FEASIBILITY STUDY FOR THE TWO PILOT PT LINES IN THE REGIONAL SYSTEM

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The purpose of preparing the "FEASIBILITY STUDY FOR THE TWO PILOT PT LINES IN THE REGIONAL SYSTEM"

The aim of this study is to support decision-making and implementation processes in the introduction of a public transport toll collection system common for all transport organisers and transport undertakings as well as a uniform passenger information model. The system may be used for intraregional and international connections. This study presents the objectives and principles underlying the introduction of a uniform toll collection system, the most important information and analyses concerning economic, technological and legal factors influencing the system, as well as the concept of its pilot implementation.

Definitions

The table below presents the terms used in this document and their definitions.

Term or abbreviation	Definition
Actor	System user representing a group of users who use similar system functions.
System actor	A system module involved in the implementation of use cases.
Check In / Check Out (CICO), be in / be out (BIBO)	The procedure for recording the start and end of a journey, either by holding the identification medium close to an infrastructure element of the vehicle or a stop, or by scanning the QR code on the infrastructure element of the vehicle or stop.
Fraud	Abuse of a card which has been stolen, copied or issued using false data in order to avoid payment for a transport service.
CICO infrastructure	A set of devices for the Check In / Check Out procedure, installed in the vehicle or at the stop. A panel with a Tag and a graphic and information element presenting project content.
Stakeholder	A beneficiary or person/entity with an interest in the success or failure of the implemented solution.

Term or abbreviation	Definition
QR Codes	QR codes which are carriers of information in the form of a structure which is scanned and then electronically processed into an object which is readable by the recording equipment.
Anti-fraud control	Control aimed at detecting fraud involving the theft or copying of tickets or encrypted data on identification media.
Licence	The term "licence" is understood by the Contracting Authority as the right to use the service provided to the Contracting Authority by a given supplier/Contractor in any form depending on the individual solution of the supplier, e.g. a paper document with an access code, electronic key or other.
Line	A fragment of a route or connected parts of a route, marked with a number on which transport services with a defined start, end and intermediate stops are carried out.
NFC	The Near Field Communication technology which facilitates the use of contactless infrastructure.
Identification Carrier	A device, a mobile application installed on a phone, or any other object used to confirm the right to a transport service or to confirm the identity of a passenger in the central system.
Platform Operator	An entity acting as the Administrator.
Transport Operator	An enterprise authorised to conduct business activities in the field of passenger transport.
Transport Organiser	A local authority competent for transport, ensuring the operation of public transport in a given area.
Panel	An element of CICO Infrastructure installed in a display case on a platform, in a vehicle or in any other place determined at the stage of pilot preparation.
Passenger	A person using a means of transport as part of a transport service.
Journey Planner (or Planner)	The service available on the portal or in the mobile app, which makes it possible to plan a journey from point A to point B according to various parameters (price, comfort, time), SRM using various means of transport, also providing the option of booking a bike within the city bike system.

Term or abbreviation	Definition
Electronic Platform (Platform)	A platform which provides access to infrastructure and application resources with specific base parameters.
Entity responsible for system implementation	A central entity aggregating and selling transport services in the regions covered by the system according to the tariffs of transport organisers operating in the regions covered by the system, providing transport organisers and undertakings with the necessary data to enable them to make the necessary financial settlements.
Vehicle	A means of urban transport, such as a bus, trolleybus or tram, used by the transport operator to provide transport services under an agreement concluded with the Transport Organiser.
Cool access tier	Data storage layer/space in a cloud service with a lower storage cost, and a higher cost of access compared to the hot data layer. The layer is designed for data that remains in the cold layer for at least 30 days. Sample uses of the cold layer: · short-term datasets for backup and system crash recovery, · older content not viewed frequently anymore but expected to be accessible immediately when needed, · large data sets which must be effectively stored, while more data is being collected for future processing (e.g. long-term storage of scientific data, raw telemetry data).
Hot access tier	A data storage layer/space with higher storage costs than cold and archive data storage layer, with a low cost of access. Sample uses of the hot layer: · data that are in active use or expected to be accessed (read from and written to) frequently. · data submitted for further processing and, where needed, migration to the cold storage tier.
CICO procedure	The procedure for recording the start and end of a journey, either by holding the transport service medium close to an infrastructure element of the vehicle or a

Term or abbreviation	Definition
	stop, or by scanning the QR code on the infrastructure element of the vehicle or a stop
Journey	An object from the start to the end of the journey, with a specified ID of the vehicle, ID of the passenger and line.
Stop	An urban transport stop or railway station on a PKM line covered by the pilot
RFID	A technology that uses radio waves to transmit data and supply energy to an electronic system (RFID tag) which serves as a label of an object through the reader, in order to identify the object.
SIPiR	The journey and payment identification system.
BOB Standard	A Swedish standard for payments for tickets developed within the Biljett och Betalprojektet project in order to combine various ticketing systems. The premise behind this standard is to build ticketing systems based on small blocks with a defined interface in relation to other blocks of the system.
Means of transport	A transport device used to transport passengers
TAG	A part of the CICO infrastructure element equipped with an NFC tag and QR code that facilitates communication with other NFC devices or an application that scans the QR code to transfer data such as the vehicle ID, stop ID, GPS location (of the stop), or the internet address of the portal.
Fare	A list of transport services, including fees for their use.
Route	A transport route between stops, covering one or more lines or parts of a line.
Terminal equipment	An element of the infrastructure which makes it possible to read data from carriers owned by passengers, and proper systematisation and exchange of data with the central application.
Transport service	A service of passenger transport by means of public transport at a specified fare. The commencement of service provision is calculated from the moment the journey by a means of transport starts until the moment of leaving the given means of transport. The passenger transport service provided by the Transport Operator in accordance with the rules governed by the Agreement concluded with the Transport Organiser. A single journey within the administrative boundaries

Term or abbreviation	Definition
	of a city or rendering available an unlimited number of journeys in a period defined in the regulations in a selected administrative area (e.g. a monthly or day ticket), are examples of the service.

PART I. THE STRATEGIC OBJECTIVE AND BENEFITS OF IMPLEMENTING A UNIFORM TOLL COLLECTION SYSTEM

The strategic objective of the uniform toll collection system is to increase the share of public transport in the total journeys made by the residents, by integrating the individual transport subsystems managed by different organisers. It is assumed that the introduction of a uniform system, which would make it as easy as possible to use public transport services, would simplify the method of payment for transport services, support travellers in planning their journeys, make it possible to offer new products, substantially raise the standard of and increase the use of means of public transport. The benefits for the user, resulting from system implementation, are presented in Table 1. Another business objective of the uniform toll collection system is to increase the profitability and effectiveness of the offerings of public transport system organisers.

One should note, however, that the toll collection system used in public transport should be user-friendly and attractive, support the passenger and not require the passenger to know the fares, transport undertakings, zones, and ticket types. The system should also facilitate adding new products offered by other actors serving passenger-transport related sectors.

Table 1 The benefits for the passenger resulting from the implementation of a uniform toll collection system

Benefits for the passenger	System functionalities/modules that bring benefits
Improved standard of transport services	• streamlining the purchase process, • optimising cost/comfort of travel based on the parameters defined by the passenger in the Planner, • linking urban transport to the metropolitan bicycle and ultimately with a system for the verification of parking spaces available in critical areas, • multiplying ticket sales channels, • utilising a dedicated smartphone app, • making payments using a payment card registered in the system,

Benefits for the passenger	System functionalities/modules that bring benefits
	• making payments/settling journeys using a dedicated card registered in the system, • cash payment – unnamed account, • payment via an internet portal, • paying for journeys using a ticket vending machine.
Shorter travel times.	• motivation to make greater use of public transport, • journey planner functionality, • timetable functionality.
Lower costs of journeys settled within the toll optimisation system.	• journey planner functionality, • timetable functionality.
Improved passenger, adult and children safety.	• the utilisation of personalised cards to make payments in public transport with the option of identity verification.
Lower payment carrier purchase costs.	• the use of electronic identity documents (e.g. electronic student cards, city cards) or a mobile device (smartphone).
The possibility of controlling the level of public transport expenditure on an ongoing basis.	• the current cost of travel (per day -1) in a given period functionality.
No need to carry cash to pay for journeys.	• the Ticket/transport service purchase functionality in the app • the Ticket/transport service purchase functionality in the portal, • support for contactless payment cards, • the electronic purse functionality, • support for passenger credit, • debt recovery functionality.

1 The functional premises of the system from the passenger's perspective

The functional premise of the uniform toll collection system from the passenger's perspective is to plan their journey in a mobile application or web portal using all possible means of transport. One example of the system's use from a passenger's perspective could be as follows: the passenger indicates the first destination – "office", and priorities (time, cost, convenience), the system will book a bike in the city bike system so that the passenger can get to the train station from the nearest bicycle parking and leave the bike in the city bike parking. At the station, the passenger (without the need to log in to the website or use the ticket office) checks in on the platform, then gets on the train and goes to the junction station where he/she checks out and changes to a tram (verifying the current timetable), and then a previously booked city

bike. Next, the passenger navigates to the nearest bicycle parking, next to the office, and reaches the first destination. The passenger plans the next stage of his/her journey. He/she visits a business partner from another country, and then they go together to one of the customers. For this purpose, the passenger rents an electric car using a CARSHARING system. He/she reserves a parking space in the port (Parking System) and a parking space in a car park dedicated to electric cars in the city centre. The passenger goes to the port by the electric car, where he/she leaves the car in a paid car park and picks up the guest from a ferry. They travel by the electric car to the city centre, where they leave the electric car. Then the guest goes to the hotel by tram – the fee for the tram is included in the price of the ferry ticket and the passenger returns home, taking a regional train and bicycle. At the end of the day, the system optimises the fees by selecting the best fares available.

In the above scenario, the Passenger:

- pays for the journey in a uniform manner (using various media), irrespective of the organiser of the service, transport undertaking or the selected means of transport,
- it is required that the Passenger is able to use at least several identification media:
    - a mobile device with an application able to communicate with the vehicle infrastructure through QR and NFC codes,
    - a mobile phone with NFC functionality,
    - carriers and contactless cards compatible with ISO/IEC 14443, verified in respect of the readers used in the solutions described herein.

2 The milestones of the implementation of a uniform toll collection system

In order to reach the strategic objective of the implementation of a uniform toll collection system it is necessary to reach the milestones and implement the respective functionalities (which is presented in Table 2).

Table 2 The milestones of the uniform toll collection system and the supporting functionalities

Milestone	Functionality facilitating the milestone
Assessment of the social acceptability of the proposed solutions	Pilot implementation of the functionalities of the IMP
Verification of technical capacity and application	Pilot implementation of the functionalities of the IMP

Milestone	Functionality facilitating the milestone
Streamlining international transport (e.g. by facilitating better connections for Passengers arriving by ferry to major transport hubs)	Pilot implementation of the functionalities of the IMP
Improving the quality of the environment by reducing emissions of harmful substances, owing to an increase in the share of public transport in the total number of residents' and visitors' journeys, and a decrease in the number of journeys by individual vehicles.	Functionality Product and fare management. Transport Operator Functionality: Journey settlement. Functionality Timetable (including optimising passengers' travel times and traffic loads).
An increase in the share of public transport in the total number of residents' and visitors' journeys.	Functionality Product and fare management. Transport Operator Functionality: Journey settlement. Functionality Timetable (including optimising passengers' travel times and traffic loads).
An increase in the economic efficiency of subsidies for regional rail transport by increasing passenger traffic on trains through the integration of regional rail and urban public transport ticketing systems.	Functionality Ticket/transport service purchase. Functionality purchase of transport service via parking meters. Functionality offering the Park&Drive fare. Functionality Journey planner connecting means of communication.
The optimisation of the transport route layout (ongoing transport management) and strategic planning of transport based on specific reports and journey analyses.	Functionality Timetable (including optimising passengers' travel times). Reporting passenger flows.
Automating and closing the loopholes in system of subsidies for transport operators as a means of honouring statutory discounts.	Functionality Product and fare management. Transport Operator Functionality: Journey settlement.
A decrease in the maintenance and repair costs of provincial roads as a result of improved attractiveness of regional public transport.	Functionality Timetable (including optimising passengers' travel times and traffic loads).
The possibility of introducing fare-based solutions used to decrease congestion on roads in areas covered by environmental protection	Functionality Product and fare management. Transport Operator Functionality: Journey settlement. Functionality Timetable (including optimising passengers' travel times and traffic loads).
Clear and transparent settlement of revenues from transport fees for services provided in	Functionality Product and fare management. Transport Operator Functionality: Journey settlement.

Milestone	Functionality facilitating the milestone
the areas for which individual public transport organisers are responsible.	
An increase in the economic efficiency of subsidies for local public transport.	Functionality Product and fare management. Transport Operator Functionality: Journey settlement. Functionality Journey planner. Journey settlement at the end of the day (settlement period).
Simplification of the rules for passenger fees.	Functionality Journey planner. Journey settlement at the end of the day (settlement period).
An increase in revenues from ticket sales in local public transport systems resulting from a decrease in the number of journeys by public transport by non-paying persons.	Functionality antifraud.
Automating the processes of current and strategic planning of transport organisation based on the analysis of current and historical data.	Functionality Timetable (including optimising passengers' travel times and traffic loads). Functionality Report module.
Automating and precise settlement of subsidies for transport operators as a means of honouring local discounts.	Functionality Product and fare management. Transport Operator Functionality: Journey settlement.
A decrease in ticket inspection costs in vehicles.	Functionality antifraud.
A decrease in environmental and repair costs, in particular in cities, due to a higher number of passengers using public transport.	Functionality Timetable (including optimising passengers' travel times and traffic loads). Functionality Report module.
Ongoing (real-time) optimisation of transport organisation based on the analysis of data on the actual workload of local transport lines.	Functionality Timetable (including optimising passengers' travel times and traffic loads). Functionality Report module.
Real-time management of the efficiency of rolling stock use.	Functionality Problem management(failures, timetable adherence).
Reducing drivers' load with ticket sales.	Functionality ticket purchase in modules: mobile app, passenger portal. Functionality Ticket/transport service portfolio.

3 Premises of the uniform toll collection system

The public transport toll collection system and uniform passenger information should come in the form of a system which:

- supports in particular the achievement of the objectives of passengers and transport organisers,
- is account-concentric (accountbase), where all the necessary information on its users is stored in a central system, and the contactless-enabled or EMV cards, or mobile phones with NFC, or QR codes serve only as the carriers of information required to identify passengers,
- is multi-modal, i.e. supports various means of transport: buses, trams, trolleybuses, the rail, city bicycles, with the option of adding support for car parks and car rental (car-sharing),
- facilitates the shaping of an urban transport development strategy owing to the options to implement various fares and discounts which allows:
    - minute, hourly, daily or monthly fee optimisation,
    - paying for transport using the pay-as-you-go model,
    - allocating preferential fares or discounts to selected routes and hours, resulting in an increase in the number of passengers in public transport and reduced traffic congestion,
    - monitoring passenger streams and the possibility of affecting their changes,
- facilitates implementing loyalty programs and support for additional municipal services (libraries, swimming pools, museums),
- is integrated with other ticketing systems in use in Europe (thanks to interoperability based on European standards), as well as those operating or planned in the field of system implementation,
- is safe and limits the risk of fraud,
- allows full access to data and has an independent data warehouse, which will significantly limit the risk of becoming dependent on a single supplier.

Within the new system, communication between infrastructure elements in the field will be based on the GSM network or other urban wireless network solutions (Wifi, WIfiMax, etc.).

Since it is impossible to install infrastructure in trains (e.g. when different trainsets are provided by the transport operator), it is necessary to build a platform infrastructure enabling the

passenger to initiate the journey (check-in) by validating the passenger's identification carrier using a device installed on the platform. The uniform toll collection system also be a system which:

- should not interfere with the present management and organisation structure of public transport in cities and communes, and not impact on the present financing rules for passenger transport in regional, district and communal perspectives.
- is able to serve passenger according to the fares applied by the organisers/carriers in the areas of their operation, securing the possibility of using statutory and commercial discounts.
- facilitates payment for journeys in public and private means of transport (road and rail haulage companies), and their multichannel validation:
    a. on mobile devices,
    b. through an online passenger portal,
    c. inside rolling stock in validating devices (payment card, dedicated card, QR code),
    d. in ticket vending machines and points of sale (cash),
    e. in passenger service points,
    f. by the driver/vehicle manager (in accordance with a decision of the organiser/operator).
- will provide transport operators with the necessary data and analysis to pursue a rational transport and tariff policy, ensuring transparent financial settlements between all ticket distributors (carriers, transport organisers) operating within the system's reach.
- will be connected to other ticketing systems, making it possible for the passengers to pay for journeys in the supported transport systems.

Furthermore, the central infrastructure of the system should facilitate its integration with other mobility promoting services (car sharing, metropolitan bicycle) and other public services. The journey and settlement identification system (SIPiR) in public transport should provide services for transport organisers, ticket issuers, transport operators and other entities which provide services in the field of public transport in the region.

4 Fares in the uniform toll collection system

Various fares may apply depending on the area and the Public Transport Organiser in charge; for the purposes of this study, the following types of fares have been defined to as processable by the system:

- a fee for transport services calculated according to periodical lump sums (including the subscription fee) covering any number of transport services for the selected zones and modes of transport,
- a distance-based fee for transport services: for a transport service based on the number of stops or kilometres travelled, with or without the possibility of transfer or break,
- a time-based fee for transport services: for transport services over a defined period of time or at progressive rates linked to the time the transport service is used, with accuracy down to one minute, based on the time difference between the start and end of the use of the transport service,
- a fee for transport services for zone data: including the possibility of using a varied fare depending on the place of start and end of the use of the transport service over an assumed period of time, with or without the possibility of breaks. The possibility of indicating the zone for which the individual fares can be defined,
- a fee for transport services calculated according to Fares for combined transport (e.g. bicycle + urban transport buses, parking + train, etc., of one transport organiser and several transport organisers),
- events – understood as fares defined for events and including the possibility of applying a varied fare throughout the day, on different days of the week (weekend days/week days, car-free days), at different times of the year,
- Pay-as-You-Go fares: to calculate and charge the fare at the end of the journey,
- fares the should facilitate offering differentiation in terms of means of transport,
- fares should facilitate the possibility of applying a zero or minus rate (understood as Passenger's revenue). The possibility of preparing special offers for certain user groups (e.g. students or employees of specific organisations),
- fares should allow the redefining of fare parameters, such as:
    - discounts,
    - zones and other geographic parameters determining included/excluded routes,
    - start point, sections,

- time parameters (number of journeys in a period of time, limited days on which means of transport are available, validity until a given date),
- sales parameters: Operators, carriers, deposit, personalised vs. bearer ticket,
- it is assumed that the list of products will be extended to include other types of tickets such as group tickets, event tickets, off-peak tickets and other products.

5 Passenger identification carriers and their registration in the uniform toll collection system

5.1 Passenger identification carriers

The goals to be met with the uniform public transport toll collection system and the cost of its construction mostly depend on the used passenger identification carriers. Passenger identification carriers that are viable and recommended for use in the uniform toll collection system are listed in the following sections:

- contactless cards (including Mifare Ultralight paper cards):
  - personalised cards, including dedicated loyalty programmes, student ID cards,
  - non-personalised (bearer) cards,
  - other NFC devices such as key-chains, bands, rings, nail wraps – basically acting as identification carriers, but can also be marketing gadgets.
- Devices (smartphones, tablets) compatible with the app assisting passengers/users during journeys, with a central user account and journey parameters pre-set on the account (discounts, number of people, additional luggage, etc.), type of payment (account credited with funds, added credit card, online transfers), where the phone is identified inside the vehicle through:
  - passenger interaction (pressing a button in the app or indicating the line number),
  - NFC technology, where the passenger holds the phone close to the active contactless reader in the ticket validator – communication with the system takes place using the infrastructure of the vehicle or ticket validator,
  - NFC technology, where the passenger holds the phone close to an NFC information carrier inside the vehicle (a tag, a sticker). Communication with the system takes place via GSM communication in the passenger's device,

- NFC technology allowing the **emulation of a contactless payment card (EMV**). Communication with the system takes place via GSM communication of the payment terminal in the vehicle, where card data are not stored in the system, but only a unique code (token) is generated. The toll is collected in agreement with the payment operator, the risk of lack of funds is borne by the payment operator,
- NFC technology allowing the **emulation of a contactless payment card (EMV**). Communication with the system takes place via vehicle infrastructure communication, card data exist in the system, each element of the system is certified for compliance with PCI DSS, it is possible to optimise transport fees from the system level, the risk of lack of funds is borne by the entity responsible for the system,
- QR code technology; where the passenger reads the QR code in the vehicle (a sticker). Communication with the system takes place via GSM communication in the passenger's device,
- QR technology, where the passenger holds the phone close to the QR-code reader in the ticket validator – communication with the system takes place using the infrastructure of the vehicle (ticket validator). The purchase of transport services in another ticketing system is possible.

- The contactless payment card (EMV):
  - EMV 1 – communication with the system takes place via GSM communication of the payment terminal installed in the vehicle, where card data are not stored in the system, but only a unique code (a token) is generated. The toll is collected in agreement with the payment operator, the risk of lack of funds is borne by the payment operator,
  - EMV 2 – communication with the system takes place via vehicle infrastructure communication, card data exist in the system, each element of the system is certified for compliance with PCI DSS, it is possible to optimise transport fees and card service fees from the system level, the risk of lack of funds is borne by the entity responsible for the system.
- The paper ticket:

- a traditional paper ticket which must be validated in a mechanical ticket validator without the possibility of identifying the ticket through the system, secured with a magnetic stripe or other elements which make it difficult to forge the ticket. It is necessary to distribute tickets to points of sale, except for ticket machines,
- a paper ticket in the form of QR, which must be validated in a ticket validator equipped with an optical reader with ticket identification by the system, secured with the system's code-generation method and anti-fraud mechanisms, there is no need to distribute the tickets to points of sale, at points of sale, the ticket can be printed by a standard receipt printer.

5.2 The registration of passenger identification carriers in vehicles

One can distinguish between the following ways of registration in vehicles:

- no registration for passengers with period tickets, verified only during inspections,
- CI-check in, the passenger registers only boarding the vehicle using the validation device,
- CICO-check in/check out, the passenger registers boarding and alighting from the vehicle using the validation device,
- BIBO-be in/be out, the system automatically determines whether the passenger is inside the vehicle (using radio communication with the carrier or based on the passenger's location),
- CIBO: check in, be out.

The manner of journey registration and settlement has various implications for the user. Table 3 compares the functional aspects for individual user types.

Table 3 A comparison of functional aspects

Passenger infrastructure element	Occasional users	Owners of monthly tickets
Traditional ticket	It is necessary to choose a type of service every time. Journey registration is required every time.	A single decision about the type of service, repeated periodically. No need to register the start of service use in the vehicle.

Passenger infrastructure element	Occasional users	Owners of monthly tickets
	Ticket validity inspection is necessary (e.g. for time-limited tickets/section tickets). To be purchased before every journey. Time spent on every transaction. Impossible to optimise payments in a given period of time.	Ticket validity inspection is necessary, hampered validation by the passenger, automatic passenger validation. A one-off purchase. Impossible to optimise payments in a given period of time.
CICO for NFC carriers and the mobile app	A single decision on concluding an agreement, registering the account and purchasing the carrier. No need to select the service. It is necessary to register boarding and alighting from the vehicle. Actions must be repeated every time for combined transport journeys. Automatic settlement on the basis of data from the reader. It can be the case that the user forgets to register alighting from the vehicle (possible solution: settlement on the basis of the fare adopted in the terms and conditions). The possibility of studying passenger streams, where passengers can be ascribed to relevant vehicles.	
BIBO – only for mobile devices	A single decision on concluding an agreement, registering the account and purchasing the carrier. No need to select the service. No need to register the start of service use in the vehicle. Automatic settlement based on data from the application, based on the location or data from the BIBO (BLE) system installed in the vehicle. The possibility of additional fees being charged as a result of approaching the registration zone despite not using the service -> unjustified registration of the service. Limited number of production deployments. Permanent collection of passenger location data – passenger tracking, increased battery consumption.	
CIBO only for mobile devices	A single decision on concluding an agreement, registering the account and purchasing the carrier. No need to select the service. It is necessary to register boarding the vehicle. Actions must be repeated every time for combined transport journeys.	

Passenger infrastructure element	Occasional users	Owners of monthly tickets
	Automatic settlement on the basis of data on the location. Limited number of production deployments. Permanent collection of passenger location data – passenger tracking, increased battery consumption.	

6 Variants of the implementation of the uniform toll collection system

When considering the viable variants for the design of the uniform toll collection system, the different perspectives of the project stakeholders should be taken into account.

- In variant I, passengers' objectives were adopted as priorities, these included: reducing purchases of the payment carrier and the possibility of using already-held carriers, simplifying the process of confirming the rights to travel, lower costs of journeys settled within the toll optimisation system.
- In variant II, transport organisers' objectives were adopted as priorities, these included: an increase in the share of public transport in the total number of residents' and visitors' journeys, an increase in the economic efficiency of subsidies for local public transport, automating the processes of current and strategic planning of transport organisation.
- In variant III, variants I and II are optimised to maximise objectives with minimum project outlays.
- In variant IV, a very dynamic growth of the smartphone technology is preferred.

For each of these variants, passengers should be divided into two groups.

Group 1 "Anonymous" – Passengers who do not provide their data, want to remain anonymous, give up most of the facilities and discounts, loyalty programs, and some optimisation options – e.g. tourists.

Group 2 "Personalized – optimised" – Passengers who have so far used long-term monthly tickets, who want to actively use the offered discounts, loyalty products, and opportunities to optimise transport costs.

In the discussed variants the following solutions were abandoned:

- traditional paper tickets – due to it being impossible to achieve the majority of the anticipated objectives of the system,

- EMV 2 cards due to the necessity of PCI DSS certification, which would significantly reduce the number of system providers and introduce an additional risk of becoming dependent on a third party, which could change the terms of service and introduce a PIN for each transaction. This, in turn, would necessitate the replacement of all ticket validators or could significantly increase transaction handling costs.

6.1 Variant 1 – Passengers' priority

In this variant, Passengers from group 1 "Anonymous" may use already held carriers in accordance with the global BYOD (Bring Your Own Device) trend, which consists in using an already used application for a mobile device or a contactless payment card (EMV) as a ticket/transport service carrier.

Passengers from group 2 "Personalised – optimised" can use a dedicated city or regional card and a dedicated portal and mobile application.

The way of handling transport services for individual groups would be as follows (Table 4):

Table 4 The manner of calculating fares for individual groups (variant 1)

Fare type	Group 1 "Anonymous"	Group 2 "Personalised - optimised". Lowest price guarantee
Single-journey ticket Urban transport	Contactless payment card (EMV) QR ticket Third-party apps (requires CI*)	City cards, Regional Card, App, requires CICO**
Timed/transfer journey Urban transport	Contactless payment card (EMV) QR ticket Third-party apps (requires CI)	
Section rail transport Section urban transport	Contactless payment card (EMV) QR ticket Third-party apps (CI required – necessary to select the end stop during purchase)	
Events	Tourist Card/third-party apps using QR code (requires CI)	
Period ticket Degressive fares/combined fares	X	App, Regional Card, does not require CICO or CI

*CI – registered boarding **CICO – registered boarding and alighting

In this variant, it is recommended to anticipate the modification of fares for Group 1 "Anonymous" passengers with ATM cards to cover investment costs allocated for ticket validators and payment operators' fees. In terms of costs, this variant is characterised by fees (commission) being incurred for the benefit of the payment operator when tickets are purchased using a credit card (per every transaction).

In variant 1, it is also necessary to refit ticket vending machines to facilitate issuing cards or printing tickets with a QR code, which will make it possible to use carriers (cards) repeatedly or print tickets on a carrier supported by an optical reader in the vehicle (the target is to abandon mechanical validators).

The use of the QR code would make it possible for cities with no ticket vending machines to build a sales network based on existing outlets, e.g. retail chains, without the need to distribute paper tickets to these points of sale.

6.2 Variant 2 – Transport organisers' objectives priority

In this variant the city cards, Mobile App and Internet Portal should serve as the main carriers of transport services. All cards should be provided in secure technology (MIFARE DESFire and higher), except for NFC tickets, issued on paper carriers dedicated to lower-value transport services. Paper tickets utilising contactless technology will be available at ticket vending machines (the possibility of implementing paper contactless cards in existing ticket vending machines should be explored). The use of urban transport services in this variant entails the necessity of confirming the boarding and alighting from the vehicle (check-in/check-out, CICO). This makes it possible to collect information on passengers who use public transport, such as the transport operator, line and route.

The use of city cards makes it possible to form a dedicated transport policy by offering:

- incentives, such as fares, for the reduction of traffic congestion, e.g.:
    - discounts – free journeys at rush hours on dedicated routes,
    - discounts on transport routes implemented along particularly congested roads,
    - free journeys outside rush hours for selected social groups,
    - increased service frequency,
- optimised layout of transport routes,
- reducing congestion on roads which generate increased environmental and repair costs (viaducts, bridges, district heating substation, etc.).

All journeys (including reduced-toll journeys) must be able to accurately indicate the passenger, line, route and time. This will make it possible to achieve the objectives of economic growth, local transport subsidies and automatise the settlement of transport subsidies. The introduction of the CICO requirement may contribute to a decrease in the number of public transport journeys by non-payers, as the duplication of carriers will be detectable through correlation analyses. In addition, the application of appropriately secured cards will make it significantly more difficult to duplicate carriers.

In this variant, due to the possibility of purchasing packages of transport services on a contactless carrier, it should be possible to refund unused amounts, e.g. at customer service points.

In this variant, the individual fares for the presented groups should be handled in the manner presented in Table 5.

Table 5 The manner of calculating fares for individual groups (variant 2)

Fare type	Group 1 "Anonymous"	Group 2 "Personalised - optimised". Lowest price guarantee, pay as you go
Single-journey ticket Urban transport	Paper tickets – MIFARE ultralight within a package or a card, depending on the purchase value Third-party apps (requires CICO)**	City cards, Regional Card, App, requires CICO
Timed/transfer journey Urban transport		
Section rail transport		
Events		
Period ticket Degressive fares/combined fares	X	App, Regional Card, requires CICO

**CICO – registered boarding and alighting

6.3 Variant 3 – Balanced objectives of passengers and transport organisers

In this variant, the modification of fares for Group 1 "Anonymous" passengers with ATM cards is anticipated to cover investment costs allocated for ticket validators and payment operator's fees. All passengers are required to register boarding and alighting from the vehicle (including group 2 "Personalised – optimised" passengers). In terms of costs, this variant is characterised by fees being incurred for the benefit of the payment operator when tickets are purchased using a credit card (per every transaction).

In variant 3, it is necessary to refit ticket vending machines to facilitate issuing cards or printing tickets with a QR code or NFC. This will make it possible to use carriers (cards) repeatedly or print tickets on a carrier supported by an optical reader/NFC reader in the vehicle (the target is to abandon mechanical validators and traditional paper tickets).

The application of the QR code would make it possible for cities with no ticket vending machines to build a sales network based on existing retail outlets, without the need to distribute paper tickets to these points of sale.

In this variant, the individual fares for the presented groups should be handled in the manner presented in Table 6.

Table 6 The manner of calculating fares for individual groups (variant 3)

Fare type	Group 1 "Anonymous"	Group 2 "Personalised - optimised". Lowest price guarantee, pay as you go
Single-journey ticket Urban transport	Contactless payment card (EMV) Ultralight paper ticket, QR ticket; Third-party apps (CICO required)	City cards, Regional Card, App, requires CICO
Timed/transfer journey Urban transport		
Section rail transport		
Section urban transport		
Events	Tourist Card/other sales networks using QR code	
Period ticket Degressive fares/combined fares	X	App, Regional Card, requires CICO

6.4 Variant 4 – Ready for the development of technologies of the future

This variant assumes the possibility of using QR codes and the mobile app, where the use of phones will supersede paper QR codes. It also assumes the possibility of selling QR codes through sales networks, without the need to distribute paper tickets (similarly to phone top-ups). The monthly ticket should be available in the mobile app or assigned to an ID document with a photo and signature. No use of NFC carriers and readers is envisaged. Not using NFC carriers might hinder integration with the city card system, within which the option of utilising the mobile app, generating QR codes, should be provided for. In the case of the city bike system, integration would be possible through the App.

In this variant, the individual fares for the presented groups should be handled in the manner presented in Table 7.

Table 7 The manner of servicing individual fares for individual groups (variant 4)

Fare type	Group 1 "Anonymous"	Group 2 "Personalised - optimised". Lowest price guarantee, pay as you go
Single-journey ticket Urban transport	QR ticket, third-party apps, (requires CICO)**	App, requires CICO
Timed/transfer journey Urban transport		
Section rail transport		
Section urban transport		
Events		
Period ticket Degressive fares/combined fares	X	App, requires CICO

**CICO – registered boarding and alighting

6.5 The recommended variant

Based on the conducted analyses, variant 3 should be recommended, because of the following:

- Option 3 makes it possible to devise an active strategy within the development of public transport in the region, including full information on passenger streams, as well as to create tools facilitating the removal of barriers hindering access to the core of the metropolis and regional centres,
- Variant 3 implements the objectives of transport organisers and passengers. While it requires additional activities for passengers to register their boarding and alighting from vehicles, there is great potential for the difficulties associated with additional activities to be compensated for by both attractive fares and loyalty packages, as well as by improving the quality of urban transport (service frequency, reducing the number of people using main lines, adjustment of timetables to passengers' expectations) through the development of active transport policy,
- Variant 3 is ready for technological changes in terms of mobile technology advancements, card payments, and compliance with European standards, as well as the development of BiBo passenger identification systems (automatic passenger identification in the vehicle),

- In variant 3, the system is largely independent of the payment operator, ATM cards, and substantial changes in trends of use of individual identification carriers (e.g. phones),
- Variant 3 will make it possible for tourists to easily move about the region, and, when coupled with information from the Tourist Card, it will facilitate the promotion of tourist attractions.

7 Estimating the costs of the uniform toll collection system and its parameters

In order to estimate the costs of the uniform toll collection system, they should be broken down into investment costs and annual operating costs.

7.1 Investment costs

Investment costs should cover the four major cost groups:

- Software: this cost group should include the costs of the IT system consisting of individual solution modules (e.g. Billing, Servicing remote devices, Journey planner, Data warehouse, Data broker, etc.), which will ensure the achievement of the objectives provided for individual variants.
- Passenger infrastructure, including passenger identification carriers – to be purchased as part of the project. The numbers and types of the carriers vary in respective variants, with influences the estimated variant costs.
- Terminal equipment infrastructure, which provides for equipping vehicles with ticket validators, on-board computers and GSM communication modules. The number of devices was defined based on data on the currently operated rolling stock.
- Other costs, which include the costs of organising the activities of the entity implementing the uniform toll collection system, design tools necessary to implement the project and the knowledge necessary to obtain it.

7.2 Operating costs

Operating costs should cover:

- The costs of GSM services allowing data from ticket validators to be transferred to the system.

- The costs of payment handling and ticket distribution – these are ticket distribution costs paid to intermediaries and payment operators (with various distribution rates being adopted depending on the variant).
- The costs of know-how and organising the activity of the company implementing the uniform toll collection system.
- The costs of maintenance of and support for the purchased software.
- The costs of the staff of the company implementing the uniform toll collection system, necessary for the purposes of servicing, maintenance and analysis preparation.
- The costs of tools of the company implementing the uniform toll collection system and the Cloud (cloud-based and accessible via dedicated links).

7.3 Transport service indicators

The study analysed data in order to develop indicators to help assess the convergence of data between ticket issuers. It should be noted that some data (e.g. the number of annually transported passengers) is usually estimated on the basis of expert indicators or statistical surveys (the present systems usually do not facilitate the obtaining of actual and permanent data).

When analysing the indicators, a number of data were examined and the following indicators were selected as best reflecting the proportionality of the services between the individual ticket issuers:

- Ticket Validator Share Indicator (TVSI) understood as the target number of ticket validators deployed in the issuer's vehicles, in relation to the total number of ticket validators; expressed as a percentage.
- Transport Service Share Indicator (TrSSI) understood as the percentage of transport services of the given issuer, in relation to the total number of transport services; expressed as a percentage.
- Tickets Sold Share Indicator (TiSSI) understood as the percentage of sold tickets of the given issuer, in relation to the total number of tickets sold; expressed as a percentage.
- Revenue Share Indicator (RSI) understood as the percentage of revenue of the given issuer, in relation to the total revenue; expressed as a percentage.

7.4 The parameters of the uniform toll collection system and the manner of their calculation

A set of quantitative parameters was defined under the study to streamline the development and implementation processes for the uniform toll collection system. These parameters can be also used to estimate the costs of the system.

Table 8 The quantitative parameters of vehicle infrastructure

No.	Parameter	Symbol/Formula	Description
Veh	Number of vehicles	Veh	Number of buses, trams, traction units and rail buses, resulting from survey data, which translates into the number of on-board computers.
Val	Number of currently installed ticket validators	Val	Number of ticket validators resulting from survey data. It is a variable parameter for rail.
D	Number of doors	D	Number of doors in the vehicles, which translates into the number of readers installed in the vehicles. It is a variable parameter for rail.
Re	Number of readers	Re=D Re=Val	Number of readers corresponding to the number of doors. It is a variable parameter for rail – it corresponds, in the variant, to the number of ticket validators.
Driv	Driver's position	Driv=Veh	The number of driver's positions corresponds to the number of vehicles.
Comp	On-board computer	Comp=Veh	The number of on-board computers corresponds to the number of vehicles.
GSM	GSM communication	GSM=Veh	Number of messages.
POS	POS position	POS	
Insp	Inspection reader	Insp	Number of inspection readers

Table 9 Parameters to specify the database size

No.	Parameter	Symbol/Formula	Description
MN	Number of messages.	*MN*	Number of messages sent between system infrastructure elements. Depends on the number of elements (carriers /

No.	Parameter	Symbol/Formula	Description
			vehicles), number of journeys and unit size of the message.
AN	Number of named and unnamed accounts	*AN*	Number of all accounts, which corresponds to the number of carriers registered in the system.
DBV	Database volume	*DBV=MN*US*PC*	The assumed database size depending on the number of messages, unit size of individual messages, taking into account the timeframe. The database volume also encompasses data stored for reporting purposes.
PC	Annual change indicator	*PC*	The parameter which reflects annual changes.
AS	Account size	*AS=DBV/ NO*	Database size for one account.

The database size is determined by the number and size of messages sent between infrastructure elements and the size of personalised and anonymous accounts.

Table 10 Transport speed

No.	Parameter	Symbol/Formula	Description
PVmax	The maximum number of passengers per vehicle	*PVmax*	The maximum number of journeys in a 15-minute rush period. The parameter is used to calculate the number is messages to be handled in the rush period.
MNrush	The number of messages in a 15-minute rush period.	*MNrush=PVmax*VehNo+BL*	The number messages to be handled in the rush period.
RatC	The messages per core/second rate	*RatC*	Message per second handling rate.

Table 11 Quantitative parameters for IT infrastructure

No.	Parameter	Symbol/Formula	Description
	Total data recorded in the database by an account [GB]	*TD=AN**AS	The expected database size based on the number of accounts and account size.

No.	Parameter	Symbol/Formula	Description
	USS disk memory	*DM*	A parameter used to calculate the monthly or annual fee for maintaining data in the database, per GB.
CN	Core number parameter	*CN*	The parameter determining the number of cores needed for 1 million accounts.
CPU	Number of CPU cores	*CPU*=CN**MN*	Number of cores necessary for all accounts in the system.
ProcN	Number of processors in a server	*ProcN*	
SN	Number of servers.	*SN=CPU/ProcN*	Number of servers.
	Database size	*DBS=DM*TD*	USS disk memory*total data recorded in the database by an account.
	Electricity consumption per matrix	*M*	Parameter used to calculate electricity cost per matrix.
	Electricity consumption per server	*S*	Parameter used to calculate electricity cost per server.

Table 12 Cost parameters for IT infrastructure

No.	Parameter	Symbol/Formula	Description
	Data maintenance	*DM=TD*GBC*	Total data * annual cost per 1 GB.
	Data backup	*DB=3*TD*GBC*	The cost of maintaining tripled production space.
	Server fee	*SF*	A fee for a specified number of servers per year.
KW	An annual fee for 1 KW	*KW*	An annual fee for 1KW of electrical power.
	Primary server room	*PSS=DM+SF+DB*	The cost of data maintenance including servers and backup.

8 The interoperability of the uniform toll collection system / an application perspective

The uniform toll collection system should ensure interoperability at the four following levels.

8.1 Interoperability Level 1 – interusability

It is required that the Passenger is able to use the following identification carriers:

- a paper ticket with a QR code (including the possibility of displaying the QR code on a mobile device),
- a telephone/mobile device with the uniform toll collection system app or a third-party app,
- a telephone/mobile device with NFC,
- an NFC carrier (a contactless card or other carrier compatible with ISO/IEC 14443, verified in respect of the readers indicated in the next chapter). The NFC carriers within the solution will include at least: City cards, Tourist Card (it is recommended to use at least the MIfare Desfire technology) and mifare ultralight cards/tickets,
- a contactless payment card (EMV)- only for transactions concerning single-use tickets.

It is required to facilitate for the passenger, irrespective of the selected carrier, to purchase multiple transport services making up a single journey using a single carrier.

8.2 Interoperability Level 2 – intermodality

The validation equipment within the system should be capable of reading all the identification carriers used within the system.

- ticket validator (in the vehicle) equipped with:
    - QR code reader,
    - NFC contactless reader facilitating the reading of cards or other ID carriers, compliant with ISO/IEC 14443, NFC, as agreed by the Supplier and the system implementation entity,
    - contactless payment card terminal.
- beacon/NFC token/QR code for the mobile app, in the bus,
- inspector terminal,
    - QR code reader,
    - NFC contactless reader facilitating the reading of cards or other ID carriers, compliant with ISO/IEC 14443, NFC, as agreed by the Supplier and the system implementation entity,

The inspection of contactless payment cards should take place without it being necessary to read the card. It is recommended to tokenise the cards and transfer to the inspector only a part of the card number (e.g. the last 4 digits) on the basis of which the inspector would visually check its conformity with the card held by the Passenger.

8.3 Interoperability Level 3 – fare type compatibility

The system should be capable of handling all payments based on the existing and planned fares within the system and the supported means of transport.

8.4 Interoperability Level 4 – data exchange

It is assumed that the systems will cooperate with external systems (including the city bike system) in compliance with the required standards.

PART II. THE LEGAL ANALYSIS OF THE CORE ACTIVITIES OF THE ENTITIES IMPLEMENTING THE UNIFORM TOLL COLLECTION SYSTEM

When preparing this study, several variants of the core activities of the entities implementing the uniform toll collection system were adopted:

a) **Variant No 1 – as an endeavour based on commercial principles,**
b) **Variant No 2 – as an endeavour based on the principles of an "in-house" task (pursuant to Directive 2014/24/EU of the European Parliament and of the Council or the Public Procurement Law),**
c) **Variant No 3 – as an endeavour based on the principles of a public-private partnership, in accordance with the following premises:**
    - The company selects the private partner pursuant to the statutory mode;
    - The private partner conducts all the activities of the Company provided for in Variant No 2;
    - The company only supervises the performance of the agreement with the private partner;
    - The private partner is the beneficiary of EU funds;
    - The private partner transfers payments for project implementation to the Company (the commercial variant) or receives payments from the Company for system availability (the in-house variant).

9 The main conclusions of the legal analysis

During the preparation of the this document, complex legal analyses were carried out. The main conclusions of these analyses for the individual variants are presented below.

9.1 Variant No 1

1) In principle, it is possible to achieve a state, at the level of financial flows between the partners and the Company, in which there will be no risk of public aid if the Project achieves permanent profitability.
2) At the same time, the financing gap will have to be calculated for each type of subsidy, resulting in the expected level of grant between Variant No 2 and Variant No 3.
3) In principle, there are no legal risks related to gaining commercial revenues and revenues from cooperation within the metropolitan bike project and ticket sales regardless of their issuers, which results in there being no additional financial costs.
4) There are no legal risks in respect of the commercialisation of additional system functionalities, including support for settlements, which can generate additional financial benefits.
5) The implementation of the Project in this variant means a chance of increased profitability of the Project, with a high risk of failure due to the fact that the Project is a pilot project on a national scale.
6) Due to the need to calculate the financial gap, the risk of returning part of the grant is updated if the gap is not taken into account at the appropriate level at the application stage.
7) As the project is commercial and profitable in nature, the funding from each source will have to be treated as state aid which, in the absence of a public service contract, can only be *de facto* accounted for as de minimis aid or a block exemption, which limits or reduces the level of funding.
8) The implementation of the Project in this variant updates the legal risk as regards the possibility of the participation of local authorities in a commercial project which does not entail public service tasks.
9) The implementation of the Project in this variant is associated with a risk related to state aid in the absence of a public service contract and the need for at least partial support of the Company by partners, e.g. in the case of lack of profitability despite such original

assumptions – which would have to take place through so-called private investor tests. At the same time, the lack of a public service contract, if such services are actually provided, may result in risks in the field of tasks and obligations of the Company and its shareholders.

10) In this variant, the Interreg funding will constitute state aid and cannot be deemed as compatible with the common market through a compensation mechanism, which will result in the need to calculate the financing gap – see points 6 and 7 above.

9.2 Variant No 2

1) State aid within this variant will constitute permitted aid according to the scheme of compensation of costs incurred for services of general economic interest, pursuant to Regulation 1370/2007 or EC Decision 2012/21/EC. It is recommended to apply both these legal bases to settle the compensation that the Company will receive, according to the double-safeguard principle, which does cause not any methodological or practical differences.
2) It is not possible to indicate that the Company does not receive state aid based on the Altmark criteria since, according to the authors of the analysis, it is impossible to demonstrate the marketability of the compensation received by the Company.
3) The implementation of the project based on this variant results in there being no need to calculate the financial gap – point 142 of the Guidelines of the Ministry of Investment and Economic Development, which translates into no "penalty" for project profitability in respect of the subsidy amount.
4) At the same time, the Interreg funding, even treated as permissible state aid, will also not result in it being necessary to calculate the financial gap, if the Company correctly forecasts and verifies compensation (exclusion specified in Article 61 (8) (c) of Regulation 1303/2013).
5) All legal and financial risks related to generating commercial revenues (regardless of their source, including the metropolitan bike) will be permanently minimised based on the compensation mechanism.
6) All legal and financial risks related to the commercialisation of additional functionalities of the system, including support in the field of settlements will be permanently minimised based on the compensation mechanism.
7) The implementation of this variant, however, makes it structurally necessary to monitor

the 90/10 or 80/20 ratios throughout the whole stage of the performance of the entrusted task. At the same time, even in the case of the risk of exceeding this ratio, there are possible schemes of excluding commercial revenues from regulating the above-mentioned ratios (among the most popular in the country, it is worth mentioning the creation of "daughter" or "sister" companies which take over commercial activities).

8) According to the authors of this Analysis, the 80/20 ratio should be regarded as recommended, due to it not being necessary to apply the provisions of the Public Procurement Law in the case of opting for the aid scheme based on Regulation 1370/2007 (i.e. collective transport) or a scheme based on the Articles of Association and the provisions of the Act on Municipal Services in accordance with the views presented in the opinion of the President of the Public Procurement Office.
9) The implementation of the variant creates a risk of reduced profitability of the project (due to limiting the profit to the so-called reasonable level), while, at the same time, there is a high chance of "legalisation" and minimisation of risks as regards state aid.
10) What is relevant and distinguishing Variant No 2 from Variants 1 and 3, is the risk associated with the financing gap, and, consequently, the opportunity to secure the highest level of funding the eligible expenses.
11) The absence of legal and financial risks in the relations between partners and the Company, resulting from the application of the compensation mechanism and concluding a relevant public service contract, which will specify the rules and regulations concerning the entrusted task and the rights and obligations of the parties.
12) In this variant, the Interreg funding will constitute state aid and cannot be declared as compatible with the common market through a compensation mechanism, which will result in no need to calculate the financing gap.

9.3 Variant No 3

1) It is important that the Project in this variant can be implemented according to the cost compensation scheme or as a project not receiving state aid, the above de facto depends on its profitability and whether it is necessary to support the private partner.
2) As all PPP projects entail revenues (irrespective of whether they are generated by the public or private party), it will be necessary to calculate the financing gap, and given the methodology of such calculation and the fact that the private partner usually wants to

maximise profitability, in financial terms the project will be the least beneficial as regards the amount of funding.

3) If the project is implemented without state aid (the project is profitable for both the private partner and the Company), there will be no risks associated with commercial revenues and additional activities implemented within the PPP.
4) These advantages, however, are associated with a high legal risk in terms of feasibility and timeliness of the project (necessary pre-implementation analyses for the PPP) – the so-called hybrid projects.
5) The implementation of the Project in this variant is an opportunity to increase the profitability of the endeavour, which is encumbered with the risk of the necessity to return funding in respect of the financing gap.
6) At the same time, a high risk of project failure should be underlined. This may be due to selecting an inappropriate partner or inappropriate partnership rules, which, given the absence of correct pre-implementation analyses, appears to be a risk which cannot be excluded.
7) Given the above, one should pay attention to revenue risks associated with the division of risks under the PPP, and, in consequence, to the possible risk related to state aid for the Company, which can transpire in the case of inappropriate division of such risks.
8) The implementation of the Project in this Variant is associated with a risk related to state aid in the absence of a public service contract and the need for at least partial support of the Company by partners, e.g. in the case of lack of profitability despite such original assumptions – which would have to take place through so-called private investor tests.
9) In this variant, the Interreg funding will constitute state aid and cannot be declared as compatible with the common market through a compensation mechanism, which will result in the need to calculate the financing gap.

9.4 A recommendation concerning the selection of the core activities of the entities implementing the uniform toll collection system

1) **Variant No 2 is practically the only legally feasible variant, with no significant legal risks,** i.e. the implementation of the uniform toll collection system by the Company as an "in-house" entity.
2) The above is due to the following:

a. The implementation of the System in Variants No. 1 and 3, i.e. in the variants anticipating the commercial (profitable) operation of the System, is burdened with a substantial risk related to state aid and the funding level, which will be reduced as a result of the financing gap mechanism.

b. In Variant No 2, we do not apply the financing gap mechanism, because all the state aid received by the Company (including grants) is settled accordingly under the compensation settlement methodology, which results in the possibility of maximising the funding amount.

c. In Variant No 2 all state aid is settled using the compensation scheme. The applied ratio of public to private activity should be 80/20, and its type adjusted to the activity pursued by the Company (it does not have to be revenue-based, as provided for in the Public Procurement Law).

d. As a result, although we are formally dealing with a project involving state aid, the state aid is fully compatible with the common market through the compensation mechanism.

e. In this model, one may also attempt to exclude the factors related to state aid altogether through the absence of the internal and external commercialisation of the Project and its infrastructure and tools, which will result in the exclusion of one of the factors set out in Article 107(1) TFEU, i.e. the factor related to running a business activity.

f. The donor of aid in this model (Variant No 2) is always the public entity which enters into a public service contract with the "in-house" entity, and it is the public entity which formally settles all aid in the compensation account, which significantly simplifies reporting in this respect.

g. In the other variants, it is not possible to permanently minimise the risk, which can only be attempted on an ad-hoc basis through the so-called private investor tests. These tests, however, do not include aid received by the Company under aid programmes, which makes it necessary to classify this aid as *de minimis* or aid granted under block exemptions, and this again updates the risk of lower funding in respect of the calculation of the financing gap.

h. In other variants, the economic risk of the Project, i.e. the situation in which the Project, despite earlier assumptions, cannot be sustained on commercial terms,

cannot be hedged and minimised. In such a case, the subsequent conversion to Variant No 2, i.e. the "in-house" – compensation scheme, would be practically impossible.

i. On the other hand, transition from the "in-house" – compensation scheme, to the commercial one (e.g. Variant No 1) is always possible, as it can always be the case that the Company generates revenues which will make it possible to operate without physically granted compensation – in this option it would only serve as a security in the case of deteriorating market conditions.

10 The analysis of the risk of illegal state aid in Variant No 2

In the case of implementing Variant No 2 it should be indicated that the provision of state aid by shareholders in the Company to the Company operating in the "in-house" system, leads to a conclusion that the Company may be subject to the risk of illegal state aid, due to all the four conditions specified in Article 107(1) TFEU being met. In order to minimise this risk, it will be necessary to implement a compensation scheme for services of general economic interest.

Variant No 2 provides for the Company being an internal operator and it being financed through compensation, among other things. In this case, the state aid scheme should include the following elements:

a) The Company should perform the majority of its activities for the benefit of the institutions which have entrusted it with the performance of a task of general interest;
b) The Company should be collectively controlled, in a way corresponding to that of an internal operator of a given shareholder;
c) The tasks should be entrusted in a way consistent with Community legislation and, alternatively, also with the Public Procurement Law, i.e.:
    a. It is necessary to meet the conditions of Regulation 1370/2007 or the Public Procurement Law. It can be, however, indicated that three "in-house" variants are possible:
        1. One implemented pursuant to the Public Procurement Law – resulting in a contract with a 90/10 ratio,
        2. One implemented based on the Articles of Association and the Act on Municipal Services – in this case we are not dealing with a

contract concluded by public entities and an internal operator, but an 80/20 ratio may be employed,

3. One implemented pursuant to Regulation 1370/2007, in the case of which we are dealing with a public service contract, and are, analogously, applying the 80/20 ratio.

b. The amount of compensation must be forecast.

c. The public service contract must be entered into.

In the opinion of the authors of the analysis, as regards the presented "in-house" variants (90/10 or 80/20), in terms of minimising the risk, the recommended variant should be the one with the 80/20 ratio and based on Regulation 1370/2007. This is due to the following:

a) It ensures that the risks associated with compliance with the national "in-house" regulations are minimised;

b) It clearly defines the rights and obligations of the public party and the internal operator (Company) in the form of a public service contract;

c) It makes it possible to determine the methodology of compensation settlement in a comprehensive manner (e.g. through the use of non-standard methods of settling donations from public entities, e.g. in the form of the so-called investment compensation) the method of settling state aid.

PART III. CONCEPT FOR THE PILOT IMPLEMENTATION OF A UNIFORM TOLL COLLECTION SYSTEM

Activities aimed at creating a database, and establishing integration mechanisms and tools to be used by Passengers and Transport Organisers, such as web portals, the Passenger's App and the Controller's App, should be considered pilot implementation priorities. However, pilot implementation covers only part of the functions envisaged within the target solution, and its range includes selected areas that are critical for transport performance within transport corridors and the most important integration hubs.

Based on the conducted analyses, it is recommended that the Check-In/Check-Out procedure for journeys recording be used as part of pilot implementation. The area and range of pilot implementation are tightly connected with pilot objectives and the target solution assumptions. Therefore, they should be each time determined by the entity implementing the uniform toll collection system.

11 Operational objectives of pilot implementation

Pilot actions should be planned in consideration of the target solution vision. They should correspond to the following objectives:

Operational objectives of pilot implementation

1. Determining and verifying the technical capacities offered by the designed public transport toll collection system and uniform passenger information within selected test areas.
2. Assessing the usefulness (User Experience) of both the technology and functions offered by the tested solutions.
3. Creating a database – vehicle identification, stops location and lines, in combination with the records held by various Transport Organisers and Undertakings.

Auxiliary objectives serving the purpose of defining the scope and requirements to be met by the solution:

1. Verifying the potential of using the Check-In/Check-Out procedure in urban and rail transport by verifying the data submitted for passenger flow visualisation and settlement purposes.
2. Acquiring data, including GPS data, enabling the determination of urban and rail transport tariffs of various Transport Organisers.
   2.1. Assessing the possible simplifications regarding the verification of travel entitlements.
   2.2. Assessing the functioning of the NFC standard.
   2.3. Assessing the functioning of QR codes, and in particular the QR code reading time.
3. Assessing the efficiency of communication between the Controller's App and the Reader App, and the remaining modules, as well as verifying whether the scope of data storage, as determined for pilot implementation, is sufficient.
4. Verifying the potential of using the Check-In/Check-Out procedure in urban and rail transport, based on its assessment by users (utility aspects and operational barriers).
5. Developing an operational procedure to be launched in the case of identifying discrepancies between the data stored in electronic urban systems and the data stipulated in the resolutions on determining transport stops by individual Organisers.

6. Assessing the possible application of optimisation rules by providing data enabling their assessment.
7. Verifying integration with the system managed by Transport Organisers, carried out according to the BOB standard, enabling cross-border settlements of the proceeds from the sales of transport services between various Transport Organisers.
8. Creating the Passenger Portal enabling the purchase of cross-border tickets for journeys planned and visualised on the basis of the acquired data.

11.1 Key products necessary for accomplishing the operational objectives of pilot implementation

To accomplish said objectives, it appears necessary to develop a range of products serving data acquisition, updating and management purposes, as well as products enabling the verification and use of such data for providing the functions dedicated to both Transport Organisers and Passengers.

1. With a view to enabling data acquisition, integration-oriented actions should be envisaged, aiming at:
   1.1. Creating data structures
   1.2. Creating integration mechanisms
   1.3. Enabling integration with Transport Organisers' apps
   1.4. Enabling temporary integration with the target solution, as well as data migration.
2. In order to enable the storage and dissemination of coherent data, along with data management, the following products should be planned:
   2.1. Pilot actions providing a collection of data on stops, vehicles, schedules, lines and routes displayed on transport maps.
   2.2. A database management app.
3. With the aim of creating a toll collection system for passengers planning cross-border journeys, and in order for the relevant data to be disseminated, verified and handled by the users, the following products should be envisaged:
   3.1 The Controller's App with the implemented BOB standard, well-communicated with the Blekinge system, enabling both the recording of data on stops, along with global positioning (GPS), and the verification of the course of the CICO procedure.

3.2. The Passenger's App serving the purpose of conducting the CICO procedure based on the Passenger App's interaction with elements of the CICO infrastructure, enabling the visualisation of the passenger's journey route.

3.3 The Reader App for collecting data through the implementation of the CICO procedure.

3.4. The Transport Organiser's Portal used for both updating data and analysing the results of the delivered reports, which can facilitate managerial decisions, e.g. regarding tariff plans.

3.5. The Portal will also enable the planning of cross-border journeys and ticket purchase for selected routes.

3.6. Questionnaires to verify user experience.

4. Reports containing information on the results of pilot actions:

4.1. Assessing the possible simplifications regarding the verification of travel entitlements.

4.2. Assessing the functioning of the NFC standard.

4.3. Assessing the functioning of QR codes, and in particular the QR code reading time.

4.4. Assessing the efficiency of communication between the Controller's App and the Reader App, and the remaining modules, as well as verifying whether the scope of data storage, as determined for pilot implementation, is sufficient.

4.5. Verifying the potential of using the Check-In/Check-Out procedure in urban and rail transport, based on its assessment by users (the usability aspect and operational barriers).

4.6. Developing an operational procedure to be launched in the case of discrepancies between the data stored in electronic urban systems and the data stipulated in the resolutions on determining transport stops by individual Organisers.

4.7. Assessing the possible application of optimisation rules by providing data enabling their assessment.

12 Technological and legal analysis of infrastructure and application resources

For pilot implementation purposes, a contract award procedure should be conducted regarding access to the infrastructural and application resources of the cloud platform. This should be achieved on the basis of access “licenses” and include the deployment of the delivered technological solution. The requirements to be imposed on the Service Provider are outlined below.

12.1 Compliance with binding laws

The “licences” granted must satisfy the following requirements:

2. The storage, processing and dissemination of data compliant with binding laws,
3. The possibility to restrict the data processing/storage area, as part of the provided service, to the EU Member States,
3. Contractual obligations confirming the compliance with Regulation of the European Parliament and of the Council (EU) 2016/679 of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), and with the provisions of the Act of 10 May 2018 on personal data protection (Polish Journal of Laws of 2018, item 1000) and its implementing regulations, and also confirming the role of the service operator as a co-processor of data,
4. A contractual obligation under which the ownership of all data processed/stored as part of the service will be retained by the Contracting Authority,
5. Mechanisms enabling the satisfaction of requirements regarding the accountability and monitoring of both users and services,
6. A warranty that the Contracting Authority's data will be removed from the Platform following contract termination,
7. A warranty of the lack of access to the Contracting Authority's data available in the Platform, except for maintenance work which will each time be subject to the Contracting Authority's consent and must be performed exclusively by authorised persons representing the Platform supplier organisation,
8. A warranty that the data stored in the disseminated resources will be automatically removed within 180 days following “licence” expiry and contract termination unless the Contracting Authority decides otherwise.

12.2 Compliance with binding standards

The cloud computing environment must conform to the following standards:

1. ISO 27001 – Information technology -- Security techniques -- Information security management systems;
2. ISO 27017 – Information technology -- Security techniques -- Code of practice for information security controls based on ISO/IEC 27002 for cloud services;

3. ISO 27018 – Information technology -- Security techniques -- Code of practice for protection of personally identifiable information (PII) in public clouds acting as PII processors.

The satisfaction of these requirements must be confirmed by adequate certificates to be produced at the Contracting Authority's request.

In addition, the cloud computing environment must be compliant with the following standards:

1. The availability of tools for the migration of applications and data, both from own environments to the Platform and from the Platform to any other platform based on the X64 servers standard, enabling the transfer of services if such a decision is made.

2. The use of generally recognised and disseminated industrial standards within the Platform to enable the potential application of various technologies and solutions within one platform, including in particular:
   2.1. UK G-Cloud
   2.2. SOC 1, SOC 2
   2.3. TDS (tabular data stream)
   2.4. Open Authentication Standard – OAuth
   2.5. OData

3. The use of generally recognised and disseminated industrial standards within the Platform to enable interoperability compliance with the following standards:
   3.1. HTTP(S) – TLS
   3.2. Docker
   3.3. REST API
   3.4. Google API

4. The use of generally recognised and disseminated industrial standards within the Platform to enable programming compliance with the following standards:
   4.1. Java
   4.2. .NET
   4.3. PHP
   4.4. Python
   4.5. Node.js
   4.6. Visual Studio and Eclipse tool support

5. Platform support for standard OpenSource solutions, such as WordPress, Joomla, Drupal, OrchardCMS, MediaWiki, phpBB or Mojo. Access to predefined images with software within the platform.

12.3 Other requirements

The "licences" granted must satisfy the following additional requirements:

1. A guaranteed access to platform services at a level of 99.90% or higher (SLA),
2. Access to an administrative portal to be launched by selecting the services available within the platform,
3. A possibility to launch virtual machines by selecting readily available templates containing various configurations (the number of cores, disk memory and internal memory),
4. A possibility to select from among various types of disks and their volumes.
5. A possibility to launch ASP.NET, PHP, Java or Python-based web apps, with an automatic distribution of HTTP traffic among several working servers.
6. GUI-based management; scripts with a remote access option.
7. A possibility to analyse real-time data and historical data.
8. Communication with the service via REST API.
9. The collection of operational data by means of dedicated software (the agent).
10. Mobile-app creation tools meeting the following requirements (optionally available within the service):
    - 10.1. iOS, Android and HTML5 support
    - 10.2. Java, JavaScript and .Net support
    - 10.3. Integration with notification and authorisation services
    - 10.4. The handling of outgoing e-mails
    - 10.5. The handling of scripts and scheduled tasks
    - 10.6. Readily available programming libraries for the following development environments: .NET, Java/Android, Node.js, PHP
    - 10.7. Ruby, Python, PowerShell
    - 10.8. Possibility to collect log files and monitor the service.
11. Data storage satisfying the following requirements (optionally available within the service):
    - 11.1. High scalability, auto-partitioning, load-balancing

11.2. The storage of data disseminated as blobs, tables, disks, files and queues

11.3. Windows and Linux client systems support

11.4. Scalability of a single 500TB storage resource

11.5. Data replication – at least 3 copies in the same location

11.6. Replication to other locations at no less than a 100 km distance from the basic location

11.7. Access to storage resources based on REST API

12. Access to services enabling a web app launching as a readily available service, along with infrastructure components maintained by the service provider and fully automated scaling options. Such services should enable the launching of apps operating within at least the following technologies: ASP .NET, PHP, Python, Java.
13. Access to relational and non-relational databases, including those based on the Hadoop technology, as readily available services.
14. A possibility to establish a dedicated connection between the Contracting Authority's seat and the Platform provider, using the MPLS technology.
15. A possibility to serialise a range of solutions based on virtual machines into a specific text format (e.g. XML or JSON), along with their configuration, so as to enable their automatic de-serialisation and the establishing of a readily available working environment on that basis.
16. The data processing centres (at least two) providing the basis for the service of access to infrastructure and application must remain permanently active and ensure continuous data replication between them.
17. The system must comprise all the necessary tools for creating and storing backup copies of all data. The copies must be created and stored in a manner allowing them to be reversed to the state from before 30 days. The copies must be stored for 12 months from the date of their creation. The Supplier of this solution is in charge of a correct storage of data copies.
18. The Contracting Authority must be allowed to make, at any time, copies of all or selected data for every task. The Contracting Authority must be able to export all or selected data to external storage or other cloud computing environments.
19. There should be at least two independent communications operators connected to the proposed data centre.

20. The cloud computing environment must ensure access to the monitoring system comprising information on the use of cloud resources and a settlement system to enable payments for the use of such resources.
21. In case the Contracting Authority exhausts the right to access one of the modules, the offered solution must allow the transfer of access needs from one module to another.

13 Functional parameters of individual modules

A block diagram of the solution architecture is presented below.

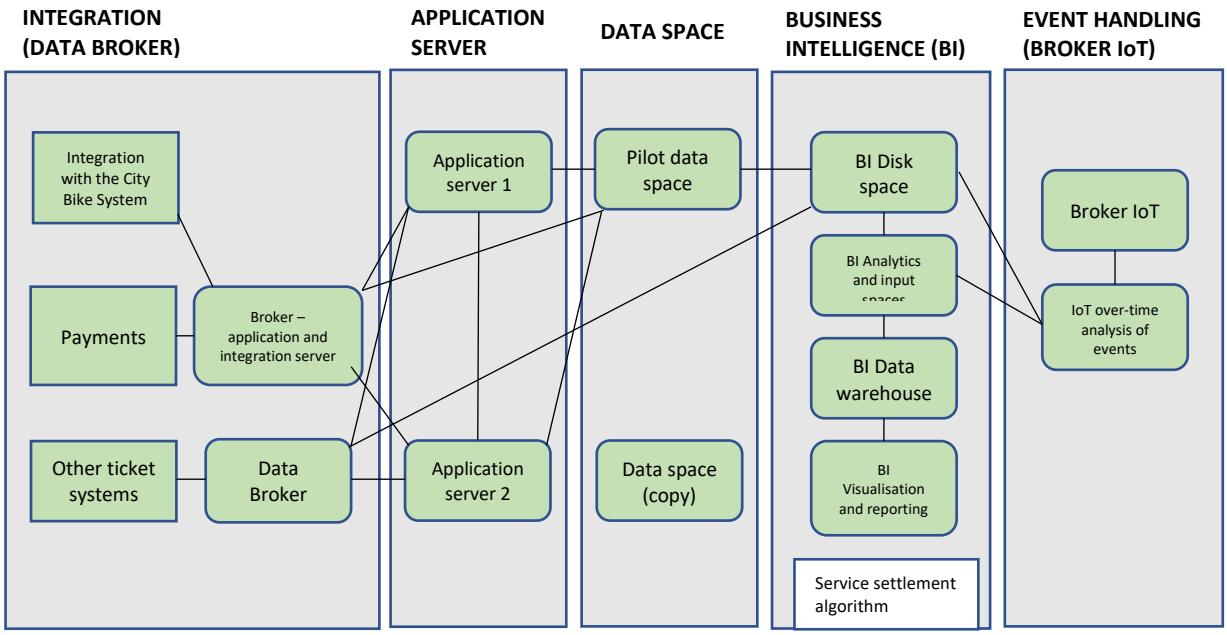

Figure 1 A block diagram of the solution architecture

13.1 Integration (Data Broker) Module

The optimum functional parameters of the Integration Module are given below.

1. XML message processing.
2. Simple file processing.
3. Exchange of messages based on EDIFACT, AS2 and X12 protocols.
4. Support for the visual design, creation, automation and implementation of business processes as a series of steps.
5. Availability of connectors to connect with external services, including database service and mailing service connectors based on SMTP and REST API.

6. Synchronous and asynchronous messaging with queue, topic and subscription/newsletter support.
7. Access to queues through API REST interfaces, and HTTP or HTTPS protocols.
8. Integration with external environments based on SOAP or REST.
9. Scalability to make the service more efficient: 1,000,000 interactions between systems per month.

13.2 Application Server Module

The optimum functional parameters of the Application Server Module are given below.

1. A Web-based application creation and hosting service in a selected programming language, without infrastructure management, supporting Java, ASP.NET, classic ASP websites, Node.js, PHP and Python.

2. Auto-scaling and high accessibility, supporting both Windows and Linux, without the need for app re-implementation.

3. A possibility to use the functions offered by the DevOps approach, such as continual implementations from VSTS, GitHub, Docker Hub and other sources.

4. Support for numerous implementation environments (production and temporary environments).

5. A possibility to handle 4 systems and 2,000,000 messages daily, with the following minimum parameters of the virtual machine dedicated for the app operation: 1 core, 3.5 GB of RAM, 250 GB of local memory.

13.3 Data Space Module

The optimum functional parameters of the Data Space Module are given below.

1. A relational database engine enabling the creation of partition tables and in-memory, with a possibility to establish b-tree indexes and indexes on columns.
2. A non-relational database engine enabling the analyses of large data volumes (5TB) with loading times not exceeding 30 minutes.
3. A repository established for the purpose of big data analyses, enabling the storage of data of all types and sizes. Access to Data Lake resources should be provided through API REST WebHDFS interfaces.

4. A graph database – a database that uses graph structures with nodes, edges and properties to represent and store data, and to handle semantic queries.
5. 15 TB of data, continual operation mode, unlimited access to database licences.

13.4 Business Intelligence Module

The optimum functional parameters of the Business Intelligence Module are given below.

1. A tool supporting the creation and publication of reports prepared on the basis of the available data sources.
2. A possibility to export the created reports as external files, at least in the following formats: PDF, XLSX, DOCX, ODT, HTML.
3. Maximum report generation time: 30 seconds.
4. A reporting portal serving the purpose of disseminating the prepared reports to predefined recipients or a model of publications for an unlimited number of recipients (public access).
5. An app for mobile devices providing access to published reports directly from a device, while preserving the interactive form of the reports.
6. A possibility to analyse datasets with a minimum volume of 10 TB of cold-layer data and 5 TB of hot-layer data, and the visualisation of at least 30 reports per hour, with at least 15 reports differing in the scope of analysed data.
7. The assumed use of the Business Intelligence Model by the Contracting Authority corresponds to 50% of the access time with access to reporting functions provided on business days.
8. A possibility to conduct spatial analyses, and to use the SQL and R languages.

13.5 Event Handling Module

The optimum functional parameters of the Event Handling Module are given below.

1. The service offers a number of ways for the device to communicate with the environment and vice versa.
2. Such communication comprises one-way messaging, file transfer and demand-response methods.
3. The gateway enables safe communication and access control using security keys or X.509 certificates for individual devices;

4. The gateway offers extended functions of management events monitoring, concerning device identity and communications;
5. The gateway uses a public protocol that allows the devices to run natively on MQTT 3.1.1, HTTPS 1.1 or AMQP 1.0 protocols.
6. The handling of 6,000,000 messages daily (4 peak hours, with 300,000 messages per 15 minutes), a continuous operation mode.

14 The required scope of implementation of the technological solution supplied for the pilot implementation of the designed public transport toll collection system.

The correct implementation of the technological solution supplied for the pilot implementation of the designed public transport toll collection system should be ensured by the Contractor through:

1. Technical support in the scope necessary for the proper implementation: an IT architect and an administrator of the databases and tools of the platform operating in a cloud computing environment.
2. Four-day-long training for the Contracting Authority's staff. The minimum training programme is outlined below:

Day 1:

1. Introduction
    1.1. Service models
    1.2. Service management
    1.3. Admin rights management
    1.4. Catalogue services
    1.5. User synchronisation options
2. Integration (Data Broker) Module:
    2.1. Service overview
    2.2. Implementation scenarios
    2.3. Service configuration
    2.4. Service management

Day 2:

3. Application Server Module
    3.1. Types of virtual machines

15 Pilot implementation stages

The area and range of pilot implementation are strictly connected with pilot objectives and the target solution assumptions. A division of the pilot implementation process into two stages (Organiser-oriented and Passenger-oriented) has been considered an optimum solution, with the territorial coverage of Stage 1 being regional, and that of Stage 2 international.

15.1 Organiser-oriented Stage

In view of constructing a database including the data gathered in various cities, the Organiser's App should be developed to act as a tool fostering the cooperation between various Organisers, focused on data consistency and updates. Selected functions enabling passenger and vehicle identification, as well as recording the start and end of a journey, should also be implemented

in order for the collection of data to be supported through the Check-In/ Check-Out procedure conducted by the pilot participants, using the transport services within the pilot implementation area.

Following the initial entry of the Organisers' data to the system, by means of the Organiser's Portal, the data will be verified and supplemented using the CICO procedure and the Controller's App functions serving the stops recording purpose. To this end, public transport vehicles and railway stations should be equipped with elements of the CICO infrastructure. The data transferred through the CICO procedure to telephones will include, *inter alia*, vehicle ID numbers (for urban transport) and stop ID numbers (for railway stations). The app will add specific locations based on the phone's GPS data, which will enable the pairing of data on stops with lines and routes along which a given vehicle operates.

At the pilot implementation stage, the collected data should be used for launching the subsequent functions by means of the Passenger's Portal. The Portal will be used for planning cross-border journeys along selected lines, purchasing cross-border tickets and visualising passengers' journeys.

With the aim of creating a consistent and complete database, independent of the Transport Organiser, an operational procedure to be launched in the case of identifying discrepancies between the data stored in electronic urban systems and the data stipulated in the resolutions on determining transport stops by individual Organisers should be developed during pilot implementation. Data should be supplemented with locations in the PL-2000 reference system or the PL-1992 system, subject to prior arrangements, which will be available in the target solution for journey settlement purposes.

As part of pilot implementation, the regional system should be fed with data on potential routes, stops and rolling stock, regarding all urban transport lines of the Transport Organisers participating in the pilot actions. To this end, a set of apps should be developed, along with unique vehicle identifiers using both NFC tags and QR codes.

15.2 Passenger-oriented stage

Stage 2 of pilot implementation should have a cross-border character, given the expected integration of both the transport system and communication between IT systems for passengers within the pilot implementation area. Journeys made by test passengers for the purpose of Stage 2 of pilot implementation should be possible between the hubs identified during Stage 1. The

projected integration with the system managed by transport organisers should be conducted by means of the BOB standard elements, enabling cross-border settlements of the proceeds from transport services between various Transport Organisers. Such integration will allow Passengers to purchase tickets, e.g. through a portal of one of the transport operators/organisers. A sample layout of the portal is presented below.

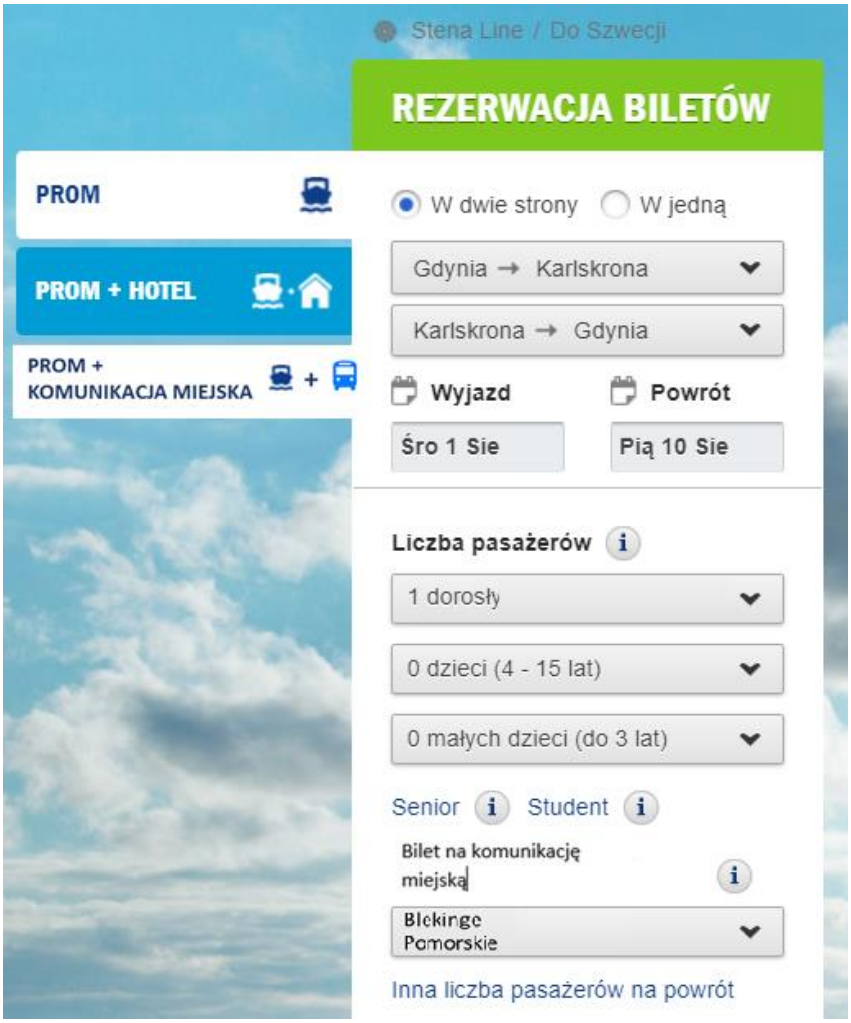

Figure 2 Visualisation of the potential change to the Stena Line Portal [https://www.stenaline.pl/do-szwecji] in order to enable the purchase of a ferry ticket along with an urban transport ticket in the Pomeranian Voivodeship and the Blekinge Region

15.3 Agreements regarding the participation in pilot implementation between rolling stock and infrastructure managers

To meet the pilot implementation objectives, vehicle and platform infrastructure elements must be assembled. Depending on the area and transport network infrastructure element type, network facilities, as well as vehicles and railway stops are managed by various entities.

Nonetheless, the assembly of any vehicle or station elements requires an agreement to be concluded between the entity implementing a uniform toll collection system and the entities in charge of a given facility. This may be a bilateral agreement (between the entity implementing the system and the Transport Operator, subject to the Transport Organiser's consent) or a tripartite agreement (between the entity implementing the system, the Transport Organiser and the Transport Operator).

15.4 Assumptions regarding pilot participants

The pilot participants' role is to verify the effects of the pilot actions. The Controller's App, the Passenger's App or the CICO procedure require testing, both in technical terms (to verify their efficiency) and in terms of their usefulness. As the sources of data on stops are strongly dispersed, on-the-spot verifications are required. The app or portal operation can be tested by the pilot participants using public transport and willing to verify the aspects indicated by the Contracting Authority in the course of their journeys which are made independently of the pilot actions. However, considering the large number of stops that are subject to verification, and the need to test the Controller's App, it is necessary to engage an additional group of people to perform the pilot actions as instructed by the Contracting Authority. The pilot participants should, therefore, be divided into three groups:

Group A – professional testers conducting pilot actions with the aim of collecting data and verifying the mobile apps that have been developed. Group A participants will perform specific tasks, including app tests. The underlying purpose of cooperating with this group will be to collect data on stops and to verify the technical aspects of both the CICO procedure and the Controller's App. The group should be diversified, including people acting as mothers with children, students, workers, tourists, seniors and disabled passengers.

Group B – people using public transport for their regular journeys, during which they make use of the pilot system, while also holding season tickets consistent with the Tariff binding at a given Transport Organiser. The underlying purpose of cooperating with this group will be to analyse passengers' behaviours and opinions on the CICO procedure, the Passenger's App and various aspects of using the CICO infrastructure. A set of benefits should be envisaged for this group to encourage their participation in the pilot actions.

Group C – people making cross-border journeys who, as part of the pilot actions, will devote one day in their journey to follow the cross-border journey scenario.

15.5 Transport service mediums in pilot implementation

Depending on which group they represent, the pilot participants should use a different set of carriers:

Group A (hired participants)

- Mobile devices with the Reader App and the Controller's App (owned by the entity implementing a uniform toll collection system or an external service Contractor)
- Mobile devices with the Passenger's App (owned by the tester)
- NFC cards
- Currently used cards, such as Resident's Cards
- Sky Cash and JakDojade app tickets

Group B (testing passengers)

- Mobile devices with the Passenger's App (owned by the tester)

Group C (passengers travelling from/to Sweden)

- Carriers provided for under the target solution
- Carriers used in the partner region – Blekinge:
- NFC cards
- Mobile devices with the App
- QR codes

15.6 Surveys

One of the pilot implementation objectives should be to assess the usefulness of the tested solutions. This could be done by conducting a social acceptance survey, which is a method of measuring acceptability, based on a questionnaire to be completed by the pilot participants.

The questionnaire should be completed using the Portal launched for the pilot implementation purpose. Redirection to the Portal might be done from the Passenger's App level.

The most important aspects to be surveyed may include:

2. Identifying technical problems

Assessing tag location and marking, as well as indicating the optimum location

Assessing GSM coverage

Assessing label readability

Assessing the method of communicating with the test group coordinator

Assessing the convenience of using the proposed solution

Indicators enabling comparisons with the solution currently in use

16 Analysis of the organisational and technical capacities of pilot implementation

16.1 Assumptions regarding pilot system requirements

Participants:

1. Passenger registration and the assignment of ID numbers of both the card and mobile device should be conducted through importing flat files.

2. No storage or administration of real personal data should be done in the pilot system.
3. The app functions, in the course of pilot implementation, should only be available to a closed group of people whose data will be transferred from the file provided by the Contracting Authority. In case a NFC tag or QR code is read by a person not belonging to the pilot group, he/she should be redirected to a website whose address was coded in the tag and defined at the technical design stage.

Identification Carriers:

1. Vehicle registration should be done via the CICO procedure, using two different carriers.
2. Mobile devices using NFC and reading data from QR codes
3. A NFC/RFID card communicating with the Reader App and the Controller's App
4. The Controller's App, the Reader App and the Passenger's App will only be compatible with Android devices.

Passenger's verification:

1. Pilot implementation should entail travel entitlements verification, which should include checking the time which has passed from the moment at which the passenger lost his/her travel entitlements in the central system to the moment at which the controller identifies the lack of such entitlements.
2. Pilot implementation should also comprise anti-fraud control which should verify whether the number of the card which was used to perform the Check-in (CI) action was not active at any place and time that would imply its use by two different people.

Communication standard

1. For the pilot implementation purpose, the BOB standard should be used for communication between the system and apps within the areas indicated at the technical design stage. The data model should conform to the BOB standard in the area of major business objects.

16.2 Pilot implementation limitations

1. The pilot implementation stage does not have to involve real-time optimisation. The system should provide data to assess the possible use of optimisation rules as part of an analytical back-office solution.
2. The pilot system functions do not need to include payment or settlement handling.

16.3 Assumptions regarding infrastructure elements used in pilot implementation

1. Tagged panels, equipped with NFC labels or marked with QR codes, depending on the means of transport, should be placed:
    2.1. In urban transport vehicles to ensure clear vehicle identification
    2.2. At railway stops to ensure clear railway stop identification and location
2. CICO infrastructure elements should also be used as end tools as part of the target system. At the pilot implementation stage, only one panel should be assembled in a vehicle, whereas the target solution should provide for the number of panels appropriate for the vehicle type and structure, in order to ensure the sufficient availability and visibility of the panels.
3. All the designed solutions regarding rolling stock and railway stop/station equipment with tagged panels require prior arrangements to be made with the Contracting Authority and the final approval to be granted.

16.4 Panel assembly instructions

The panels serving as CICO infrastructure elements must satisfy the conditions ensuring their proper visibility, readability and convenience of use. In addition, it is also necessary to take into account the requirements imposed by entities managing railway infrastructure or public transport rolling stock.

17 Requirements regarding the urban rolling stock to feature pilot implementation

The following table outlines the requirements concerning panel assembly in urban transport vehicles. The requirements have been divided into categories and contain a proposal as to the requirement satisfaction, which must be verified by the Supplier in terms of feasibility.

Table 13 The Contracting Authority's instructions regarding the assembly of panels in vehicles

Requirement category	Criterion	The Contracting Authority's proposal to be verified by the Supplier
Number	justified by the pilot implementation needs	1 panel per vehicle
Visibility	well visible to the passengers getting on	displayed at the window *vis a vis* the entrance door depending on the number of doors
Location	ensuring a convenient access	close to the wheelchair/pushchair space, based on the internal vehicle space analysis
Safety	protecting the panel user against falling down	optimally, close to railing, door pulls, etc.
No collision	no collision with other passenger service elements, arranged at a safe distance from ticket validators.	A verification of options available for various types of rolling stocks is required.
Ergonomics	panel dimensions ensuring visibility and convenient use; assembly height enabling access to all user groups	A-5 format, displayed in a horizontal layout, with the lower edge at a height of 110 cm
Conveniences for the disabled	location closed to the entrance for disabled passengers, adequate height	the lower edge at a height of 110 cm
Assembly	easy, efficient and non-invasive for either the vehicle itself or equipment	foil panel stuck onto the internal vehicle window

17.1 Material and dimensional solutions, as well as content, graphic design and range of colours

The panels to be displayed in buses, trolleybuses and trams, as well as at railway stops/stations should not differ from one another. However, it is required by the Contracting Authority that the Supplier verify whether the panels to be assembled at railway stops/stations need using materials that meet higher weather resistance standards, as compared to the panels to be displayed in urban transport vehicles. Table 14 features a set of instructions regarding material solutions.

Table 14 Instructions regarding material solutions

No.	Requirement category	Criterion	The Contracting Authority's proposal to be verified by the Supplier
1.	Dimensions	convenient for users and easy to assemble	A-5 Corners rounded with 5cm radius

No.	Requirement category	Criterion	The Contracting Authority's proposal to be verified by the Supplier
2.	Format	enabling the potential simultaneous QR and TAG use	in a horizontal layout
3.	Material	durable and resistant to mechanical damage and adverse weather conditions	Foil
4.	Assembly	easy, efficient and non-invasive for the display area	foil panel stuck onto the window
5.	Conveniences for the disabled	adapted for people on wheelchairs and those with visual impairments	the lower edge at a height of 110cm Braille signs used
6.	Functional equipment	QR code	matrix graphic code sized approx. 7x7 cm
		TAG	a small melted processor with a flat antenna suggested dimensions approx. 5x5 cm - 7x7cm or approx. Ø 5cm – Ø 7cm a typical pictogram should be used
7.	Supplementary equipment	User instruction (additionally with Braille signs) A logo provided by the Contracting Authority	based on the Contracting Authority's design
8.	Graphic design and range of colours	QR, TAG, inscriptions, signs, logotypes, pictograms, approx. 5-10 colours	based on the Contracting Authority's design

18 Analysis of the panel construction technology (TAG + QR)

18.1 Evaluation of individual panel construction variants using different technologies

The analysis of the panel construction technology included characteristic factors determining the appraisal, which can be grouped by:

1. The carrier type (paper, foil, PVC),
2. The cover type (varnish, foil, laminate),
3. Printing (double-sided or one-sided),
4. Individual QR codes (a direct imprint or a stick),
5. The glue type.

Different variants were analysed in terms of:

1. The fixing method and the NFC module type for a given carrier,
2. The assembly process and the potential replacement of damaged panels,

3. The use process (durability, resistance).

Once the detailed data were provided by producers, some options were found to be mutually exclusive. It was also revealed that many options did not significantly influence the price or its essential constituents, such as:

1. The carrier

The individual QR code (a separately printed code, which is then stuck onto the panel, is a much cheaper option, especially in the case of foil and PVC)

Double-sided printing (for foil and PVC).

It is suggested that, irrespective of the selected variant, the panels be:

1. Printed with a full range of colours (with the printing technology matching the carrier);

2. Double-printed (a white blank sheet displayed at the bus window does not look well from the outside; it should bear at least the city/transport operators's logo);

3. UV-protected;

4. Water resistant (so that they do not get damaged or impregnated, e.g. while cleaning the window or washing down the panel itself).

It is, therefore, suggested that a foil material , 500 or 700 um thick, be used, with 4x4 double-sided printing and a UV filter because:

1. PVC materials are not flexible enough.

2. Advertising foil stuck onto windows is a well-proven and commonly used technology.

3. With larger quantities (> 1600), a foil panel price is lower than a PVC panel price.

18.2 Estimation of labour intensity required for a vehicle inventory

The idea behind preparing an inventory of the Transport Organiser's vehicles is to gather information that is significant in terms of the actual vehicle condition, and to verify the accuracy of the vehicle data stored in the databases of IT systems belonging to Transport Organisers.

The inventory should comprise, in relation to each vehicle:

1. at least 4 vehicle photos (displaying the internal and external parts),

2. the identification number (ID) of the panel (TAG +QR),

3. the vehicle number linked to the panel's ID (TAG +QR),

4. the vehicle number linked to vehicle data from the telematic database (verification whether the inventory data are consistent with the data stored in the IT system,

The principal objective of the inventory should be to verify the data recording status in the currently used IT systems with the actual status established through inventory work.
The panel (TAG + OR) assembly is a natural activity which does not block off the preparation of the vehicle inventory.

18.3 Analysis of QR code dimensions

Decoding may be hindered if the code dimensions are either too small or too big. The minimum code dimensions, depending on the scanning distance and the number of characters to be coded, and hence on the number of modules on the QR tag, are given on the following website: blog.QRStuff.com.

Table 15 The minimum dimensions of the QR code, depending on the distance and number of signs. Source: http://blog.QRStuff.com/2011/11/23/qr-code-minimum-size

Number of modules	Number of characters	Minimum code dimensions when scanned from a distance		
		150 mm	300 mm	450 mm
25x25	26	15 mm	30 mm	46 mm
35x35	72	21 mm	42 mm	64 mm
45x45	125	27 mm	54 mm	82 mm
60x60	249	36 mm	72 mm	109 mm
80x08	468	48 mm	96 mm	146 mm
100x100	739	60 mm	120 mm	182 mm

18.4 NFC tag analysis

The tag type is the first aspect to be taken into consideration. Four major tag types are currently distinguished, differing in the capacity and format. Type 1 and 2 tags are based on ISO 134443A. They are intended for reading (with a formatting option) with a rather low speed of 106kb/s. These solutions, being relatively inexpensive and popular, are suitable for consumables (e.g. posters). Type 3 tag is based on the Sony FeliCa system (ISO 18092). The data transmission speed in this case is higher, up to 424kb/s. The operational mode of these tags (reading/recording) can be configured before they are launched. This is a more expensive solution, recommended for more advanced uses. Type 4 tags are the resultant of type 1 and 3 tags. They are based on ISO 14443A, but with a bigger memory and a higher transfer speed. They can also be configured so as to allow for a single information record, as in the case of type 3 tags.

Table 16 A comparison of NFC tag types

	Type 1 tag	Type 2 tag	Type 3 tag	Type 4 tag
Standard	ISO14443A	ISO14443A	Japanese Industrial Standard (JIS) X 6319-4	ISO14443A
Memory size	96 B – 2 kB	96 B – 2 kB	<= 1MB	<= 32 kB
Speed	106 kb/s	106 kb/s	212 kb/s 424 kb/s	106 kb/s 212 kb/s 424 kb/s
Tag reading/recording	Yes, for reading only.	Yes, for reading only.	Yes, for reading only. Can be configured before they are launched.	Yes, for reading only. Can be configured before they are launched.

Compatibility with reading devices (or, in fact, with mobile phones) is the second parameter to be considered in the tag selection process. Initially, phone/tablet producers used modules that ensured full compatibility of the offered devices. With time, new NFC modules began to appear on the market which did not conform to all the requirements, aiming at price reductions, and hence they no longer ensured compatibility with all the NFC tags.

The third parameter to be taken into consideration is memory size. When memory is not big enough, we will not be able to transfer all the necessary information, whereas an excessive memory will increase the tag purchase cost. Based on the data to be transferred through the tag, it was estimated that the number of characters should not exceed 125, and thus the memory size of 168B should be sufficient.

Based on the above information, three NFC tag requirements have been formulated, i.e.:

1. They must conform to ISO 134443A.
2. They must be compatible with all types of mobile phones and tablets equipped with NFC modules.
3. Their memory should be at least 168B to enable coding 132 characters which should suffice to convey the necessary information.

18.5 Requirements regarding information coding

The infrastructure elements serving the object identification purpose should transfer data enabling the collection and verification of data acquired from IT systems of Transport Organisers. The dissemination process should take place through the NFC labels communicating with cards and mobile devices equipped with NFC readers, and through the QR code providing information via the scanning app, deciphering the code displayed on the panel.

The range of disseminated data will differ, depending on the object equipped with the infrastructure element. Devices equipped with the app operated by an authenticated User (the Controller or Passenger) in the pilot system should participate in data transfer to the relevant system modules.

If an attempt to operate the app is made by an unauthenticated user, i.e. a person not taking part in pilot implementation, he/she should be redirected, as a result of tag integration, to a portal of the entity in charge of implementing the uniform toll collection system, displaying generally accessible information about the system.

1. The elements displayed in vehicles must contain vehicle identification data enabling the vehicle linking in the database to the relevant Transport Operator and the line along which the vehicle operates.

2. The elements displayed at railway stops and stations must contain station identification data, along with the GPS location, route and line running through the station, included in pilot implementation.

19 System elements

This chapter outlines the modules jointly forming the planned pilot system.

In the course of identifying the system requirements, modules taking part in the implementation of various requirements and use cases were defined. At the same time, as the pilot system must correspond to the architectural assumptions of the target solution and the standard architecture based on BOB, individual modules should relate to elements of the reference solutions although they have not been defined in the same way.

19.1 Communication between system elements

A simplified diagram of communication between individual system elements is presented below:

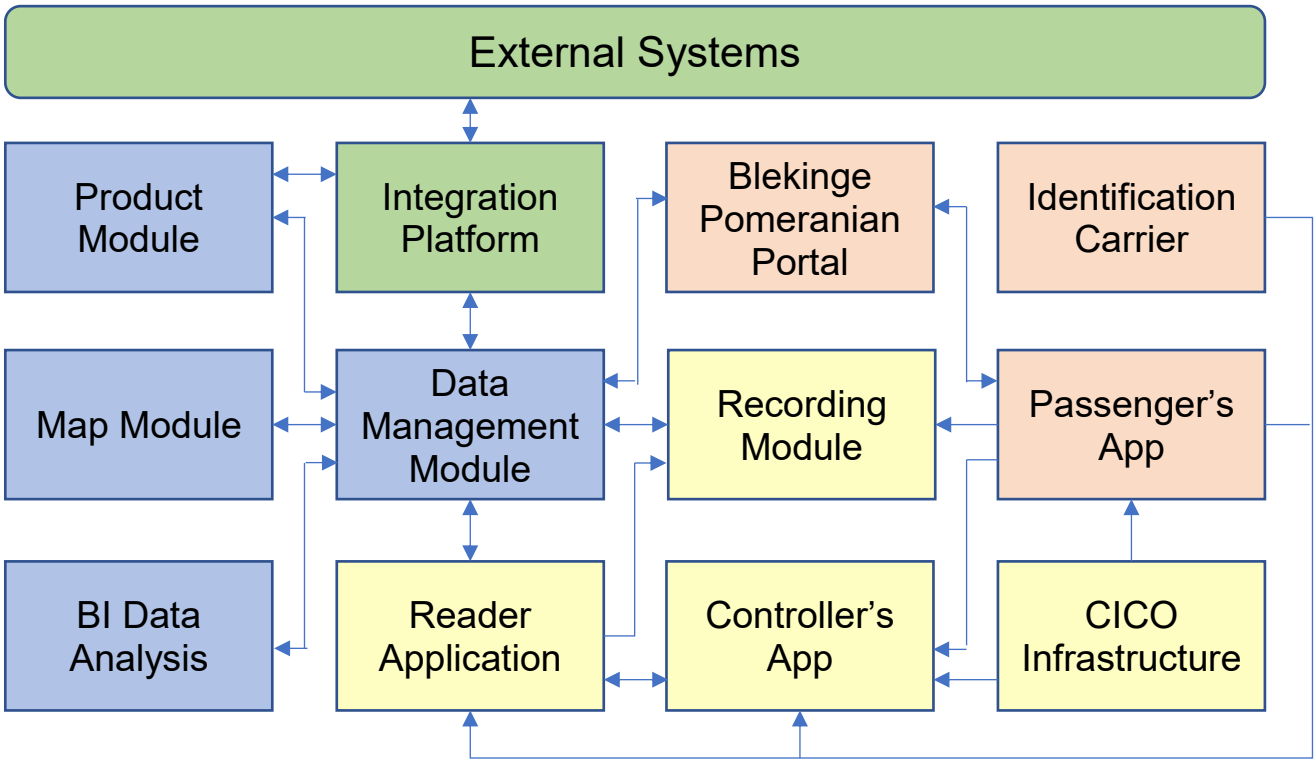

Figure 3 **A simplified diagram of inter-module communication**

A central place in the above model is occupied by the recording module to which all the events are sent, and the data management module which is responsible for the relations between the event data being transferred and the data stored in the database. The remaining modules marked in yellow act as end devices responsible for the collection and dissemination of events resulting from the interactions with modules which, in turn, interact with the passengers themselves. The modules marked in blue are connected with the database and represent various types of data or take part in data processing.

20 Roles of various system elements

The following system elements, i.e. modules performing roles corresponding to those of the reference modules based on BOB architecture, are also system actors.

Identification Carrier
An element of the passenger's infrastructure in the form of an NFC card or a mobile device.
The Identification Carrier serves the purpose of conducting the Check-in/Check-out procedure, during which the system records data on the event and participating objects. It is one of the elements that facilitates developing the Data Collection product.

Passenger's App
The app is installed on the passenger's mobile device, serving the purpose of conducting the CICO procedure by scanning the QR code, or by bringing the NFC label on the mobile device close to the CICO infrastructure element, following which the app displays information on recording the start and end of the journey.
While performing the CICO procedure, the App transfers object location and identification data to the system.
The App also serves the role of a communication path for testers to deliver questionnaires, or to report incidents requiring test coordinator's intervention or system repairs to be performed by the supplier.
The Passenger's App's functions will be available through the Portal. It will also contribute to accomplishing the objective of the Data Collection product.

Reader App
The App installed on the tester's mobile device serves the purpose of recording the passenger's CICO actions using the NFC card. The recording of the vehicle reader takes place by the

device's touching the CICO infrastructure element, which is followed by the transfer of identification and location data. The App displays information on the CICO procedure outcomes, depending on the authentication status of the passenger using the card. It also enables location-based real-time stop recording. This function will be utilised as part of pilot implementation with the aim of collecting the largest possible amount of data on stops, and their linkage to lines and routes.

The Reader App will contribute to accomplishing the objective of the Data Collection product.

Controller's App

The App is installed on the professional tester's mobile device. It enables recording the start and end of the control during which the passenger authentication and entitlements are verified, as well as whether the passenger has performed the Check-in action.

As part of the passenger verification procedure, the Controller's App will also perform anti-fraud control, using business rules determining the time and distance for Check-in events pointing to abuse.

The Controller's App performs the functions envisaged in the Controller's App product. It will also be partly used for the Data Collection product.

Recording Module

The module serves the purpose of recording all events occurring within the system in the course of procedures related to the journey, control or inventory. The module cooperates with individual apps and CICO infrastructure elements for the Data Collection product purpose.

Data Management Module

The module handles all the data entered into the system using administrative object definitions, by means of the Recording Module or by data synchronisation with external systems.

The Data Management Module also enables configuration of authorisations and launching of reports. It performs the functions envisaged for the Database Management App, while also cooperating with other system elements to ensure the proper use of functions implemented by the Data Collection and the Transport Organiser's Portal products. It will also contribute to developing Reports summarising the activities of Test Groups.

Integration Platform

The platform serving the purpose of transferring data between modules, apps and IT systems.

Products Module

The module enabled the linking of recorded journeys to specific transport services and journey prices, based on defined tariffs and user profiles. It supports the functioning of the Organiser's Portal, forming part of the Transport Organiser's Portal.

Data Analysis

This tool supports the creation and publication of reports based on the acquired data with the scope defined by the administrator, using the sources of all data gathered in the system. The reports so generated will serve the purpose of assessing the efficiency of tested functions, visualising passenger flows or journey plans, and making forecasts based on the obtained results. Selected reports will be disseminated to Transport Organisers via the Integration Platform and the Organiser's Portal.

The module is an element supplied as part of a separate order which will, however, be disseminated in connection with the functions offered by the Controller's App, the Portal Organiser's App and the Portal. It constitutes an indispensable support in developing Reports summarising the activities of Test Groups.

Organiser's Portal

The portal serves the purpose of disseminating, updating and monitoring data gathered in the course of pilot actions. This module, performing functions for the Transport Organiser's Portal, will also enable the dissemination of reports to authorised users indicated by Transport Operators and Organisers, as well as Transport Undertakings.

Portal

Access to the Portal will be provided to passengers, enabling them to purchase cross-border tickets, with journey planning and tariff optimisation functions. The Portal also handles passenger information.

CICO Infrastructure

Panels equipped with NFC labels and QR codes, also referred to as tags. The tags contain vehicle Ids for urban transport and station Ids for the PKM line.

Maps Module

The module provides access to maps, enabling object location and the display of object-related information. The Map Module is used for visualisations of passenger flows for individual Transport Organisers, using the Organiser's Portal, and for real-time visualisations of the routes taken by passengers, as displayed via the Passenger's App. The module performs functions for the Portal product.

Considering that the principal objective of pilot implementation is to create the Database and the Controller's App, whereas the payment and settlement handling between Transport Organisers will be developed as part of the target system, the most important role in the planned pilot solution is played by elements related to data acquisition and management, and to vehicle recording and verification. The mapping of the proposed pilot system modules onto elements of the BOB reference architecture is outlined below.

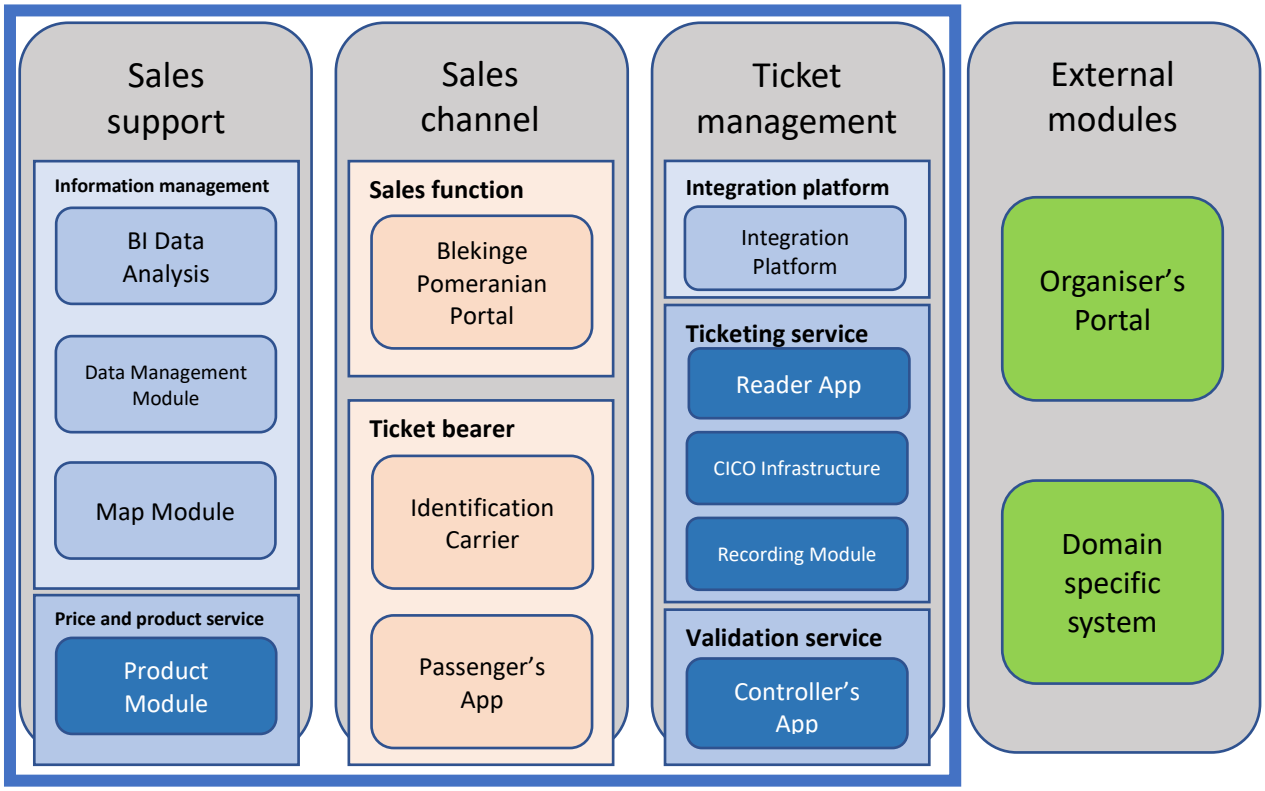

Figure 4 The mapping of the pilot solution modules onto BOB Architecture

20.1 System elements in relation to the target solution

The target system infrastructure should, in principle, be much more extended, including readers of information carriers and driver-dedicated functions. In this regard, the pilot system only

provides for launching the Reader App which will feature selected ticket validator and driver-dedicated functions. The Controller's App available as part of the pilot system corresponds to the controller's terminal which will form an infrastructure element of the target solution.
The figure below outlines the roles played by individual elements of the pilot system in relation to the target system.

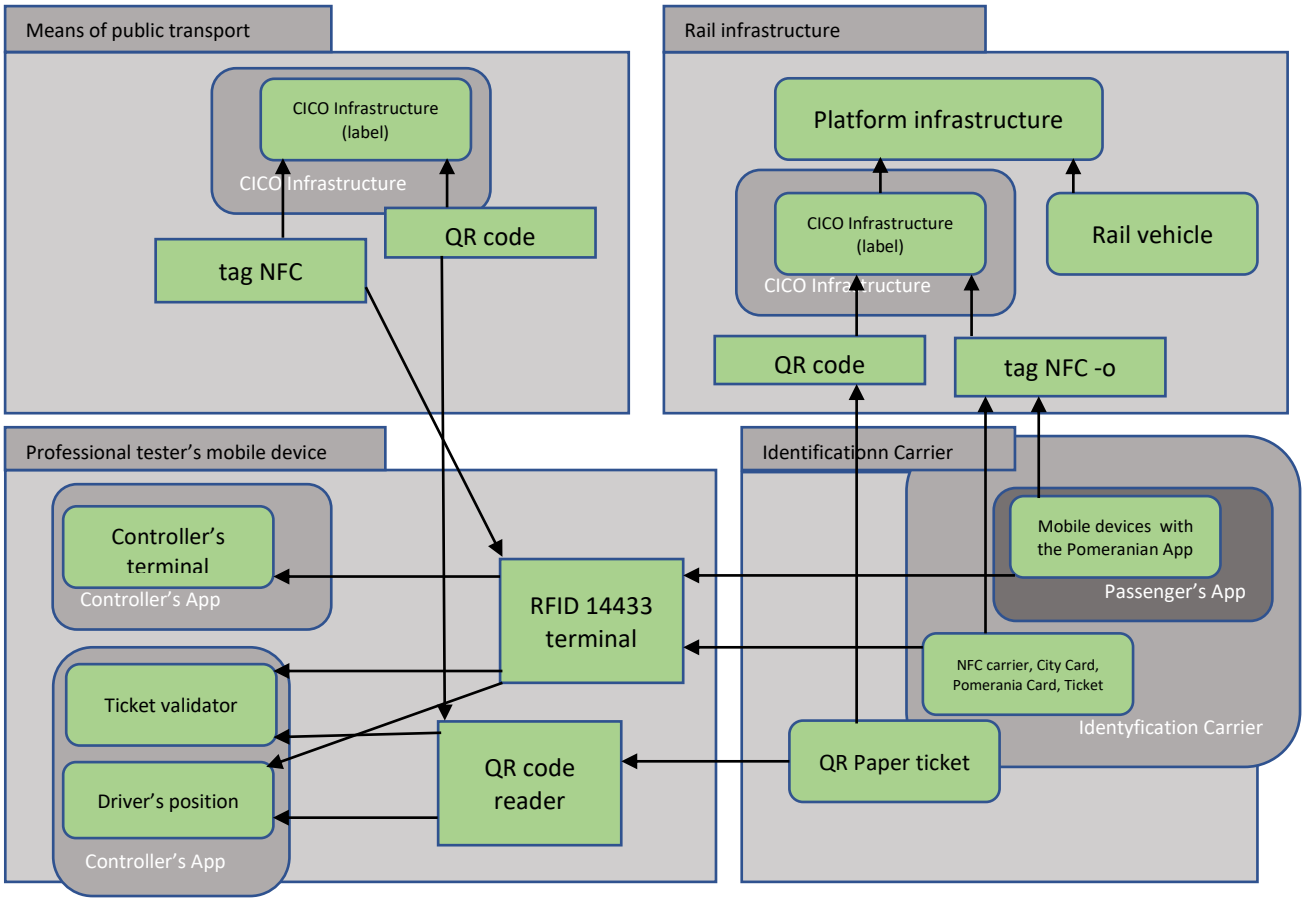

Figure 5 System elements in relation to the target solution

Infrastructure elements of the target solution, in relation to the entire pilot system model, are outlined below.

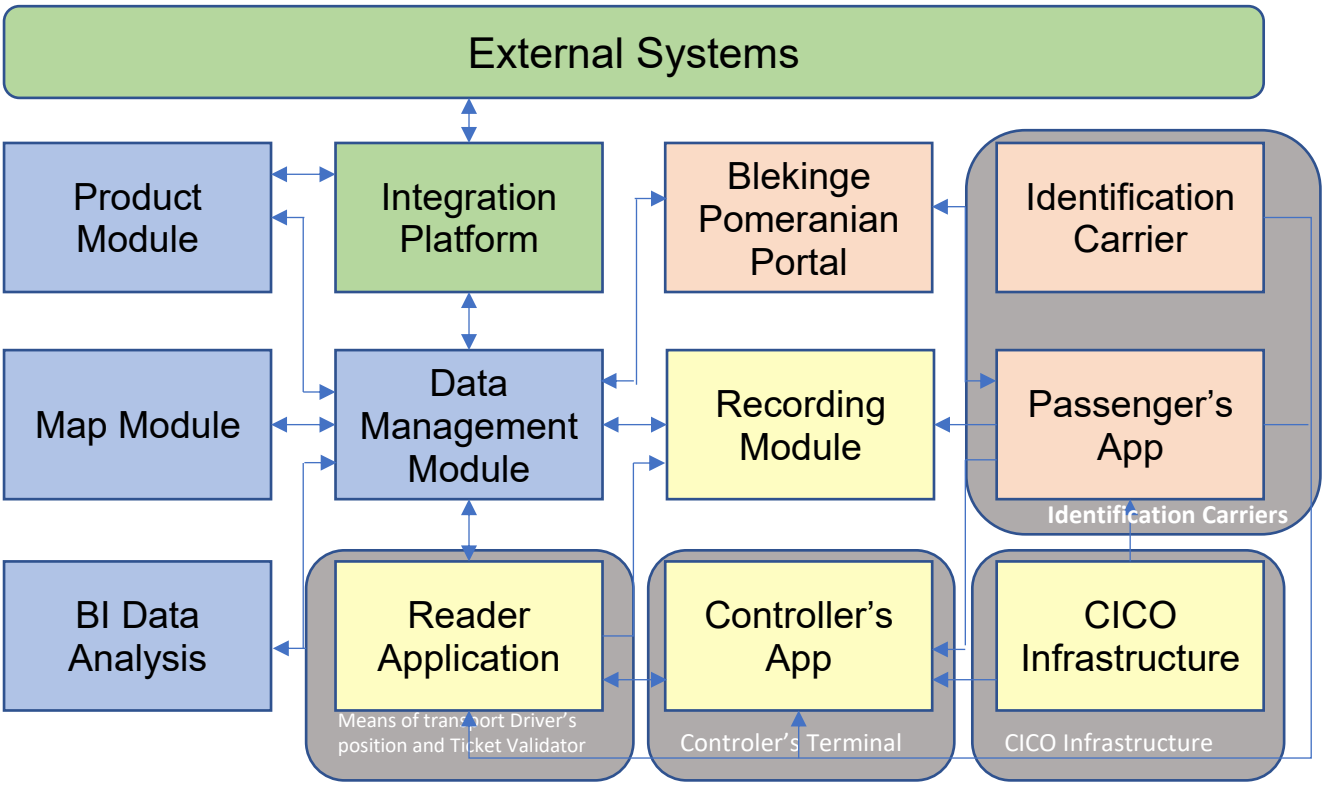

Figure 6 Elements of the target solution in relation to elements of the pilot system

20.2 External systems

In view of the acquisition and synchronisation of data with the Transport Organisers' systems, certain pilot actions should be envisaged leading to the development of coherent data structures and integration mechanisms.

The Organiser's Portal should be developed with the aim of disseminating data in the form of pilot implementation reports. Integration measures must also include an interface with the target system.

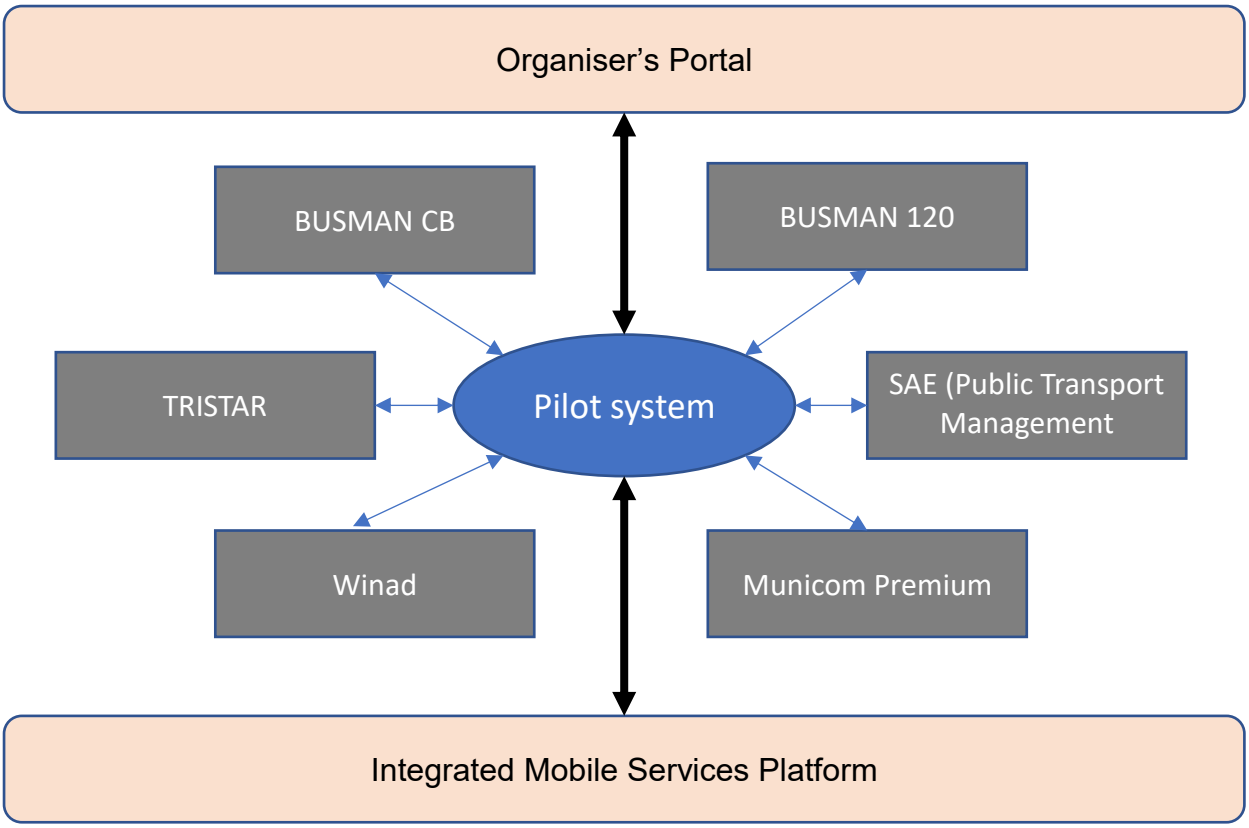

Figure 7 Systems integrated with the pilot solution

21 List of Requirements

This chapter presents business requirements to be satisfied in the course of pilot implementation.

Types of requirements

The requirements are divided into functional and non-functional. The requirements of both types are outlined below.

Functional requirements

Functional requirements define the expectations regarding system performance and its outcomes. They have been formulated in relation to the objectives assumed within the uniform toll collection system. The most important aspects concerning functional requirements are described below.

Conducting of the CICO procedure

This set of requirements describes the system functions addressing the principal operational objectives of pilot implementation. They indicate the most important issues related to the procedure of recording the start and end of the journey, along with expectations regarding the Passenger's App and the Reader App that are involved in that procedure.
The Data Collection product is the major product addressing this set of requirements.

Conducting of the control procedure
This set of requirements concerns the conducting of the control procedure using the Controller's App, starting with registering the control procedure in a given vehicle or railway station, through passenger verification, including his/her authorisations and events that he/she has generated, to de-registration.
This set of requirements is met via the Controller's App product.

Portal operation
This set of requirements concerns the functions available as part of the Portal product. They refer to the informative part of the Portal which enables Passengers to get generally accessible information about the project, along with information on the connections available through pilot implementation. It also comprises requirements enabling the planning and purchase of journeys, and then the real-time visualisation of the journey, also available via the Passenger's App.

Reporting
This set defines the expectations regarding the administrative definition of reports, along with a requirement to ensure the possibility to generate reports that are particularly important for pilot implementation, including passenger flow visualisations, data reports providing the basis for settlements between organisers, reports using optimisation rules, and reports enabling verification of the operational efficiency of individual application and system functions.
The report functions will be performed as part of developing Reports summarising the activities of Test Groups. Some reports will be available to Transport Operators and Organisers thanks to developing the Transport Organiser's Portal product.

Object definitions
Objects defined in the system include stops, lines, routes, vehicles, tariffs and Identification Carriers. Roles envisaged in the system, which will be linked to other objects, also constitute separate objects. For instance, a given vehicle will be linked to the Transport Operator or Undertaking, and Tariffs to the Transport Organiser.

Object definitions are assigned mainly in an administrative manner:

1. by the Platform Operator acting as the Administrator of the system, as part of the Database Management App product,
2. by Transport Operators and Organisers that will use the Transport Organiser's Portal to this end,
3. by the Controller in the course of journeys, to record stop locations with the aim of verifying and supplementing data gathered in the database as part of the Data Collection product.

Map operation

Functions connected with the visualisation of journey routes, the search for objects and the presentation of object-related information will be performed as part of the Portal product. Maps will be displayed not only via the Portal and the Passenger's App, for the purpose of journey planning or acquiring Passenger information, but also via the Organiser's Portal for object data management purposes, and via the Controller's App to record or verify stop locations.

Rights management

Access to individual system functions will be configured using the rights assigned to the roles defined in the system, and also directly to individual Users. Rights management will take place as part of the Database Management App product.

Non-functional requirements

Non-functional requirements correspond to the Contracting Authority's minimum expectations regarding the quality of the solution offered by the Supplier.

1. Administration
2. Architecture
3. Safety
4. Ergonomics
5. Reliability
6. Training
7. Environment
8. Efficiency

22 List of Use Cases

The present chapter contains a list and description of use cases, along with actors participating in the performance of system functions.

22.1 Use Case Actors

Personal actors are system users performing actions to launch specific system functions, implemented by system actors and referred to herein as modules.

22.2 Administrator

The role of the Administrator, as a personal actor, should be performed in the pilot project by the Platform Operator. The principal activity of the Administrator involves:

1. Defining and updating objects
2. Updating and managing data
3. Performing rights management
4. Defining and generating reports
5. Handling maps and updating background layers

These actions are mainly performed via the Data Management Module and the Organiser's Platform.

Some of the use cases may require engaging the Recording Module, the Products Module including data sources, and the Map Module providing background maps for object location and identification purposes.

22.3 User of the Organiser's Portal

The Organiser's Portal Users are Actors who perform the following roles:

1. Transport Organiser
2. Platform Operator
3. Local Government Unit
4. Separate Budget Entity performing Transport Operators duties
5. Transport Operator
6. Transport Undertaking

The actions available for this role are similar to the Administrator's actions; however, they are more limited. The Organiser's Portal User will be allowed to perform the following actions:

1. Defining and updating objects
2. Updating and managing data, within the scope of rights granted by the Administrator

3. Defining and developing reports, within the scope of rights granted to the User and configured by the Administrator
4. Performing map operations.

These actions will be available via the Organiser's Portal but they will also engage the Data Management Portal which will enable updating the relations between the modified objects or data provided to the modules responsible for their further handling.

22.4 Passenger

The Passenger's role will be assigned to the pilot participants making their journeys, testing the Passenger's App, the CICO procedure and the Portal supported by the Map Module and the Passenger Information Portal.

Passenger's activities in the system have been divided into the following groups:

1. Conducting of the CICO procedure
2. Conducting of the control procedure
3. Map operation
4. Portal operation
5. Authentication
6. Incident reporting

The passenger uses the Passenger's App, the Portal and the Identification Carrier. The performance of these actions, in order to meet the pilot implementation objective, additionally requires launching the functions delivered by the Data Management Module, the Map Module, the Recording Module, the CICO Infrastructure and the IT System, with the latter corresponding, in the case of UC23 (Sales Service), to the Stena Line portal, the Blekingetrafiken portal or any other system providing payment and income settlement functions. In this case, the IT system's role can also be performed by the billing module of the target solution – the IMSP (PZUM).

22.5 Controller

As in the case of the Passenger's role, the Controller's role will be performed by the pilot participants belonging to group A (professional testers), equipped with an additional mobile device comprising the Controller's App and the Reader App.

The Controller's actions can be divided into the following functional groups:

1. Conducting of the control procedure

1.1. Carrier reading

1.2. Passenger identification

1.3. Collection and transfer of control data

2. Conducting of the CICO procedure

2.1. Simulation of the ticket validator functions on the Professional Tester's Mobile Device

3. Data collection (based on stops recording)

3.1. Vehicle identification

3.2. Stop identification

The Controller mainly uses the following two apps: the Controller's App and the Reader App, both interacting with the CICO Infrastructure and the passenger's identification carriers to ensure the performance of the required functions. They are supported by the Recording Module and the Data Management Module.

23 Estimation of the pilot implementation costs

When estimating the pilot implementation costs, costs connected with organising pilot actions need to be taken into consideration, including the travel costs of pilot participants, the costs of equipping them with mobile phones, and the costs of remuneration for professional testers (group A). Some of the pilot implementation costs are connected with preparing the vehicle inventory and CICO infrastructure. The budget to be spend on pilot implementation includes software creation and implementation costs incurred in connection with IT projects.

24 Pilot implementation planning – a proposed scheme

The following table contains a sample pilot implementation scheme for the uniform toll collection system, along with indicative time required for performing individual pilot implementation stages, products and tasks.

Table 17 Pilot actions plan

Item type	Topic	Indicative performance period [in months]
STAGE	**PREPARATION FOR PILOT IMPLEMENTATION**	**4**
	Contract award	1
Task	Preparing a contract award	1
Task	Signing a contract with the system supplier	1

Item type	Topic	Indicative performance period [in months]
Decision	Deciding about the entity to act as a party to the contract with Participants	2
Task	Selecting a company/role to implement the Project (Investment) Supervision duties	1
Milestone	**Contracts with the Supplier and Project Supervisor – concluded**	
Product	Organising test groups	3
Task	Defining contractual provisions, or rules and regulations	2
Task	Concluding the recruitment procedure	1
Product	Agreement with the Transport Organiser	2
Task	Contacting the Transport Organiser regarding further processing of the agreement	1
Task	Defining the agreement provisions	1
Task	Concluding the agreement	1
Milestone	**Agreement with Transport Organisers – concluded/signed**	
	Analysis and Design	1
Product	Tag label design	1
Decision	Deciding on the ownership of the app and data collection (cloud computing) environment	1
Product	Architecture design	1
Product	System and app specifications	1
Milestone	**Specifications regarding the system and product development – prepared**	
STAGE	**IMPLEMENTATION**	**16**
	Integration	4
Task	Creating data structures	1
Task	Creating an integration mechanism	13
Task	Creating an integration mechanism for the purpose of acquiring data from Organisers	1
Task	Creating an integration mechanism enabling the provision of data for ticket purchase purposes	16
Task	Introducing changes to IT systems	5
Product	Integration with the Organiser's apps	1
Product	Integration with systems/portals	12
Milestone	**Integrations – performed**	
Product	Tagging Procedure Plan	1
Task	Tagging individual vehicles assigned to lines within a pre-defined area	2
Milestone	**Vehicles and stops equipped with CICO infrastructure elements – an inventory prepared**	
	DATABASE – database feed (along with migration)	4
Product	Data collection	4
Task	Performing the initial data feed	1

Item type	Topic	Indicative performance period [in months]
Task	Verifying and supplementing data through pilot actions (Inventory, journeys made by Participants) – the Organiser's Perspective	4
Product	Database Management App	1
Milestone	**Database – launched; Data migration – performed**	
	Apps – software	10
Product	Controller's App	10
Task	Ensuring the adequate functions to enable carrier reading, including the currently available functions	1
Task	Ensuring full functionality, including verification mechanisms compliant with the BOB standard	11
Product	Passenger's App	1
Product	Reader App	1
Milestone	**Fully functional apps – launched**	
	Portals – construction (software)	10
Product	Integrated Passenger Information and Ticket System Portal	10
Product	Transport Organiser's Portal	1
Product	Portal	12
Milestone	**Portals – established – Software included**	
STAGE	**SYSTEM VERIFICATION**	**9**
	Data collection and Controller's App version 1 tests	1
Product	Test scenarios	1
Task	Preparing data for app tests	1
Task	Tests conducted by the Contractor	1
Task	Tests conducted by the Contracting Authority	1
Product	Test report	1
Milestone	**Version 1 tests – conducted and reported**	
	Data collection and Controller's App version 1 tests	2
Product	Test scenarios	1
Task	Preparing data for app tests	1
Task	Tests conducted by the Contractor	1
Task	Tests conducted by the Contracting Authority	1
Product	Test report	1
Milestone	**Version 2 tests – conducted and reported**	
STAGE	**PILOT JOURNEYS**	**3**
Task	Group A and B journeys – the Organiser and Controller's perspective	2
Product	Data acquisition reports (Group A)	2
Milestone	**Journeys aimed at data collection and verification of the first version of the Controller's App – made and reported**	
Task	Group A journeys – the Controller's perspective	2
Task	Group B journeys – the Passenger's perspective	3

Item type	Topic	Indicative performance period [in months]
Task	Group C journeys – the Passenger and Organiser's perspective	2
Product	Data acquisition reports (Group A)	1
Milestone	**Journeys aimed at verifying the cross-border ticket purchase and the full version of the Controller's App – made and reported**	
STAGE	**PILOT IMPLEMENTATION REPORT**	**2**
Product	Reports summarising the conclusions drawn from data analyses	2
Milestone	**Reports (pilot implementation) - Developed**	

LIST OF FIGURES

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