The operation of ITS in public transport service: guidelines for Public Authorities and operators

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Abstract

ITS (Intelligent Transport Systems) has increasingly captured the interest of the Public Administrations (Transport Executives, Mobility Agencies, Municipalities, etc) for mobility governance and Public Transport (PT) services (and for the emerging concept of “Smart City”). The overall aim of the paper is to show that the implementation of ITS technology itself is not enough to increase transport services performances as the objectives of ITS implementation and operational and organizational procedure impacts on system specifications. ITS for PT services (fleet control- AVM, e-ticketing systems and user information) are described outlining the role of AVM as a key system for service control and data production. The current market situation is analysed from the demand and offer sides, in order to outline and explain why sometimes ITS applications do not achieve the planned objectives. Some examples of the cross-relations among stakeholders' objectives and needs, service operation and system functionalities are provided. Finally the importance of the implementation of a feasibility study for guaranteeing full operating systems is described in terms of contents and actions.

Keywords: Mobility governance, public transport services, ITS.

Résumé

Les STI (Systèmes de Transport Intelligent) ont capturé l’intérêt des Administrations Publiques (opérateurs, agenciers pour la mobilité, Municipalités, etc.) de façon croissante. Le but de ce document est celui de démontrer que, très souvent, la technologie toute seule ne suffit pas pour répondre aux besoins des usagers. De plus il vise à souligner l’exigence de définir une méthodologie pour analyser les besoins des usagers et les caractéristiques du système du point de vue technique, organisationnel et opérationnel. Les STI pour le transport (gestion de flotte, systèmes de contrôle automatisé des véhicules, e-ticketing et information des usagers) sont décrits, en remarquant le rôle fondamental des systèmes de contrôle automatisé des véhicules pour le suivi du service et la production d’information. La situation actuelle du marché est analysée du côté de la demande et de l’offre, à fin d’expliquer les raisons pour lesquelles parfois les STI n’atteignent pas les objectifs planifiés. Quelques exemples en matière sont aussi donnés. Finalement, l’importance de développer une étude de faisabilité garantissant un correct et complet fonctionnement du système et étant en mesure d’atteindre les objectifs planifiés, est soulignée.

Mots-clé: Gouvernance de la mobilité, services de transport public, STI (Systèmes de Transport Intelligent)

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1. Introduction

1.1. Smart city and mobility governance

In the last years the "smart city" concept has been emerging with the meaning of a well-functioning urban/metropolitan area able to tackle citizens problems and constraints related to city accessibility and life quality: reduction of energy consumption and pollution level, increase of social cohesion, improvement of health and safety conditions, friendly relationship with public offices, higher quality level of mobility and public transport. The most attractive and productive European cities (and outside Europe) show that the "smart" concept is directly linked to the concept of "smart mobility" in terms of the cooperation among the different mobility services and operators (co-modality) and of efficient, wide-covering and high-quality public transport services.

At general level, "smart city" is not representing a model suitable to all the cities, but rather a profitable methodology leading to and supporting all the cycle of planning, implementation and integration of the mobility services and solutions in order to assure their effective management compared to operational needs and targets of the stakeholders (increase of performances and quality, better image for the users/citizens). In the mobility and transport area, the "basic" services are already identified and sometimes even consolidated: what must be done, as along with the cooperation among all the involved actors, is to select those which are more suitable to citizens requirements, the city context and policy and to integrate them in a unified and optimised mobility offer.

1.2. Common strategies for urban mobility at European level

Generally speaking, the solutions adopted for urban mobility are seldom built on a mix of actions related to infrastructures (i.e. parking, reserved lanes, etc.), regulation (i.e. Limited Traffic Zones, road pricing, permissions for loading/unloading of goods, etc.), technologies (ITS - Intelligent Transport System: i.e. sw for planning and network/traffic modelling, monitoring traffic systems and parking management systems, access control, VMS - Variable Messages Signals, traffic lights coordination, ITS for public transport: i.e. AVM/SAE for the monitoring of the fleet, users information, integrated ticketing systems, public vehicles priority, video surveillance).

The common elements of this mix of solutions consists of the adoption of an integrated approach based on the “avoid-shift-improve” paradigm. This paradigm include as main actions:

- Avoid useless trips acting on the integration of territory consumption with transport planning, including the realization of a dedicated corridors on the main axis and an efficient and appropriate network of reserved lanes for public vehicles;
- Shift the modal split in favour of the improvement of collective transport measures;
- Improve alternative sustainable transport modes (green services, low-emissions vehicles, etc.).

The actions must be planned, coordinated and implemented through a specific master plan which is now indicated at European level as “SUMP” Sustainable Urban Mobility Plan.

1.3. ITS and urban mobility services

The services, systems and tools for mobility governance are continuously evolving towards new solutions based on the last technological achievements. These products captured the interest of Public Administrations and Mobility Operators for their potential benefits in providing direct access to the information, supporting "real-time" or "on-demand" services, implementing customized services based on the identified needs of user target groups or/and the context area, controlling and coordinating the various processes active on the network, allowing the interoperability of services and the overall co-modality in terms of cooperation among the different actors involved in the overall mobility chain.

Even technologies' potential is relevant, ITS systems for "smart cities" do not represent the whole solution but a part of it: this assumption must be carefully taken into account by Public Administration, Transport and Mobility representative and technicians in order to avoid the inappropriate idea of "buying technologies and automatically solving the problems".
Indeed, although the implementation and operation of ITS systems is becoming wider and wider, the real experiences and applications carried out by different cities show very often the lack of an appropriate strategic view supporting the planning, the identification of the objectives of ITS and the assessment/comparison of real benefits achieved by the implemented and operated system.

The previous considerations highlight the need for the town to adopt an ITS master plan as an important part of the general sustainable mobility plan “SUMP” as well indicated in the different European acts (Directive 2010/40/UE and the following approved normative).

It is not possible to define a general reference ITS model answering to the requirements of distinct cities which are different in context, urban structure, socio-economic attributes, etc. Indeed the specific objectives and needs of mobility stakeholders and the context of the city/urban area (in terms of operational and organizational procedures of involved stakeholders) ask to tailor each solution for mobility service operation and management.

2. ITS as a tool for the improvement of quality and performances of public transport services

2.1. Common measures for public transport services

The approach emerging and solutions implemented in metropolitan and urban areas for public transport services can be summarised as follows:

- Operation of public transport services on main axes with priority and dedicated corridors/lanes, improvement of the coverage (in terms of time and areas) and quality of services in terms of headways, reliability, travelling time and comfort (BRT, BHLS, etc.);
- Provision of feeder and flexible services in order to integrate the main public transport axes and to adapt it to a wider range of travel requirements and services expectations by the users and the citizens;
- Integration of public transport with green services (bike sharing, bike station system, collective taxis, etc.) and with other transport modes (tram/metro, urban train services, parking infrastructures, etc.)
- Provision of added value services to citizens (i.e. infomobility, etc.).

ITS introduction can be planned over time and it is not mandatory to implement each of them at earlier stage of service operation. ITS can be introduced gradually according to the objectives and the requirements identified by Transport Operators or Mobility Agencies on the basis of the role of public transport in the cities (overall accessibility, improvement of performances, monitoring of the contract services, operation management and control of the reliability of the services in terms of travelled km, performances indicators, etc.). Furthermore the priority level in the implementation of ITS depends on the importance and on the impacts that ITS systems can have on the overall chain of Public Transport services and on the targets/improvements which are planned.

2.2. ITS and public transport services

ITS systems largely adopted in Public Transport services, supporting the management, coordination and quality enhancement of such services, are the following:

- AVM/SAE - Automatic Vehicle System which is the base tool to guarantee the reliability of the services, the compliance with the scheduled timetable (arrival time at bus stops/headway), to allow the effective real-time monitoring of the fleet, the management of irregular cases (delay/advance time compared to scheduled timetable, vehicle out of service on the routing, diversions of the routing, etc.);
- Traffic lights priority acting on the improvement of travelling time along a specific axes and/or corridors;
- E-ticketing system contributing to the increase of the overall service accessibility (boarding time, tariff flexibility, discount, etc.) and the interoperability among different transport/mobility services and operators;
- Users information systems (on board, at bus stops/terminals, web-portal, apps on smart phones, etc.) which allow to proved static and dynamic information on the state of the service;
- Video surveillance systems allowing the improvement of on-board a bus stops/terminal security and coordinate the related actions.

2.3. The role of AVM system

Among the above mentioned ITS systems, AVM is recognized as the fundamental key component for:

- Managing the Public Transport operation, thus preserving the reliability of the services compared to the planned schedule and in response to daily demand, daily events and disruptions, thanks to the control and regulation functionalities;
• Providing ancillary functions to other ITS systems, providing an “all-purpose” communication and on-board connectivity for installed devices (validators, info-panels, audio announcement, etc.), a data feed to real-time systems such as traveller information and traffic signal priority and the provision of a wide amount of data for planning, analysis and administrative functions.

Specifically, through the long-range communication network, an AVM system provides real-time data transmission between the software control platform and the vehicles on the network (buses, trams, trolleys, etc.), which are equipped with on-board devices. This allows the real-time collection of position and status of vehicles. Based on this collected information, the software control platform manages functions (visualization, commands, etc.) for control, monitoring and regulation of the services in case of discrepancies during the services (delays, vehicles out of service, road works, diversions, etc.) and generates the arrival times to stations to be visualized on panels and distributed on info-channels.

2.4. Functional specification of ITS systems for public transport services

The fleet monitoring system is normally the core ITS system. It is of extremely high importance since it performs multiple core roles:
• Supporting operations management
• Providing essential information to other ITS systems (e.g. passenger information)
• Generating and collecting data for post-event analysis, planning and administration
• Providing a ‘communication channel’ between in-vehicle systems and central systems

The functional requirements of an AVM system depend on both the objectives and on the organization modalities and operation procedures adopted by the Transport Companies for the day-by-day service management. Therefore, AVM systems generally present a well-consolidated set of functionalities to be customized.

The objectives of an AVM system include:
• To localize and monitoring the vehicles and to compare their location on the service with the scheduled time or the headway (e.g. intervals between vehicles time by time of day);
• In case of delays of the vehicles on the line, to arrange the departures as close as possible to the service plan, and maintain proper intervals;
• In case of more serious disruptions, to manage the corrective actions in order to guarantee the compliance of the service with scheduled one (vehicles substitution, added vehicles on the line, driver replacement, etc.);
• To guarantee voice communication, pre-coded/free text messages and alarms between Control Centre and in-vehicle terminals;
• To estimate next stops arrival time based on the current position, delays, service conditions on the line;
• To record all arrival and departures time at stops/timing points for calculating service performance index, restructuring schedules planning and carrying out the intervention measures.

From the architecture point of view, an AVM system consists of these key components:
• A Control Centre, from which the system management is performed by the control room operators
• In-vehicle devices, including GPS, communication devices, the driver’s console, and systems supported by the AVM system (e.g. information display units)
• A Communications system, both between the vehicle and the control centre, and between the control centre and other facilities and services.
• Depot/terminal devices for loading and unloading the service data.

ITS-passenger Information is provided in many cities. The AVM and other systems generate ‘real-time’ information, which allow the customer to be advised about the actual arrival times of buses and of service conditions. Passenger information services can broadly be considered in three clusters:
• Pre-trip
  o Journey planners
  o Route and timetable information
  o Fares and ticketing information
  o Stop location, and how to access the system
Service change and disruption information
- Alert services
- Customer support services

- In-trip, off-vehicle
  - Real-time information about route numbers and arrival times, at terminals and bus stops
  - Platform/bay assignment of routes, at BRT stops and terminals
  - Service disruption information

- In-trip, in-vehicle
  - In-vehicle display of next stop and transfer information
  - Automated voice announcements of stops

The most common media for ITS-based information delivery are:
- Multi-line display units at terminals and bus stops
- Single- and two-line display units in-vehicle
- Flat screen/plasma screen display units at terminals and in vehicles
- Mobile phones, smart phones and PDAs.

The e-ticketing system has been emerging as a supporting tool to optimize and integrate different transport services, to guarantee the cooperation of different transport operators (i.e. BHLS or trunk and feeder services operated by different Operators) and to enable the interoperability among mobility services, in particular in urban/metropolitan area (i.e. payment integration between parking and bus services, train/bus services, etc.). One of the most critical points to be faced in order to appropriately define system functionalities is the definition of commercial rules among the involved operators.

Relating to smart card technology following options are available:
- contactless smart card on PVC support standard (Calypso ISO 14443 type A and B, MiFare, etc.) for contracts/subscriptions load;
- rechargeable / single use "chip-on-paper" (multi-tickets, etc.).

In case of interoperable systems, a common data structure must be defined and agreed between the involved mobility/transport operators. NFC technologies allowing the simulation of more smart card data structure on the provider chip of the smartphone.

Other technological solutions used in ticketing system allow users to buy tickets through SMS, to recharge pre-paid tickets or contracts/subscriptions remotely (to be eventually charged on the smart card on-board or at ticketing vending machines through the white list mechanism), the printing and reading (for validation) of bar code tickets.

Interoperation between AVM and e-ticketing systems is required for control (when tickets tariffs depends on the geographical location) or an association between validations and service data (line, stops, I/O matrix, etc.) is required. Interoperation between AVM and e-ticketing systems acts at board level (through the definition of an appropriate communication protocol for commands, data transmission, sw uploads, failure notification, etc.) and at central level (data exchange on service data, stops, etc.).

3. An outlook of ITS market

3.1. Weakness of ITS market on offer side

For Public Transport sector, the market presents many ITS products and systems that are consolidated at system/devices level. Consolidated systems/products may present advantages in terms of costs and development risks, as IT provider can spread investment and development costs over a higher number of installations and these products are built on the experience gained in prior implementations. On the opposite, in terms of disadvantages, this kind of products may be seldom not so flexible to adapt functions and operational procedures to the various requirements of the specific public transport operators and stakeholders. On the other hand niche market products have been tuned in specific contexts and it can be hardly transferred in other context.

Despite the extensive achievements of ITS for urban public transport services, it must be acknowledged that the market is not a perfect world. The weakness on the ITS offer side market are the following:
• Limited capacity (or willingness) from IT providers to customize their solutions/products to meet the true requirements and operational needs of mobility agencies and transport companies. This is frequently due to the rough knowledge of the entire transport service cycle life production;
• Underestimation of critical issues dealing with the interaction activities with other ITS providers/suppliers (e.g. for integration of external databases, integration of ticket validators with the AVM on board terminal);
• Business approach of acting just as a supplier of devices and off-the-shelf software, and not as the “Problem Solving Partner” required by Transport Companies, Agencies and Public Administrations.
These supplier-side factors can negatively affect the ability to consolidate available solutions for public transport services.

3.2. 

3.2. Weakness of ITS market on demand side

ITS has increasingly captured the interest of the main Public Administration (Local Authority, Mobility Agency, Transport operator, etc.) largely driven by the common perception that implementation of ITS can immediately achieve real results and better performances, enables the introduction of new customer-facing services, while at the same time decreasing the amount of human resources required (e.g. in on-street control and administration functions), resulting in overall costs savings. This perception is enforced by the decreasing cost trends of hw solutions and by the wider availability of telecommunications and internet platforms.
The weakness on ITS market demand side consists of an excessive and not motivated “faith” in a sort of “plug&play” implementation and integration of technological solutions which are seen as the “mandatory and self-necessary” tools to facilitate public transport operation and management and to improve services performances. Easiness for implementation both in terms of human resources and time are also largely promoted on a “not explanatory” basis and this approach is too often shared by clients’ side (Public Administration, Agencies, Operators, etc).

This approach can affect the whole life-cycle of the ITS from the planning and feasibility phase to the contracting/tendering, from the implementation and testing phase to the maintenance and operation, including:
• Insufficiently clear identification of the needs, requirements, and performance to be provided by the system. This is often because appropriate funds and resources have not been allocated to carry out a dedicated Feasibility Study before the procurement process;
• Insufficient awareness of the actual results, benefits, and practical problems encountered by other Transport Authorities and Operators with comparable systems. This is partly due to the lack of industry-wide benchmarking of existing applications. It is also partly due to the willingness of Clients to accept the claimed successes of the ITS suppliers (i.e. their promotional material) without performing their own due diligence and market study;
• Launching procurement processes which are more oriented to technology provision, with poor estimation of the supporting services and related costs (customization, installation, travel expenses for on-site activities, software maintenance, etc.);
• Procurement processes and contracts set up without proper relation to system performance and support processes required to achieving BRT service indicators.

4. The base conditions for introducing ITS solutions

4.1. Framework conditions for ITS design and implementation for public transport

The definition of the architectural, functional and technical specifications of ITS systems depends on:
• The objectives to be achieved through ITS implementation and the following definition of related performances indicators and target values;
• The analysis of the context (institutional level, relationship and interactions between the involved stakeholders, main attributes of the mobility and transport offer, services already on the network, interoperability, etc.) where ITS for public transport are introduced and public transport operation;
• The operational procedures and the organizational structure of the operators and the relationship/interactions between the involved actors;
• The interactions/impacts among the previous listed and the identification of technical, functional and operational requirements whom ITS specifications must comply to.
The close relationship among the functionalities and technical specifications of ITS solutions, the objectives, the reference scenario and the organizational and operational dimensions explains why it is not possible to consider a single ITS as suitable to “fit” every single requirement and situation. This also explains the errors made when comparing results and performances of ITS solutions adopted in different context scenarios: the same system can generate good benefits in one context and produce worst results in another one. No system can fit all the situations as the functionalities must be tailored to operational and organizational procedures and adapted to reference service scenario.

4.2. Beyond the technology: operational and organizational dimensions

The actual experience with ITS applications in a wide range of countries is that the expected or claimed performance and/or benefits are often not achieved. In particular, when ITS is not accompanied by the necessary organizational and operational measures, systems operation can be probably not sounded with the operators' or stakeholders' procedure: in this case the system performances can be lower than expected and the results of its implementation not complying with planned ones. The importance of the supporting conditions in terms of organizational structure and operational day-to-day procedures required to efficiently operate ITS are too often underestimated. The impacts of such factors can negatively affect the start up and management of ITS. Most part of the functionalities - even if they appear the same at general level - can be articulated in a wide range of different operative scenario, depending on the actual organization and operational procedure which will be adapted in the system management. Indeed ITS systems provide a wide range of functionalities which must be customized in accordance with the needs and requirements of the Contractor (Public Transport Operator, Mobility Agency, etc.), and then the efficiency and the performances of such systems strictly depends on various no-technological factors. Examples of these factors are: organization structure, operational procedures, interactions modalities, operators skills and training, the quality and updating of the configuration data (to be imported by the systems), the capability to guarantee a continuous improvement of the system over time.

In particular, being ITS systems used in public transport highly complex, their success deals with the efficiency of the different kind of interactions between the systems and the area/offices of the managing organization (Public Transport Operator, Mobility Agency, etc.) and between the system and external suite/package/technologies. Providing an example for AVM system, its operation requires a high level of interactions of the following area/offices:

- Area in charge of the planning of the system due the certification of network and scheduling data, compliance between the network model used in the planning phase and in AVM system, etc.);
- Area in charge of the monitoring and regulation of the service operation (at central level, on the road, on corridors, etc.) and staff used for restoring the regularity of service conditions;
- Drivers due to the interactions with on-board terminals, radio communication with the Control Room, transmission and reception of pre-coded messages, management of the alarms events, etc.;
- Area in charge of the operative actions supporting the operation of the service (depots management, assessment of the service performances, etc);
- Vehicles and infrastructures maintenance (failures, monitoring of CAN signals, monitoring of the efficiency of the data transmission);
- Area in charge of IT management (database, LAN/WAN/VPN connectivity, sw maintenance, security, etc.).

Generally speaking, the operation of an ITS system, like the AVM, requires that the provided functionalities allow the appropriate management of the operative cases (use cases) occurring in the day-by-day management of the system/service, the adequate management of the responsibility level and interactions among the areas/departments of the involved operators. ITS systems functionalities must comply with the operational requirements to be adopted rather than vice versa, even if an adaptation of the current organizational structure and reallocation of tasks/responsibilities may be required as seldom occurring in the introduction of a technological system.

On the same way the introduction of e-ticketing systems must guarantee the compliance with the accounting procedure (revenue flows, ticketing vending accounting as front-office and back-office level) and the marketing/commercial analysis (number of passengers, validations per lines, O/D surveys, etc.).
4.3. Cross-relations between objectives and ITS architecture and functionalities: some examples

ITS systems need to be firmly based on the objectives which mobility agencies and transport companies wish to achieve through their implementation. ITS systems must provide appropriate functionalities compared to the objectives to be achieved and they must be designed in order to make these functionalities compliant with the operational requirements of Transport Operators and Mobility Agencies/Authorities. This will reflect on the definition of the most appropriate architecture as well as on the identification of technical and operational solutions to be guaranteed by the systems.

In the following we will provide some examples related to the design of SAE/AVM and ticketing system. As regards SAE/AVM implementation, a first example may highlight the cross-relation between system functionalities and architecture. AVM systems allowing the operator to monitor the service and regulate it. In case of BRT, high demand lines, service in peak hours, etc. traffic impacts and perturbation of the scheduled timetable can affect the regulation of the fleet otherwise, in case of feeder lines, suburban or peripheral service, low demand areas, etc. the service control does not require a full real-time monitoring. In the first case AVM system must provide appropriate monitoring functionalities and real-time procedure for the regulation of the fleet (trip limitation, routing diversion, headway restoring, etc.) are more relevant as the voice communication between the vehicles and the control operator. In the second case the above mentioned functionalities are not so relevant, being these limited to delay/advance notification: on the other hand the system must guarantee an efficient management of irregular cases (vehicle out of service, etc.). On the architecture side, reflecting on the organization structure and operational procedure to be adopted, when an effective real-time monitoring is required (BHLS, trunk, high demand service, etc.), a dedicated Control Room with operator workstations is the most suitable solution, whereas this architecture could be over-consuming when the service mainly requires for management of irregular conditions. In the first case dedicated staff for the real-time monitoring and control of the fleet can be trained and adopted, while in the other cases the real-time monitoring can take place over specific time period (peak hours) or can be never carried out; under this second operational scenario the operators can interact with the system working on their own workstation even installed in different location over the territory and connected through LAN/WAN/VPN/internet. Each operator will interact with the system in order to manage the operation of every single responsibility (fleet control, vehicles assignment, IT department, depots, vehicles maintenance, etc.). The system must provide appropriate access rights for data reading/modification on the basis of users profile logged. In case of critical event if no real-time monitoring procedure is planned, AVM system must guarantee the transmission of SMS/e-mail notifications to recipients/mailing list. In the metropolitan/large scale urban context or when a single transport operator manage different kind of service schemes AVM system can guarantee both the management and regulation scenario previously described switching automatically from one to another based on the service/line/day hours.

A second example of the impacts of the objectives on AVM requirements and specifications deals with the definition of the priority between the provision of real-time users information compared to the certification of quality indicators of the operated services (travelled km, delays at stop points, number of diversions compared to scheduled timetable, etc.). In the first option AVM system must guarantee appropriate functionalities at Central level especially for the management of irregular conditions, otherwise the data provided by information panels/web portal/SMS/mobile apps would probably be wrong (or just show the scheduled times). In the second case, higher level of performances in terms of on-board functionalities (line matching) must be guaranteed by the system. An AVM system can be suitable for generating real-time information on panels but it cannot be able, at the same time, to guarantee appropriate performances for the certification of operated services. Also the definition of the most appropriate system architecture is different from one case to the other: in the first case a periodic communication between the Central sw and the on-board devices is generated while, in the second scenario, this communication is reduced (at terminal/depots, at the end of service) and the on-board devices must run as autonomous systems. On the organizational and operational side, the requirement for the provision of real-time information deals with the organization of appropriate monitoring and control procedures and related resources: even if the functionalities provided by the system are operationally appropriate, users information could be generated incorrectly (in presence of irregular conditions of the services) in case the Transport Operator should not be able to define and adopt the appropriate operational procedure to be used in case of vehicle substitution, modification of the vehicles assignment, etc.
A third example related to the definition of the technical and functional requirements of AVM system and the set up of appropriate supporting procedures and allocation of responsibilities is represented by the assignment operation between the vehicles and the service (line/routing). In general this operation can be performed at different levels and by means of different procedures: automatic assignment based on service planning, assignment by the Control Centre operator, assignment by the driver. The priority level of the different assignment modalities can be defined starting from the operational procedure which can be adopted and the allocation of responsibilities (control level, drivers, etc.). Also the percentage of irregular cases during the service must be evaluated in order to select the suitable scenario and the following priority level. AVM system must be so flexible as to guarantee the management and the automatic migration from a scenario to another acting on a configuration tool of the central system.

Moving from AVM system to ticketing system, it must be stressed that the functionalities of the ticketing system can be defined only after the vending/validation/clearing rules have been established and agreed among all the operators and stakeholders: the e-ticketing system must implement these rules. Among these rules the interoperability ones are critical in case of multi-operator/multi-services scenarios.

A second example dealing with e-ticketing is the configuration of fares assigned to stops and lines which can be managed within the e-ticketing central system environment or in the planning sw depending on the organizational requirements and the interactions between the involved department/area of the transport operators.

A third example is the integration of e-ticketing system functionalities for data export with the commercial and accounting sw/procedures which must guarantee appropriate level of detailed data and synthetic report (electronic tickets, SMS/app vending channel, paper tickets, etc.).

5. A smart way to introduce ITS: the role of feasibility analysis

Based on the observation of a wide range of real experiences, a key underlying reason for the gap between intention and actual results is the lack of a robust feasibility analysis. For any proposed ITS investment, it is strongly recommended to carry out an in-depth feasibility study of the system to be implemented. The feasibility study is the opportunity for setting and specifying real requirements and objectives to be achieved and for designing system functionalities. Not surprisingly, when the technical systems are designed to respond to the well-considered and detailed requirements of the transit agencies, they have a far higher chance of success. The feasibility study is also an opportunity for all internal and external stakeholders to understand the ITS system and its longer-term potential.

Feasibility analysis should include:
- Define the real objectives to be achieved by the system implementation
- Identify the relevant actors and their responsibilities
- Define the suitable functions and technical requirements
- Evaluate the impacts of the system on organization and current operation
- Define appropriate management and maintenance procedures, and allocation of dedicated resources, definition of the required training courses and know-how transmission;
- Analyze investment and operation cost impacts.

The Feasibility Study must clearly identify the different implementation steps and target up the launch of the system in order to facilitate the monitoring and management of the implementation plan within time and budget constraints.

In particular, some common sense recommendations can be highlighted in order to set the role of the stakeholders involved in the definition and management of ITS systems and in the management of transport service contracts.
- To identify the technological needs, the requirements and the expected performances of ITS taking into account the different service scenario/scheme;
- To understand and focus on the critical issues of the implementation;
- To estimate the implementation time in a realistic way;
- To gather a deep knowledge of results, added values and problems faced in similar implementations;
- To mediate the role of technologies with the operational procedures and the organizational scenarios which can be realistically supported by the Operator in the short-medium time;
• To define training activities of the different involved resources focused on the improvement of technical knowledge and the enhancement of skills of the internal staff. It is a smart way to proceed involving in the feasibility study some of the key resources later in charge of the management of the system;
• To quantify all the costs as investment, operational costs, cost for the support of the implementation, internal resources, maintenance;
• To define the testing and acceptance procedure including the procedure for the assessment of performances indicators;
• To define, at contractual level, suitable prescriptions allowing the payments during the implementation only when the test of defined intermediate milestone is carried out successfully.

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