# *ANNEX II + III:* TECHNICAL SPECIFICATIONS + TECHNICAL OFFER

**Contract title: Supply of Supply of Ticket management system and Ticket Validator p 1 /…**

**Publication reference:** TS/2020/421-733\_VM/Sup-07

**Columns 1-2 should be completed by the contracting authority**

**Columns 3-4 should be completed by the tenderer**

**Column 5 is reserved for the evaluation committee**

Annex III - the contractor's technical offer

The tenderers are requested to complete the template on the next pages:

* Column 2 is completed by the contracting authority shows the required specifications (not to be modified by the tenderer),
* Column 3 is to be filled in by the tenderer and must detail what is offered (for example the words ‘compliant’ or ‘yes’ are not sufficient)
* Column 4 allows the tenderer to make comments on its proposed supply and to make eventual references to the documentation

The eventual documentation supplied should clearly indicate (highlight, mark) the models offered and the options included, if any, so that the evaluators can see the exact configuration. Offers that do not permit to identify precisely the models and the specifications may be rejected by the evaluation committee.

The offer must be clear enough to allow the evaluators to make an easy comparison between the requested specifications and the offeredspecifications.

| **1.**  **Item number** | **2.**  **Specifications required** | **3.**  **Specifications offered** | **4.**  **Notes, remarks,  ref to documentation** | **5.**  **Evaluation committee’s notes** |
| --- | --- | --- | --- | --- |
| **1** | \* see below the technical requirements |  |  |  |

**\*TECHNICAL REQUIREMENTS**

**INTERCOMMUNITY REGULAR PASSENGER TRANSPORTATION IN GYUMRI AND VANADZOR COMMUNITIES**

**WITH INTEGRATED ELECTRONIC TICKET SYSTEM**

**Preface**

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# INTRODUCTION

## **1.1. CURRENT CONDITION AND EXISTING PROBLEMS**

**Gyumri community.**

As part of the reforms implemented in the Gyumri community, in 2020 and 2021, the community acquired 66 "Gazelle" minibuses. The intra-community route network of Gyumri, established in 2020, is planned to operate 85 vehicles. The municipality of Gyumri aims to fully service the intra-community route network through the operator, a municipal subsidiary company. In order to achieve the stated goal, Gyumri Municipality is carrying out relevant works.

Currently, there are 8 minibus routes operating in Gyumri intra-community route network. 5 of the routes are served by the operator "Gyumri Bus" CJSC and 3 by a private company. The transportation fee for one passenger for the routes served by "Gyumri Bus" CJSC is set at 100 AMD by the decision of Gyumri Council of Elders, and 150 AMD for the routes served by the organization selected by the tender, but the transportation is actually carried out at 100 AMD.

In order to operate in the internal route network of Gyumri, the municipality aims to purchase two dozen buses in 2023 under the subsidy project.

**Vanadzor community.**

Currently, there are 19 minibus routes operated by 101 means of transport in Vanadzor intra-community route network. The routes are operated by private companies. The fare for one passenger is AMD 100.

Within the framework of the "Alliance for Better City Governance" Project, it is planned to provide Gyumri and Vanadzor communities with environmentally friendly means of transport - electric buses, which will be operated on regular intra-community routes.

The absence of a ticket system does not provide an opportunity to ensure the full collection of transport fares in regular passenger transport, which is an obstacle to the provision of quality services in regular intra-community passenger transport. The mentioned situation is mainly due to the lack of information technologies used in the intra-community transport, as well as the incomplete control of the financial resources generated in the field of regular passenger transport. The ticket system in Gyumri and Vanadzor intra-community regular passenger transportation will ensure the improvement of the efficiency of operation of intra-community route networks and the quality of service services.

## **1.2. OBJECTIVE**

In the communities of Gyumri and Vanadzor, introduce a ticket system for intra-community regular passenger transportation, which will make the new route networks formed in the communities complete. The introduced ticket system is aimed at increasing the quality of transport services provided in the communities. The use of modern passenger ticket mechanisms will make public transport attractive. At the same time, the introduced ticket system should increase the controllability and transparency of ticket sales, revenue generated from regular passenger transportation, contributing to increase the profitability of intra-community transport.

The plan is to introduce a ticket system for intra-community regular passenger transportation in Gyumri and Vanadzor communities.

## **1.3. THE SCOPE OF APPLICATION**

Regular intra-community bus (minibus) passenger transportation of Gyumri and Vanadzor communities.

## **1.4. ASSIGNMENT**

Create a toolkit for the efficient operation of public transport in Gyumri and Vanadzor communities:

* full fare payment: ticket system,
* creation of prerequisites for increasing the efficiency of the route network operation and setting the transport fare.

## **1.5. BENEFICIARIES**

* Citizens (passengers) using intra-community bus (minibus) regular passenger transport services of Gyumri and Vanadzor communities,
* The municipal governments of Gyumri and Vanadzor,
* Organizations providing regular intra-community bus (minibus) passenger transportation of Gyumri and Vanadzor communities.

## **1.6. BASIC PRINCIPLES**

* integration,
* scale,
* Unity,
* Possibility of using different types of tickets.

## **1.7. INTEGRATION**

The ticket system should be a single integrated system of fare payment and ensure the operation of a single information processing center from ticket issuance.

## **1.8. SCALABILITY**

The system should be able to ensure the use of the ticket system in vehicles of different capacity (buses and minibuses).

The system should have the ability to use fixed and differentiated (differentiated), unattended and closed-entry fare payment technologies.

The introduced system must meet the requirements of every organization (regardless of the organizational-legal form) that provides regular intra-community bus (minibus) passenger transportation of Gyumri and Vanadzor communities.

## **1.9. UNITY**

The system must ensure the fulfillment of the following requirements in the public transport of Gyumri and Vanadzor communities:

- automated management of all tickets,

- introduction of ticket sales points, payment terminals, internet environment and automated system of ticket sales accounting in them,

- (validators and barrier tags) in vehicles and recording of passengers transported at the entry control points (including passengers with traffic privileges by category),

- in case of emergency situations, control of entry and exit by the driver using a special button,

- implementation of the ticket security system.

## **1.10. TICKET SYSTEM**

The ticket system should be operated using information technologies, with the possibility of implementing new software solutions (adding and changing the code of this project).

## **1.11. TRANSPORTATION AND TRANSPORTATION FEES**

The implemented system must be functional and enable to evaluate the actual work performed based on physical indicators and calculate the amount of money collected for it.

## **1.12. CONTROL**

The ticket system should ensure the accurate calculation of transported passengers and be a tool to effectively manage and control the work of public transport in Gyumri and Vanadzor communities.

## **1.13. INCREASE INCOME**

The system must ensure the integrity of charging transportation fees and, as far as possible, exclude all possible options for evading the payment of transport fees, including the abuse of the transport privilege by passengers with public transport privileges (if the transport privilege is limited).

## **1.14. EVALUATION AND DECISION MAKING**

A marketing toolkit should be implemented to manage the ticket system and evaluate the results of the decisions made, such as fares or ticket types.

The system should provide an opportunity to calculate and estimate the amount of the transportation feeս according to the vehicles operated on individual routes, according to the days and hours of transportation (trains).

## **1.15. BASIC TERMS AND ABBREVIATIONS**

The following key concepts and abbreviations are used in these technical requirements:

**Door lock:** a passenger access control device designed to be placed in a motor vehicle near the entry (exit) door. The lock is designed to allow or block the entry of passengers. The wallet must be used together with the validator.

**Contactless bank cards (PayPass/payWave) -** a payment instrument that belongs to the category of contactless payment technology (PayPass/payWave) bank cards.

**Operator of financial transactions:** Bank of RA, which must accept payments made by bank cards and online, with appropriate deviceinstalled.

**Route -** a one-time fact of the passenger's right to receive a paid transportation service, defined by the conditions of the purchased ticket,

**electronic ticket balance -** an electronic environment for storing conditional units corresponding to the amount, using which it is possible to use the services provided by the ticket system,

**An identification number is** a sequence of digits created by a special algorithm, which guarantees the uniqueness of these numbers and sequence without the possibility of changing it.

**Preferential ticket** : a ticket that gives the right to travel in whole or in part to citizens entitled to a discount,

**Blacklist:** a list of ticket carriers for which all or part of the activities are prohibited.

**Balance:** the balance of the electronic ticket balance, limited to the transportation services provided through the ticket system,

**Balance recharge:** balance recharge,

**Huntlist:** A list of tickets for which all actions are allowed. It is applied mainly for ticket carriers with QR code.

**Normative information:** a set of configuration data declared in the ticket system.

**Payment terminal:** an automated self-service device of EasyPay, Telcell, Idram or other payment operator, designed for purchasing one-time tickets and replenishing the balance.

**Validator (Validator) -** ticket system device for reading, checking, redeeming the ticket, selling and redeeming all types of ticket carriers.

**Ticket (Electronic ticket):** Document in electronic or paper medium certifying the conclusion of the passenger transportation contract,

**Ticket carrier (media):** a physical object or software and hardware environment capable of storing ticket information in digital form;

**A ticket product,** a form of offering to provide a fare-based intra-community scheduled passenger transport service, is defined by the list of services and the cost.

**Ticket system:** software-hardware solution for ticket generation, redemption, accounting.

**Redemption of the ticket -** consumption of the funds involved in the transportation contract from the ticket account or electronic ticket balance,

**Fare:** the appropriate tariff conditions established for the implementation of regular passenger transportation, which is offered during the tender by the winning organization in the tender or set by the community council in the case of carrying out transportation through an operator,

**Transaction:** operations related to passenger ticket, including ticket acquisition, validation, balance replenishment, accounting of ticket type information,

**The passenger's personal office is** an application for the provision of electronic services for the self-service of the passenger registered in the ticket system.

**User:** a natural or legal person who uses the ticket system as a consumer of transport services or as a participant in the provision of transport passenger transport,

**Myfare cards:** ticket carrier, contactless identification card with Mifare technology,

**NFC (Near Field Communication),** a short-range (up to 10 cm) high-frequency wireless communication technology that allows non-contact data exchange between devices located at short distances.

**Mobile devices with NFC technology:** a mobile device (or electronic accessory) with an NFC chip connected to a bank card emulation for contactless payment services (e.g. Apple Pay, Google Pay).

**Bank card -** NFC - contactless payment cards issued by banks, or their data carriers, through which payments are made,

**API (Application projectming interface):** a set of ready-made procedures, functions, which are provided by certain software standards to connect the database and services with other external software environments.

**SMS:** transmission of a short text message via a mobile GSM network.

## **1.16. SYSTEM SUPPLIER REQUIREMENTS**

The Supplier Company shall ensure full implementation of the system. The works performed should include:

- Technological design of the system (agreed with the customer),

- Supply, installation, adjustment and operation of devicenecessary for system operation,

- software development,

- provision, installation, configuration and operation of software,

- organization of server work necessary for the normal operation of the software,

- creation of a centralized database,

- system launch and commissioning,

- installation and adjustment of barrier covers in vehicles,

- installation and adjustment of validators in vehicles, as well as organization of work with barrier tags,

- warranty and post-warranty maintenance of the system.

When implementing the system, global trends in the development of fare collection systems should be taken into account.

The implemented system should have the ability to develop and upgrade, adding new elements and technologies.

The supplier is responsible for the final result of the project.

The payment equipments provided by the Ticket System Provider Company must have licenses for at least VISA, MasterCard (EMV Contactless) and Armenian Card payment systems, as well as ensure the acceptance of contactless (NFC) payments. The supplier company must ensure the licensing of the validators used in the ticket system and the integration with the relevant payment systems and the processing center with contactless bank cards.

## **1.17. SYSTEM INSTALLATION DEADLINE**

The introduction of the ticket system is planned to be implemented within 7 months after the signing of the contract , which should include the connection of electric buses to the ticket system.

The supplier company must ensure the connection of other motor vehicles operated in Gyumri and Vanadzor intra-community route networks to the implemented Ticket system in accordance with the procedure and terms agreed with Gyumri and Vanadzor Municipalities.

## **1.18. SYSTEM STORAGE AND MAINTENANCE**

The reliable operation of ticket system device must be based on high-quality maintenance.

The System Provider Company must perform the software operational maintenance of the system for a period of 1 year, namely:

- Ensuring 24/7 uninterrupted operation of the software system,

- Implementation of software updates,

- Implementation of adjustments at the customer's request,

- Implementation of non-essential changes to the project at the customer's request. The works that do not include the creation of new functional possibilities and for the implementation of which the specialist will need no more than 2 working days are considered non-essential.

## **1.19. SYSTEM HARDWARE WARRANTY**

System device must have at least 365 days warranty guaranteed by the manufacturer. Warranty service must be performed by the Supply Company or its representative. The warranty service of the device must be performed within a reasonable period of time or an equivalent replacement device must be provided, until the repair of the device that is out of order.

## **1.20. INSTRUCTION AND TRAINING**

In order to effectively implement the ticket system, the Supply Company must implement the implementation of personnel, community servants, education and training of employees involved in the process of providing transportation organizations and services.

# GENERAL REQUIREMENTS TO THE TICKET SYSTEM

## **2.1 . PRINCIPLES OF SYSTEM OPERATION**

The principles of the unified ticket system are:

- Provision of all public transport of intra-community bus (minibus) regular passenger transportation of Gyumri and Vanadzor communities (regardless of the organizational and legal form) with a unified ticket system.

- Installation of unified ticket system device (validators, ticket stubs) in all vehicles involved in regular intra-community bus (minibus) passenger transportation of Gyumri and Vanadzor communities, of which:

* for electric buses, must be purchased by the Supply Company and installed during the implementation of the Ticket System,
* the others must be purchased by Gyumri and Vanadzor Municipalities or transportation organizations and installed by the Supply Company or its representatives within the time and order agreed with the Municipalities and transportation organizations,

- Ability to create flexible ticket products,

- Creation of affordable options for ticket sales: provision of cash and non-cash ticket purchase options (including from the Internet environment),

- Possibility of integration with EasyPay, Idram, Telcell, Mobidram or other payment terminals operating in Gyumri and Vanadzor communities, through which it will be possible to top up electronic ticket balances,

- The possibility of purchasing tickets (paying for the trip) with bank NFC cards through validators installed in buses (minibuses),

- Issuance and accounting of tickets with the privilege of traveling at nominal, free and discount rates (pass and certificate),

- Providing the possibility of interaction with online payment and settlement systems,

- Provision of ticket sales and passenger flow analysis capabilities,

- Ensuring flexible integration or expansion of the ticket system.

## **2.2 . USERS OF THE SYSTEM AND THEIR FUNCTIONS**

|  |  |  |
| --- | --- | --- |
| Users: | Description: | Directions of interaction |
| Passengers | Passengers should be able to use the system with online and self-service options | Website providing ticket system services |
| A mobile application for the provision of ticket system services |
| Payment terminals or applications that, being integrated with the ticket system via API, provide access to certain services |
| Validators installed in vehicles |
| Transport service provider companies | Transportation providing organizations or operator | Software interfaces for employees |
| Ticket system operator | Ticket system management officers who must ensure the overall functioning of the system | Software interfaces for ticket system administrators in each municipality |
| Software and hardware service provider of the Ticket System | A representative or partner of the System Provider Company, who must provide system maintenance | Software interfaces for employees |

## **2.3. OPERATING CONDITIONS OF THE SYSTEM**

Balance information and ticket information must be stored in the ticket system.

Ticket validation mechanisms:

- The validator must read the information from the carrier, transfer it to the ticket system, which must make a decision whether to open the ticket or not.

- In case of loss or bad connection, the decision to validate the ticket must be made by the validator according to the black and blacklists.

- In case of reestablishment of the connection with the ticket system, the information about the transactions made must be synchronized with the ticket system.

The mentioned mechanism should have the following capabilities:

- Buying a ticket,

- Ability to validate and redeem tickets,

- Combating fraud based on real-time analysis of large amounts of data,

- Implementation of system monitoring in real time and centralized automated updating.

Lack of communication between the system and the validators should not cause the process to be interrupted. The autonomous operation of the system must be achieved as a result of a combination of pre-organized and installed components and subsystems.

## **2.4. TICKET VALIDATION**

Ticket validation must be done by:

- The validator must read the data from the drive,

- The validator must send the data received from the carrier to the ticket system,

- If no validation data is received from the central ticket system within the scheduled time, the decision on the entry permit shall be made based on the local verification of the validator. The validator must perform a check based on the black and whitelists in the validator's local memory.

- During online authentication, when the connection is broken, access decisions must be made based on local authentication results.

- The validator must transmit an order to the barrier claimer to allow or deny entry.

- The data on the entrances must be temporarily stored in the internal memory of the validator for later transmission to the central ticket system.

- The validator must be regularly synchronized with the central ticket system.

## **2.5. THE MAIN TYPES AND FUNCTIONALITY OF CARRIERS**

The system should be equipped with techniques for handling and managing different types of media.

**The main types of carriers are:**

- **One-time use ticket (paper, electronic version with QR code) .**

The passenger must be able to purchase a one-time ticket at ticket sales points, payment terminals or other electronic payment environments.

When purchasing a one-time ticket with any available option, the passenger acquires the ticket (QR code). After confirming the payment, the ticket should be generated in the ticket system and issued to the passenger. After the passenger scans the visible part of the single-use ticket QR on the validator scanner, the ticket system must identify the ticket and redeem it. After the ticket has been paid, the barrier claim must be opened.

**- Ticket carriers.**

Passenger access rights with subscription cards are regulated by a contactless Mifare card. After purchasing the cards in advance, it is necessary to charge them or attach to the card by purchasing a ticket product. After the recharge, the balance corresponding to the recharge must be stored in the system, and in the case of purchasing a ticket product, also the information about the ticket product.

When the passenger presents the card to the validator, the system must authenticate the card by sending the card's identification data to the central ticket system. If no response is received from the central ticket system within the specified time period, the validator shall perform a local check for blacklisting and blacklisting of the carrier.

Along with paying off the ticket, a corresponding deduction from the balance should be carried out. In case of a negative balance or insufficient funds for the trip, entry will be refused and the barrier will not be opened.

The passenger must be able to purchase ticket carriers from sales points. Ticket carriers must be able to be recharged at points of sale, through payment terminals and electronic payment methods.

In case of cash or non-cash charging of ticket carriers, the passenger must approach the point of sale and after identifying the ticket carrier on the relevant deviceand making the payment, the relevant product or amount must be re-registered in the central ticket system.

In case of recharge using payment terminals and electronic payment methods, the recharge must be done using the identification number of the carrier. The passenger must enter the identification number in the appropriate field and select the specified amount or type of product and pay for the purchased service.

**Electronic ticket (E-ticket, NFC).**

It should be possible to purchase tickets in the electronic version by making a payment directly at the validator with NFC-enabled mobile devices or bank NFC cards. In this case, the processes of ticket payment, generation, validation and "allowing access" must be performed in parallel, immediately after touching the mobile device or contactless bank card to the validator.

# FUNCTIONAL STRUCTURE OF THE SYSTEM

The system must be functional and secure:

**- Ticket product management,** which will allow you to create, modify and implement ticket products,

**- Issuance and accounting of ticket carriers,** which will allow to manage the entire cycle of creation of ticket carriers, from the application for creation (registration) to the end of operation,

**- Management and monitoring of the ticket system equipment,** which is intended for the management and monitoring of devices that are part of the ticket system installed in vehicles and other places,

**- Anti-fraud** , designed to detect fraudulent activities, develop behavioral models and their practical application,

**- Ticket sales and recharge of the passenger's electronic ticket balance,** which is intended for ticket sales and recharge of the electronic ticket balance,

**- User data management and provision of access rights,** intended for user data management and redistribution of rights,

**- The collection and management of passenger activity information** , designed to ensure the collection, recording, storage and prompt presentation of passenger activity data (including ticket purchases, financial transactions),

**- Trip registration and payment,** which will enable trip registration, ticket validation, storage of necessary information in the Ticket System and validation devices,

**- Accountability and analysis,** which will enable data collection and consolidation and analysis and reporting based on them,

**- Billing** is one of the main functions of the system, which should ensure the activities related to accounting and control of service provision, their payment and invoicing,

**- Mechanisms of mutual reports** , which will enable different users of the system to provide mutual reports,

**- Registration of complaints and suggestions** , which will enable to record complaints and suggestions,

**- Data security and protection** , designed to ensure the security of operations and protect information from unauthorized access.

## **3.1. TICKET PRODUCT MANAGEMENT**

By purchasing a Ticket, the passenger gets the right to use the regular passenger transport service. The ticket can be made of a certain material (paper or other) or registered electronically. A ticket is a set of data stored in the system in digital form, which confirms the passenger's right to use a regular passenger transport service. Ticket identification technologies should allow tickets to be divided into several types.

**Ticket carriers and their description:**

**- Disposable ticket carriers** : paper ticket (QR code), Electronic ticket (QR code created in the application),

**- Transport cards:** reusable ticket carrier - Mifare or cards of other corresponding standard, including various accessories containing information carriers (watch, ring, etc.),

**- Bank cards and electronic payment carriers** : contactless bank cards (PayPass/PayWave) and mobile devices using NFC technology,

**- Mobile application** , a software solution that allows you to have a personal account and attach bank cards and virtual transport cards to it.

Carrier-attached service types and fares shall be determined by ticket product. Products should be divided into several types (the list of products should have the possibility to expand).

Ticket product types are:

* A single-use ticket for one journey,
* A single-use ticket with a valid period,
* Ticket "X flight" with a limited validity period,
* Ticket wallet (passenger's electronic ticket balance),
* Post-paid tickets, including tickets issued to special groups (citizens who have the privilege of traveling with preferential or free or reduced fares).

At the same time, the system should be able to create and add new products, as well as modify the following data of ticket products:

* **Available means of transport:** the means of transport for which ticket products can be used.
* **The maximum number of trips for a certain period** , the maximum number of marches for the specified period. The specified period can be both the period of validity of the ticket and its subsets. For example, a one-month ticket, but no more than 300 trips per month and no more than 15 trips per day.

- **Number of journeys** , used for tickets that have X journeys,

- **Short description** : the name of the product, which should be visible to users of the system,

- **Characteristic** : the name of the product, which must be visible to passengers,

- **Media type** : the list of media for which this product is available,

- **Amount of negative balance** : threshold of permissible negative balance, up to which it is possible to provide any of the services available on the ticket (carrier),

- **Setting the cost limit when working in offline (no connection) mode** , limiting the upper limit of the cost of the balance of carriers during the long-term absence of communication between the ticket system and validators,

* **Special Groups Category** : Attaching a special groups category to the carrier,

The system must be able to make the ticket product created in the ticket system available to validators through remote synchronization.

## **3.2. MANAGEMENT OF TICKET CARRIERS**

All ticket carriers must be registered in the ticket system before a ticket product can be registered to them. Ticket carriers for special groups must contain a picture and personal information. The system must contain mechanisms through which it will be possible to control the complete movement of the carriers.

The company managing the ticket number may not be a manufacturer of ticket carriers, but must perform the functions of recording the carriers as well as generating and recording data for personalization. Carrier accounting system should have the following functional features:

- Central management management of carrier accounting,

- Collection of data for carrier personalization,

- Flexible integration (API) with various frameworks for customization,

- Flexible setting options,

- Accounting for distribution of media between storage and sales points.

## **3.3. MANAGEMENT AND MONITORING OF TICKET SYSTEM DEVICE**

The system should provide centralized management of ticket system hardware, allowing to add (change) settings, including blacklists, ticket and carrier lookup lists and other necessary information.

The monitoring system must include all deviceregistered in the system:

- Validators,

- Barrier,

- Server node equipment.

The system must have the following remote control mechanisms:

- To update validators software and settings,

- To provide feedback on software and configuration updates,

- To receive and process the validator's diagnostic information,

- Receiving logs from the validator's action log,

- Sending settings to the validator: centralized, grouped or selectively.

## **3.4. RESISTANCE AGAINST FRAUDS**

The ticket system can become an object of attack by cybercriminals. The system should have a set of functions that will reduce the risks of fraud and minimize the consequences of attacks. The system must have protection mechanisms at the level of the server node of the ticket system, at the level of the main functions of the ticket system, at the level of communication with devices, at the level of devices intended for sale, at the level of validators, at the level of interaction with external information systems, at the level of personal accounts of users and at the level of the analytical system that detects fraudulent transactions.

The system shall include mechanisms to counter at least the following actions:

- Unauthorized charging of the user's personal account,

- Unauthorized sale of tickets.

Key Functional Requirements are:

- Carriers must be protected with keys,

In order to protect data, the system must use appropriate standards of encryption algorithms.

- The system should not allow ticket sales and balance replenishment operations without confirming the operation with encryption algorithms and making a corresponding entry in the database.

- The system must record the interaction of all types of media and authentication devices,

- Databases must be secured against unauthorized editing and removal of information.

## **3.5. SALE OF TICKETS AND RECHARGING OF ELECTRONIC TICKET BALANCE**

One of the global trends in the development of ticket systems is the use of bank cards and mobile devices as a means of contactless payment. These ticket methods allow you to reduce maintenance costs. The ticket system should focus on self-service ticket options.

The main ways to sell tickets are:

- Ticket sales points (payment terminals, points of sale),

- the web-portal,

- Mobile application,

- Contactless payment with bank cards and electronic payment methods.

A whole set of APIs should be provided in the system for online ticket sales.

## **3.6. USER DATA MANAGEMENT AND PROVISION OF ACCESS RIGHTS**

The main users of the system are:

* **Customers** : passengers (personalized, non-personalized), corporate customers, citizens with the right to free travel,
* **Internal users** : ticket system manager, internal users (service staff, etc.)
* **External users** : ticket sales and carrier charging agents, Financial Transaction Operator, and other external users.

Passenger registration in the system must be carried out remotely. In order to attach to the relevant ticket carrier, the passenger must provide the following information:

* email address,
* Mobile phone number.
* A registered passenger gets the following features:
* Attach several ticket carriers and ticket products to your account,
* Use a private office, which will allow you to receive the following information:
* see the balance of the carrier,
* number of tickets,
* the history of routes,
* block lost carrier,
* transfer the balance of the carrier to another carrier,
* Receive information to registered e-mail or hone number.

In order for a registered user to be able to access his/her personal account, the user's login name and password are required.

Registration in the system is mandatory for corporate groups and citizens entitled to free travel.

The above services are not available for non-personalized passengers.

## **3.7. ASSORTMENT AND MANAGEMENT OF INFORMATION ON PASSENGER ACTIVITIES**

In order to detect and prevent fraud and fraud, all self-service and service activities performed by passengers in the system and transactional data must be collected.

The models for processing and collecting the collected information may be different, but they should have the following basic composition:

* List of passenger ticket carriers,
* List of products attached to passenger carriers,
* Product purchase history,
* Balance recharge history,
* Trip history by products used,
* History of actions performed in the user's account.
* The system should also provide data analytics and provisioning mechanisms.

## **3.8. TRAVEL ACCOUNTING AND PAYMENT**

The main functions of the ticket system are: trip accounting and payment control. The passenger's ticket is the basis for receiving the transportation service. The passenger can also receive a regular transportation service using contactless technology bank cards and electronic payment methods (subject to availability of funds).

The service must be provided using a medium registered in the system as a protected identifier. To receive the service, the passenger must touch the carrier to the corresponding part of the validator. Validators must perform ticket and bank card authentication. Validation should be done according to information on the media, blacklists, fraud detection algorithms and software logic.

If the validation is successful, the passenger should be notified (with the door opening, light or sound signal and confirmation information on the screen).

Data processed as a result of ticket validation must be stored in the validator's memory and be deleted after synchronization in the central hub of the ticket system.

The system must provide different scenarios of journey accounting and management, depending on the type of product used by the passenger and the situation:

* Route accounting and management scenarios,
* Postpaid scenarios for route accounting and management,
* Scenarios for the passenger to purchase the ticket immediately at the start of the trip using the electronic ticket balance or bank card,
* When there is no connection between the validation device and the ticket system (connection failure).

## **3.9. REPORTS AND ANALYSIS**

The system should be equipped with tools for generating analytical reports, as well as with the ability to customize reporting periods, schedules and reporting methods (number of trips, number of transfers, sales, passenger flows, passenger behavior profiles, etc.).

Reporting and analytics functionality should be consolidated and viewed as a separate subsystem.

The system should provide the ability to provide reports to ticket system users automatically and on demand (automatically sending to e- mail).

## **3.10. BILLING**

Billing is one of the main functions of the system, which should ensure the accounting and control of service provision, their payment and operations related to transactions.

In the billing subsystem, the information about the sale and redemption of the ticket should be recorded.

When validators work online (where there is a stable connection between the validator and the ticket system), the validator must transmit the ticket information to the system, as a result, the ticket validation information is recorded in the system, and then, in order to inform the passenger and allow entry, the validation the confirmation must be passed from the ticket system back to the validator.

When the connection is unstable or there is no connection between the validators and the ticket system, the decision on ticket validation must be made by the validator, later, when the connection is restored, the validator must transfer the information about the validated tickets to the ticket system.

The working mode should have the ability to change quickly depending on the parameters (communication quality) that are needed at the moment for effective synchronization with the ticket system.

The main functions of the billing system are:

* Calculate payments, ticket purchase, account charging,
* Calculate ticket validation,
* Manage charges made for services rendered,
* Make adjustments to payments and charges,
* Carry out a comparison of the services provided and the payments (charges) made,
* Manage service delivery depending on the status of payments (charges).
* The secondary functions of the billing system are :
* The tariffication of services, according to the parameters given in the product,
* Possibility of retariffification (recalculation) when :
* the tariffication model cannot be implemented online,
* In case of transaction delays,
* Possibility of retariffification (recalculation) in case of errors during calculation.

## **3.11. DATA SECURITY AND PROTECTION**

In order to ensure the security of operations performed in the ticket system and to protect the information in the system from unauthorized access, the system must have mechanisms and a set of functions.

The system must provide the following functionality:

* Ability to encrypt all information transmitted through external channels,
* Ability to use different encryption keys for different subsystems,
* Possibility to manage the validity period of encryption keys.

The roles of administrators and security administrators must be separated in the system.

The degrees of identification of user access rights must be manageable.

All types of accesses performed by different users should be recorded in logs or appropriate databases.

# SUBSYSTEMS AND THEIR STRUCTURE

To provide the functionality covered in Section 3, the system must be divided into subsystems that must perform one or more functions and interact with other subsystems.

## **4.1. INTERACTION WITH PASSENGERS SUBSYSTEM**

Subsystems intended to interact with customers must include functions and functions through which customers will interact with the system and can, according to defined conditions, perform a certain set of actions. Those subsystems are:

* Passenger notification subsystem,
* Passenger's personal office,
* Passenger's mobile application.

## **4.1.1. PASSENGER NOTIFICATION SUBSYSTEM**

The subsystem is designed to communicate with the customer or passenger by means of electronic communication. The subsystem shall provide the following functionality:

* Management of information resources:
* email,
* SMS,
* Push-notification in personal office (mobile application),
* Creation (modification) of informational messages,
* Before notifying the information, the possibility of choosing the information medium (e-mail, SMS, Push-notification),
* Ability to send invoices along with informational messages.

## **4.1.2. THE PASSENGER'S PERSONAL OFFICE**

The passenger's personal office (website) should enable the passenger to access the personal office and perform various functions depending on the passenger's status.

Functionality required for unaccounted or unauthenticated users :

* Availability of multilingual interface (Armenian, English),
* Provision of information about products,
* Ticket carrier balance check (with identification number),
* Replenishment of the ticket carriers balance (with identification number),
* Registration of a new personal office.
* The personal office must provide the following ticket or charging options:
* With a bank card,
* With electronic payment systems.
* Functionality required for registered and authenticated users :
* rovision of information about products,
* Ticket carrier balance check (with identification number),
* Replenishment of the ticket carrier's balance (with identification number),
* Providing information on purchased products,
* Balance checking and replenishment,
* Provision of information on supplements,
* Provision of information on the marches carried out,
* Carrier blocking (unblocking), except for carriers provided to special groups,
* Discharge of unused balance on another carrier, except for carriers provided to citizens with traffic privileges,
* Creation of complaints and receiving a response.

## **4.1.3. MOBILE APP**

The mobile application is a software solution and is designed for IOS and Android platforms. A mobile application should aim to increase the self-service capability.

The mobile application should provide the following functionality, for unregistered users:

* Availability of multilingual interface (Armenian, English),
* Provision of information about products,
* Ticket carrier balance check (with identification number),
* Replenishment of the ticket carrier's balance (with identification number),
* Registration of a new personal office,

For registered users:

* Multilingual interface (Armenian, English),
* Simplifying authentication using a fingerprint, PIN code or biometric data,
* Provision of information about products,
* Ability to select and edit ticket products,
* Ticket carrier balance check (with identification number),
* Replenishment of the ticket carrier's balance (with identification number),
* Providing information on purchased products,
* Balance checking and replenishment,
* Provision of information on supplements,
* Provision of information on the marches carried out,
* Carrier blocking (unblocking), except for carriers provided to special groups,
* Discharge of unused balance on another carrier, except for carriers provided to citizens with traffic privileges,
* Attaching and editing a bank card,
* Ability to generate a one-time QR ticket,
* Creation of complaints and receiving a response.

## **4.2. SUBSYSTEMS OF THE TICKET SYSTEM KERNEL**

## **4.2.1. SUBSYSTEMS OF TICKET ACCOUNTING**

The ticket accounting subsystem is designed to record, process and store ticket information. The subsystem must manage ticket accounting, the current balance of trips (trains), and perform the functions of accounting for ticket sales and ticket redemption after validation.

The subsystem must contain (store) the following information about the ticket:

* Ticket identification number (non-repeating),
* The operator,
* Product type,
* Date of sale,
* Validity period,
* The balance,
* Identification number (non-repeatable) of the carrier on which the ticket is registered,
* Ticket status.

The subsystem shall provide the following functionality:

Ticket accounting function:

- Ticket accounting in the accounting subsystem,

- Transaction accounting in the transaction accounting subsystem,

- Attaching tickets to carriers,

- Ticket validity management:

- Checking the current status of the ticket and making possible changes in the future,

- Change of ticket status,

- Status change accounting in the transaction accounting subsystem,

- Ability to search by ticket identification number (non-repeating),

- Filtering of tickets according to selected characteristics.

## **4.2.2. TICKET ISSUANCE AND ACCOUNTING SUBSYSTEM**

The sub-system of issuing and recording ticket carriers is intended for registration, processing and storage of information about ticket carriers. The subsystem must ensure the accounting, storage and distribution of all media to outlets.

The carrier issuing and accounting subsystem shall allow the following information to be attached to the carrier:

- Carrier type,

- Carrier number in the ticket system,

- Carrier identification number (non-repeating),

- Carrier registration date,

- Application status,

- Information about being on black and black lists.

For the coordinating officer, the sub-system of issuing and accounting of carriers must provide the following functionality:

- Carrier accounting by uploading data (batch (csv, xlsx)),

- Removal, modification of registered media,

- Reads information from the carrier,

- Storage of changes made to the carrier (including the ability to view),

- Accounting for shipments of carriers,

- Accounting of the fact of carrier blocking (unblocking).

## **4.2.3. SUBSYSTEM OF ELECTRONIC TICKET BALANCES**

The subsystem of electronic ticket balances is intended for the storage and management of balances of ticket carriers in the ticket system. The subsystem should provide an opportunity to perform payment, settlement, etc.

The subsystem shall provide the following functionality:

- Balance recharge,

- Balance settlement,

- Creation of electronic ticket balance with registration of virtual carrier,

- managing the validity period of the electronic ticket balance.

## **4.2.4. TRANSACTION ACCOUNTING SUBSYSTEM**

Transaction accounting subsystem is designed for accounting, processing and storage of information on financial transactions.

The subsystem shall account for and store the following types of transactions (transactions):

- ticket sales,

- Cancellation of sale by the system,

- electronic ticket balance recharge,

- cancellation of e-ticket balance recharge,

- Validation transactions,

- Cancellation of the trip from the ticket,

- withdrawal of funds from the electronic ticket balance,

- Carrier status change transactions,

- Transaction of attaching (disengaging) the carrier to the personal office,

- ticket generation order transactions by 3rd party systems,

- Carrier change transactions.

The subsystem shall maintain records of:

- Successfully executed (completed) transactions,

- Unsuccessfully performed (completed) transactions, if possible, recording the reason for the failure.

The following minimum information (characteristics) are required for transaction accounting:

- Transaction (transaction) identification number (non-overlapping),

- Date and time of execution of the transaction,

- Date and time of transaction registration,

- Type of transaction (transaction),

- The device that performed the transaction (type, device identification number),

- Place of installation of the device (vehicle) that performed the transaction,

- The name of the transport operator or transport organization,

- Possibility to record other information about the transaction, depending on the type of transaction,

- Transaction status,

- The reason for rejection.

The subsystem shall provide the following functionality:

- Search for deals (transactions) according to the above-mentioned characteristics,

- Accounting of transactions (transactions) according to the type of transactions,

- Search for deals (transactions) by identification number.

## **4.2.5. VALIDATION SUBSYSTEM**

The validation subsystem shall provide validation of tickets and carriers at the ticket number and validator level.

The components of the validation subsystem must be located in the ticket system core and at the validators level. The subsystem must function:

- In case of secure connection, the main authentication function should be performed in the core of the ticket system,

- In case of an unstable connection between the validators and the core of the ticket system, the validation must be performed at the level of the validators, and in the case of connection regulation, the data about the completed (completed) transactions must be transferred to the ticket system.

The subsystem, in the case of offline validation at the validator level, must provide the following functionality:

- Verification of information from the carrier,

- local (validator level) checking of black (back-list) and hunt-list lists,

- Local (validator level) checking of duplicate entries (validation),

- Local (validator level) checking to ensure the traffic of special groups,

- Transfer of information recorded during offline (offline) validation to the ticket system, immediately in case of connection restoration.

The subsystem at the level of validators, in the case of online validation, must provide the following functionality:

- Verification of information from the carrier,

- Black (back-list) and hunt-list (hunt-list) checking,

- Check for duplicate entries (validation),

- Checking the available balance (tickets) for the trip,

- For special groups, checking the right to travel.

In case of authentication with contactless bank cards or electronic payment methods available on mobile devices (Apple Pay, Google Pay):

- Ticket accounting in the ticket accounting subsystem,

- Track registration in the ticket registration subsystem.

## **4.2.6. BLACKLIST MANAGEMENT SUBSYSTEM**

The blacklist management subsystem shall ensure the maintenance, synchronization with validators and management of the lists of drives and tickets with usage restrictions.

The blacklist management subsystem must synchronize the following types of lists with validators:

- Ticket blacklists,

- Carrier blacklists,

- Ticket search lists,

- Carrier huntlists,

The system shall provide the following blacklist management functionality:

- Blacklisting of carriers and tickets:

- In case of detection of fraudulent activities, based on the information received from the fraud prevention subsystem,

- In case of individual registrations, made by Ticket System administrators,

- Maintenance of black lists and changes made to them,

- Ability to unload from blacklist and blacklist validators,

- Ability to promptly update blacklists if there is a connection,

- Ability to update blacklists and blacklists according to the schedule,

- Ability to download, upload and modify blacklists and blacklists for authorized user.

The subsystem must provide the following functionality in terms of search lists:

- Counting tickets and carriers by making changes to the lists by the authorized operator,

- Maintenance of hunt lists and changes made to them,

- Ability to update search lists promptly if there is a connection.

## **4.2.7. TARIFF AND TICKET PRODUCT MANAGEMENT SUBSYSTEM**

The tariff and ticket product management subsystem is designed for the management of tariff and ticket products. The subsystem must support ticket products and their lifetime (development, testing, implementation, support and operation). The subsystem must ensure the compatibility of ticket products, vehicle types, validation order and sales channels. The main requirements are:

- Determining the compatibility of ticket products in order of priority,

- Definition of compatibility of ticket products and media,

- Definition of compatibility of ticket products and sales channels,

- Defining ticket products and sales channels according to passenger subgroups.

The subsystem must provide mechanisms for the implementation of business processes, such as the creation of different types of products, including the possibility of choosing the order of validation.

## **4.2.8. FRAUD PREVENTION SUBSYSTEM**

The fraud prevention subsystem is designed for immediate detection and neutralization of unauthorized actions in the ticket system, both autonomously and through the operator. The purpose of the subsystem is to develop and implement measures to control and prevent fraud risks.

The subsystem shall implement countermeasures against the following unauthorized actions:

- Unauthorized ticket change and balance recharge,

- Unauthorized ticket sales,

- Large-scale use of tosms (carrier) in a short period of time.

The fraud prevention subsystem shall perform a search for fraud and suspicious activity through tickets and carriers in the following different scenarios:

- If necessary, perform a double check of information coming from online and authenticating devices according to the relevant parameters,

- Fraud detection (provision of the opportunity) according to the relevant parameters,

- Search for individual action according to relevant parameters.

In the case of fraud, the system should perform the following actions (or any of them):

- Adding a ticket or carrier to blacklists,

- Addition of a ticket or carrier to the search lists,

- Blocking of the passenger's personal account,

- Providing a report to the system operator about the account or carrier that made suspicious transactions in order to block the passenger's personal account.

## **4.2.9. REPORTING AND ANALYSIS SUBSYSTEM**

The reporting and analysis subsystem should ensure the integration and consolidation of data necessary for the management of the internal processes of the ticket system, as well as the provision of reports to the management and control bodies and the implementation of analytical functions. The subsystem must meet the following requirements:

- Use of mechanisms for obtaining flexible reporting forms in tabular and graphical form,

- The subsystem should allow export of reports in PDF, Excel, CSV formats.

The system shall collect data at least according to the following principles:

- Number of tickets (product) sold, according to:

- Product type,

- Carrier type,

- Sales method,

- Number of validated tickets (carriers), according to :

- Transport operator (carrier),

- Product type,

- Carrier type,

- Period.

## **4.2.10. SUBSYSTEM FOR PARTNERS (OPERATOR, CARRIER)**

The partner subsystem (website) is intended for transport operators (carrying organizations). The subsystem must provide the ability to create a group of users with their respective access rights.

The subsystem must provide the following main functions for the partner (operator, transport organizations):

- Provision of reports on the volume of services provided and received for a certain period of time,

- Notification of change of registration data.

In order to perform mutual settlements, the following functionality must be available for the partner:

- Search for individual transactions,

- Viewing partner's accounts,

- Download reports (MS Excel, xml, .pdf, CSV),

- Transactions, print, export (MS Excel, xml, CSV).

# SECURITY REQUIREMENTS

The proposed solutions should ensure the security of the entire system for risk mitigation, threat prevention and rapid response.

## **5.1. DEVICESAFETY STANDARDS**

All deviceincluded in the system must meet the following safety standards:

- The information stored in the validator must be protected from unauthorized access,

- Modern encryption algorithms must be used in the system,

- All devices and systems involved in the process of processing bank cards and electronic payments must fully comply with PCI-DSS international standards.

## **5.2. SYSTEM SECURITY ELEMENTS**

The system should provide:

- Compliance of personal data processing with GDPR,

- Compliance of processing and protection of personal data with the legislation of the Republic of Armenia, in particular with the requirements of the Law of the Republic of Armenia "On Protection of Personal Data",

- The security of accessing accounts, which must be ensured by an encrypted (HTTPS) channel and have the ability of 2 factor authentication ,

- In case of communication breakdowns and interruptions, automatic (if necessary, also manual) smooth transition to backup channels that can ensure the normal operation of system components,

- In the event of a general software failure, the ability to automatically (and manually, if necessary) switch to the backup backup version.

The system should exclude the loss of data from servers and databases by ensuring simultaneous registration of data in the main and backup servers (redundancy).

## **5.3. REQUIREMENTS FOR SYSTEM AUTOMATIC**

The system should have the following autonomy capabilities:

- Validators should provide the ability to work online with the central ticket system, but also be designed with the ability to operate autonomously.

- The system must have mechanisms to autonomously manage the synchronization of all devices to ensure data and operational integrity.

# FUNCTIONAL REQUIREMENTS FOR SYSTEM EQUIPMENT

## **6.1 BARRIERS**

Motor vehicles (buses and mini-buses), in order to allow or restrict the entry of passengers, control gates with validators must be installed at the doors of motor vehicles.

Barriers are an integral part of the overall system and are designed to ensure passenger entry (in minibuses, also exit) to the bus.

Barriers must be managed by validators, that is, they must be opened and ensure the passenger's access to the vehicle, only upon receiving the appropriate instruction from the validator. The means of transport (mainly minibuses) where passenger entry and exit is carried out through the same door must be equipped with such barriers that will be able to ensure the passenger's exit from the vehicle as well. In the case of passenger entry and exit mode, the tickets must also record the number of passengers leaving the vehicle (by time) and transfer the information to the validators, the goal is to compare the number of boarding and disembarking passengers (should be the same) in order to rule out violations, as well as record a defined the number of passengers in the vehicle during the period, which will make it possible to review the existing route network accordingly, based on the analysis.

Packages must have the following features:

- Ability to work in parallel with the validator,

- Ability to be controlled by the driver in force majeure situations,

- Implementation of modes to skip the passenger flow. "for entry only", "for exit only" and "for entry and exit".

## **6.2. VALIDATORS**

Validators are one of the important components of the system and are designed to validate tickets using ticket carriers and bank cards. Validators should have the following functionality:

- Information color screen: at least 3.5 inches,

- Ability to read tickets (Mifare, NFC, EMV Contactless bank cards and payment applications for mobile devices, QR code):

- The service time of one passenger should not exceed 2 seconds, except for payments made with bank cards and NFC technologies of mobile devices, the execution time of which depends on the connection and the processing center of the payment organization.

- Interruption of operation and possibility of sound signal if more than one ticket carrier is detected at a distance of up to 8 cm from the validator at the same time,

- Signal option for unlicensed entries,

## **6.3. PAYMENT TERMINALS**

Payment terminals (EasyPay, Idram, Telcell, Mobidram) are intended for ticket sales and subscription card charging. Payment terminals must be integrated with the central ticket system through APIs and ensure secure data transfer.

# TECHNICAL REQUIREMENTS FOR SYSTEM DEVICES

1. **Validators -** 10 must be supplied within the scope of this tender.

Technical parameters of validators should be no less than:

* 1 GHz
* Ram 1 GB DDR3
* Flash 8 GB or more
* Display 3.5" TFT / IPS
* Scanner: Barcode, QR
* Card reader: ISO 14443 A/B, ISO 18092, EMVCo L1 & L2
* Internal loudspeaker:

Communication inputs and outputs:

* 1 x RJ 45 Ethernet 10/100 Mbit
* 3G/4G SIM slot
* 1 x USB 2.0

Terms of use:

* The working temperature should be from -20°C to +60°C,
* The storage temperature should be from -40°C to +70°C,
* The working humidity should be between 20% and 85%,
* Storage humidity should be between 5% and 95%.

Electricity:

* Nominal voltage 24 VDC (Nominal VDC supply voltage),
* Operating voltage (Operating voltage) 10-36 VDC,
* Nominal current strength (Nominal current) 0.8 A,
* Over voltage protection,
* Current spike protection.

Installation type:

* In bus and minibus

Warranty:

* 365 days

The wallet and the Validator can be part of one device, in this case separate wallets and separate validators will not be required. At the same time, in the event that the barrier claim and the validator are part of one device, the requirements submitted to the barrier claim and validators must be the same as the technical requirements submitted to the barrier claim and validator separately.

1. **Barrier covers -** 10 to 20 pieces must be supplied within the framework of this tender.

**The technical properties of the barrier must be no less than:**

- Dimensions (depending on the type and dimensions of the vehicle):

- height: from 900 to 1400xmm,

- length: from 1000 to 1300 mm,

- width: from 150 to 300 mm,

- The opening of the shutter should be 500 to 650 mm.

The sizes of the barrier covers are preliminary, they will be additionally agreed with the Supplier Company after completing the purchase process of electric buses.

- The barrier compartment allowing the entry (exit) of the passenger must have the possibility of displaying a light signal about opening or refusing to open.

Installation type:

* On the floor or side walls of the vehicle

Warranty:

* 365 days

The wallet and the Validator can be part of one device, in this case separate wallets and separate validators will not be required. At the same time, in the event that the barrier claim and the validator are part of one device, the requirements submitted to the barrier claim and validators must be the same as the technical requirements submitted to the barrier claim and validator separately.