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Policy paper on infrastructure

On the move: delivering automated fare collection

European Bank
for Reconstruction and Development

Contents

1. Introduction

Automated fare collection (AFC) systems are a key component of sustainable, high-quality urban transport services. However, their introduction is a complex and far-reaching endeavour that affects all parts of a transport organisation, significantly increases user interaction with the transport service and may take several years to complete. In short, AFCs are far from being simple IT projects.

Successful projects have acknowledged early on that setbacks and changes along the way are not exceptional but, rather, to be expected. However, with good preparation and delivery, and a responsible private sector partner, there is no reason that AFC cannot succeed and become a key element of an accessible, high-quality public transport service.

Despite its potential, the uptake of AFC remains low throughout the countries of operations of the European Bank for Reconstruction and Development (EBRD), and mainly limited to the largest capitals and cities. Further expansion is constrained by a number of obstacles. These require specific responses to their regulatory, contractual and legal context and operational environment. Moreover, the complex nature of these obstacles requires specific skills and the capacity to prepare and deliver solutions, critical factors in the success of AFC projects. For these purposes, cities increasingly seek support from funding entities such as the EBRD.

In response to these needs, this policy paper on AFC is aimed at city officials and public authorities. It seeks to inform and guide the introduction, upgrade or expansion of their systems through identification, design, delivery and operation.

This paper addresses the objectives, challenges and lessons learned from AFC schemes, with a particular focus on emerging markets and second-tier cities with limited resources. It focuses on defining the challenges and their importance to the AFC sector, and introduces a range of project and policy solutions including best-practice, market-driven approaches and other commercial alternatives that have been used successfully. It supports transition and reform for efficient, accountable revenue collection and the promotion of sustainable public transport systems, compatible with funding support from the EBRD and other lending institutions.

This AFC policy paper has been prepared by the EBRD, with funding provided by its Infrastructure Project Preparation Facility (IPPF). While the paper reflects widely held views and opinions, it does not necessarily reflect the views of the EBRD and is not intended to be exhaustive. Clients are advised to seek specific advice from industry experts for their own project development.

2. EBRD policy dialogue on automated fare collection

Recent EBRD policy dialogue in 2016 on automated fare collection engaged participants from the public sector to discuss their experience and methods of designing and delivering AFC projects and of engaging the private sector. A total of 11 city authorities took part, from Georgia (Tbilisi), Hungary (Budapest), Romania (Galati, Iasi and Pitesti), Serbia (Belgrade) and Ukraine (Ivano-Frankivsk, Kiev, Lviv, Odessa and Vinnytsia).

The policy dialogue work took place in three stages:

- Pre-event dialogue and a questionnaire were undertaken, to identify the current status of AFC developments, issues experienced and/or intentions for future AFC systems.[1]
- An AFC seminar was held on 7 and 8 November 2016. It comprised a visit to TfL, London, covering development of AFC systems including Oyster and EMV, and a one-day seminar in London with case study presentations from other cities that have implemented such schemes (Belgrade, Serbia, and Reading, UK), together with presentations by AFC technical experts and dialogue between public sector participants on lessons learned and best practice.
- Building on the first two stages of policy dialogue, this paper presents guidance and suggests approaches to the identification, design, delivery and operation of AFC systems.

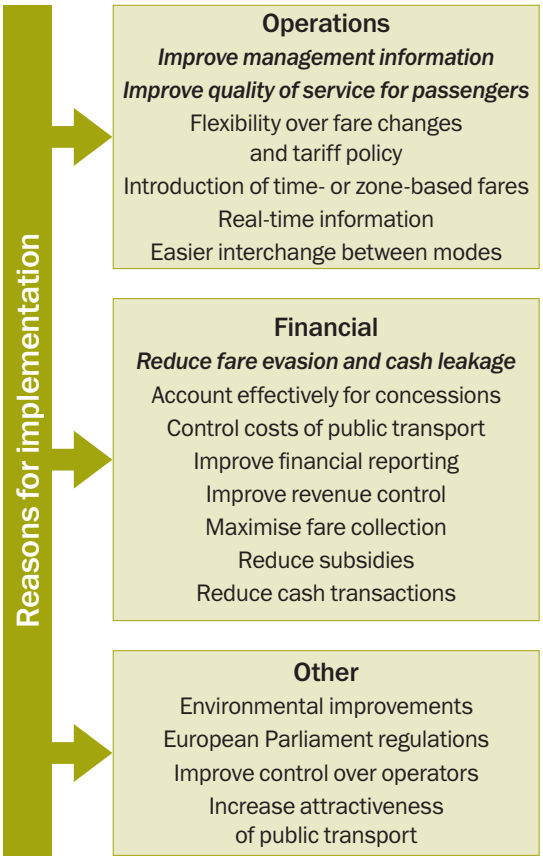
[1] Refer to Annex 1 for the questionnaire and Annexes 2 and 3 for results.

3. Rationale for AFC

3.1 Objectives

The reasons for implementing or considering AFC schemes vary, as illustrated in Figure 1.

Figure 1: Reasons for introducing AFC



(The three most common reasons are shown in italics)

Source: AFC survey November 2016.

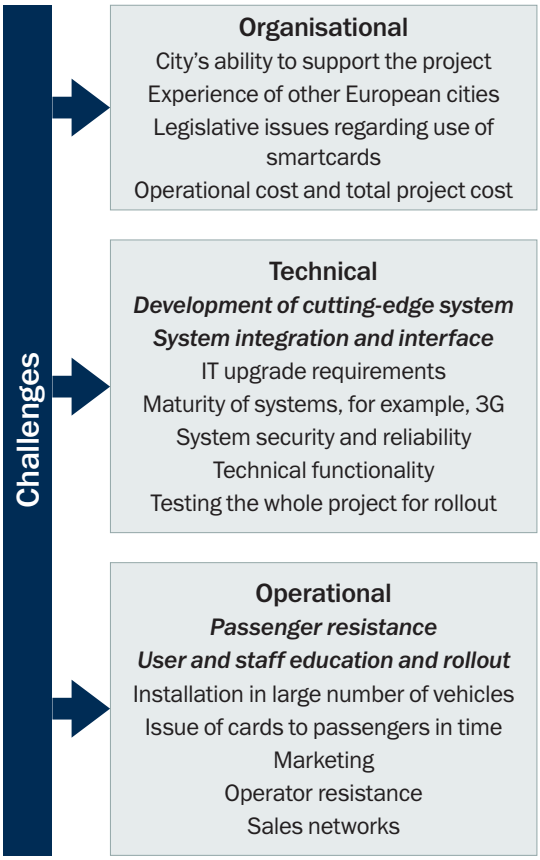
Reducing cash leakage and improving management's information and control are often quoted as the main reasons for implementing AFC. This is to be expected as many systems still rely on drivers to collect on-board fares. Notably, AFC addresses a predominant objective of controlling and reducing public subsidy by reducing cash leakage and fare evasion and by accounting accurately for concession subsidies.

Replacing the existing methods of fare collection with simple electronic passes is often the starting point to reforming the system. It may be particularly suited to smaller cities with limited financial or management resources for a comprehensive scheme and for which gradual change may be suitable.

3.2 Challenges

Figure 2 summarises the challenges faced in implementing an AFC project.

Figure 2: Challenges in introducing AFC systems



(The four most common reasons are shown in italics)

Source: AFC survey November 2016.

While some of these challenges may be expected – for example, a city's ability to support a project and its lack of experience with such projects – common opinion suggests that certain issues must be addressed, such as resistance from passengers, and the education of users and staff. Thus, although AFC systems and their technology are becoming more familiar and accepted in Europe, understanding of AFC systems is less widespread in many countries. Communication methods must therefore be carefully considered to encourage public acceptance and the development of skills.

A number of other challenges, such as the maturity of systems (for example, 3G or 4G communications systems), or legislative issues regarding the use of smartcards, are often not identified but can become very real for some cities during AFC implementation.

3.3 Policy environment

The introduction of an AFC system is a key urban transport initiative for many cities. It is either achieved as a project in its own right or as part of a much wider programme, including components such as the renewal of bus fleets or related measures to encourage greater use of public transport.

Yet, while many cities wish to implement these systems, few seem able to do so. On the face of it, it may appear that implementing an AFC system is no more complicated than a large information technology-based project. However, it is not that simple.

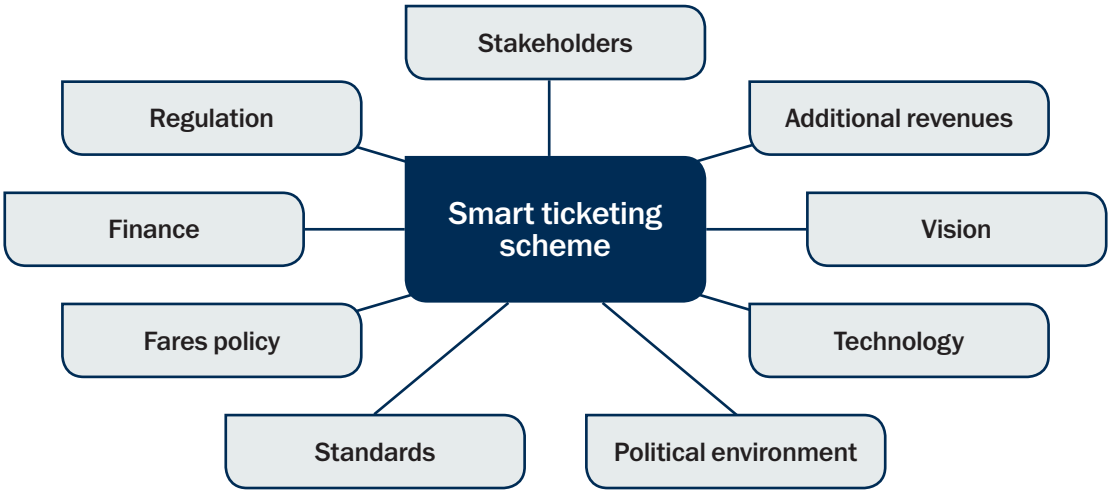
An AFC system interfaces with almost every part of a transport system. It has to be reliable. It interfaces with the end-user, has numerous moving parts, a high public profile and it deals with a critical and sensitive area of any transport organisation, namely its fare revenue.

Moreover, AFC schemes are highly dependent on a range of policy issues as shown in Figure 3.

AFC systems are not a commodity like other IT systems. Their interfaces are numerous and their interlinked, interdependent nature means that they are also complex. Consequently, projects often take longer than planned to implement or their costs overrun. They may not achieve all of their objectives and, in some cases, are abandoned altogether. Failure or delay may be due to regulatory issues, insufficient planning, budget limitations, technological problems, insufficient skills and capacity, inadequate implementation, or political interference.

Whatever the reason, a project that fails or is failing is very much in the public domain. It endangers the credibility and reputation of the transport entity and its political masters. Anticipating and avoiding these issues is, therefore, vital for the successful implementation of an AFC system.

Figure 3: Policy environment for AFC



3.4 Extending the reach of AFC

AFC systems are currently operated mainly in the larger capital cities worldwide. These are complex systems, usually in cities that have multi-modal transport, a large, affluent middle-class ridership, and complex fare structures as well as considerable management expertise and financial resources.

These systems also employ state-of-the-art technology and have been set up to solve specific ticketing or customer-centric problems within each city. Such problems include lowering levels of fraud, reducing queues at ticket offices or gate-lines and improving the customer experience. Moreover, implementation has often been in conjunction with other improvements in urban transport such as renewal of a vehicle fleet, or introduction of a new metro line or system.

These schemes are serviced by a limited number of large private sector contractors who provide a fully outsourced service to their customers. They are financed in various ways: public-private partnerships (PPPs), private finance initiatives (PFIs), bank loans or direct public funding, normally on a 'design, build, operate and maintain' (DBOM) basis.

The challenge for smaller cities is to introduce similar systems, adapted to the specific issues and objectives of their transport systems. They need to be affordable, have clear objectives and be introduced with minimum disruption for the transport entity and the travelling public.

4. Guidelines for AFC implementation

AFC is a highly adapted tool which can support the financial sustainability and development of public transport services. It provides a real opportunity for a step-change in the level of service quality for users, through new fare structures, ticketing and the information available to users.

However, AFC remains a tool. In order to be effective, it requires a stable operating environment, in which multiple operators are willing to entrust fare collection to a separate entity that will distribute fare revenues fairly and efficiently through a settlement system. At a system level, it requires new skill sets to develop and operate the system that are often not readily available in the local or even regional market.

However, greater understanding and awareness of the issues and solutions for AFC development, combined with new technology, are opening the possibilities offered by AFC systems to cities worldwide.

4.1 Defining and preparing an AFC Scheme

4.1.1 Vision and objectives of an AFC scheme

It is very important to consider the issues that the introduction or improvement of AFC systems can solve. These issues will vary from city to city. Some overriding objectives apply to any scheme, for example, fraud reduction, removing on-board payments or improving customer experience. However, there may be other objectives which might apply to a particular city. For example:

- In the Netherlands, the metro system was gated to prevent stations from being populated by vagrants at night.
- In London, a key motivation was to minimise revenue leakage, while also increasing gate throughput and avoiding station overcrowding. Under conventional magnetic-strip systems, the maximum throughput is 25 people per minute; for smartcards, this rises to 40 people per minute.

In emerging economies, the main goals of AFC systems are often cited as being the reduction of fraud and cash leakage and improving information for the effective management of the system. While the ultimate aim may be to get cash off vehicles, some cash sales on-board may need to continue in the short or medium term. Thought should be given to city-specific factors when establishing the vison and objectives of an AFC scheme, as indicated below.

Figure 4: Establishing the vision and objectives of an AFC scheme

EXPERIENCE
Organisational – areas where organisations want to improve Staff – understand where areas of improvement are needed Global – experience from other schemes that can be replicated
KNOWLEDGE
Market business and trends – application of technology trends to fare-collection environment Resources and skills – skills are required across the whole organisation to implement a major change project
INSPIRATION
Seeing current facts in the context of the future Needing to understand long-term trends in technology and the impact they will have

The objectives of a scheme also shape the way the system is specified and how it is implemented. If there are short- and long-term aims, such as adding EMV at a later date or accepting another currency of payment, this flexibility needs to be considered at an early stage. In such cases, a modular approach may offer a more adapted solution.

4.1.2 Developing political support and engagement

Political support for an AFC scheme is critical, although it should be based on a well-defined scheme. The scheme must demonstrate that it fulfils a clear transport need, both for the authorities and for the users, present a financially robust business case and offer benefits to the end-user. Such a project is a strong basis on which to build political consensus.

AFC schemes that are promoted based on a poorly conceived concept, without clear cost benefits or objectives, will struggle through the trials of project funding and delivery. Similarly, implementation close to electoral timetables can introduce disruptive pressures on the project schedule, especially to 'go live' before an election date.

Fare policy or tariff is often a political issue. Some fare options in larger cities, such as zone- or time-based ticketing, fare calculation formulae, or differential pricing, may be unachievable in the initial stages. There needs to be a clear understanding that tariff and AFC design are closely related. For example, in London, if the bus fare was not a flat fee but rather zonal, not only would a check-out terminal be required, but exiting from a bus would be slowed and customer discipline to remember to check out would need to be reinforced.

Moreover, the AFC system should, where possible, be 'future-proofed', that is, able to adapt to future expansion of fare options and the system's reach as well as to respond to possible changes in user profile and fare structure.

Furthermore, it is important to exercise caution in accepting political imperatives which may be detrimental to the AFC system, for example, combining AFC systems with an existing national card scheme such as student or pensioner's concession card. This approach involves a third party, which often leads to issues with regard to compatibility, card ownership and issuance, all of which can slow the development of AFC or stop it completely, while issues linked to vested interests are resolved.

4.1.3 Defining institutional or regulatory set-up, including operations

Successful implementation of AFC systems requires a stable institutional, regulatory and operational environment. This is a critical part of the initial set-up of the system and must be largely in place before funding is engaged and the system is tendered. The way transport services are organised and structured is fundamental to the successful implementation of AFC, and a key concern for funding institutions.

However, in many emerging economies, the public transport system uses route licences in which the operator collects the fares directly, with – notably in the case of municipal operators – possible compensation for concessionary fares through public subsidy. Trying to implement an AFC system in such an environment is difficult as operators are likely to resist the controls and transparency that the transition to an integrated fare-collection scheme entails.

Reform of public transport operations towards a gross-cost contract method is a likely precondition for AFC implementation. An AFC project may thus have to be preceded by legislative reforms and renewed operating contracts, possibly incurring lengthy negotiations and lead times. This needs to be considered carefully when assessing the required conditions for a new AFC system and how the new system contributes to public transport improvements and reforms.

Better-developed AFC systems, which have multiple operators and offer integrated fares and services, generally operate under a transport authority that is responsible for transport strategy and sets fares and policy, independently of transport operations. Examples of this approach include Transport for London (TfL) in London, and the Budapest Transport Authority (BKK) in Budapest.

Such authorities set the parameters for operations, for example service frequency, age of vehicles, routes to be operated and contract services, for private and public operators alike. Generally, such operators do not receive payments based on fares (the 'farebox') but instead are reimbursed on the basis of service performance (bus-kilometres, frequency, reliability and so on), in accordance with the gross-cost contract model. Reducing the involvement of the operator in fare collection, and resulting on-board cash payments, is often a key objective of AFC.

Moreover, certain regulatory problems can have a considerable impact on system operability, for instance:

- legislative issues regarding the use of smartcards to collect fares (as occurred in Ukraine)
- the ability of revenue inspectors to levy fines without police presence (Belgrade)
- the introduction of a national identity card, leading to further complexity and delay (Budapest, during implementation).

4.1.4 Viability of AFC integration and operation

The technology involved in AFC systems must consider the following four factors for adequate system integration and operation:

- close link to payment technology and the available methods for payment (such as EMV penetration)
- need for secure transactions, protected from fraud or theft of personal data
- reliance on high-bandwidth, reliable mobile communications for online AFC systems (usually 3G or 4G)
- continual need to update system security and software and integrate changes in fares and fare types throughout the life of the system.

For a transport or city authority, this usually requires a specialised technology integrator and operator to meet such responsibilities. Refer to section 4.3 for implementation strategy.

4.1.5 Financial viability

AFC systems are expensive to implement, both in terms of finance and manpower. There needs to be sufficient paying ridership and fares (the farebox) to cover the underlying costs of the system. Furthermore, fare structure should be considered, including various ticket types, season tickets, and concessionary travel policy and its application. If concessionary passengers are a significant proportion of the ridership, implementation of AFC is unlikely to bring a sufficient increase in the farebox. Conversely, although it may reduce fraud, more accurate data on the volume of concessionary travel may actually reduce subsidy from central government. This is naturally of great interest to government but less so to the transport operator.

These issues are particularly relevant for smaller cities that have smaller economies of scale and higher system costs per passenger. Put simply, without sufficient farebox, implementation of an AFC system may not be financially viable and may not recover the costs it creates for the transport authority or city. In such cases, implementation of an AFC system may only be viable within an overall strategy of urban transport reform aimed at improved service quality, reforms to sector regulation and concession policy as well as associated improvement in farebox and cost recovery.

A key issue is the existing cost of ticket sales. This may be compared to the AFC project, as ticket sales are often poorly accounted for, even in larger cities. A business case is necessary to ensure that the time, cost and effort required for the scheme are viable and sufficient to meet its objectives. In general, the business case should include a cost-benefit analysis detailing specific benefits of the scheme with regard to problems that the implementation of AFC is intended to solve, such as queueing.

Moreover, cost estimates should take account of local market conditions and risks in the system design, to ensure that the city authorities plan for sufficient budget and that the subsequent tender conditions allow for the selection of high-quality bids.

4.2 Technology solutions for AFC

4.2.1 Industry standards

Certain standards are in place for ticketing systems, for the following reasons:

- **Safety and reliability:** Users perceive standardised products and services to be more dependable. This in turn raises user confidence, increasing the take-up of new technologies.
- **Support for government policies and legislation:** Standards are frequently cited by regulators and legislators as protecting user and business interests and supporting government policies. In Europe, standards play a central role within the European Union's Single Market.
- **Interoperability:** The ability of devices to work together relies on products and services complying with standards.
- **Business benefits:** Standards provide a solid foundation on which to develop new technologies and to enhance existing practices.

Specifically, standards:
- open up market access
- provide economies of scale
- encourage innovation
- increase awareness of technical developments and initiatives.

Current standards are summarised as follows:

Smartcard standards	
Contactless cards	ISO/IEC 14443
File structure	ISO/IEC 7816-4
Architecture	EN ISO 24014-1 (IFM)
Applications	EN 15320 (IOPTA)
Data elements	EN 1545
Security	ISO 15408 (common criteria)

While these standards should be reviewed for each project, based on local context and regulations, system requirements, market practice and capacity, they should be followed where possible for the reasons indicated above. In addition, following these standards maximises industry participation in, and the efficiency of, the tender process.

A number of smartcard systems are in use although these tend to be used on a national rather than an international scale, some of which are summarised in Figure 5.

Figure 5: Standards for smartcard systems

	ITSO (United Kingdom)	Calypso (Belgium, France, Italy, Latvia, Portugal)	VDV (Germany)	OV-Chipkaart (Netherlands)
Scope	Developed a common specification to enable the use of interoperable smart cards and other media in transport.	Calypso is a set of technical specifications describing a fast and secure contactless transaction between a terminal and a portable device.	Verband Deutscher Verkehrsunternehmen (VDV) is responsible for the development of the standard for eTicketing in Germany.	TransLink Systems operates and maintains a national standard for end-to-end smart ticketing in the Netherlands.
Users	Nine per cent of all public transport journeys in the United Kingdom are made using ITSO-compliant smartcards.	More than 150 million Calypso cards and 500,000 readers across 25 different countries.	Ten billion trips a year, €11 billion in revenues, and 75 per cent of all trips made by season ticket holders.	Four to five million transactions per day when in full operation.

While the standards shown in Figure 5 are national standards, some such as Calypso and ITSO are transferable to other markets and should be considered. Developing a national standard for a local system is often not viable and not recommended, unless substantial market development is anticipated.

4.2.2 Security

The system would normally be expected to have the following important security elements:

- a secure trip purse on the e-card with an encryption key dedicated to the AFC scheme
- secure AFC e-card technology (the standard of Common Criteria Evaluation Assurance Level (EAL 4) should be considered)
- assurance of entitlement to concessionary e-cards through application vetting by the relevant authority or the municipality.

The other parts of the systems architecture will be secured through IP security to prevent unauthorised access to the ticket vending machine (TVM) and kiosk equipment, fixed and mobile network security mechanisms to secure access to validators, and robust cash-collection boxes within the TVMs to resist vandalism.

In line with technical standards such as ISO 27001, the global standard for information security management systems, a number of security measures should be put in place, notably:

- systems to be operated in secure data centres with a back-up location and provision for business continuity
- intrusion detection systems and firewalls between external and internal networks
- measures to prevent viruses
- personnel must be vetted to check their credentials and their log-on IDs must be secured
- defined operating procedures concerning the processing of personal data must be in place to prevent breaches of customer privacy
- customer-account access will use established SSL access to web servers.

4.2.3 Personal data protection

This is becoming one of the most difficult issues for operators, especially with the introduction of new standards for data protection such as the EU General Data Protection Regulation (GDPR). Transit operators are usually required to collect personal data for buses and passes, sometimes even for every card or passenger, especially if the city is planning smart-city applications. As data protection regulations come into force this collection will need to be considered very carefully, although open-loop systems reduce the need for additional personal data collection.

4.2.4 Intellectual property and card- and account-based systems

The preferred technical solution for AFC is an open-loop system, an open system being one where the standard specifications, that is, the intellectual property rights (IPR), are freely available and can be obtained for a low or nominal cost. Open loop can also work with bank cards (known as EMV cards) and near-field communications (NFCs) such as mobile phones.

The alternative proprietary closed-loop system works with a travel card in specified transport environments. The IPR is owned by the developer of the system and is licenced to the user, who never becomes the owner. In such a case, the operator is tied to one contractor who may charge a premium for changes or modifications. However, a number of such schemes are in operation and they are thus a tried-and-tested system.

In the case of an open-loop system, information about each user (an account) is held in the back office. The only information held on the card is a number which connects the card to the back-office account. The user is able to access their account through the internet to top up the card or buy different travel products.

On a card-based system that is closed-loop, user information is held on the card including journeys undertaken during the day and balance available for travel. This is synchronised with the back office at least once a day so that the back-office account and the card show the same value at the beginning of each day. As the card is the primary travel document, it cannot be topped up through the internet but instead has to be taken to a system-connected machine to be topped up or to enable travel products (such as monthly passes) to be added.

The use of open-loop account-based systems were previously confined to larger cities such as Chicago, London and Washington, D.C., mainly as a consequence of the cost, time and effort required to obtain the necessary banking security permissions. Also, the number of suppliers offering systems and equipment, such as validators, was limited due to the development costs involved.

However, as experience in these systems has grown, the challenges and costs of their implementation have fallen. Equipment and systems have become less expensive and more widely available. A good illustration is Reading in the United Kingdom, a mid-sized town with a population of under 200,000, which is implementing an EMV-based system for a relatively modest amount, although within an existing, mature contactless-payment environment.

Nevertheless, a tried-and-tested closed system should not be ruled out completely. In some instances, it may provide the most cost-effective solution, especially for smaller cities or those with reduced farebox volumes.

Figure 6 compares both systems.

Figure 6: Two main types of AFC system

Card-based
• Closed systems • Agency issues and manages own media, can be expensive • Proprietary systems and formats • Network of machines for adding value/topping up smartcards • External revaluing networks • Require special point-of-sale (POS) devices • Details stored on card • Fare changes require code changes on all validators
Account-based
• Master account resides in the back office • Card is only a token to reference the account • Non-payment cards can be used to identify account (ID Card, Campus Card, Ski Pass), little cost to transit operator • Fare calculation rules exist only in the back office • Assume card is OK unless it is on the hotlist • Updates must be frequent • No fare calculation at reader • Open-loop systems require the collection of less personal data

4.2.5 System functionality

System functionality is defined in the technical requirements, as part of the tender documents.

The AFC system should be designed to cater for the range of users, payment types and fare options to be provided and, considering its core function as a public transport system, open to all city residents and visitors.

Smartcard schemes are widely accepted and available, while cash payments are generally required for a transitional period to enable user adoption of the new scheme. Additional functionality such as EMV and mobile apps may be considered based on related technology penetration, user preference, value for money and system maturity (system reliability, availability of similar technology from several suppliers). In initial schemes, these may be offered as options in system design, to be decided at tender stage based on tenders received.

However, caution must be exercised to avoid going for an innovative scheme at the expense of a more conventional open- or closed-loop solution. Taking the innovative route may seem attractive but can result in a city being tied to only one contractor. This can reduce competition, including for future upgrades, and make the implementation process more problematic.

4.2.6 Age of the fleet

Unlike cars, public transport vehicles, and rail vehicles in particular, may have considerable longevity. In eastern Europe, it is not uncommon to find vehicle fleets that have been in use for over 25 years, with some being in excess of 50 years old. This can make the implementation of AFC more difficult, as such vehicles are not easily wired for AFC.[2] The age of the fleet and the ease with which AFC equipment can be installed is an issue any contractor will pay close attention to, as this is a high-risk area for them.

[2] There has been anecdotal evidence of vehicles catching fire when AFC-type equipment was installed and in use.

4.3 Implementation strategy for AFC

4.3.1 Phased and managed rollout versus 'big bang'

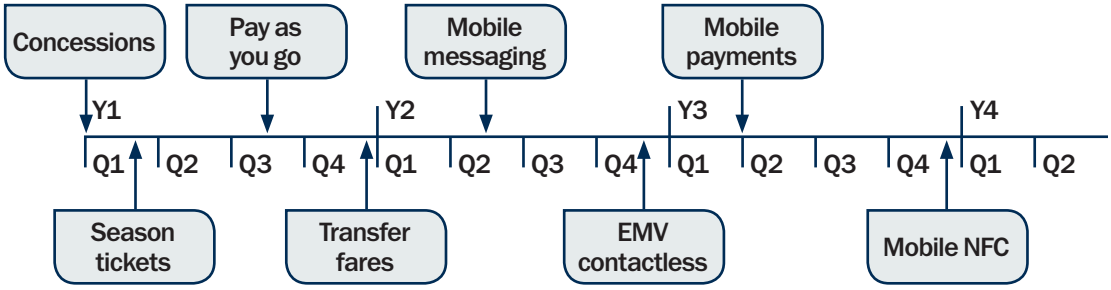
When implementing an AFC system it is tempting to adopt a 'big-bang' approach, that is, to roll out the entire system at once. This is not surprising, as all parties want the project completed and working as quickly as possible. However, unlike most IT systems, the introduction of AFC is so complex and all-encompassing that completion of everything at once has often proved to be very difficult.

It is critical to consider from an early stage how the new system will be implemented. A phased and managed rollout with gradual implementation across the system has several advantages.

- The system can be built and tested more easily if it is in discrete parts. This is especially important if there are limited resources available for testing (for example, as occurred in Belgrade).
- The contractor is more likely to be able to meet milestones and deadlines as resources can be used more efficiently (in Belgrade, installing validators in all vehicles at once was a big challenge).
- Gradual introduction allows users to more easily assimilate the new system and how it works.
- Public relations messages are often easier to get across to users if the system is being rolled out step by step. The messages at each step will be shorter and more focused than if the city tries to convey multiple messages about major changes to ticketing systems all at once. Regular, targeted PR messages about the latest phase will also make progress appear more rapid than may be the case.

A possible timeline for AFC rollout is shown in Figure 7.

Figure 7: Indicative timeline for AFC rollout



Source: Pillar Strategy Ltd.

As Figure 7 shows, a rollout strategy could take several years and not everything would operate from day one. The project could also change to reflect transport strategy and developments and as technology improves. The mechanism for controlling project change must be robust and changes may have to be frozen at key stages to enable the implementation of major milestones.

It is also likely that the assets will have to be refreshed as the system progresses. In the scenario above, some of the assets (such as laptops) might not have a lifespan of five years in a harsh transport environment and might need regular updates or replacement.

However, a gradual rollout could bring its own difficulties, if the process is highly politicised and where the political environment is unstable. In such contexts, a more holistic and rapid introduction of a new AFC system could reduce these issues. Moreover, in such cases, gradual rollout could also cost more, especially if the skills required for the rollout are not readily available locally and if larger contracts could offer increased economies of scale for sourcing these skills.

Defining the extent of AFC development in the project and defining the merits of a rapid versus a gradual process will require different approaches for different contexts. These approaches should consider not only technical and operational capacity and ambitions, but also the political climate, to determine whether a 'big-bang' or phased approach is the more suitable.

4.3.2 Options for private sector engagement

The implementation of AFC projects provides good opportunities for public-private partnerships, where private sector skills are critical for the implementation and delivery of the AFC system. Even the largest cities do not have the in-house expertise to design, build, operate and maintain an AFC system. Therefore, some or all of these services must be contracted out to the private sector. Likewise, it is important that a large part of the risk of system integration and operation is borne by the contractor, rather than remaining with the client.

The most common form of AFC contract is the 'design, build, operate and maintain' (DBOM) with variations on this approach such as the 'design, build and maintain' (DBM) or 'design and build' (DB). Schemes that mobilise private finance under PPP schemes are often 'design, build, finance, operate and maintain' (DBFOM). As noted above, the need for long-term enhancements to the software and for a reliable and secure communications and IT environment means that it is often preferable to ask the supplier to take an 'operate' role for the AFC IT over the life of the contract.

Project phases are generally defined as follows.

- Design-and-build period relates to the development of the system until testing and commissioning (go-live).
- Operation refers to the system operation to provide the IT interface for the sales outlets, ticket-selling and inspection teams, without however performing sales and enforcement activities themselves, which remain with the city authorities or the operator.
- Maintenance refers to maintaining the system and equipment. It ensures that the back-office system is patched and upgraded as required, the gates and equipment such as readers or TVMs are maintained for peak performance to meet KPIs, and that the system continues to work effectively and securely over the communications network and within a datacentre or a secure, resilient private cloud environment.

Figure 8 summarises each contract type, along with the advantages and disadvantages of each.

Figure 8: Options for private sector contracting

Type	Description	Advantages	Disadvantages
DBFOM	Under the 'design, build, finance, operate and maintain' option the whole of fare collection is outsourced to one third-party contractor. In addition, the contract is financed by a scheme such as a PPP or PFI involving sponsor banks. It is commonly used in schemes across many parts of the world. The contractor will be responsible for interpreting the terms of reference to produce a complete system that will be designed, built, maintained and operated by them for the client. Time frame: Typically 10-12 years, depending on time to repay the finance.	Simpler to manage, deals with one entity. Used successfully in a number of schemes, such as London, Budapest, Chicago and Washington, D.C. Avoids the requirement for a system integrator. Availability of finance from an outside lender.	Ties client to one supplier who can be so firmly entrenched that it is difficult for another supplier to replace them in a cost-effective manner. Any delays or changes require the approval of the lender, which can be time-consuming and expensive. Loss-leading build/install can be offset by expensive maintenance, resulting in a high overall cost. DBFOM requires a larger contractor with this type of experience, of which there are a limited number. Close monitoring by the client is required.
DBOM	Under the 'design, build, operate and maintain' option all fare collection is outsourced to one third-party contractor. DBOM is commonly used on schemes in many parts of the world. The city provides the financing. The contractor is responsible for interpreting the terms of reference to produce a complete system which will be designed, built, operated and maintained by them for the client. Time frame: Typically 10-12 years, depending on the time taken to repay any financing.	Simpler to manage, dealing with one entity. Used successfully on a number of schemes, for example, Budapest, Chicago, London and Washington, D.C. Avoids requirement for system integrator.	Ties client to one supplier who can be so firmly entrenched it is difficult for another supplier to replace them in a cost-effective manner. Loss-leading build/install can be offset by expensive maintenance resulting in a high overall cost. Requires larger contractor with this type of experience, of which there are a limited number. Close monitoring by the client is required.
DBM + O	Under this option the 'design, build and maintain' contracts are let to the same supplier but operation is undertaken by a separate contractor or by the city itself. Time frame: 5-7 years for each element.	Does not tie the client to one supplier. It is easier to change supplier at the end of contract. Option of in-house maintenance.	Client must act as system integrator. Conflict between operators or builders needs to be managed by the client. Availability of in-house expertise to operate if it is taken in-house.
DB+OM	In this option the 'design and build' is considered as one contract and the 'operate and maintain' as a second contract undertaken by either the same or independent contractors or by the client. Splitting the 'operate and maintain' contract is not recommended as this will add unnecessary complication, through the use of a further contractor who will require monitoring. Time frame: 5-7 years for each element.	Does not tie the client to one supplier. It is easier to change supplier/operator. Option of in-house maintenance or operation.	Client must act as system integrator.Conflict between builders and operate-maintain supplier needs to be managed by the client. Availability of in-house expertise to operate if it is taken in-house. Greater risk of failures due to the maintainer not understanding how the system was designed or built.

The DBFOM or DBOM contract is often the most suitable, especially for smaller entities with limited resources, where it is beneficial to embed system integration and long-term system hosting or operation within the contract. The key point here is that the greater the responsibility of the client for system management and interface, the greater the likelihood of project risk passing back to the client. Being aware and guarding against this is essential when defining the appropriate type of contract for the private sector.

There are potential difficulties in splitting the 'design and build' from the 'operation and maintenance'. The maintenance operator may have a preferred design that is different to the one already built and there is room for potential conflict between the designing and operating parties, each blaming the other for system outages. This may require the involvement of the client to resolve disputes which is time-consuming and often an inefficient use of resources. Similarly, splitting operations and maintenance can lead to similar conflicts. Moreover, it may be difficult for the city authorities to find another operator who is willing to maintain and integrate the software, due to the risks involved. The real value of DBOM is that the contractor has a vested interest in the system operating to defined service requirements and for the long term.

The DBFOM type of contract is a public-private partnership, sometimes known in the UK as a private finance initiative. Under these options the funding for the project is obtained by the private contractor who then repays the loans through the fee received from the client. The contractor takes up all the initial design, construction and installation costs. In order to repay the investment, the contractor has a vested interest to design and build the system efficiently, to ensure that the system works, meets or exceeds its KPIs and even that end users use it. The private contractor may also undertake marketing of the new system to ensure that passengers are well-informed about how the new system works and adopt it.

It is also important within DBOM or DBFOM to ensure that KPIs such as service-level requirements and the performance regime are developed in good time with operators so that they clearly understand what is required.

While it may seem attractive for the private contractor to take all risk, expect perhaps reputational risk, there are various drawbacks to this approach, in particular, that this will render funding arrangements substantially more complex and increase borrowing costs.

A key point to consider, whichever model is chosen, is the need for changes and upgrades in system design and service requirements during implementation and operation periods. The amount of time, effort and cost required to undertake such changes can be considerable. Careful management is needed to ensure that a change process is built into the contract, and its impact on contract output or deadlines, irrespective of the form of contract chosen, is considered. This is also discussed in section 4.4.2 (Managing change in the live system).

4.3.3 Risk profile

A key element when using the PPP format is the transfer of risk. While most risk can be transferred to the contractor, reputational risk cannot. Reputational risk is significant for AFC systems and will always remain with the transport authority. It is thus important for the authority to assume strict control over AFC delivery, irrespective of contract type.

Under a DBFOM or DBOM contract the risk for the system design, build and operation transfers to the contractor. However, even for such contracts, risk must be carefully managed to ensure that it does not inadvertently pass back to the client. In particular, the city must ensure that it only provides acceptance or consent to proceed or operate, rather than approving outputs and thus assuming responsibility for later changes. Approval or instruction to the contractor implies that the city is accepting the risk of the activity being undertaken. Assurance or the giving of consent means that the city is aware of the activity, is aware of what has been done but the risk of whether it is fit for purpose and will operate satisfactorily remains with the contractor.

4.4 System implementation and delivery

4.4.1 Project implementation team

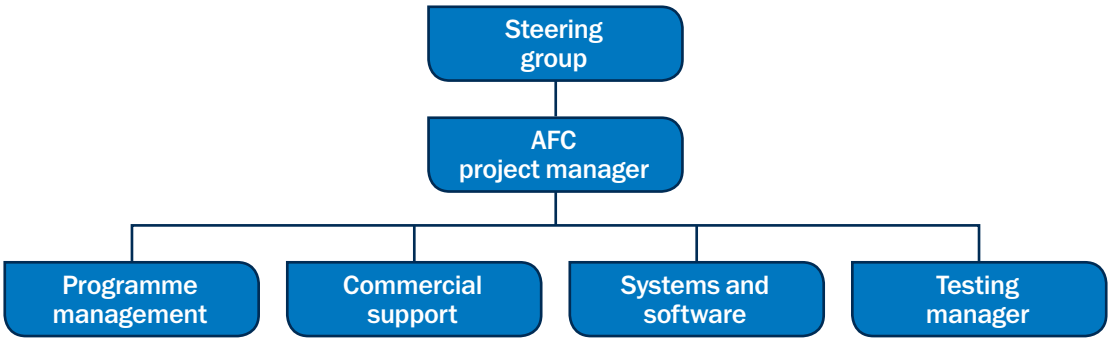
AFC systems require a highly specialised skill set that is often not readily available to city authorities. Thus it is imperative for the city to define and engage a well-qualified and staffed project implementation team. Without such a dedicated team, successful implementation can be critically compromised.

- A small, centralised and dedicated implementation team provides a key point of focus for the contractor to interact with through project preparation, delivery and operation, rather than having to interface with many different departments.
- On the client side, the implementation team focuses skills and efforts to manage the contractor and his performance under the contract and ensure that the project is successfully delivered. This cannot be done by individuals who have other day jobs or are on the implementation team as a secondary activity.
- It provides an opportunity for the client to bring in skills which are more relevant than would otherwise be possible.

A project leader or manager should be appointed at the inception of the project, preferably before conducting a feasibility study. As the project progresses, other skills will need to be added which will provide core functions of commercial and financial support, IT and technical support and programme management, with a full team in place at project tendering. It is likely that not all of the skills will be available in-house and it is generally necessary to bring in specialist skills from outside consultants or third parties, even for larger cities and clients.

The essential staffing of an AFC project implementation unit is shown in Figure 9.

Figure 9: AFC project implementation unit



Why a mixed implementation team?

The temptation when building an implementation team is to use only transport and IT professionals. This is not necessarily the best solution. A mix of disciplines, including programme management, engineering, commercial experience and financial background is required. Transport professionals and IT skills are certainly needed but experience of IT system integration projects, especially on the part of the project leader, and regardless of their sector background, is vital.

The key group is the steering group that should oversee the project and delegate day-to-day operations to the project manager. The team shown above is the smallest needed, with staff able to work on the project full-time. As the project progresses, other skills will need to be added, even if only in the short term, such as for liaison with operators for the installation of equipment.

4.4.2 Managing change in the live system

AFC systems operate in a complex, multi-interface environment with emerging user requirements and demands and technological developments. In such an environment, it is not surprising that changes are common throughout the design, implementation and operation of the system. Change should be viewed as a necessary requirement of successful AFC projects, not as something to be avoided. The key is to anticipate the processes required to introduce change through the life of the AFC and, to the extent possible, integrate technology development into the contract requirements, including system and software upgrades.

Change may represent a large part of the final cost of the system. Indeed, it is not unknown for changes to incur higher capital costs than the initial contract cost. The funding of these may be from the existing contract in the event of other savings or substitutions, by a loan extension from the funding entity or through the city's own budgetary resources.

4.4.3 System testing

The AFC system including on-board systems, ticket vending machines, retail equipment, back-office and central systems, web-based access to customer accounts and revenue protection devices, all constitute a single operating system. For such a system, design and integration is critical and should preferably be provided by a single contractor. Similarly, transaction performance tests and non-interrupted tests are crucial, and need to be closely managed, to ensure effective handover and operation of the system.

4.4.4 Communication with stakeholders

Marketing and public relations are key areas which are often overlooked. Ideally the project will have a marketing and PR strategy and policy to address the stakeholders who need to be informed about the project. These include transport users, staff, political groups, press and lenders. Failure to communicate with any of these stakeholders can have negative impacts on project delivery. (See box "Who are a scheme's stakeholders?".

It is also important to manage expectations when issuing PR messages. In particular, care should be taken in announcing firm dates for the introduction or implementation of either the whole or part of the system, to ensure the client retains control over implementation of the process throughout likely changes and delays, while at the same time maintaining public interest in the scheme.

Who are a scheme's stakeholders?

Passengers. These are the sternest critics of any project. Passengers need to be informed of the objectives and kept up to date on progress and implementation dates. In addition, it is important to recognise that changes to the fare collection system will be new to many and therefore the use of ambassadors to help with using new technology and fare issuing machines need to be considered.

Staff. They also need to be aware of changes and the result of these and they will be concerned about employment. Again, failure to keep them on-side will result in serious issues. Involving staff early on, for example in the implementation of staff passes on the system, creates a good proving ground for the new system. If there is no goodwill from staff this will be more difficult.

Political groups. These also need to be kept informed. It is particularly important if a mayor is seeking re-election or a period of political instability appears to be imminent.

Press. The press will be following the project with interest, especially if they are politically aligned. It is important therefore to keep them on-side, with regular briefings with "friendly press". It is necessary to have a message available in case anything goes wrong. Disaster planning in case the scheme runs into difficulties in implementation or operation is good practice.

Funders. Funders also need to know what the issues are and be regularly updated with progress. On larger schemes the lenders may employ technical advisers to assist them with understanding the project. Both groups need to be kept well-informed and best practice is for the implementation team to hold regular briefings (at least annually) to update leaders and their advisers on progress, with quarterly written updates being provided.

4.4.5 Transition risk

The transition risks associated with moving from a familiar paper-based system to a more advanced AFC system, often with smartcards, can be considerable and should not be underestimated. Two types of risk are associated with this process.

a. Transition risks for a new system

The most significant risks for implementing an AFC system concern the passenger's ability to obtain access to a smartcard for travel use and to be able to top up their smart card with cash payments before boarding transport. This will remain predominant until there is wider access to internet, credit card or bank accounts for top-ups. Availability of the distribution network (working hours, density, number of outlets, queues, and so on) is also of major importance as well as encouraging users to remember to touch in for their trip. Therefore, a significant education programme may be needed to ensure widespread acceptance and adoption of the new AFC system.

An AFC system, in conjunction with changes in fare policy, provides the technical tools to achieve a city's strategic objectives, but carries inherent risks during implementation due to the novelty of the IT systems involved. Therefore, the AFC contractor should ideally submit a 'transition plan' for risk evaluation and mitigation at an early stage of the project implementation.

b. Transition risks for user behaviour

Existing systems are generally paper-based monthly passes and single fares, collected as cash on-board by drivers or conductors. Therefore, one of the most significant risks for implementing an AFC system concerns the passengers' acceptance of using the new system. In particular, the procedure for topping up may be too complex with too many options, taking more time and reducing the system's attractiveness. This may also limit opportunities for reducing cash leakage. A completed passenger education plan and promotion campaign is thus necessary to encourage customers to adopt smartcards and also to touch in on entry to vehicles. Similar transition risks apply to drivers and staff in operating a new system and training is necessary for these groups from an early stage.

4.4.6 Risk register

It is good practice for all parties involved in the project to maintain a project risk register, which should be reviewed and updated at regular intervals, to identify and consider all risks and plan mitigation actions to reduce or avoid the risk.

5. Case studies

5.1 Summary

Belgrade, Serbia, and Reading, UK, provide two contrasting but successful examples of AFC development. Their experiences are highly relevant to many small, medium-sized and larger cities, with some fundamental differences. Belgrade opted for a major upgrade of its ticketing system by the city authority across its multi-modal transport network with a fully integrated AFC contract, whereas Reading illustrates continuous, incremental improvement for a single mode (bus) by the one large city-bus operator and two cross-city boundary operators, all of whom are part of the AFC scheme.

The relative size and differences between the two AFC schemes are shown in Figure 10.

Figure 10: Summary of Belgrade and Reading AFC systems

Belgrade	Reading
Capital city, Serbia	County town, Berkshire, UK
Population: 1.2 million	Population: 156,000
System owner: City	System owner: Operator
Fleet size: 2,000 vehicles	Fleet size: 191 vehicles
Operators: Six, both private and public	Operators: One - Reading Buses
Modes: Buses, trolleybuses, trams, light rail	Modes: Buses
Ticket method: Zonal	Ticket method: Point to-point
Type of system: AFC integrated with traffic-management system	Type of system: AFC system developed since 1990s
Ticket types: Paper tickets, paper contactless tickets, personalised and non-personalised smartcards.	Ticket types: Smartcards, contactless bankcards, paper QR codes, mobile device QR codes.

The case studies in Figure 10 illustrate that while the two entities have taken different paths and timescales, both have achieved or are achieving their objectives and there is no one-size-fits-all solution for AFC schemes.

5.2 The Belgrade experience

Belgrade approached AFC as a seismic change by moving from paper tickets and manual systems for counting passengers through to an integrated AFC system and traffic-management system in one stage. This was because there had been no real development or modernisation of ticketing systems for many years, resulting in widespread fraud, a black market in prepaid monthly tickets, and considerable financial losses.

In selecting a system and contractor they chose a 10-year 'design, build, finance, operate and transfer' (DBFOT) contract, with the city assuming ownership of the system after that period. A private partner, APEX, invested in the equipment and implemented the system as a full turnkey solution. When the system installation was complete, the system was rolled out as a 'big-bang' introduction on 1 February 2012. While this was considered to be the best approach to ensure delivery of the project, it led to a number of extreme difficulties, including installation of equipment on all vehicles, the issuance of over half a million cards in a short timeframe and testing of the whole system on completion to ensure it had all worked.

5.3 The Reading experience

Reading Buses have applied an approach of continuous improvement to their ticketing system, since the introduction of Bell punch machines in 1901. In the 1990s they introduced magnetic strip tickets with stored value, although with a very slow read time of three seconds. In the 2000s they introduced contactless smartcards and supporting carnets, stored value and concession passes, with transaction time reduced to below one second, although this did not meet UK national standards. In 2010, the next upgrade for smartcards met the UK national standards known as ITSO. In 2016, the system was upgraded further with the introduction of EMV systems for contactless bank cards. As a result, Reading can now accept a wide range of payment mediums including smartcards, contactless bank cards, paper QR codes and mobile device QR codes. Current development is considering fare-capping and peak-time pricing.

The financing and contracting approach has also adapted to legislative changes in the UK. Reading Buses are owned by the local municipality, Reading Borough Council. The early schemes were sponsored and supported by Berkshire County Council as part of government initiatives. Subsequently, following deregulation of bus services in the UK in the 1980s, Reading Buses had to fund developments from their own resources. Their contractor was a small IT company with premises close to Reading. Although this has tied the city to one company, it has allowed more tailored software integration and their recent development of EMV has moved them closer to an open system. Although the contractor was new to ticketing systems, they have proved to be a responsive partner through the AFC development.

While fraud has not been a major consideration, improved management information and greater convenience for customers, with reduced boarding times and faster journeys, were seen as key benefits of the AFC scheme.

However, this more continuous approach to system development has brought certain challenges for Reading Buses. In particular, step-by-step accreditation for EMV was often time-consuming and difficult and system development from the early stages of smartcard to contactless may have taken too long, with some missed opportunities along the way.

6. Lessons learned

Key lessons learned from AFC implementation, including the case studies cited above and other experiences from participating cities, can be summarised as follows.

1. The 'big-bang' approach is challenging and may not be the best method for implementation. Attempting to launch a completely new system in its entirety on day one can lead to difficulties. The travelling public may find the changes too overwhelming and reject the system if everything changes at once. Having the trust and goodwill of end-users is vital. There can also be problems with testing the whole system with limited resources, rolling out all the equipment onto the transport modes and issuing sufficient user cards before the go-live date. If implementation occurs in phases, communications to end-users can be simpler, limited test resources can be focused on each phase, and smaller and more manageable numbers of cards and equipment are required. However, 'big-bang' approaches may be suitable, in particular for smaller cities or where specific political, legislative, operational or technical issues would argue in favour of such an approach. Clients thus need to consider carefully the best approach to system rollout, based on their operational and legislative context and cost-efficiency considerations, to assess how much can be anticipated and packaged within a single contract, and how much should be left for further improvements or extensions at a later date.

2. Use of a modular platform may be recommended, notably where the development process is not subject to undue political intervention. The use of a modular platform allows greater flexibility when upgrades or extensions to the system are needed. Changes or extensions are more straightforward because modules can be either changed or added on as required.

3. Keep the scheme as simple as possible with a preference for tried-and-tested solutions rather than pursuit of innovation as a goal in itself. City authorities should avoid getting immediately drawn into national schemes or nice-to-have additions (such as bike hire schemes or car parking) as these involve more stakeholders with a wider integration and user interface, which slows down preparation and implementation and adds further risk. Additions should wait until the system is well established and understood by users.

4. Do not overlook the benefits of simple issues such as reducing the handling of cash, or taking cash off modes of transport. These are real benefits which can ensure the project is financially viable as well as making day-to-day operations more efficient. Operators who have removed or reduced the amount of cash handling have generally found the benefits to be greater than expected.

5. Employ a contractor with recognised AFC skills and experience but also credible local capacity, especially for software programming and system integration. An absentee contractor can quickly compound issues when system problems arise, and the ability to contact a contractor quickly to resolve issues is critical. It is also good practice to share offices with the contractor to allow easy access between the two, although these offices should be on separate floors, for the purposes of confidentiality.

6. Seek performance-based contracting with upfront financial contribution by private contractors, in particular where local authorities have limited technical and operational capacity and knowledge.

7. Try to avoid radically changing the fare structure and implementing an AFC scheme at the same time. This can add to confusion about the scheme for travel users and can be a PR disaster. Fare increases can be seen as paying for the implementation of an AFC system and can elicit negative comment from the public.

8. Try not to tie yourself to a particular partner. It may seem good business to partner with a particular bank for EMV card supply, for instance, as the cost of cards will be reduced or eliminated. However, such exclusivity should be avoided as it can become a handicap for future developments.

9. Anticipate changes during system design, installation and operation. Build change processes into contract structures and conditions, capacity requirements for the project implementation unit, and PR processes to ensure that the city and contractor are able to deal with any issues as they arise.

10. Stay informed about the AFC market and technology developments and keep funding banks informed through implementation, so that the AFC system adapts to challenges and that appropriate steps are taken to manage changes and ensure funding support. Regular updates to funders help to keep them on-side. This is particularly important when difficulties arise during implementation.

7. Working with the EBRD

The EBRD assists its clients in developing AFC schemes that are feasible, deliver value to users and public sector authorities and optimise private sector efficiencies. It supports effective ways to engage the private sector through project delivery, including DBOM models and PPP contracts.

7.1 Overview of EBRD policy

In supporting AFC schemes, whether in their own right or as part of a larger project, the EBRD has certain overarching criteria, which Figure 11 summarises.

Figure 11: Summary of EBRD project requirements

7.2 Funding

The EBRD funds schemes that are viable with a well-considered business case. The funding is subject to a loan agreement, negotiated separately to the contract, with requirements for advances and repayment. While the funding should cover the capital expenditure needed to build the system, certain costs need to be met by the client, such as project management, marketing, communications and financial models.

The EBRD provides funding across the whole spectrum, from sovereign loans when legally necessary, to municipal loans, public utility loans backed by municipal guarantee, operational concessions (DBOM), and PPPs based on DBFO to full privatisations. AFC schemes are often supported on a sub-sovereign basis, including loans to city authorities and companies and private contractors, under special project vehicle arrangements.

Funding from the EBRD is subject to approval by the credit committee and a separate loan agreement is required.

Technical and operational support can also be provided to support AFC preparation and implementation, subject to the specific needs of the client and project characteristics.

7.3 Project strategy and preparation

The EBRD should be involved early on during preparation of the AFC system, the main step of which is a feasibility study undertaken by the city. The study establishes the business case for the AFC project through a full legal, operational and technical analysis and an economic and financial analysis, and recommends the technical and operational solutions to be adopted. It forms the basis of any funding request to the EBRD.

A key requirement of EBRD support is that any system design should allow the highest degree of open competition for private contractors, based on industry-accepted standards and available solutions and technology platforms.

Moreover, legislative changes are often critical to project implementation and their impact should be factored into the project timescales. The EBRD can advise on legislative changes that are needed, and, where appropriate, can assist the city in advocating for such changes.

7.4 Tendering and contract management

For projects funded by the EBRD, the Bank's Procurement Policies and Rules are applied, which override local rules and policy. For AFC systems, given their inherently complex nature, a two-stage tender is generally applied. The first round is to provide an unpriced, technical solution and serves to establish qualified bidders and the final technical requirements for tender. The second round is for a final technical and price offer, with the lowest[3] qualified bid being the successful contractor. A full guide to the Procurement Policies and Rules is available on www.ebrd.com.

Regular meetings are required to review progress and see how challenges are being overcome. On large projects, a lender's supervisor is appointed to oversee progress on behalf of the Bank, assess variations and changes to the contract and report regularly with the client on contract performance. The cost of technical advisers is met by the client as part of loan repayments. It is also important and good practice to keep the lender well informed about progress and about issues that arise, as a lender who does not hear regularly how the project is progressing will often assume the worst, even if this is not the case.

[3] This may include lifetime costs, including operation and maintenance costs, as relevant.

8. Acknowledgements

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9. Annexes

Annex 1. Questionnaire

As the first stage of the research process, participants were contacted during the weeks prior to the seminar and asked to complete the following questionnaire. The questionnaire was introduced, led and undertaken by Mogul Associates Ltd, the consultants engaged by the EBRD to lead this dialogue.

Urban transport sector
1. Please describe the regulatory and policy environment for urban public transport in your city: public transport strategy/policy, current route-licensing practice, fare structure – integrated fares (if any), ticket price (concessions, season passes, single tickets.) and method for revision.
2. Please give a description of existing operators for urban transport services in your city or jurisdiction: current operators (public/private), transport mode, fleet sizes, number or length of routes, annual passengers, revenues.
3. Is there a subsidy from central government or city hall? How is it allocated? What is the estimated cost-recovery ratio for public or private operators?
AFC project
4. What are the existing ticket types (paper, magnetic, smartcard and so on)? Where are tickets currently being sold (on board, TVMs, outlets and so on)? Any existing AFC system?
5. Please describe the current AFC project which the city plans to implement. What is the stage of preparation of the project (feasibility study – design – procurement)? Have there been previous studies or attempts to introduce AFC in the past? Why have they not succeeded?
6. Why is an AFC scheme being considered or implemented? What do you consider to be the key drivers (city control of revenue; improved subsidy allocation; higher revenue collection or lower evasion; improved user service)? Is it part of a wider project, for example, in conjunction with new vehicles; part of a public transport strategy?
7. What is the planned contractual form? For example, is it a 'design, build, operate and maintain' contract, procurement of equipment only, or some combination of the two?
8. Is implementation of AFC to be achieved in stages (for instance, part of the network only) or will it be a 'big-bang' rollout? Do you intend to maintain on-board sales or exclusively off-board?
Challenges for AFC implementation
9. What do you see as the key challenges for project implementation (city or PIU capacity; system integration or interface; private sector interest; installation and/or operation cost; sales networks; technology and IT upgrade requirements; user acceptance; operator resistance; regulation issues)?
10. How do you plan to ensure city capacity for system delivery, management and upgrade? Have you considered the soft skills required for system introduction and rollout, for example, communications policy with staff and customers?
11. What do you consider as the benefits of external funding, for example, loans from the EBRD? What is your previous experience of international financial institution funding?

Annex 2. Summary of AFC system status and challenges

		Q1 and Q2				
Country	**City**	**Population**	**Ridership**	**Route kilometres**	**Private or public operator**	**Multi-modal ?**
Georgia	Tblisi	1,118,035	359 million	Not known	Public and private	Yes: Bus/minibus/metro
Hungary	Budapest	1,759,407	1,578.2 million	1,402	Public: BKV, and private	Yes: Tram/trolley/bus/ suburban trains/ funicular/metro
Romania	Galati	249,432	Not known	617	Public: Transurb SA	Yes: Tram/trolley/bus
	Pitesti	155,383	25 million	Not known	Public: Publitrans 2000 SA	No: Bus only
	Iasi	290,422	142.1 miillion	366	Public: Iasi Public Transport	Yes: Tram/bus/minibus
Serbia	Belgrade	1,166,763	Not known	Not known	Public and private	Yes: Tram/ trolley/ bus/ suburban trains
Ukraine	Ivano-Frankivsk	230,929	Not known	Not known	Public and private	Yes: Trolley/bus
	Vinnytsia	372,484	91.6 million	Not known	Private: City is enabler	Yes: Tram/trolley/bus
	Lviv	728,350	164.5 million	Not known	Public and private	Yes: Tram/trolley/bus
	Kiev	2,900,920	1,131.5 million	Not known	Public and private	Yes: Tram/trolley/bus/ suburban trains/ funicular/ minibus
	Odessa	1,016,515	Not known	Not known	Public and private	Yes: Tram/trolley/bus

		Q3		Q4	Q5
Country	**City**	**Subsidy**	**Concessions**	**Current system**	**Current status of project**
Georgia	Tblisi	Yes	Yes	AFC system Metromoney card Coin acceptors on bus	Complete, now on Phase 2 Phase 2 feasibility study
Hungary	Budapest	Yes	Yes	Paper tickets and passes	Build
Romania	Galati	Yes	Yes	Paper tickets	Tender
	Pitesti	Yes	Yes	Paper tickets	Feasibility study
	Iasi	Yes	Yes	Paper tickets	Feasibility study
Serbia	Belgrade	Not known	Not known	AFC system Zonal tariff using smartcards Paper contactless cards Paper tickets	Completed
Ukraine	Ivano-Frankivsk	Yes	Yes	Single paper tickets	Preliminary study completed
	Vinnytsia	Yes	Yes	Single and monthly paper tickets	Consultancy stage
	Lviv	Yes	Yes	Single and monthly paper tickets, discounted tickets for students	Trials undertaken but not proceeded with
	Kiev	Yes, public only	Yes, public only	Single paper tickets Subway tokens	Feasibility study
	Odessa	Yes	Yes	Single paper tickets	Feasibility study

		Q6	Q7	Q8
Country	**City**	**Reasons for implementation**	**Form of contract**	**Rollout**
Georgia	Tblisi	1. Improve revenue control 2. Reduce fare evasion 3. Improve quality of service for passengers	DBOM	Not known
Hungary	Budapest	1. Improve revenue control 2. Reduce fare evasion 3. Improve quality of service for passengers 4. Improve management information	DBOM	Phased
Romania	Galati	1. Reduce fare evasion 2. Improve management information 3. Reduce subsidies 4. Environmental improvements	DBOM	Not known
	Pitesti	1. Reduce fare evasion 2. Improve management information 3. Improve tariff policy	DBM	Not Known
	Iasi	1. European Parliament regulations 2. Improve management information 3. Reduce fare evasion 4. Introduction of time- or zone-based fares 5. Assist with reducing air pollution or sound pollution (in conjunction with new buses)	DBOM	Not known
Serbia	Belgrade	1. Cost control over public transport 2. Improved control over operators 3. Flexibility over fare changes 4. Real-time information	BOT	'Big bang'
Ukraine	Ivano-Frankivsk	1. Reduce cash transactions 2. Easier interchange between modes 3. Effective accounting for concessions 4. Improve financial reporting	Not known	Not known
	Vinnytsia	1. Reduce cash leakage 2. Improve quality of service for passengers 3. Increase attractiveness of public transport 4. Improve management information 5. Reduce subsidies	DBOM	Phased
	Lviv	1. Reduced cash usage and leakage 2. Allows multimodal interchange 3. Effective accounting for concessions 4. Improved financial reporting 5. Introduction of time- or zone-based fares	DBM	Phased
	Kiev	1. Maximise fare collection 2. Improve data collection	Not known	Not known
	Odessa	1. Maximise fare collection 2. Improve quality of service for passengers	Not known	'Big bang'

		Q9	Q10	Q11
Country	**City**	**Challenges**	**Capacity**	**Benefits of funding**
Georgia	Tblisi	1. System integration 2. Sales networks 3. User acceptance	Not known but a system implemented previously	More flexible arrangements with loans
Hungary	Budapest	1. Development of cutting-edge system 2. System integration and interface 3. System security and reliability 4. User education and rollout	Limited, under review	Not completed
Romania	Galati	1. Technical functionality	Limited resources	Worked with the EBRD before
	Pitesti	1. Staff training 2. Marketing	Marketing plan only discussed	Worked with the EBRD before
	Iasi	1. Acceptance by passengers	Will educate passengers	Not completed
Serbia	Belgrade	1. Installation in large number of vehicles 2. Issue of cards to passengers in time 3. Testing the whole project for rollout	Not known	Not funded by the EBRD
Ukraine	Ivano-Frankivsk	1. Experience of other European cities 2. Residents' interests 3. Ability of city to support the project	Currently in planning stage	Many funded projects
	Vinnytsia	1. Maturity of systems, such as 3G 2. Legislative issues regarding the use of smartcards	Use of consultants to support city team	Use EBRD for affordability and technical expertise
	Lviv	Not completed	Not completed	Not completed
	Kiev	1. Lack of experience of such projects	To be developed	Has used the EBRD before Likes EBRD technical support
	Odessa	1. Operator resistance 2. IT upgrade requirements 3. Operations cost and total project cost	Not known	Has used the EBRD before Likes EBRD technical support

Annex 3. Results of AFC questionnaire

As the first stage of the above process participants were contacted prior to the seminar and asked to complete the questionnaire. The questionnaire was introduced, led and undertaken by Mogul Associates Ltd, the consultants engaged by the EBRD to lead this dialogue.

The questionnaire in Annex 1 asked participants to give their thoughts and experience on the issues they were either facing or expected to face when implementing an AFC system. Participants were asked to address issues needed to deliver AFC projects and engage the private sector and/or improve the way the sector functions to support AFC projects.

The plan was to share the issues previously identified in the questionnaires between participants and senior experts and practitioners at the seminar. As there was insufficient time between the receipt of questionnaires and the start of the seminar for a detailed response only a summary could be given at that stage. The detailed analysis has now been completed and is presented and summarised in this report.

3.1 Results of the questionnaires

3.1.1 Return of questionnaires

In the period leading up to the seminar questionnaires were issued to 13 cities that had been invited to the seminar, from 5 countries. These were:

Country	City
Georgia	Tblisi
Hungary	Budapest
Romania	Bucharest Constanta Galati Iasi Pitesti
Serbia	Belgrade
Ukraine	Ivano-Frankivsk Kiev Lviv Odessa Vinnytsia

The number returned is summarised as follows.

Summary	Number
Questionnaires issued	13
Returned complete	10
Returned incomplete	1
Not returned	2

The detailed results of the questionnaires are shown in Annex 3. The fully completed, returned questionnaires were comprehensive and detailed and provided good-quality, useful information. The main points from the summary are detailed in section 3 below.

3.2 Detailed results

3.2.1 City population

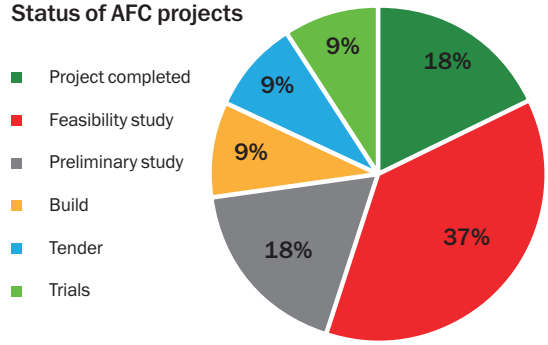
The relative size of the cities responding to the questionnaire can be summarised as follows.

Population	Number of cities responding
Over 2 million	1
1 to 2 million	4
0.5 million to 1 million	1
0.25 million to 0 .5 million	2
0 to 0.25 million	3
Total	**11**

This shows that smaller cities are starting to consider the implementation of AFC as just over 50 per cent of the respondents had a population of less than 1 million.

3.2.2 Status of projects

In eastern Europe, the take-up of AFC has been more limited. Development of ticketing systems has not been a high priority and indeed in some cities such as Budapest the transport systems have regressed to having a greater reliance on manual checks. Certain capital cities such as Belgrade, Bucharest and Tbilisi have embraced AFC technology with varying degrees of success. Others such a Budapest are implementing schemes. Some, including Kiev, have yet to start AFC schemes. A number of smaller cities have commissioned feasibility studies and trials, but none have successfully implemented a scheme. The furthest advanced is Galati under an EBRD-sponsored scheme which is approaching the tender stage. Based on the responses from the delegates' questionnaires the position can therefore be summarised as follows:



The majority of projects in our sample are therefore in their early stages. This is to be expected as eastern Europe has yet to embrace AFC as much as cities in western Europe.

3.2.3 Transport modes

An analysis of transport modes is shown in the table below.

Type	Number
Multi-modal:	**10**
Bus	10
Tram	8
Trolleybus	8
Suburban trains	3
Funicular	2
Metro	2
Minibus	2
Single mode:	**1**
Bus	1

Most of the respondents have a multi-modal system with at least two types of transport. However, only two respondents referred to improving multi-modal transfers as a reason for implementing an AFC system.

3.2.4 Ticket types

The most common type of ticket is the single-trip ticket as shown below.

Types of ticket	Number
Single-trip paper	10
Paper and passes	3
Concessions	11
Smartcards	2
Tokens	1

Only a few respondents indicated that passes were an issue; this is an area that can be further developed under an AFC system. Again, only two respondents referred to this as a reason for implementing AFC.

3.2.5 Reasons for implementation

This was one of the most important questions because without a clear vision of why a scheme is being undertaken the scheme is less likely to succeed. In addition, without this vision it becomes more difficult to involve interested parties such as lenders or potential contractors from the private sector. The reasons for implementing AFC can be summarised as follows.

Reasons for implementation	Number	%
Reduce fare evasion and cash leakage	7	17%
Improve management information	6	15%
Improve quality of service for passengers	4	10%
Easier interchange between modes	2	5%
Account effectively for concessions	2	5%
Environmental improvements	2	5%
Flexibility over fare changes and tariff policy	2	5%
Improved financial reporting	2	5%
Improved revenue control	2	5%
Introduce time- or zone-based fares	2	5%
Maximise fare collection	2	5%
Reduce subsidies	2	5%
Control costs of public transport	1	2%
European Parliament regulations	1	2%
Improve control over operators	1	2%
Increase public transport attractiveness	1	2%
Provide real-time information	1	2%
Reduce cash transactions	1	2%
Total	**41**	**100%**

It is clear that the main reason given for implementation of an AFC system is to reduce fare evasion and cash leakage (17 per cent of respondents). This is closely followed by the recognition that more and better management information is required by transport operators (15 per cent). The third reason mentioned is to improve the customer experience (10 per cent). While rather vague, this does show that in eastern Europe there is now recognition that urban transport users are customers rather than passengers who have no choice about which mode of transport they use.

We noted that although Tbilisi had introduced a smartcard system, in conversation they explained that the current system did not offer a good customer experience. It was difficult for locals and visitors alike to know how to obtain tickets. Therefore, the main aim of their second phase of smartcard implementation is to overcome this difficulty.

There were also some surprising results. Environmental improvements were cited while cost issues did not seem to feature as much as may have been expected.

3.2.6 Challenges facing implementation

This was another area of great interest as understanding the challenges facing implementation allows the provision of support to overcome them. The results can be summarised as follows.

Challenges	Number
Passenger resistance	4
System integration and interface	2
User and staff education and rollout	2
City's ability to support the project	1
Development of cutting-edge system	1
Experience of other European cities	1
Installation in large number of vehicles	1
Issuing cards to passengers in time	1
IT upgrade requirements	1
Lack of experience of such projects	1
Legislative issues regarding the use of smartcards	1
Marketing	1
Maturity of systems, such as 3G	1
Operations cost and total project cost	1
Operator resistance	1
Sales networks	1
System security and reliability	1
Technical functionality	1
Testing the whole project for rollout	1

Passenger resistance was the challenge most often cited and it ranked higher than staff resistance. Again, this was unexpected. Since AFC systems have been in existence for over ten years and are now generally understood passenger resistance should have reduced. The other challenges reflected the particular issues facing each respondent.

3.2.7 'Big-bang' or phased rollout?

The respondents' views on whether a project should conclude with a 'big-bang' (project completed and rolled out all at once) or a phased rollout (system rolled out in phases) can be summarised as follows.

Completion	Number
'Big-bang'	2
Phased	3
Unknown	6
Total	**11**

Slightly more respondents suggested that phased rollout was a better option but there was some discussion at the seminar with one of the respondents that had used the 'big-bang' approach. They thought, on reflection, that they were forced into completing the entire project on time but that from the perspective of practical implementation a phased rollout would have been preferable. This respondent cited the difficulties of testing the whole system, adding card installations to all the vehicles at the same time as significant challenges (see section 3.2.6).

3.2.8 Contracting method

This was also an interesting area as the concept of a completely outsourced system is still quite new in eastern Europe although familiar in western Europe. The results for this part of the questionnaire are shown below.

Type	Number
DBOM	5
DBM	2
BOT	1
Not known	3
Total	**11**

It appears that 'design, build, operate and maintain' (DBOM) is the most popular choice, with two respondents opting for 'design, build and maintain' (DBM) and one for 'build, operate and transfer' (BOT). The remaining three respondents had still to decide on the form of any contract that would be undertaken.

3.2.9 Experience of lending

This was the least well-answered of the questions, possibly because it could have been more specific. Although a number of the respondents had experience of lending with various bodies there did seem to be a bias towards the EBRD. Three respondents referred to the technical advice that had been made available to them on previous projects by the EBRD which suggested that this was an important differentiator from other lenders.

3.3. Seminar report

3.3.1 Seminar overview

The seminar, which took place on 7 and 8 November 2016, sought to identify challenges and issues that arise when an AFC system is implemented and to suggest the principles and best practice to follow. This was conducted from two perspectives: first, the viewpoint of the EBRD, explaining what the Bank was trying to do and also what it expected from the transport authority when a scheme is proposed and while it is being implemented. The second viewpoint was that of a number of experts in the field who had either implemented schemes or were in the process of doing so. Both of these viewpoints were supported by AFC experts who led the seminar and also presented their views. Their AFC schemes were split across entities of various sizes, ranging from London as a large capital city, to Belgrade, a medium-sized capital city and to Reading, a county town in the Thames Valley of the UK. This was important to showcase that solutions are available to an entity regardless of its size.

3.3.2 Attendance

Thirteen cities were invited to send delegates to the event, as follows.

Country	City
Georgia	Tblisi
Hungary	Budapest
Romania	Bucharest Constanta Galati Iasi Pitesti
Serbia	Belgrade
Ukraine	Ivano-Frankivsk Kiev Lviv Odessa Vinnytsia

Of these, only representatives from the city of Constanta did not attend the seminar.

The representatives included city mayors, deputy mayors, heads of transport departments and members of AFC implementation teams.

3.3.3 Seminar report

The first afternoon of the session was spent visiting Transport for London (TfL) for a presentation on the status of their system. Since the introduction of the Oyster card in 2003 TfL have continued to adapt and improve the system, leading to the successful introduction of contactless payments in 2011. TfL explained that one of the drivers for implementing the system was the need to improve through-put at the gates (with a target of 40 people per minute versus 25 per minute) and also reduce the costs of revenue collection. Until the project TfL had not been able to quantify the costs of revenue collection. These were discovered to amount to 14 per cent of revenue. Since the implementation of the current system this figure has fallen to 7 per cent of revenue and further cost reductions are being sought. TfL also pointed out that they believed implementation of the system had itself resulted in a 3 per cent increase in ridership. This was put down to the ease and speed of smart ticketing compared with the previous systems.

On the second day of the seminar, following introductions by all participants, the EBRD and seminar leaders made presentations and case studies were put forward. A plenary session followed, where all delegates gave their views on implementing AFC.

The presentation by the EBRD covered related topics including the requirements of the EBRD for funding such projects and a high-level view of various projects that the EBRD had covered.

The Bank's presenters stressed that this was a policy dialogue event and that urban transport planning is key to the success of AFC:

- Fare structures, integrated fares, where the service operates, integrated mobility and related integrated planning and operations are needed to make AFC a key component and to enable its effective use
- AFC is compatible with several issues that the EBRD supports – efficiency, transparency, user experience, sustainable mobility, green economy, green funding proposals, and is a key element of smart city solutions.
- AFC obtains data to enable transport authorities to provide the right service. AFC is a tool, not just an operating platform. It helps better adapted travel fares to be available for passengers and the operating system should be adaptable to future fare changes.

Presentations were also given on Belgrade and Reading, effectively covering a medium-sized and a smaller city.

Lastly, the seminar leaders gave two presentations on perceived best practice in implementing AFC systems: first, a high-level view of the principles, and second, a more detailed presentation on matters such as programming, contract requirements and organisational functions.

3.4. Conclusions

The main conclusions reached through the questionnaires and the seminar were that the reasons for implementing a scheme, and the challenges of the scheme, may not necessarily be the ones that first spring to mind. Also, it would seem that a number of smaller cities are starting to look seriously at AFC schemes although most of these are still at the feasibility stage. There was also some recognition among cities that have implemented schemes that some aspects of their AFC projects could have been done better.

The quality and usefulness of the information gathered has been noted by the EBRD. It is recommended that a questionnaire based on the one used in this study (modified to particular circumstances) be used in the early stages of a project's evaluation.

3.5. Acknowledgements

Mogul Associates Ltd and the EBRD would like to acknowledge and thank all the respondents to the questionnaires for their time and support in providing the comprehensive and detailed responses which we received. In particular, Mogul Associates Ltd would like to thank Ms Jacqueline Alexandre and Mr Marek Waskiewicz for their support and assistance during the seminar.

Annex 4. EBRD policy dialogue series

The European Bank for Reconstruction and Development has the mandate to pursue, in its countries of operations, necessary improvements and reforms to promote both resource efficiency and a sound platform for commercial, operational and financial sustainability for the relevant sectors.

Policy dialogue with governments, regulatory authorities and market participants is a vital part of the EBRD's mandate. The policy dialogue initiative aims to increase economic resilience, foster integration and address common global and regional challenges. The activities of the EBRD include project financing, provision of technical assistance and policy support.

The EBRD Policy Dialogue series was introduced in November 2015 to support policy dialogue in infrastructure sectors (transport and municipal services) with key EBRD clients in the Bank's countries of operations.

Each policy dialogue consists of a public sector dialogue process, with one or several seminars of one to two days and publication of a policy paper, facilitated with technical specialists. Each seminar is held in London or in EBRD countries of operations.

The policy dialogue series is funded by the EBRD's Infrastructure Project Preparation Facility (IPPF).

Current publications

- "Facilities management PPPs: How best to incorporate the private sector": Social infrastructure PPPs in the healthcare, educational and other public-building sectors require careful preparation to strike a balance between reaping the potential gains of private sector management efficiencies and losing control of what is for many countries an essential public infrastructure related to public services. With several countries now moving toward PPPs in these sectors, which roles should the private sector play, and which areas of activity should be retained by the public sector?
- "Performance-based road contracting: Approaches to national road network management": The countries where the EBRD invests still suffer from poor performance of their roads. Their life-cycle is far shorter than comparably specified roads in OECD countries, for example. One of the reasons for this is the lack of continuous maintenance to keep a road in good condition. Another is the focus on 'input-based' (for example, unit-cost) rather than 'output-based' road contracts. Performance-based contracting as part of an overall asset-management approach to roads has proven to be effective elsewhere, but under certain conditions and institutional settings.
- "Challenges and opportunities in the district heating sector: methods to achieve full cost recovery": The district heating sector involves another essential service, which often presents the need for heavy capex investments that may stretch the limits of users' ability to fully amortise these through full-cost recovery fares. In the face of potential affordability constraints, how can public policy best target certain user groups with public support? On the input side, how can the cost of service delivery be contained in an effort to close financial gaps? How might a Regulated Asset Base method be used?
- "The way forward with automated fare collection": AFC systems are being prepared and implemented in several cities as a means of improving public transport's overall efficiency and regulation. When is it most appropriate to pursue a contractual model based on public sector ownership with outsourced operations? When does a full PPP approach make more sense?

Glossary

AFC	Automated fare collection
AVL	Automatic vehicle location
BKK	Budapest Travel Authority
BOT	Build, operate, transfer
Capex	Capital expenditure
CoO	Country of operations
DBFOM	Design, build, finance, operate and maintain
DBFOT	Design, build, finance, operate and transfer
DBOM	Design, build, operate and maintain
DBM	Design, build and maintain
EAL	Evaluation assurance level
EBRD, the Bank	European Bank for Reconstruction and Development
EMV	Eurocard MasterCard Visa contactless card
GDPR	General Data Protection Regulation
IPR	Intellectual property rights
IT	Information technology
ITSO	UK national standard for smartcards
KPI	Key performance indicator
NFC	Near-field communications
PBC	Performance-based contract
PFI	Private finance initiative
PIU	Project implementation unit
POS	Point-of-sale
PPP	Public-private partnership
PP&R	Procurement Policy and Rules
PR	Public relations
QR	Quick response code
RTPI	Real-time passenger information
SSL	Secure sockets layer
TC	Technical cooperation
TOR	Terms of reference
TfL	Transport for London
TVM	Ticket vending machine
UK	United Kingdom

896 Policy paper on infrastructure - On the move: delivering automated fare collection

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