devices

In order to achieve the above described goals, several travel media types need to be used in parallel.

An open system is planned in order to ensure cost-effectiveness and long-term sustainability, making it possible to expand the system with other, technologically compatible devices and travel media.

Similar automated fare collection systems generally use Mifare chips, which are practically the industry standard. Based on our analysis and market research, we recommend the use of two Mifare-based product lines – or technologically compatible equipment. Paper-based travel media would be based on the Mifare Ultralight C standard, and plastic travel media would use Mifare DESFire EV1 chips. Both products provide the characteristics that are important for this application, making them suitable for public transport use. These capabilities include encryption and security, reliability and guaranteed speed of communication and expected life.

The system also needs to be able to use NFC-based cards from reliable external providers as travel media (e.g. cards issued in the NEK system). However, the introduction of these features cannot be automatic; in order to protect security and service quality, the joining of a new card issuing partner needs to be preceded by a detailed analysis, including the review of
compliance with the specification, the drawing up of rules on usage and the signing of the necessary contracts.

Regarding the use and introduction of the various travel media types, the issue of which travel modes and travel products will be supported by the travel media needs to be considered and decided (e.g. contactless bank cards cannot be used for purchasing passes). The decision and any subsequent reviews need to take into account the durability and expiry of the travel media in question, as well as security considerations.

6.13.3. Self-service vending machines

Vending machines, already in use, are designed to provide passengers convenient 24-hour access to travel product purchases. Vending machines will be needed in an automated fare collection system as well, although their role will be somewhat different. International experience shows that the opportunities provided by this sales channel are worth exploiting, as it improves the quality of service and passenger satisfaction and reduces sales costs.

The machines available in the market can be used for the anonymous purchasing of paper and plastic cards, for travel product purchases and balance top-ups for existing travel media, and they can also serve as info terminals.

We recommend increasing the number of own vending machines that accept bank cards – a feature which is convenient for passengers and helps reduce the cost of cash handling for the provider.

We believe that it is worth signing an agreement with banks on the use of cash machines (ATMs) as a self-service sales channel, significantly improving the coverage currently provided by vending machines. The server-based architecture provides an excellent basis for this, and banks are well adapted to reselling virtual products due to the technologies and contractual arrangements they use.

6.13.4. Validators

Validators need to communicate with travel media, read data from the cards in order to identify them and send the information necessary for validation to the central system. Validators do more than simply relay data: they also receive and manage data – see the discussion of list management below.
Validators need to be installed in all places where passengers can – or have to – validate tickets or passes. Validators need to be installed on buses, trams, trolleybuses and the platforms of non-gateable HÉV stations. Validators also need to be integrated into the gates at metro stations and the gateable HÉV stations. Considering the current vehicle fleet and station infrastructure in Budapest, approximately 10,000 validators will be needed.

On buses where 100% front-door boarding can be introduced (throughout the entire length of the line, in the entire operation period), it is sufficient to install a validator at the front in a location where the driver can see it and hear the signal beep. In this case, such vehicles can only be used on front-door-boarding only lines. Other buses and trams need to have at least one validator per door or door pair, placed in a location where validators do not interfere with safe boarding and exiting.

Validators mounted on board vehicles need support disabling for the time of ticket and pass control, stopping fare evaders validating when they see ticket inspectors.

The devices need to be able to communicate with all contactless cards and standard NFC devices that are supported as travel media.

One master validator needs to be selected on every vehicle and station. This device will be responsible for communicating with the central system, managing the so-called validation lists, storing and sending logs and controlling the secondary (slave) validators associated with it.

Regarding list management, it should be noted that the goal is to set up a server-based real time system in which the central system determines the success or rejection of each validation and sends this information to the validator. As a timely response cannot be guaranteed in all cases, on-board devices need to be able to make a decision on validations autonomously, without a network connection as well. This functionality can be provided using "local" intelligence, using a black list. The black list will mainly contain the number of expired, lost, stolen or fraudulent travel media. Travel media on the black list will be rejected by the validator.

The synchronizing of lists will be carried out on every vehicle and station by the above-mentioned master validator. The lists will be compiled, updated and distributed by the central system.
Keeping records of the travel media validated recently at each station and vehicle is also a list management task. This is intended to reduce the risk of a known fraud method, namely the repeated use of the same travel media. Validators store the data of every validated travel media for a given period (generally, 5 to 10 minutes) on a list. The travel media on the list cannot be validated. After this period, the travel media is automatically removed from the list. The master validator plays a crucial role in this process as well, as this filtering cannot be done simply on individual devices; to make the method effective, all the devices on a vehicle or station need to be coordinated (so that two people cannot enter with the same travel media at two gates of the same metro station).

6.13.5. Entry gates

Entry gates are among the most effective tools in the fight against fare evasion. Around the world, they are used for controlling access to metro trains or even suburban trains. This makes entry faster and more convenient than entry with manual control by ticket inspectors.

There are several gate models to choose from. The following types are available:

- tripod turnstile
- flap
- pivoting
- retracting

Among these, the retracting gates are the most advanced in terms of security, throughput capacity and efficiency. 40-50 people can pass through one gate per minute, and in optimal circumstances, this figure can reach 60. This performance is achieved by not closing the door panels between two passengers when traffic is thick and constant – unless the upcoming passenger fails to validate their travel media or the travel media is rejected. There are several metro stations in Budapest where space is so limited at the entrance that according to preliminary analyses the necessary throughput can only be achieved by using retracting panel gates. Pivoting door gates are widely used in some countries. This type of gate offers the least resistance to those who attempt to enter illicitly: they can just throw their weight against the panel. If the gate was not programmed to open in this case, it would break, which could cause operation costs to skyrocket. Due to the direction and type of movement, full-height pivoting door gates need a high gate body as well, otherwise, they could become unstable or even collapse (this has been known to happen).
Gates have to meet several important criteria:

- both the door panels and the gate body need to be high enough to prevent people from jumping or climbing over them, or at least to make this difficult;
- they need to resist vandalism, forceful opening attempts and other fraud attempts;
- they need to guarantee the security of passenger traffic (protect against pinching and injury);
- they need to be able to serve traffic in both directions, but they have to be lockable in either direction;
- they need to have validators on both sides (for entry and exit control);
- they need to support the integration of any type of validator;
- they need to be able to provide a sustained throughput of 40-45 people/minute;
- the principle and practice of operation need to be programmable based on parameters;
- they need to register fraud attempts and fraud;
- they need to support connection to a facility protection system;
- they need to support remote on/off switching and programming/setup (e.g. change the direction of passenger flow) one by one and in groups as well;
- the monitoring system needs to integrate into the central system of the automated fare collection system;
- mechanical parts need to be limited in number, relatively cheap, simple and quickly accessible;
- they need to be proven as usable in public transport for years;

Gates need to be controlled by validators installed on them. If the travel media is validated successfully, the gate opens; if the validator decides that the passenger does not have the right to travel on that line, it signals the rejection of the media and the gate remains closed.

Gates also need to have a visual signal unit that notifies the ticket inspectors present at the station if a passenger is using concession travel media or travel product. This will make it easier to execute random checks on users of concessions, eliminating abuse.
When planning the number and location of gates to be installed at each metro station, the expected simultaneous entry and exit traffic, the evacuation plan of the station and the relevant legislation all need to be taken into account.

The gates can receive passenger traffic from both directions, even at the same time. Wherever this is possible, entry and exit traffic should be separated to ensure a better flow. Station staff and the central dispatcher service need to be able to change the direction of traffic at gates in real time, and the gates need to be able to switch directions based on a predetermined schedule adapted to traffic patterns.

For security, the movements of passengers need to be monitored via CCTV on both the entry and the exit side of gates, so that the person on call can take immediate action (e.g. open gates) to avoid or manage congestion and accidents.

All station entrances need to have, apart from the gates that serve normal traffic, a lock gate and a service gate. The lock gate is needed for the unassisted entry and exit of passengers with a disability, people who need help and passengers with large luggage, while the service gate allows the station staff, officials and special groups to pass through.

At launch, only entry control is planned, but the gates need to support validation and control on exit as well. Therefore, they need to support mounting validators on the exit side as well.

6.13.6. **Inspector handheld devices**

Ticket inspectors need to be supplied with portable devices that ensure efficient and fast controls throughout the entire shift. The devices need to be able to communicate with travel media and the central system – and possibly with the vehicle’s on-board computer. They need to be able to determine the validity of tickets and passes, and whether the passenger validated them as required. Therefore, inspector handheld devices – like validators – need to be constantly connected to the central system and need to be able to use the local black list as well. Apart from reading cards, they need to support several wireless and mobile communication standards (Bluetooth, Wi-Fi, 3G, possibly 4G/LTE).

Ticket inspectors need to be able to temporarily disable all validators on board a vehicle. There are several solutions for this; one of them is to send the command from the inspector handheld device.

More advanced devices can support registering fare evasion and related data, and even the reading of contactless bank and traditional bank cards, speeding up controls, reducing the
administrative burden and providing an additional incentive to pay the fees. When procuring the devices, the range of specialized devices available on the market should be reviewed, as well as the possibility of using one of the widely available non-specialized devices.

6.13.7. Electronic sales channels

One of the main reasons for choosing a server-based solution was the opportunity to use electronic sales channels.

Gradually, three new channels can be added to the existing sales network:

- Internet self-service portal
- smartphone application
- telephone customer service.

It is important to provide passengers 24/7 access to sales channels, as Budapest public transport operates non-stop. These solutions are quick and convenient for passengers, and their operation costs are lower than those of other sales channels.

They are capable of offering the following main services to passengers:

- travel media requests
- disabling of stolen and lost travel media, requesting replacements
- travel product purchases
- balance top-ups
- querying of data on previous travel (travel history)

When planning the weight of each channel and the products to be offered through them, the characteristics of the channel in question and the expected passenger demand need to be taken into account.

Customer identification, data protection and the possibility of future further developments need to be taken into account when drawing up such systems.

6.13.8. Communication over wired and mobile networks

The operation of the system requires constant and reliable data communication between the central server and the peripherals (validators, ticket vending machines etc.).
possible and economical, wired networks should be used (e.g. metro stations). The data network of metro stations needs to be highly reliable in terms of architecture and components.

In other places, where mobility is a requirement (on board of vehicles, inspector handheld devices), a mobile data network can be used. Plans need to take into account the required bandwidth and data quantities.

The system also needs to be able to adapt to communication breakdowns, e.g. a situation where the central system temporarily cannot be reached. Processes need to be planned so that passenger traffic can continue through minor downtimes if necessary, processing validations later.

6.14. Data security

The entire system must be designed with special attention to the security of communication, data storage and data access.

In connection with the use of contactless technology, the management and protection of information stored on the travel media is especially important. Third parties must be prevented from accessing, stealing and using the data of the card holder without permission.

In terms of data security, a server-based setup is decidedly advantageous compared to storing data (personalization data, free balance, purchased products etc.) on the travel media. With card-based systems, the available balance, the purchased products and in some cases the verification data of the card holder are stored on the card itself. If the card is used only for identification, no changing or sensitive data need to be stored on it. The card is only linked to the card holder in the central system records; in case of a personalized card, this is the only place where the personal data of the card holder is stored. This solution can minimize the risk of card hacking and data leaks. Naturally required data (name, time of birth, photo) can be printed on personalized cards, especially in case of concession cards.

The primary reason for proposing the use of the above mentioned Mifare Ultralight C and DESFire EV1 chip media is security. For security, learning from fraud attempts committed abroad, it has been determined that relying on the security of the chip itself alone is not sufficient for data security and cloning prevention. Both chips have symmetrical key encryption capabilities; Ultralight C supports 3DES (triple DES) encryption, while DESFire EV1 supports AES encryption. With appropriately long keys, these encryption algorithms
meet our expectations, especially in terms of encryption and communication speeds. This would be complemented by a digital signature of the identification data on the card, and possibly its encryption (using PKI technology). This would not be controlled by the chip in the media but the validators and control devices, which have sufficient computing power for PKI technology.

When it comes to data protection, the most important component of the system is data security in the central system. A strict system of access levels needs to be set up for employees with access to data (customer service, operators etc.) to make sure that all employees only have access to the data they need for their job. Data access also needs to be logged to ensure tracking.

Reports and trend analyses provided by the central system also need to fully respect data security and data protection rules.

**Internet self-service portal**

The security and data protection aspects of the Internet and mobile phone self-service portals are especially important as they allow users to manage user data and execute transactions with financial consequences. In the issuing and management of login names and passwords, steps need to be taken to prevent access by unauthorized parties and abuse. Card holders need to be able to disable and change any compromised identification data.

**Fraud management**

Suspicious transactions and operations need to be monitored and, if necessary, alerts need to be raised by a central system module and reports in order to reduce or eliminate damage and risk from fraud and abuse. Operators need to disable/blacklist suspicious cards without delay. Suspicious login attempts and operations also need to be monitored to prevent abuse.

For registered travel media, a service can be introduced which sends notifications of events affecting the travel media, including fraud attempts and disabling through the channels requested by the travel media holder (sms, e-mail, smartphone application etc.).
Protection of bank card data

One of the keys to the success of the bank card payment system is the universally secure operation of the entire system. Aware of the weight of this demand, card companies set up PCI SSC (the Payment Card Industry Security Standards Council) in 2006, which forces affected parties to ensure security through various regulation tools and accredited auditors. Affected parties include: banks, merchants, service providers and software and hardware manufacturers. There are three standards, applied depending on what issue is at hand:

- PTS (PIN Transaction Security) – on the testing and regulation of devices for entering PIN codes. This mainly affects hardware manufacturers.
- PA DSS (Payment Application Data Security Standard) – on the regulation of payment tools. This affects software manufacturers and distributors.
- PCI DSS (Payment Card Industry Data Security Standards) – comprehensive security standards for bank card payments, covering IT systems, organizational and regulation issues and human resources. It affects banks, merchants and service providers.

Bank cards play a role at several points of the automated fare collection system.

- bank card payments at physical points of sale,
- travel product purchases via Internet or smartphone application,
- use of contactless bank cards directly as travel media

These processes can involve the relaying, processing or storing of bank card data (card number, expiry date, name of card holder). Therefore, the automated fare collection system will need to meet PCI DSS requirements. Compliance will need to be proven to the acquirer bank and thus the card companies on a yearly basis, through a bank card safety audit or a self-assessment procedure depending on transaction volume.

The extent of exposure depends on the concrete implementation of the system, which can be determined by a deep analysis once the detailed business specification has been drawn up. The aim of the analysis is to identify the flaws of the specification and define the divergences from the standard. By entering the results of the analysis in the specification, the document becomes more precise, and it can also prevent costly subsequent modifications.
The initial audit, required at launch, is followed by regular, usually annual reviews. Controls include the review of the system modules, the methods for securely storing and handling bank card holder data, the existence and consistent and documented application of internal regulations and user and operator trainings.

Even though the Budapest automated fare collection system will only start to support contactless bank cards directly at a later stage, the preparation for PCI DSS compliance for secure card handling needs to be an essential part of the process from the start of the design phase.
7. Launch Schedule

The launch of the above described the automated fare collection system is a very complex task, which can only be implemented after thorough preparation, with a significant investment of time and money.

Ensuring financing for the entire system can take months if not years; therefore, procurement cannot be carried out as a single procedure due to lack of funding. Therefore, it is not even possible to provide new travel media and advantageous travel product purchase options at least to pass users and eliminate pass counterfeiting by 2014. The only feasible option appears to be to lay the groundwork for the system in the shortest possible time, within a realistic budget. Therefore, we propose to break down the project into project phases. The phased launch provides the following advantages:

- Logistical and communicational risks are drastically reduced.
- Well-chosen implementation phase boundaries contribute to maintaining continuous competition between suppliers, as each phase can be covered by a new public procurement procedure. The most important precondition for this solution is to establish well-documented connection points between subsystems, based on standards.
- The completion of each subtask can produce tangible, visible results at the end of each phase. Passengers and the city will benefit from the advantages of the project earlier, and the client has an opportunity to gauge the reception of the new system and adapt the model if necessary.
- The division of the project into phases also sets a schedule for the purchasing of the various components that make up the system.

This way, the logical and physical connections between the phases and subsystems, set up by different suppliers, would be the responsibility of the client (BKK) instead of a single supplier. The risks associated with this need to be analysed further. Naturally, an external company that specializes in such tasks could be contracted in order to manage this risk, essentially for project management and system integration tasks, but that would increase the costs by up to 20-30 per cent. Based on the experience gained during the implementation of the first phase, a decision can be made whether to make use of external integration
expertise, and in a similar fashion, a decision can be made based on the integration of phase II and III about how to manage the coordination of phase III and IV.

Considering the above, we propose the division of the project into the following four phases.

7.1. Phase I: Migration of pass holders to the automated fare collection system

**Selected target date: December 2013 – October 2014**

Before the selected target date, a test period can take place with the participation of BKK employees and possibly another special group of clients.

The end of 2013 was selected as the target date so that in the first part of the phase, the full-price personalized 2014 passes can be issued in the new system (I/a sub-phase). The end of the phase is linked to the start of the school year in autumn 2014.

Thus, the central system, including for instance the online portal, will be set up by the end of 2013, the system will be prepared for handling PIA products (only passes, however) and it will be available for live use. Ticket inspectors (some of them, at least) will receive handheld devices so that they can check annual passes. By the start of the next sub-phase, all ticket inspectors will have inspector handheld devices, and the system and the devices will be able to check the travel rights of new passenger groups introduced in the sub-phase.

During the next sub-phase, I/b, passengers who use other pre-purchased full-price passes with validity longer than one month (quarterly passes and semester passes) will receive cards issued by BKK instead of the current paper coupons. These cards will be personalized as well.

With on-going quality control and error correction, the issuing of personalized BKK cards for passengers who wish to buy a full-price month pass can start after this stage in spring 2014 (sub-phase I/c). It is important to set a final date for media replacements at this point – with certain incentives to make passengers interested in procuring their cards as soon as possible. The end date needs to be during the summer holidays for practical reasons.

If the NEK system will be operational by this time, NEK integration will be part of phase I. Introduction for the various concession groups (students, pensioners) will be staggered. If the NEK system or other related preconditions are not available, concession (student, pensioner etc.) passes need to be issued on BKK cards as well, storing concession eligibility data...
centrally at BKK. There will be 2-3 months in the summer of 2014 when all (paying) passengers using a concession will need to be supplied with new travel media (sub-phase I/d). Students should receive their new media at the end of the summer break, in September and October 2014, before the start of autumn break (sub-phase I/e).

The validation procedure will not change. Passengers who use some other travel product will still need to purchase paper-based tickets, and the validity of tickets will not change.

The cards to be used as travel media are expected to be made available through BKK's new customer service, while passes will also be sold online, adding a new sales channel to the system. In addition, the possibility and justifiability of expanding the existing ticket office infrastructure already in the first phase needs to be reviewed, as well as the possibility of introducing ticket and pass controls on buses with front-door boarding and by partner transport operators.

Pass holders cannot be transitioned to the new system overnight. Several months will be needed for the transition, as several hundred thousand passengers are involved. The transition can only take place after the system goes live; cards cannot be issued until then, and their validity could not be checked.

7.2. Phase II: Implementation of ticket-type travel products

Selected target date: by the end of the first half of 2015

In parallel with the start of phase I, the preparations for phase II and will start, as well as work on the vehicles, because the most important task is the installation of ticket validators on all vehicles and metro and HÉV stations. Based on the experiences of the FUTÁR project, taking into account the implementation of the new bus operation model that is expected to be on-going in the next few years, as well as the few operator contracts that will certainly be signed by then, the installation of the approximately ten thousand validators on the vehicles of all private operators and BKV and the relevant infrastructure will certainly take several months.

The remaining travel products cannot be converted to electronic travel products until this job is completed, as time-based tickets and daily fare capping can only be used if passengers can log the start of their trip at any vehicle or station.
Entry gates are not a prerequisite of the introduction of the time-based ticket associated with electronic travel media or the fare cap: it is sufficient if the validators, to be installed on the gates later, are fully operational. In this phase, a few validators with a wireless data connection to the central system need to be installed at metro stations.

Apart from the physical installation of validators and gates, the central system also needs to be prepared for handling PAYG products. Most of the travel products that are currently purchased as paper tickets will become PAYG travel products after phase II goes live. This means that passengers will not have to know what tickets they will need and purchase them in advance; they will only need to make sure they have a sufficient balance on the money account attached to their card.

When the installation of the validators is complete, the sale of time-based tickets and day passes can start. New sales channels (ticket vending machines) will be added, and the current reseller network will need to be prepared for the new system as well.

There will be two new types of travel media on sale:

- There will be anonymous contactless plastic cards issued by BKK, aimed at occasional travellers.

- At the same time, the sale of paper-based contactless cards will start as well, as one possible option for a single trip in Budapest. For occasional travel into the suburbs, passengers will still have to buy a traditional paper ticket unless they wish to purchase a plastic card mentioned in the previous paragraph.

When determining the time period necessary for the transition to electronic tickets — as opposed to passes — there are several options:

- there is a period of overlap when both ticket types are in use. The advantage is that passengers get a chance to use up their existing tickets; no processes need to be put into place for buying tickets back, and there is no negative flow of cash.

- The other solution is a switch to new tickets without a transition. This makes logistics, sales, validation and controls easier to handle, but leftover tickets need to be bought back from passengers.

When traditional paper tickets are fully eliminated, the old validators can be gradually removed. Thus, our calculations show that ticket punchers cannot be gone from Budapest before 2015.
7.3. Phase III: Installation of automatic gates

**Selected target date: Gradually from 2014; expected to last 1-2 years,** depending on the progress of planned infrastructure development projects (e.g. H6 & H7 renovation, connection between H8/H9 and M2, possible renovation of M3).

In parallel with the installation of validators the installation of gates at stations can start. This task will take a long time, as, apart from procuring several types of permits, some construction work (modification and expansion of stations) might be necessary on top of the installation itself. If the relevant public procurement procedure is published in early 2013, the start of the installation work can be reasonably planned for early 2014. Until the use of paper tickets ends completely, the gates need to remain open. They will need to be installed with on-going passenger traffic.

This phase will be necessary if it turns out that the installation of the gates takes much more time than the other tasks in the previous phase. If this proves to be the case, the controls of travel media at metro and HÉV stations will take place in accordance with the processes of the new system, but the gates will not be operational at stations. Therefore, ticket inspectors will still need to control travel media at the entrance – perhaps in smaller numbers.

The entry gates can only be switched on when the use of all old paper travel media has been terminated. That in turn can only take place once the new validators are available and operational on all vehicles – and at every station where this is necessary.

However, the above schedule would still allow travel to suburbs with a paper ticket, which could mainly cause problems on HÉV lines, as entry at some HÉV stations may be controlled by gates. This issue has not yet been resolved; a solution will need to be found in the future.

It is also possible to switch on the entry gates at some stations before the entire network is switched on. The advantage of this solution is that automatic controls can be introduced station by station this way, gradually increasing efficiency and allowing the transfer of ticket inspectors to surface vehicles.

Finally, there is a theoretical option to switch on some of the gates at metro stations while traditional paper tickets are still in use. In this case, passengers using the new electronic media will use entry gates normally, while passengers using traditional paper tickets pass through traditional control by ticket inspectors at the entry (and occasionally at the exit).
7.4. Phase IV: Accepting contactless bank cards

**Selected target date: 2014-2015**

By the end of phase III the system itself will be a functioning unit, and will meet all the goals set for it. Phase IV will involve the introduction of an easy-to-use, cost-effective solution for occasional travellers. Passengers who have a contactless bank card will be able to use public transport services without prior registration or travel product purchase, simply by touching the card on the validator (the card does not literally need to touch the device). The PCI DSS audit needs to be successfully completed by the start of the phase.

In order for this solution to work, a contract between BKK and an acquirer needs to be in force, and the special MasterCard and Visa rules need to be in force in Hungary as well, laying down the rules of the use of contactless bank cards in public transport.

7.5. Procurement schedule

The four-phase project can be divided into the following stages from the point of view of (public) procurements:

- **Public procurement package 1**
  - supply, commissioning and operation of central system
  - devices and possibly services related to card issuing and handling
  - supply and operation of inspector handheld devices

- **Public procurement package 2**
  - supply, installation and operation of ticket validators
  - supply, commissioning and operation of ticket vending machines

- **Public procurement package 3**
  - installation and operation of high bandwidth telecommunication system
  - supply, installation and operation of entry gates, integration with validators

- **Public procurement package 4**
  - bank card merchant/acquirer services

- reseller contracts
• contract on cooperation with NEK system
• contracts with BKV and bus operators
Figure 10: Planned project schedule
7.6. Summary

Various aspects of the four phases described above are summed up in the following table:

<table>
<thead>
<tr>
<th></th>
<th>Phase I: Passes</th>
<th>Phase II: Tickets</th>
<th>Phase III: Gates</th>
<th>Phase IV: Bank cards</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIA travel products</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>not pertinent</td>
</tr>
<tr>
<td>PAYG travel products</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>travel in Budapest - pass</td>
<td>with new media</td>
<td>only with new media</td>
<td>only with new media</td>
<td>not pertinent</td>
</tr>
<tr>
<td>travel in Budapest - ticket</td>
<td>paper ticket</td>
<td>new media, time-based tickets, fare capping end of the use of paper tickets</td>
<td>only with new media, time-based tickets, fare capping</td>
<td>time-based tickets, fare capping</td>
</tr>
<tr>
<td>Travel to or from suburbs -</td>
<td>with new media</td>
<td>with new media</td>
<td>only with new media</td>
<td>not pertinent</td>
</tr>
<tr>
<td>pass</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel to or from suburbs -</td>
<td>paper ticket</td>
<td>new travel media or paper ticket</td>
<td>only with new media</td>
<td>yes</td>
</tr>
<tr>
<td>ticket</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>travel media in use</td>
<td>Personalized</td>
<td>Personalized cards issued by BKK, anonymous cards issued by NEK or BKK, smart</td>
<td>Personalized cards issued by BKK, anonymous cards issued by NEK or BKK, smart</td>
<td>Personalized cards issued by BKK, anonymous cards issued by NEK or BKK, smart</td>
</tr>
<tr>
<td></td>
<td>cards</td>
<td>paper, traditional paper tickets (gradually eliminated)</td>
<td>paper</td>
<td>paper</td>
</tr>
<tr>
<td>validators</td>
<td>only old hole</td>
<td>new validators appear, in parallel with old devices use of old ones terminates at</td>
<td>only new</td>
<td>only new</td>
</tr>
<tr>
<td></td>
<td>punchers,</td>
<td>end of phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>time-stamp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>validators</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspector handheld devices</td>
<td>introduced,</td>
<td>present, only partially in use</td>
<td>fully in use</td>
<td>fully in use</td>
</tr>
<tr>
<td></td>
<td>fully by the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>end of the phase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gates</td>
<td>none</td>
<td>may appear, but always open</td>
<td>present, operating</td>
<td>present, operating</td>
</tr>
</tbody>
</table>

**Table 10: Proposal for introduction schedule**
8. Cost estimate

8.1. Estimate of the cost of the entire system

<table>
<thead>
<tr>
<th>Item</th>
<th>Number of pieces</th>
<th>Unit cost (EUR)</th>
<th>Cost total (EUR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central system, inspector handheld devices (hardware, software licences)</td>
<td></td>
<td></td>
<td>3,000,000</td>
</tr>
<tr>
<td>Cards, card issuing</td>
<td>3,000,000</td>
<td>1.5</td>
<td>4,500,000</td>
</tr>
<tr>
<td>Marketing communication campaigns</td>
<td></td>
<td></td>
<td>2,000,000</td>
</tr>
<tr>
<td>Validators, including installation (buses, trams, trolleybuses, metro entry gates)</td>
<td>10,000</td>
<td>1,000</td>
<td>10,000,000</td>
</tr>
<tr>
<td>Supply and installation of ticket vending machines</td>
<td>250</td>
<td>25,000</td>
<td>6,250,000</td>
</tr>
<tr>
<td>Supply and commissioning of subsector distribution server systems (metro and HÉV stations, other sites)</td>
<td>150</td>
<td>20,000</td>
<td>3,000,000</td>
</tr>
<tr>
<td>Supply and installation of entry gates (M1, M2, M3, M4, some HÉV stations)</td>
<td>500</td>
<td>30,000</td>
<td>15,000,000</td>
</tr>
<tr>
<td>Project management and preparation on the client’s side, project management on the supplier’s side</td>
<td></td>
<td>12%</td>
<td>5,250,000</td>
</tr>
<tr>
<td><strong>Investment total</strong></td>
<td></td>
<td></td>
<td><strong>49,000,000</strong></td>
</tr>
</tbody>
</table>

Table 11: Project costs breakdown

Lines of the table that are not detailed here are discussed in the following subchapter as part of the cost estimate for the introduction of phase I.
The 1000 EUR flat rate cost for validators includes installation on vehicles. The number of validators necessary was calculated based on the size of the available vehicle fleet, in accordance with the issues noted in the section on the devices. The average device price includes installation costs. If large numbers of new vehicles are put into service, significant costs savings can result from preparing cabling at the future location of validators in the handrail tubes already in the factory, or even installing the validators themselves there.

At the time of the writing of the present study, approximately 250 ticket vending machines operate in Budapest. This is the number we based our plans on. Naturally, while the number of ticket vending machines will be the same, the locations can be different, and there will be very large technological differences in their operation.

Our assumption is that a small local server system will need to be installed at all depots and all gated stations, which makes the operation and repair of devices on buses, trolleybuses and trams easier, and in the case of metro station entry gates, the station manager system will ensure the operation of gates in "orphan" mode when the computer network or the central gate control system is down, and it will have monitoring and coordination functions in normal circumstances as well.

We calculated based on international experience that the design, permits and installation of a "passenger corridor" will cost – including the price of the gate itself – 30,000 euros on average. A passenger corridor is taken to be a path between two gate bodies, through which passengers can enter or exit the area of a metro station.

The number of gates was determined in part based on earlier plans, and in part based on new, cautious calculations and the plans of the M4 stations. The capacity of approximately 500 "passenger corridors" can cover the installation of gates on a few HEV stations.

All subtotals – and thus the grand total as well – contain a cca. 10% reserve.

8.2. Estimate of phase I costs

Phase I includes setting up the entire central system, as well as partial mass card issuing. The indicated number of cards covers the replacing of all travel media; the number of cards necessary for pass holders is estimated to be half of the total based on passenger traffic data. Naturally, this number may be reduced further if those who are eligible for a concession
receive their contactless NEK cards by the end of 2013 and can use it in the automated fare collection system.

The manufacturing cost of each card is no more than one euro. Calculating with a distribution cost of 5 euros per card, subtracting the estimated purchase price of 3.5 euros (HUF 1000), we arrive at a per-unit cost of 1.5 euros.

A marketing communication campaign on the various changes is necessary before the launch. Approximately half of the above communication budget is related to phase I.

Thus, the estimated cost of phase I is:

<table>
<thead>
<tr>
<th>Item</th>
<th>Number of pieces</th>
<th>Unit cost</th>
<th>Cost total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central system, inspector handheld devices (hardware, software licences)</td>
<td></td>
<td></td>
<td>EUR 3,000,000</td>
</tr>
<tr>
<td>Cards, card issuing</td>
<td>1,500,000</td>
<td>EUR 1.5</td>
<td>EUR 2,250,000</td>
</tr>
<tr>
<td>Marketing, communication</td>
<td></td>
<td></td>
<td>EUR 1,000,000</td>
</tr>
<tr>
<td>Supplier side project management</td>
<td></td>
<td>12%</td>
<td>EUR 750,000</td>
</tr>
<tr>
<td>Project preparation and project management on the client side</td>
<td></td>
<td></td>
<td>EUR 600,000</td>
</tr>
<tr>
<td><strong>Investment total (EUR)</strong></td>
<td></td>
<td></td>
<td>EUR 7,600,000</td>
</tr>
<tr>
<td><strong>Investment total (HUF)</strong></td>
<td></td>
<td></td>
<td>HUF 2.43 billion</td>
</tr>
</tbody>
</table>

Table 12: Project cost breakdown of phase I
9. Financing Options

The total investment cost of the automated fare collection system is approximately HUF 15 billion\(^\text{11}\), which justifies reviewing as many financing options as possible. The financing option chosen and the way the project is run are interrelated.

The resource-intensiveness of the full implementation of the system is the main reason why the staggered launch is proposed. The completion of phase I requires approximately HUF 2.5 billion\(^\text{11}\). This can be covered by the Municipality of Budapest alone. In order to be able to meet the proposed schedule, this sum needs to be secured by June 2012.

Our primary goal is to implement the project as a European Union project, with EU co-financing. This requires the support of the Hungarian Government, which has not yet been secured. Government support of the project is in the public interest: the system will significantly reduce abuse of the legally mandated travel concessions provided by the state to certain social groups (students, pensioners etc.) and the possibilities of fare evasion – these abuses are estimated to cause billions of forints of damage each year. The formalized feasibility study was prepared in accordance with the methodology required for EU co-financing and includes a cost-benefit analysis, i.e. a calculation of the return on investment.

As we currently do not have Government backing for starting the project, meeting the schedule described in Chapter 0 would require own capital or a bank loan. If own capital is available, the preparation of the first phase of the project can start virtually immediately. If a bank loan is to be used, we recommend initiating talks with the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD), as financing the project through commercial banks would require a different approach than financing through the two above institutions set up for financing public projects of this type. In order to be able to start implementing the project with EIB or EBRD financing, but keep open the option of

\(^{11}\) Net sum calculated at an exchange rate of 320 HUF/EUR. The estimated cost does not include the setting up of new BKK customer service points or the adaptation of existing ticket offices.
converting it into an EU project later, the methodology for the calculation of return on investment should be cleared with the banks, the National Development Agency, JASPERS, and, if necessary, EU institutions as well. Therefore, the structure and nature of the present study follows – wherever possible – the methodology prescribed for the feasibility studies of EU transport development projects (e.g. review of alternatives). With a view to the goal of EU co-financing, EU public procurement principles must be fully respected from the very beginning, irrespective of the financing used in the initial phase.

EU projects also require return on investment calculations and cost-benefit analyses. There are two ways of calculating the return on investment in case of an electronic fare collection system in an urban public transport system. In one model, the fare revenue is considered to be the revenue of the automated fare collection system, which will likely show the project paying for itself financially. In the other model, the entirety of the public transport system is considered, in which case, even a modern automated fare collection system is unlikely to cause the entire system to ever generate a profit; therefore, this model cannot show the project as paying for itself financially; it can be demonstrated as socially useful at best. The two models are vastly different, and therefore the ROI calculation method to be used is closely tied to the project financing method chosen. The above mentioned institutions need to be consulted in order to convert the present study into a formal feasibility study with an appropriate cost-benefit analysis.

It should be noted that in case of EU co-financing, BKK or the Municipality of Budapest needs to provide a certain amount of funding as its own contribution. This is expected to be provided from an EIB loan as in previous EU-backed infrastructure development projects.

It is important to note that the EIB and the EBRD have provisionally noted their interest in providing a loan for an automated fare collection system project, but concrete negotiations were not held in 2011 on this issue.

Financing the project from a loan from a commercial bank will only be considered if EU co-financing and EIB and EBRD loans are not available. This model should only be discussed in detail if it becomes the only remaining option.

Theoretically, the system could be constructed without any own investment (i.e. without any investment by the Municipality of Budapest), in a PPP arrangement where the supplier provides the financing in return for operating the system for several years. Phase I in itself is
not large enough for this model. While the entire system is suitable for this model in terms of the economies of scale, but – learning from BKV’s 2006 tender and some other larger national PPP infrastructure investment projects, this option is only recommended as a last resort.

Considering the above, the action to be taken for financing can be summed up as follows:

- The Municipality of Budapest provides the 2.5 billion forints necessary for phase I from its own resources or credit so that the public procurement call can be issued in mid-2012
- BKK does its utmost to secure the Government’s support for EU co-financing
- BKK requests a mandate from the Municipality of Budapest for negotiations with the EIB and the EBRD on a loan for the entire project and a proposal to be submitted to the Municipality
- The methods for preparing the feasibility study and calculating the return on investment that are acceptable for all possible (co)financers are chosen with the organisations involved
- BKK collects more information on supplier financing through continued market research
10. Action Plan

The preparatory work that has already started with a view to introducing the proposed automated fare collection system needs to continue. In order to maintain the project schedule, as many as possible of the below tasks will need to be completed in 2012.

- Continuation of the work within the framework of a project organization based on the pre-feasibility study, its expansion as needed by expert competences
- Cooperation with the NEK system with a view to the online verification of concessions and the acceptance of NEK cards as travel media
- Studying the methods and possibilities of travel media manufacturing, preparation of detailed cost-benefit analyses on internal and outsourced production
- Further review of the revenues, costs and locations of the existing sales network, consideration of possible optimizations
- Preparation of impact study on smart paper and anonymous BKK card sales, including the possibility of sale by drivers and resellers
- Preparation of future reseller model, analysis of effects
- Adapting the pre-feasibility study to European Union methodology, consultation with relevant national and EU bodies
- Preparation of ROI calculations relying on external expertise, verification of source data, systematic evaluation of passenger traffic, fare evasion and counterfeiting data
- More detailed analysis and correction of investment and operation costs
- Carrying out negotiations on project financing options with banks, making a proposal on project financing option to be chosen
- Preliminary negotiations and preparation for PCI DSS compliance
- Preparation of detailed legal work plan, taking the necessary steps
- Drawing up more detailed IT architecture model and operation and organization models, assessing necessary resources
• Drawing up detailed public procurement plan and project plan

• Preparation of the public procurement call and technical specification for the first project implementation phase, starting the public procurement procedure if the owner provides financing

• Preparation of subsequent project phases so that the schedule can be maintained

• Continuation of market research among suppliers capable of providing the entirety or part of the system, in order to identify the best solution and more precisely determine project costs

• Detailed review of possibilities of cooperation with the FUTÁR system

• Measuring passenger flow in the metro network, fixing the details of the principle of operation, practice and technical specifications of the automatic metro gates, including a review of the necessary infrastructure changes at stations

• Preparation of study on fares and the validity of the time-based tickets (necessary for establishing the fare cap system and the exact principle and practice of its operation) Finalizing the travel product list.

• Setting up cooperation with Hungarian card issuers regarding the use of contactless bank cards, negotiating the details of the model, choosing and documenting the "open" data transmission protocol with the assistance of international card companies.

• Drawing up the technical and commercial details of the connection to the future national transport settlement system.

• Further discussions and cooperation with the ministry responsible for transport as the body responsible for suburban transport and regional partner providers (MÁV-START, Volán).

• Coordination with civil society organisations

• On-going quality assurance of the project, determination of indicators

• Detailed risk analysis, drawing up risk management strategy and action plan
• Monitoring similar implementations in progress around the world (Chicago, London, New
  York, Philadelphia), establishing direct contact with the transport organizers / transport
  service providers of these cities (CTA, TfL, MTA, SEPTA)
• Negotiations and preparatory work regarding issues that fall in the remit of the National
  Transport Authority
• Initiating permit procedures and procuring permits for installing devices (e.g. metro
  entry/exit gates, validators to be installed at HÉV platforms etc.).

Due to the complexity of the project, the above list is not exhaustive; it will need to be
corrected and expanded on an on-going basis as the project progresses.
## 11. Annexes

### 11.1. Dictionary

<table>
<thead>
<tr>
<th>Concept</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fare capping / best fare calculation</td>
<td>In accordance with the fare structure, passengers receive a pay pass automatically after using a certain number of time-based tickets within a given period, i.e. they can travel for free after reaching the limit until the end of the period (e.g. a day pass is awarded after using three time-based tickets). This fare structure makes it possible for passengers to always pay the best fare without having to decide in advance how much they will travel in the given period.</td>
</tr>
<tr>
<td>Zonal fare system</td>
<td>This means that the access points of public transport services, i.e. the stops and stations are grouped into zones. Travel to stops and stations in the same zone costs the same.</td>
</tr>
<tr>
<td>Server-based system</td>
<td>All travel-related information is stored on the central server of the system. The validators on board vehicles and on metro stations are constantly connected to the back office system. The travel media only contains a small amount of data, and it does not store travel products. The data necessary for validation, control etc. is stored in the back office system.</td>
</tr>
<tr>
<td>NEK card</td>
<td>Card issued within the Unified National Card System.</td>
</tr>
<tr>
<td>BKK cards</td>
<td>Card issued by the Centre for Budapest Transport.</td>
</tr>
<tr>
<td>Travel product</td>
<td>The collective name of passes and tickets in the system</td>
</tr>
<tr>
<td>Travel media</td>
<td>The object that the travel product is issued on. Currently, single tickets and passes are printed on paper, i.e. they are based on paper media. After the launch of the automated fare collection system, travel products will be associated with contactless cards, i.e. they will be issued on contactless card travel media.</td>
</tr>
<tr>
<td>FUTÁR</td>
<td>Traffic control and passenger information system.</td>
</tr>
<tr>
<td>NFC</td>
<td>A communications standard based on contactless technology, which provides close-range (8-10 cm) communication between two devices.</td>
</tr>
<tr>
<td>PAYG (Pay as you go) travel</td>
<td>Travel charges are settled after travel, charging the passenger's money account.</td>
</tr>
<tr>
<td><strong>PIA (Pay in advance) travel</strong></td>
<td>The passenger purchases a travel product in advance, before using public transport services.</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>AFC</strong></td>
<td>Automated fare collection system, i.e. an electronic ticket system.</td>
</tr>
<tr>
<td><strong>PCI DSS (Payment Card Industry Data Security Standard)</strong></td>
<td>A standard created by the Payment Card Industry Security Standards Council, which contains technical and operational safety requirements (e.g. on the storage and processing of card holder data). Its goal is to minimize fraud, data theft and other security threats against card accepting organizations.</td>
</tr>
<tr>
<td><strong>Smart paper</strong></td>
<td>Paper-based travel media type that offers a higher level of security than the current paper tickets, relying on contactless technology (NFC).</td>
</tr>
<tr>
<td><strong>Check-in</strong></td>
<td>Validation of travel media when starting a ride.</td>
</tr>
<tr>
<td><strong>Check-out</strong></td>
<td>Validation of travel media when ending a ride.</td>
</tr>
<tr>
<td><strong>Registration</strong></td>
<td>In case of BKK and NEK cards and contactless bank cards issued by third parties, the card holder can request access to BKK's online portal, through which they can access information on the transactions carried out with their card, and initiate certain transactions.</td>
</tr>
<tr>
<td><strong>Contactless bank cards</strong></td>
<td>Bank card issued by any bank following the joint standard of American Express, JCB, VISA and MasterCard (EMV) that supports contactless payment (payWave, PayPass).</td>
</tr>
<tr>
<td><strong>Black list / deny list</strong></td>
<td>A list of cards that cannot be used in the automated fare collection system (e.g. because they were disabled or have expired).</td>
</tr>
</tbody>
</table>
11.2. BKV's current travel products and their future

<table>
<thead>
<tr>
<th>Current product</th>
<th>Future name, name of replacement product if discontinued</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single ticket</td>
<td>0 (BP) zone time-based ticket</td>
</tr>
<tr>
<td>Single ticket purchased on the spot</td>
<td>to be determined</td>
</tr>
<tr>
<td>Transfer ticket</td>
<td>discontinued, 0 (BP) zone time-based ticket</td>
</tr>
<tr>
<td>10-piece discount coupon book</td>
<td>discontinued, 0 (BP) zone time-based ticket</td>
</tr>
<tr>
<td>Short section metro ticket for 3 stops</td>
<td>discontinued, 0 (BP) zone time-based ticket</td>
</tr>
<tr>
<td>Conurbation single ticket 5-10 km</td>
<td>zone 1-2 single ticket</td>
</tr>
<tr>
<td>Conurbation single ticket 5-10 km with 50% discount</td>
<td>zone 1-2 single ticket with 50% discount</td>
</tr>
<tr>
<td>Conurbation single ticket 5-10 km with 90% discount</td>
<td>zone 1-2 single ticket with 90% discount</td>
</tr>
<tr>
<td>HÉV ticket 5-30 km</td>
<td>zone 1-6 single ticket</td>
</tr>
<tr>
<td>HÉV ticket 5-30 km with 50 % discount</td>
<td>zone 1-6 single ticket with 50% discount</td>
</tr>
<tr>
<td>HÉV ticket 5-30 km with 90 % discount</td>
<td>zone 1-6 single ticket with 90% discount</td>
</tr>
<tr>
<td>Budapest 24-hour travel card</td>
<td>Budapest 24-hour travel card</td>
</tr>
<tr>
<td>Budapest 24-hour group travel card</td>
<td>Budapest 24-hour group travel card</td>
</tr>
<tr>
<td>Budapest 7-day travel card</td>
<td>Budapest 7-day travel card</td>
</tr>
<tr>
<td>Budapest 72-hour travel card</td>
<td>Budapest 72-hour travel card</td>
</tr>
<tr>
<td>Discount group student ticket</td>
<td>Discount group student ticket</td>
</tr>
</tbody>
</table>

Table 13: Tickets

---

12 rate governed by interurban fare decree
<table>
<thead>
<tr>
<th>Current name of product</th>
<th>Future name, name of replacement product if discontinued</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budapest Card</td>
<td>Budapest Card</td>
</tr>
<tr>
<td>Blank tickets filled in by hand</td>
<td>discontinued, products sold individually</td>
</tr>
<tr>
<td>Ticket for travel on credit</td>
<td>Ticket for travel on credit</td>
</tr>
<tr>
<td>Ticket for the Sikló funicular railway</td>
<td>Ticket for the Sikló funicular railway</td>
</tr>
<tr>
<td>Children’s ticket for the Sikló funicular railway</td>
<td>Children’s ticket for the Sikló funicular railway</td>
</tr>
<tr>
<td>Return ticket for the Sikló funicular railway</td>
<td>Return ticket for the Sikló funicular railway</td>
</tr>
<tr>
<td>Children’s return ticket for the Sikló funicular railway</td>
<td>Children’s return ticket for the Sikló funicular railway</td>
</tr>
<tr>
<td>Discounted ticket for the Sikló funicular railway</td>
<td>Discounted ticket for the Sikló funicular railway</td>
</tr>
<tr>
<td>Discounted return ticket for the Sikló funicular railway</td>
<td>Discounted return ticket for the Sikló funicular railway</td>
</tr>
<tr>
<td>Wheelchair ticket for the Sikló funicular railway</td>
<td>Wheelchair ticket for the Sikló funicular railway</td>
</tr>
<tr>
<td>Full-price ticket for the Libegő chairlift</td>
<td>Full-price ticket for the Libegő chairlift</td>
</tr>
<tr>
<td>Discount ticket for the Libegő chairlift</td>
<td>Discount ticket for the Libegő chairlift</td>
</tr>
<tr>
<td>Full-price return ticket for the Libegő chairlift</td>
<td>Full-price return ticket for the Libegő chairlift</td>
</tr>
<tr>
<td>Discount return ticket for the Libegő chairlift</td>
<td>Discount return ticket for the Libegő chairlift</td>
</tr>
<tr>
<td>Free ticket</td>
<td>Free ticket</td>
</tr>
</tbody>
</table>

*Table 14: Other tickets, including tickets for Sikló and Libegő, operated by BKV but not forming part of the public service transport network.*
### Table 15: Passes

<table>
<thead>
<tr>
<th>Current product</th>
<th>Future name, name of replacement product if discontinued</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Budapest pass</td>
<td>Monthly Budapest pass</td>
</tr>
<tr>
<td>Monthly Budapest pass for students</td>
<td>Monthly Budapest pass for students</td>
</tr>
<tr>
<td>Monthly Budapest pass for pensioners</td>
<td>Monthly Budapest pass for pensioners</td>
</tr>
<tr>
<td>Monthly Budapest pass for parents with small children</td>
<td>Monthly Budapest pass for parents with small children</td>
</tr>
<tr>
<td>Bicycle pass</td>
<td>Bicycle pass</td>
</tr>
<tr>
<td>14-day Budapest pass</td>
<td>14-day Budapest pass</td>
</tr>
<tr>
<td>Quarterly Budapest pass</td>
<td>Quarterly Budapest pass</td>
</tr>
<tr>
<td>Quarterly Budapest pass for students</td>
<td>Quarterly Budapest pass for students</td>
</tr>
<tr>
<td>Quarterly Budapest pass for pensioners</td>
<td>Quarterly Budapest pass for pensioners</td>
</tr>
<tr>
<td>Semester Budapest pass</td>
<td>discontinued, Monthly Budapest pass for students</td>
</tr>
<tr>
<td>Conurbation pass, 5-10 km</td>
<td>zone 1-2 pass</td>
</tr>
<tr>
<td>Conurbation student pass, 5-10 km</td>
<td>zone 1-2 student pass</td>
</tr>
<tr>
<td>Conurbation local pass</td>
<td>discontinued, zone 1 pass</td>
</tr>
<tr>
<td>Conurbation local student pass</td>
<td>discontinued, zone 1 student pass</td>
</tr>
<tr>
<td>Conurbation local pensioner pass</td>
<td>zone 1 (local) pensioner pass</td>
</tr>
<tr>
<td>HÉV pass 5-30 km</td>
<td>zone 1-6 pass</td>
</tr>
<tr>
<td>HÉV pass 5-30 km for students with 90% disc</td>
<td>zone 1-6 student pass</td>
</tr>
<tr>
<td>Annual Budapest pass at monthly price</td>
<td>discontinued, Monthly Budapest pass</td>
</tr>
<tr>
<td>Annual Budapest pass for students at monthly price</td>
<td>discontinued, Monthly Budapest pass for students</td>
</tr>
<tr>
<td>Discounted annual Budapest pass</td>
<td>annual Budapest pass</td>
</tr>
<tr>
<td>Discounted annual Budapest pass for students</td>
<td>annual Budapest pass for students</td>
</tr>
<tr>
<td>Discounted annual Budapest pass for pensioners</td>
<td>annual Budapest pass for pensioners</td>
</tr>
<tr>
<td>Annual all-line Budapest pass</td>
<td>discontinued, annual Budapest pass and annual six-zone conurbation pass</td>
</tr>
<tr>
<td>Annual Budapest pass without photo</td>
<td>discontinued</td>
</tr>
<tr>
<td>Ticket associated with special event, 1-10 days</td>
<td>0 (BP) zone ticket associated with event, 1-10 days</td>
</tr>
<tr>
<td>Combined ticket, 1-10 days</td>
<td>0 (BP) zone combined ticket, 1-10 days</td>
</tr>
</tbody>
</table>

13 depends on number of days, between 1,200 and 5,300
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[BKSZ, 2009a] BKSZ tarifaközösség koncepciója (BKSZ joint fare system plan), amended based on the opinion of the BKSZ Joint Fare System Expert Group, Budapest, 8 May 2009. (Author: Dr. Zsolt Denke)


Information provided by BKV:

- network data
- vehicle fleet data
- validator data
- sales channel cost and sales data
- ticket control activity data

A fizetési kártya üzletág Magyarországon (The payment card business in Hungary), publication of the National Bank of Hungary, Budapest 2011.