SLOVAKIA CATCHING-UP REGIONS

DIGITALIZATION OF PUBLIC TRANSPORT IN THE BANSKÁ BYSTRICA REGION

European Commission

BANSKOBYSTRICKÝ SAMOSPRÁVNY KRAJ

MINISTRY OF INVESTMENTS, REGIONAL DEVELOPMENT AND INFORMATIZATION OF THE SLOVAK REPUBLIC

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ACRONYMS AND ABBREVIATIONS

AADT	Annual Average Daily Traffic
ANT	Antennae
APC	Automatic Passenger Counting
API	Application Programming Interface
AVL	Automatic Vehicle Location
AVMS	Advanced Vehicle Monitoring System
BB	Banská Bystrica
BBSK	Banská Bystrica Self-governing Region
CAN	Controller Area Network
CAPEX	Capital Expenditure
CCTV	Closed-circuit Television
CEN	European Committee for Standardization (Comité Européen de Normalisation)
CI-CU	Check In-Check Out (CheckInd-CheckUd)
CIPTEC	Collective Innovation for Public Transport
CIS CP	The Slovak Republic Public Transport Database
CMS	Content Management System
CP.sk	Slovak national public transport timetables software product
CuRI	Catching-up Regions Initiative
CTSS-DBUS	Compañía del Tranvía de San Sebastián – DonostiaBus
CVAK	Smartphone application of MHD (City Public Transport)
DKK	Danish Krone
DPI / DPIS	Digital Passenger Infotainment / Digital Passenger Infotainment Screens
DPM	Municipal Transport Company (Dopravný podnik mesta)
DSS	Decision Support System
EBSF	European Bus System of the Future
EDISON	Public transport software product produced by the supplier M-Line
EMTA	Association of European Metropolitan Transport Authorities
EMV	Technical standard for smart payment cards and for payment terminals and automated teller machines which can accept them
ENTUR	Government-owned transport company in Norway
ETIS	European Tourism Indicators System for Sustainable Destination Management
FAIRTIQ	Brand of public transport ticketing application
FMO	Fleet Management and Operations
FMS	Fleet Management Systems Interface
GIS	Geographical Information Systems
GDPR	General Data Protection Regulation
GNSS	Global Navigation Satellite System
GPS	Global Positioning System

GSM	Global System for Mobile Communications
GTFS	Google Transit Feed Specification
ICT	Information and Communication Technologies
IDOS	Public transport search engine (Czech)
IFOPT	Identification of Fixed Objects in Public Transport
iBus	Automatic vehicle location system for London's buses
INPROP	Supplier of journey planning software
ISIC	International Student Identity Card
ISYBUS	Public transport software product produced by the supplier M-Line
IT	Information Technology
ITS	Intelligent Transport System
ITxPT	Information Technology for Public Transport: a standard promoted by UITP
KPI	Key Performance Indicator
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MaaS	Mobility-as-a-Service
MADT	Multi-application Driver Terminal
MHD	Municipal public transport system (Mestská hromadná doprava)
MMI	Man-machine Interface
MMTIS	Multimodal Travel Information Services
NAP	National Access Point
NeTEx	Network Timetable Exchange (CEN technical standard for exchanging public transport information as XML documents)
NFC	Near-field-communication
NGA	Net Generation Access
O/D	Origin/Destination
OJP	Open Journey Planner
OLTIS	A Czech-based business group
OPEX	Operational Expenditure
OPRa	Operating Raw Data
OV-Chipkaart	Dutch national public transport smartcard (Openbaar Vervoer Chipkaart)
PC	Personal Computer
POLIS	Network of European cities and regions cooperating for innovative transport solutions
PTA	Public Transport Authority purchaser of services - BBSK
PTO	Public Transport Operator
PTPs	Public Transport Priorities
PTT	Push-to-talk
QR	Quick Response
RTI	Real-time Information
RTPI	Real-time Passenger Information
SAD	Generic term that is part of the official name of several different bus operators in the Slovak Republic (Slovenská autobusová doprava)
SBB	Swiss Federal Railways (Schweizerische Bundesbahnen)

SFMCON	Management consulting company
SGR	Self-governing Region
SIRI	Standard Interface for Real-time Information
SLA	Service Level Agreement
SMP	Sustainable Mobility Strategy and Plan
SMS	Short Message Service
SOP/ SOI	Standard Operating Procedure / Standard Operating Instructions
STA	South Tyrolean Transport Structures (Südtiroler Transportstrukturen AG)
TAIEX	Technical Assistance and Information Exchange (instrument)
TAP/TAF TSI	Technical Specification for Interoperability relating to Telematics Applications for Freight/Passenger Services (Rail)
TBD	To Be Determined
TEN-T	Trans-European Transport Network
TfL	Transport for London
TFT LCD	Thin-Film-Transistor Liquid-Crystal Display
UITP	The International Association of Public Transport
VA	Voice Announcement
VCG	Vehicle Communication Gateway
VoIP	Voice over Internet Protocol
WBDT	World Bank Real-time System Design Team
ZAD	Slovak Bus Operators Association (Združenie Autobusovej Dopravy)
ŽSR	Railways of Slovak Republic (Železnice Slovenskej republiky)
ZSSK	Slovak National Rail Operator (Železničná spoločnosť Slovensko, a.s.)

EXECUTIVE SUMMARY

This report was written to support the European Union's Catching-up Regions' Initiative (CuRI) in addressing the needs of the Banská Bystrica Self-governing Region (BBSK). The BBSK's proposed public transport digitalization initiative fits into broader digital government and smart city policy developments in the Slovak Republic as a whole, and in the BBSK in particular, as a 'catching-up region'. Further work within CuRI's support framework is expected to follow in 2021 as the public transport digitalization initiative is implemented.

The BBSK's objectives in its CuRI proposal concerning public transport digitalization (referring not just to the existence of digital databases and processes but also to their compatibility and connectivity) relate entirely to the bus network. There are three reasons for this focus on the bus network. Firstly, the rail system (the remainder of BBSK's public transport) is only a small part of the total public transport network. Secondly, the bus network (run by public transport operators [PTOs]) is financed by the BBSK (which is the public transport authority [PTA] is purchaser of services, and as the client concludes a contract for services in the public interest with PTOs, as far as the financial aspect is concerned), but currently—and in the absence of digitalization—it is not effectively under its control. The third reason is because once a single coordinated, digitized BBSK bus network is in place, then it becomes much more straightforward for the BBSK to coordinate with the rail system to create a single multimodal network. This report provides both a justified strategy for implementing the proposed BBSK digitalization initiative based on an analysis of user needs and of digital literacy in the BBSK area, and a detailed design of a digitized real-time information and control system.

The objectives of the BBSK and its reasoning are explained as follows. The key objectives of the public transport digitalization strategy in the CuRI is *"to create a general proposal for a comprehensive solution of public transport digitalization in BBSK, to prepare implementation of individual steps that will need to be gradually implemented, and to have a strategy means to use EU funding from 2021 to 2027".* The reasoning for creating this through the CuRI is, firstly, to *"Reorganise the functioning of public transport (reduce operating costs of public transport, possibility to increase level of service for the same cost)";* secondly *"To Improve public transport as a service (increase public transport reliability, leading to an increase in transported passengers)",* and, thirdly, to *"Improve passenger travel information for passengers (thereby increasing public transport's prestige)".* Finally, and in summary, the overarching aim is to *"Recognise all the overall cost and steps needing to be taken so that there is one functional open system at the end of the CuRI project that will have the ability to manage public transport in BBSK".*[1]

To enable an understanding of the background to this situation, this report explains where the BBSK is situated within the Slovak Republic and describes the current public transport supply.

The BBSK is one of eight self-governing regions in the Slovak Republic, with a population of about 645,000. The region consists of 13 districts and 516 municipalities, and its administrative center is the eponymous and historic city of Banská Bystrica (the sixth largest city in the Slovak Republic, with a population of around 80,000). It is the region's largest settlement with a renowned university.

Other important towns are Zvolen, and Brezno. The Slovak Republic's main east-west motorway (D1) avoids the BBSK, although the BBSK has a good expressway (R1) linking it to D1, and onwards to Bratislava.

Transport is overseen nationally by the Ministry of Transport and Construction. The national rail network, including the tracks and the stations, is owned and managed by ŽSR (Railways of Slovak Republic), with rail passenger transport services operated by ZSSK—both are state-owned companies. The provision of bus services in the Slovak Republic is divided into regional bus operators. In the cities and large towns, buses are under the control of the municipality; this municipal public transport is known as the MHD.

Regarding the rail network, while the BBSK has some main rail routes, it is not on any trans-European rail corridor. A few railway lines in the BBSK have tortuous curves in places that traverse mountain ranges, so train service in those areas is comparatively slow. Some lines are electrified and there are also long stretches of single-track rail. There are few clock-face timetables and few consistent stopping-patterns, but some national semi-fast trains run through different lines in the BBSK. Track quality is variable with consequent speed restrictions and unreliability in some places. Railway service frequency is usually rather limited, but since 2014, national rail use has been positively affected by the national free rail travel arrangement for young people under the age of 15, and people over the age of 62. Many small intermediate stations are still open and, in some stations, platforms are very low and boarding, and alighting from, carriages, can require physical effort. Therefore, it is not possible for people with certain disabilities to use these stations.

The ŽSR has real-time data on the actual position of passenger trains, which it displays on a real-time map on its website. Both single and return tickets can be bought, but there are a range of different prices applying to different groups. Tickets can be purchased through the ZSSK website, or bought at stations, or from the onboard conductors. However, different classes of trains vary as to their prices, and some classes of trains have compulsory reservations. In summary, the rail infrastructure network in the BBSK is extensive, but generally offers rather slow and fragmented services with low frequencies. Rail users in the BBSK are presented with a network that, while offering attractive (or even zero) fares for certain classes of travelers, does not integrate with the bus network, or even provide standard conditions for bus travel.

By contrast, the bus network has a much higher geographical penetration. There are currently 319 bus lines in the region, of which about 205 are contracted by the region's administration to SAD Zvolen (approximately 63%) and SAD Lučenec (approximately 37%). Around 50 lines are contracted by neighboring regions to their own regional operators that cross over into the BBSK, or are run commercially by private operators, including some international bus lines. The remaining lines are operated on behalf of municipalities (MHDs) and are mostly run by SAD Zvolen. The service frequency of bus and trolleybus lines is generally uneven, even on MHD lines, and this irregularity means that bus travel is not 'turn up and go'.

Bus operators supply data on their bus lines to certain software companies for journey planning systems, but the agreements prevent the underlying data being shared in a machine-readable form with any other organization. This data, therefore, cannot be analyzed to produce summaries or an assessment of bus service levels. Timetables, as supplied by the operators, are available digitally from the websites of journey planner suppliers, and these may be published at stops or at public transport offices in bus stations. However, the layout is not user-friendly, and the bus line can only be identified by a six-figure number, which is very hard for an unfamiliar user to remember.

Bus depots and bus stations are in the right places—the large towns that need them most—but the quality of bus stations varies significantly across the BBSK. Bus stops are a critical element in the delivery of digitalization to a public transport network, but there is no official national database of bus stops in the Slovak Republic. To address this, the BBSK is in the process of launching a survey of all its 2,600 bus stops to collect several parameters, such as geolocalization, pictures of the surrounding area, stop panels, shelters, the accessibility for people with disabilities, and so on.

Fares are calculated on a purely distance-basis (mileage) and are set regionally. Fares are paid by cash, or by a contactless chip card, from which the fare is deducted from its stored value. There are set discounts for specific types of travelers, where the fare, paid with a card, receives a discount from the cash fare. While there are advertised links between buses and trains at certain stations and on network maps, these are not prominently displayed, and connecting times between buses and trains are not shown in timetables. While there is no integration of fares and payments between different public transport operators in the BBSK, except in very limited cases, multimodal journeys can be planned on journey planning systems. The two main BBSK bus operators were asked for information about their current databases and transfer systems so that we could understand the present extent of digitalization. However, the response was very limited.

Real-time information (the extent to which the bus is following the planned timetable, and the expected arrival at individual bus stops) is important because regularity and punctuality are the core performance of an operation. Sudden irregularities can be monitored so that the consequences for the current trip, and in particular, the subsequent trip, can be ascertained. This is essential for remedial action, for performance calculation against key performance indicators (KPIs), and for passenger information. Passengers need information before, and during, travel. This information can be used to convince more people to use public transport. However, only minimal real-time information is available on the bus network in the BBSK.

A key aspect of passenger information is journey planners, which are extremely useful to enable travelers to plan the whole of their end-to-end journey by public transport. In the Slovak Republic, there is no legal requirement to supply public transport information to a central database, unlike the model in the Czech Republic. However, because of the historical union with the Czech Republic, and the Slovak-based heritage of the supplier of the Czech journey planning system, the Czech-based system is available in the Slovak Republic through the CP application and is widely popular. This report explains the conceptual digital mobility-data architecture, and how elements would fit together under an integrated digital system built to deliver real-time information, using common and recognized standards.

In connection with this effort, the national and European legislation relating to public transport is covered in the report, which shows how general governance rules give local governments the power to introduce an integrated, digitalized public transport system. European Commission (EC)/European Union (EU) regulations and directives are included to show the broader regulatory environment—particularly the ITS Directive (2010/40/EU) with regard to the provision of EU-wide multimodal travel information services.

The report analyzes the travel behavior and needs of the region's residents and visitors, using data gathered by the World Bank from various official sources, for general travel patterns within the BBSK. To supplement this, information on the travel needs of bus users, and on the reasons why public transport is NOT used, together with an assessment of digital literacy, was gathered largely from a survey of bus users and of non-users carried out by the World Bank in November 2019. The general travel pattern data shows that trips are very unevenly spread across the BBSK. The Banská Bystrica zone generates and attracts the highest number of trips—about 468,000 trips a day. The other four zones generate and attract over 100,000 daily trips. The remaining 33 zones have less than 100,000 trips per day.

The report also found that the mode of transport used strongly depends on trip distance. In the case of intrazonal trips, public transport use holds a minimal average share of five percent. For interzonal trips—that is, trips that have their origin in one zone and their destination in another zone—trip duration is of very high importance, with a car being the most preferred mode of transport. On interzonal bus trips, the most heavily used travel corridors are corridors between district centers. There is an absence of high bus use to, and from, places that are off such main interurban corridors.

There were some key takeaways from the surveys. First, there is a high percentage of regular users who are familiar with the one bus service. Second, with regard to bus users, there are key types of travel that the bus service is not meeting. For instance, the most frequent complaint was about a lack of bus service in the evenings, where just under one-third of respondents agreed with that statement.

Another key point was that interviewees—both users and non-users—do not recognize that the bus service is a network, and so they do not treat it as such. For users, this lack of recognition is reflected by people's familiarity with only one bus route—or with two, if they are using one bus to access a nearby town from their village, and then a second one to further access a more distant town. For non-users, it is reflected by the fact that there are significant numbers of people without access to a car who travel together to venues as a group. Another key point was that users give a high rating to bus services that are reliable and dependable, and that their satisfaction can be increased by moving to a coordinated network. For non-users, both tourists and shoppers perceive problems with the bus service, while a general point is that both users and non-users have low expectations of the bus service. Both these points lead to the conclusion that the use of digital tools to plan services based 'on demand' has the potential to create major increases in bus service use.

The report also analyses digital literacy and shows that both users and non-users have digital familiarity. The user survey identified that all interviewees between the ages of 16 and 26 had a smartphone, and this figure had a 95% lower confidence level of 0.98. There is also a high level of use of the internet to gain information about planning a journey on public transport. Both users and non-users had comparable levels of smartphone ownership, and similarly high levels of awareness of the major internet public transport journey planners available. The proportion of users who accessed the internet for public transport information is high for the younger generations, but much lower for older people.

Digitalization also offers several other opportunities to promote an integrated and more effective public transport network. One of these is the simplification of network brands to grow use: simplification of line numbers to three-digits—using relationship files to link with the official the Slovak Republic's national six-figure number—is a benefit of digitalization that will make line-recognition easier for potential public transit users. It will also make the production of customer-friendly publicity easier. The key customer medium for BBSK digitalization should be a smartphone application, but this has to be very well designed (intuitive, attractive, and closely linked to the new, future, BBSK-integrated public transport network brand), allow personalization, be supportive of BBSK's interchange strategy, and have accurate data and fast operation. A presentation from Ruter (Norway) indicates the way that that particular public transport authority (PTA) designs its applications.

The report has a brief Strengths, Weakness, Opportunities and Threats (SWOT) analysis of the BBSK's current public transport situation, and then discusses governance roles. It is expected that by changing from a static public transport operator-centric controlled governance, to a more central and agile public transport authority-centric governance, opportunities will be found to optimize the use of vehicles and human resources to deliver more services for the same overall subsidy cost.

The heart of the proposed digitalization strategy is for the PTA to define the service level it wants, and then to specify contracts with PTOs on that basis, with payments and penalties determined by KPIs, and with performance against those KPIs monitored using real-time systems. Those real-time systems would use and deliver open data, via integrated systems built on European standards, and would be at the heart of the control mechanisms used to drive performance, reliability, quick response to disruption, and most importantly, fast, accurate, and relevant passenger information. In summary, there would be a consolidation of activities, which today are handled in a decentralized and closed way by the current PTOs, into a centralized open regional approach controlled by the BBSK.

The strategy defined here, will result in a design and specification for the tendering of the real-time part of the system that is modular and scalable in functionality, to accommodate gradual implementation. Some of the benefits of the strategy are described, including increased security, digitalization being introduced in a coordinated way, uniform and reliable control systems, the ability to move towards digitalization of ticketing, and giving the BBSK the means to draw up a coherent data collection strategy. Three levels of real-time system services are shown, with associated capital expenditure (CAPEX) and operational expenditure (OPEX) estimates, on which to base an EU funding application.

The main objective of the CuRI is to create a single regionwide public transport ecosystem with a complete digital twin representation of the stops, routes, and multimodal planning and ticketing. To achieve this objective will require substantial changes in the governance between the public transport authority and the public transport operators who deliver the bus operations that will shift public transportation from a PTO-centric system to a PTA-centric one. The report shows how there are several current PTO functions in the BBSK which are typically seen as PTA responsibilities in most European public transport governance models. The current governance structure makes it extremely difficult for the PTA to plan and coordinate the bus network. Moving to a new organizational structure, with a new and much wider role for the PTA, requires a buildup of roles and skills in the public transport authority, particularly in customer service—all executed through several channels—as well as a central register of bus stops, bus hubs, bus stations, and train stations.

Preparing for the procurement of public transport bus operations through a public tender will also be a critical role of the new PTA. Careful planning and good static data are both crucial to a successful procurement process. The awarding criteria need to be sharp and unbiased, living up to best practices and formal EU procurement regulation. Central to the contracts will be the KPIs: key here will be the level of service—the degree of execution. In traditional public transport, measuring these KPIs would be resource-intensive and often random, but is much more straightforward where there is a real-time system in operation. When implementing a real-time system, the most important KPI will be that each bus is properly logged onto the system and provides real-time data. From here, many measuring points will deliver complete data for the duration of its operation, depending on the level of digitalization chosen in the operation of the buses. Proposed KPIs associated with the introduction of a real-time system implementation include the following: real-time system-log-on; compliance with timetable/driver behavior; and—if the PTA has chosen to extend the real-time system to include information channels—many elements of public transport information display can be measured. With real-time system implementation, the PTO may also choose to measure additional variables, such as type of bus used, maintenance processes carried out on the bus, and operating irregularities.

Obviously, the PTO roles in a PTA-centric governance model are fewer than seen today. An open communication of objectives and game plan from the region PTA, e.g. also through an entity authorized by the PTA/purchaser of services, is encouraged. This communication should also address the possibility that the current operators will not secure the same level of operation as today, or maybe even lose most, or all, of their business.

Following governance, the next part of the report covers standards for public transport operation. These are very important as the public transport market is highly regulated in the EU when it comes to how to digitalize the operation and deliver planning and fares information to users. The four sets of regulations and standards, which are all compatible and intended to be interoperable, are as follows: Transmodel (a European set of standards for interoperability between public transport information processing systems, including Network Timetable Exchange [NeTEx] and the Standard Interface for Real-time Information [SIRI]); Information Technology for Public Transport (ITxPT) (the provision of standards for IT implemented in public transport vehicles and their communication with central back office components); EU-wide real-time traffic information services (EU) 2015/962, published in open formats and made available through National Access Points (NAPs); and, lastly, Multimodal Travel Information Services regulation (EU) 2017/1926.

Examples of best practice European models are Ruter (Norway), Malta Public Transport, Südtiroler Transportstrukturen AG (STA) (Italy), with other examples from Movia (Denmark) and Entur (Norway).

The project team received a video presentation from Ruter, which serves the Oslo and Akershus counties of Norway and is a collaboration between the two local authorities of these counties. There is strong branding across all promotional materials as well as on vehicles. In terms of information, Ruter provides real-time information at stops and stations, as well as via an application. Tickets can be bought at a wide range of outlets including via an application, onboard vehicles, at kiosks and service points, and at ticket machines. Tickets are valid on all modes of transport, including trains (except the express train to the airport). The level of service is rated highly: 97% of passengers were satisfied with their journey in 2014. While passenger numbers in Akershus County (which is somewhat similar in its geography to the BBSK) fell in the period 2000 to 2002, they have since grown substantially and are now rising at a pace that is outstripping the population growth. Ruter's customer base has high digital literacy and high 4G mobile telephony coverage. The attitude of their information technology (IT) development staff is very much 'can do', as they use publicly available open systems to develop new mobile applications for their customers.

Similarly, to Ruter, Südtiroler Transportstrukturen AG PTA information in the report is based on a video meeting with the management of STA's IT-system department. STA is in the process of rolling out a new real-time system based on NeTEx, SIRI, and ITxPT standards. In the new procurement of PTO services, the PTOs are to procure, install, and operate real-time system components in the buses that fulfill the STA specifications. However, the onboard ticketing system owned by the STA PTA, is again regulated in the operator contract. The STA can be a good reference for what it takes to operate a digitalized PTA, as the size of operation is comparable with the BBSK. In fact, the STA is implementing the digital infrastructure that is proposed for the BBSK. Therefore, valuable knowledge sharing may ease the creation of the BBSK PTA and the procurement of the digital components.

The report then presents the strategy and 'building blocks' for real-time systems. The basic configuration is explained first (Level 1), and this allows most other features to be straightforwardly designed into the system. Once the bus network is connected, it allows for many expansions and features. It is here especially that the choice of the ITxPT standard as the system architecture comes into its own. The PTA/PTO will not be locked into a proprietary setup and can subsequently easily expand the system. An obvious extension (to Level 2) is to integrate with the destination sign, as this requires no more hardware than the vehicle communication gateway (VCG) and the multi-application driver terminal (MADT), and thus can often be handled with cabling and an application on MADT. Voice announcement (VA) and voice over internet protocol (VoIP) often require an audio module. Level 3 includes an automatic passenger counting (APC) system and digital passenger infotainment screens (DPIS). These are costly in hardware and installation and are thus often the last to be added. The features of a real-time system that are the main cost drivers of CAPEX and OPEX are then described.

Next, the report includes an introduction to digital ticketing. While digital ticketing schemes, or smart ticketing schemes, are rolled out in public transport ecosystems everywhere, no standards are mandated. This can cause complications, particularly in the introduction of ticketing schemes with national coverage. The report outlines several factors that would need to be considered by the BBSK when planning a transition to a smart ticketing system.

The cost of investment and operation (CAPEX and OPEX) is then calculated: to build a credible and valid investment projection, prices are based on input from suppliers in Europe. For each component type, prices of two and preferably three different suppliers have been obtained. In addition to prices, installation times have been collected and validated on the individual solutions. All the results are grouped together in a model, to be able to conduct impact simulations distributed across CAPEX and OPEX, depending on which functions are selected. The model has been validated by one (Danish) PTA and the factual results of a 2019 tender, and, as such, we have a pricing model which reflects the current state of the real-time system market.

For onboard equipment, real-time back office and the control rooms, three investment scenarios are priced: a minimum (basic real-time scenario); a medium scenario (to include purchase and installation of microphone, speaker, and associated functions); and a maximum solution (including items such as APC, DPIS, and closed-circuit television (CCTV). Costs for bus stops and stations are based on three levels of stop types, as follows: stops in a line with no other connection; stops with more than one line; and stops or stations with multimodal travel options.

Finally, a 'road map' for the review and adoption of the BBSK's Public Transport Digitalization Strategy is shown, with timescales and steps. This lays out the strategy decisions that will need to be taken (for example, regarding ownership of real-time equipment in buses, and the evaluation and decision on system software), as well as key elements of responsibilities for different sections within the BBSK PTA, as well as the key features of the pilot.

INTRODUCTION

STUDY FOCUS AND RATIONALE

This report was written to support the work of the European Union's Catching-up Regions Initiative (CuRI) in addressing the needs of the Banská Bystrica Self-governing Region (BBSK). The BBSK's proposed public transport digitalization initiative fits into broader digital government and smart city policy developments in the Slovak Republic as a whole, and in BBSK in particular, as a 'catching-up region' and is fully in line with the World Bank's advisory support in this area. Further work, within the framework of support for CuRI, is expected to follow in 2021 as the public transport digitalization initiative is implemented.

The overall objectives of the BBSK's proposed public transport digitalization project (which would be carried out under the CuRI program) are shown in the lists A, B, C, and D under section below. In these lists, the individual elements of the project's justification, expectation, and benefits are numbered for cross-referencing in a later part of this report (Chapter 7). That chapter explains how the strategy and the real-time plans proposed in this report address those requirements of the BBSK.

It should be mentioned that the BBSK's objectives concerning public transport digitalization in its CuRI proposal, although not stated explicitly in section below, relate entirely to the bus system. There are three reasons for this focus on the bus network. First, the rail system (the remainder of the region's public transport) is only a small part of the BBSK public transport network. Second, the bus network, (run by public transport operators [PTOs]) is financed by the BBSK (which is the public transport authority [PTA]) but currently—and in the absence of digitalization—it is not effectively under its control. However, the rail network is financed nationally, and the strategic policy decisions about it are made nationally. Third, once a single, coordinated BBSK bus network is in place (its implementation enabled by the bus network's digitalization), it then becomes a much more straightforward task for the BBSK to engage and coordinate with the rail network to achieve an effective single, multimodal BBSK public transport network.

Another key point to stress at this report's outset is that digitalization refers not just to the existence of digital databases and processes but, most importantly, also to their compatibility and connectivity. A digitalized system (or group of systems) is one where the different elements exchange data between themselves (and with the 'outside world') both seamlessly and, where required to, in real time.

This report provides both a justified strategy for implementing the proposed BBSK project, and an analysis of user needs and of digital literacy in the BBSK area. The work was carried out in two stages: Phase 1—the study of user needs and digital literacy; and Phase 2—the strategy for the introduction of digitalization with systems designed to meet those needs, including a plan for the introduction of the real-time element of the strategy. The strategy and plan have been composed in the contexts of the BBSK's requirements, current EU policies, and current technologies and standards. The original terms of reference for the work in the report specified one report for each phase. However, there are several overarching issues that are relevant to both phases equally—most notably the processes of information flow in public transport, and the impact and benefits of digitalization. To ensure that any duplication between the reporting of the two phases was removed, the European Commission requested the World Bank team to produce this single report covering both phases.

BBSK DIGITALIZATION PROJECT

The proposal for the digitalization project is detailed below.

BBSK Project Objectives

A. Key objectives of the public transport digitalization strategy in the context of the CuRI

1. Create a general proposal for a comprehensive solution of public transport digitalization in the BBSK
2. Prepare implementation of individual steps that will need to be gradually implemented
3. To have a strategy means to use ESIF funding from 2021 to 2027

BBSK Project Justification

B. Reasons to create a digitalization strategy in the context of the CuRI

1. To reorganize the functioning of public transport (reduce operating costs of public transport, possibility to increase level of service for the same cost)
2. To improve public transport as a service (increase public transport reliability, leading to an increase in transported passengers)
3. To enhance travel information for passengers (availability of online/real time passenger data, thereby increasing the attractiveness of public transport)
4. To recognize the overall cost and requirements and so ensure one functional open system at the end of the CuRI with the ability to manage public transport in the BBSK

BBSK Project Expectations

C. Expectations from the CuRI strategy

1. A tailor-made solution for a public transport digitalization system so it corresponds to the needs and wants of BBSK
2. Digitalization of passenger information (online data in vehicles, at stops, on the web, through applications) and provision of additional information on the web and in the applications (price lists, maps, transport conditions, or current information concerning emergencies)
3. Digitalization of the fleet, i.e. fleet control (online overview of drivers' work, condition of vehicles, or the adherence to timetables) to ensure control over the performance of individual carriers
4. Digitalization of traffic control (online data about vehicle position on a map, delays, route, line, driver, and other vehicle parameters) enabling communication between dispatcher and driver
5. Digitalization of ticketing (possibility to purchase ticket by debit card, online, or via mobile app), thereby allowing the BBSK to have control over and an overview of passenger sales as well as the ability to analyse subsequent data

6. Digitalization of the central system and the collection of public transport data for purposes of analysis. Collection of short-term and long-term data to improve and optimize public transport

7. Digitalization for enhanced security (CCTV in vehicles, voice information)

8. Proposal of an open system solution (open data, API, etc.) that enables data transfer between the regional system (or the integrated system coordinator) and other carriers

9. Allowing for the possibility to exchange information with neighboring regions

10. Possibility to provide selected data to other entities (cities, integrated rescue system, etc.)

BBSK Project Benefits

D. Reasons, expectations, social benefits of the CuRI

The digitalization of public transport will modernize public transport, move it to a higher technological level and allow for greater passenger use. Thus, public transport may become more attractive and accessible to the region's visitors, especially tourists.

E. Expected benefits of public transport digitalization for citizens, cities, municipalities and the region (by the end of the CuRI)

1. Improved quality of public transport reliability and safety

2. Increase in the number of passengers

3. Simpler and more accessible purchase of tickets

4. Higher fare revenue

5. Increased labour mobility and better commuting opportunities

6. Sustainable rural development, i.e. reducing disadvantaged areas and excluded rural locations

7. Reduction of regional road congestion

8. Monetary savings associated with the development and maintenance of regional roads

9. Reduced need to provide parking possibilities in cities (as people travel to the city by public transport)

10. A healthier and more sustainable lifestyle

The BBSK states that all the above will need to be prepared in order to have a fully functional and operational form as of January 1, 2024, at the latest. Therefore, the BBSK needs to have a vision of what the whole system should look like, how it should work, and what it would bring in terms of the benefits—both to the customer and to the PTA. The BBSK also needs to create a time schedule, links between each step as well as how they affect each other—that is, what needs to be done first, or what can be done separately in advance, and implemented into the project later.

The BBSK also needs to know the cost and economic viability of hardware that will be used: in practice, this, for example, would mean that installing a digital display at a bus stop that has only eight journeys a day, with a total of only 10 passengers a day, would not be viable or desirable from the BBSK's point of view.

Finally, the BBSK also needs to know the cost projections for the project in order to prepare the application for EU funding.

LAYOUT OF THIS REPORT

This report covers all of the BBSK's points in section above, except that the scope of the plan production part of this report does not cover the introduction of digital ticketing, though it does take account of it happening in the longer term. Therefore, while the path to the introduction of digital ticketing is outlined in this report, it is not done in much detail.

The report follows a logical flow, with supporting papers presented as appendices.[2] These are in a separate document but are designed so that they can be read alongside the main report, should the reader wish to do so.

The report is laid out such that Chapter 2, following this introductory chapter, describes the current public transport supply in the Banská Bystrica Self-governing Region (BBSK), placing it in the context of the region and its overall transport network. This analysis of the supply of public transport in the BBSK provides a picture of the current 'service' as delivered to, and experienced by, its citizens and visitors.

An analysis and explanation of the processes involved in delivering public transport follows in Chapter 3, to show why the connectivity of these processes, through digitalization, is important. This chapter also covers the current state of these processes and information outputs as they presently exist in the BBSK. This chapter describes our understanding of how the bus component of this public transport network is delivered, and how its (limited) digital processes function, particularly in the areas of information and fares. This is essential to the understanding of user needs (as explained in a later chapter). The rationale for this section is that the underlying data structure and processes are crucial for the delivery of digitalization. Therefore, having an understanding of the current structure and processes is helpful in assessing to what extent any current levels of digitalization can be built on in the future. Such an understanding also helps to assess the quality of the existing public transport service that is supplied to users.

Chapter 4 then deals with another foundational issue—the national legislation relating to public transport and its impact, in the context of EU goals and legislation.

The report on the travel behavior and needs of the region's residents and visitors appears in Chapter 5, followed by the digital literacy analysis of the BBSK's population in Chapter 6. Chapter 7 provides a brief SWOT analysis, while Chapter 8 considers how what is being proposed for the digitalization strategy meets the BBSK's needs as laid out above.

One aspect of what is being proposed relates to the future governance of public transport. This is described in broad terms in Chapter 9. Then a chapter on standards (Chapter 10) follows, which is necessary to understand the references in Chapter 11, which covers various good practices across Europe.

The technology actually involved in the digitalization process is further explained in the next two chapters. Chapter 12 describes the various 'building blocks' in the strategy for delivering real-time information (with accompanying detail in Annex 4), and Chapter 13 outlines the elements of digital ticketing.

The cost of investment and operation (CAPEX and OPEX) in Chapter 14 is based on a real-time system cost modelling tool. CAPEX and OPEX is estimated based on a set of assumptions and sizing scenarios. The 15th and final chapter on delivering the CuRI project discusses a breakdown of the planning and development work necessary to produce the procurement specifications that reflect the objectives set out by the BBSK.

CURRENT PUBLIC TRANSPORT SUPPLY IN THE BANSKÁ BYSTRICA REGION

BACKGROUND TO THE BANSKÁ BYSTRICA REGION

The Banská Bystrica Region is one of eight self-governing regions in the Slovak Republic, with a population of about 645,000: it is the largest Slovak region in area. The majority of population are Slovaks (77.6%) but Hungarians make up 10.6%, with Roma 2.5%[3] and Czechs less than one percent.[4]

FIGURE 1. **Districts of the Banská Bystrica Region**

Source: World Bank, 2020

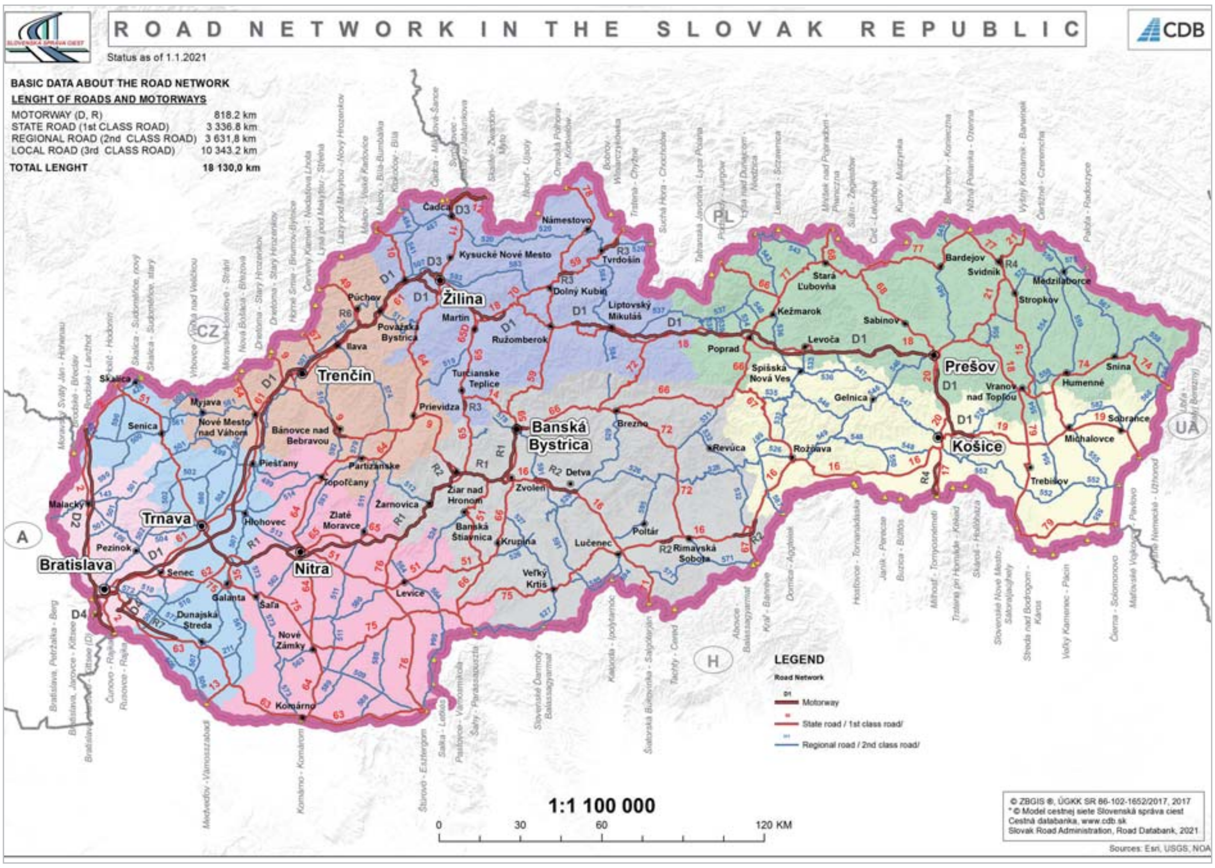
The region consists of 13 districts and 516 municipalities. Its administrative center is the eponymous and historic city of Banská Bystrica (the sixth largest city in the Slovak Republic, with a population of around 80,000), the region's largest settlement with a renowned university.[5] Other important towns are Zvolen, Brezno, Žiar nad Hronom, and Lučenec.

TRANSPORT NETWORK ACROSS THE BANSKÁ BYSTRICA REGION

The main road travel corridors in the Banská Bystrica Region are shown on the map overleaf, which also indicates their position within the Slovak Republic. The main rail corridors (where they exist) either parallel these routes or follow alternative corridors which perform similar functions.

The Slovak Republic's main east-west motorway (D1) avoids the BBSK. The BBSK has a good expressway (R1) linking it to D1 and onwards to Bratislava, and R2 is currently being constructed between Kriváň and Lučenec (with the section between Zvolen and Kriváň already open).

FIGURE 2. **Main Road Corridors in the Banská Bystrica Region**



Source: Road Databank, department of Slovak Road Administration[6], 2020.

NATIONAL OVERVIEW OF PUBLIC TRANSPORT

Transport is overseen by the Ministry of Transport and Construction.[7] The national rail network, including the tracks and the stations, are owned and managed by ŽSR (Railways of Slovak Republic),[8] with rail passenger transport services operated by ZSSK. Both are state-owned companies.[9]

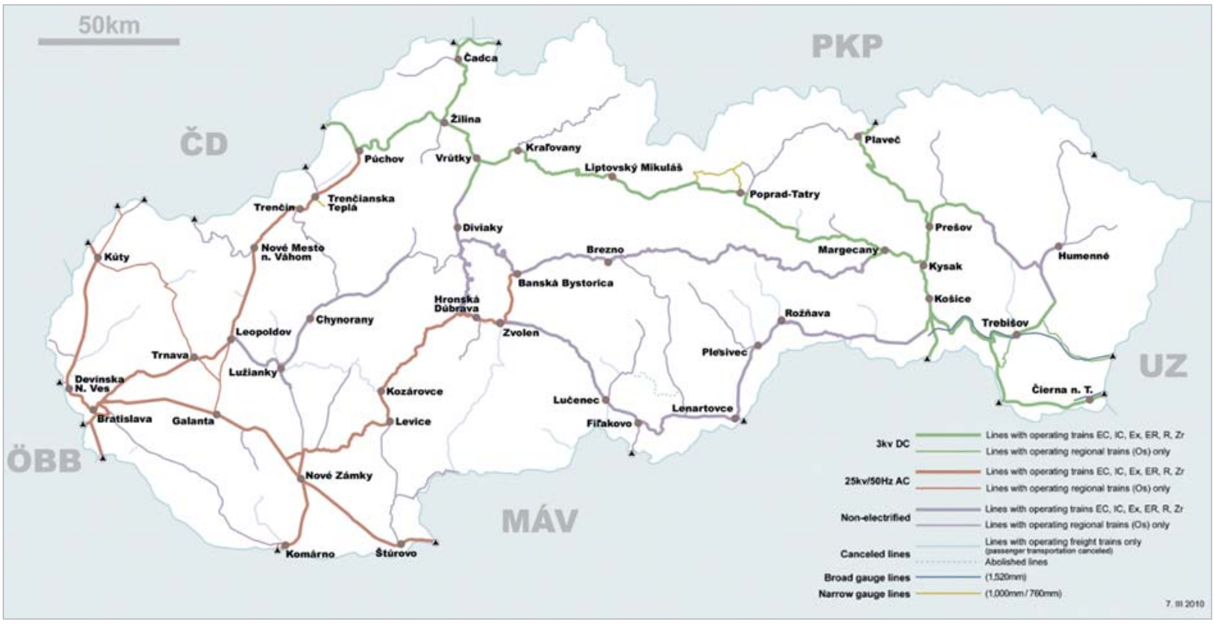
The provision of bus services in the Slovak Republic is divided into 17 regional bus operators, some of which are now owned by international public transport groups, while others have stakeholder owners representing the national government. In the cities and large towns, buses are under the control of the municipality and are known as MHD (city public transport) but may be operated by one of the regional bus operators (now joint-stock companies, but formerly part of a large state-owned conglomerate). There are also several privately-owned bus operators, operating regional, national, and some international services, including the European-wide Flixbus and RegioJet companies.

RAIL NETWORK

The main rail hub in the BBSK is Zvolen. The BBSK is not on any trans-European rail corridor, as those that go through the Slovak Republic either pass north or northwest of the BBSK, or cross into Hungary from Bratislava to the southwest of the BBSK. Also, in some parts of the BBSK (particularly in the west) the main rail lines do not seem to closely follow the main travel corridors. A few railway lines in the BBSK have tortuous curves in places to traverse mountain ranges, and trains are consequently comparatively slow in those areas. One example is the north line out of Banská Bystrica City towards Martin and Žilina. Some lines are electrified, and there are also long stretches of single-track. For instance, all rail lines into Banská Bystrica City are single-track, even though the station itself is large with many platforms. There are few clock-face timetables and few consistent stopping-patterns.

Some national semi-fast trains run through different lines in the BBSK. Track quality is variable with consequent speed restrictions and unreliability in some places.

FIGURE 3. Map of Passenger Rail Network in Banská Bystrica Region, Shown Within Slovakia



Source: Wikipedia,[10] 2020.

Rail Lines

There are 11 different rail passenger lines within the BBSK area, numbered within ŽSR's national numbering system.[11] Railway service frequency is usually rather limited. Trains stopping within the BBSK area travel to, and from, as far away as Bratislava, Prešov, and Ostrava (Czech Republic).

Since 2014, national rail use has been positively affected by the national free rail travel arrangement for young people under the age of 15, and people over the age of 62. The statistics for the Slovak Republic as a whole show that the use of public rail transport has grown by 57.8% between 2014 and 2018.[12]

RAIL STATIONS

There are 136 open-passenger rail stations within the BBSK area. Many small intermediate stations are still open, and, in several towns, there is both a main station and a much smaller 'city' station, nearer the town center. Some stations' platforms are very low and boarding to, and alighting from, carriages can require much physical effort. Therefore, it is not possible for people with certain disabilities to use these stations.

REAL-TIME TRAIN POSITIONS

ŽSR has real-time data on the actual position of passenger trains, which is displayed on a real-time map on its website.[13] The publication of the data is done in partnership with OLTIS Slovakia Ltd.[14] Real-time arrival and departure boards for passenger trains at each station (including platform numbers) can also be accessed online.[15]

RAIL FARES AND RAIL TICKETS

We understand that general rail fares are set by the Slovak government, although the national rail operator ZSSK has some commercial freedom to change fares on premium services. There is a single, per kilometer fare scale, but it varies for different classes of passengers.

Both single and return tickets can be bought, but there are a range of different prices that apply to different groups. These age categories, while similar to bus transport, are not entirely the same, so that unifying fare categories would be a challenge for an integrated ticketing system.

Tickets can be purchased through the ZSSK website,[16] or bought at stations, or from the onboard conductor. On the ZSSK website, tickets are bought for specific trains. This may also apply when tickets are bought at the stations, as different classes of trains can have different prices. Some classes of trains have compulsory reservations. Rail tickets are not integrated with other modes of transport in the BBSK (but examples of such integration can be found in the Bratislava Region).

RAIL NETWORK SUMMARY

In summary, the rail infrastructure network in the BBSK is extensive, but generally offers rather slow and fragmented services with low frequencies, which are not usually very attractive. Services on some lines, and at certain times, have a reputation for unreliability.

A real-time passenger-train data facility would provide a useful element, forming part of the foundation on which multimodal real-time integration should be built.

The rail user in the BBSK, therefore, is presented with a rail network that, while offering attractive (or even zero) fares for certain classes of travelers, does not integrate with the bus network, or even provide standard conditions for bus travel (such as age categories, or periods of validity of tickets).

BUS NETWORK

Bus Lines and Bus Operators

There are currently 319 bus lines in the region, of which about 205 are contracted by the Region's administration to SAD Zvolen (approximately 63%) and SAD Lučenec (approximately 37%). Around 50 are contracted by neighboring regions to their own regional operators and cross over into the Banská Bystrica Region, or are run commercially by private operators, including some international services. The public sector does not influence these latter commercial services other than by defining their service numbers in the national bus service numbering scheme, and by controlling adherence to safety and other operational legal requirements. While this causes challenges in fully incorporating these services within an integrated system, particularly when such services are run by operators who would not otherwise be part of such an integrated system, this issue is being addressed at a high level in other BBSK projects currently in preparation. A fully open digital system would allow the BBSK to accommodate other national and international services in terms of data; thus digital information would reach the end user.

The remaining 63 lines are operated on behalf of the municipalities (MHDs) and are mostly run by SAD Zvolen, with SAD Lučenec operating the lines in Lučenec and Rimavská Sobota. This total of 63 lines also includes the eight trolleybus lines in Banská Bystrica City, which are run by Dopravný podnik mesta Banská Bystrica, a.s., owned jointly by the city council and SAD Zvolen. A total of 9 bus operators currently run services in the BBSK, although SAD Zvolen and SAD Lučenec operate by far the majority.

Frequencies of bus and trolleybus lines are generally uneven, even on MHD lines. In some towns (including both Zvolen and Banská Bystrica City) there may be several different MHD lines connecting a housing area to the city center, but their different timetables have not been synchronised, so passengers may have to come into town on one line and return home on another (though both lines may be in the same 'line group').

The unevenness of the frequency means that bus travel is not 'turn up and go', certainly not on trunk lines connecting the key towns (where one might have expected it to be so), but not even in towns. Unless people are used to the times of their bus and/or are time-rich, they will be reluctant to use the bus service if they have not used it before.

While the bus lines contracted by the BBSK and the MHDs make up the majority of bus services in the region, and would form the 'heart' of any integrated transport system for the Banská Bystrica region, such a system would need to take into account the bus lines that are not in this category. Some of these bus lines would be included in the system (perhaps progressively, over time, as has happened in the process of integrating transport systems elsewhere).

Bus Service Levels and Information Presentation

Bus operators supply data on their bus lines to certain software companies for journey planning systems (see Chapter 3), but the agreements prevent the sharing of the underlying data in a machine-readable form with any other organization. This data, therefore, cannot be analyzed to produce summaries such as below:

- Number of departures per day from a village
- First departure or last arrival on any particular day of the week
- Complete list of buses that run between any two towns during a day

It is therefore impossible to do an assessment of the bus service levels.

Regarding the presentation of bus services to the traveler, timetables, as supplied by the operators, are available digitally from the websites of journey planner suppliers. These may be published at stops or at route information stands in bus stations. However, the layout is not user-friendly, and the bus line can only be identified by a six-figure number which makes it very hard for a user unfamiliar with the bus line to remember.

Additionally, any new user would be challenged to find the bus journey they want. This is because each day of the week has different times—yet ALL the times are together on ONE block timetable (we understand that this presentational issue is a national one). Furthermore, the top of most columns in the timetable have a symbol, and yet another page lists what all the symbols mean.

This make the travel information hard to understand, like in the online timetable in Figure 4 below, which has different departures for different days of the week shown on the same line. It should also be noted that the printing of the line number is usually miniscule. Information on individual journeys can be found on digital journey planners, but these do not provide an overview of all the journeys throughout the day. In fact, in some journey planners only two journeys are shown. This, then, is the extremely poor general information context in which bus users travel.

FIGURE 4. **Timetable of a 'Suburban' Bus Line in the BBSK: Published Online and in Timetable Boards at Certain Bus Stops**

609423 Rimavská Sobota-Hrachovo-Selce-Hrnčiarska Ves-Poltár

Platí od 9. decembra 2018 do 14. decembra 2019

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12	⟨	⟨	14	⟨	⟨	⟨	14	13	12	⟨	21		Kružno,Garaška	...	5 00	...	⟨	...	⟨	6 50	⟨	⟨	13 10	13 10	⟨	⟨	15 20	16 20	⟨	17 13	⟨	⟨	...
	⟨	⟨		⟨	⟨	⟨				⟨	22		Kružno,hor.koniec	...	...	...	⟨	...	⟨	...	⟨	⟨	...	...	⟨	⟨	...	...	⟨	...	⟨	⟨	...
	⟨	⟨		⟨	⟨	⟨				⟨	23		Kružno,OcÚ	...	...	...	⟨	...	⟨	...	⟨	⟨	...	...	⟨	⟨	...	...	⟨	...	⟨	⟨	...
	⟨	⟨		⟨	⟨	⟨				⟨	24		Kružno,ZŠ	...	...	...	⟨	...	⟨	...	⟨	⟨	...	...	⟨	⟨	...	...	⟨	...	⟨	⟨	...
	8	8		8	8	8				8	25		Veľké Teriakovce,Krásna	...	...	...	5 46	...	5 52	...	7 11	12 12	...	...	13 09	14 57	...	...	16 20	...	17 18	18 20	...
	9	9		9	9	9				9	26		Veľké Teriakovce,Jednota	...	...	...	5 47	...	5 53	...	7 13	12 14	...	...	13 11	14 58	...	...	16 21	...	17 19	18 22	...
	11	11		11	11	11				11	27		Veľké Teriakovce,Vrbovce n.Rim.,mlyn	...	...	...	5 49	...	5 55	...	7 16	12 17	...	...	13 12	15 00	...	...	16 23	...	17 21	18 25	...
	11	⟨		11	⟨	11				11	28		Veľké Teriakovce,Vrbovce n.Rim.	...	...	...	5 50	...	5 56	...	⟨	12 19	...	...	13 13	15 01	...	...	⟨	...	17 22	18 27	...
	⟨	12		⟨	12	⟨				⟨	29		Nižný Skálnik	...	...	...	⟨	...	⟨	...	7 18	⟨	...	...	⟨	⟨	...	...	16 26	...	⟨	⟨	...
	⟨	13		⟨	13	⟨				⟨	30		Vyšný Skálnik	...	...	...	⟨	...	⟨	...	7 20	⟨	...	...	⟨	⟨	...	...	16 27	...	⟨	⟨	...
	11	⟨		11	⟨	11				11	31		Veľké Teriakovce,Vrbovce n.Rim.	...	...	...	5 50	...	5 56	...	⟨	12 19	...	...	13 13	15 01	...	...	⟨	...	17 22	18 27	...
	13	14		13	⟨	13				⟨	32		**Hrachovo,rázc.na Poltár**	...	...	...	5 52	...	5 58	...	7 22	⟨	...	...	13 15	15 03	...	...	⟨	...	17 24	⟨	...
	13	14		13	15	13				13	33		Hrachovo	...	...	...	5 53	...	...	...	7 24	12 23	...	...	13 16	15 04	...	...	16 30	...	17 25	18 30	...
	15	16		15		15				15	34		Hrachovo,Svetlá,rázc.	...	...	...	│	...	...	...	7 27	12 25	...	...	13 19	15 06	...	...	...	...	17 27	18 32	...
	16	17		16		16				16	35		Hrachovo,Svetlá,osada	...	...	...	5 56	...	...	...	7 29	12 27	...	...	13 20	15 08	...	...	...	...	17 28	18 33	...
	19	20		19		19				19	36		**Selce,stred**	...	...	...	5 59	...	...	...	7 33	12 31	...	...	13 25	15 12	...	...	...	...	17 32	18 36	...
	20	21		20		20				20	37		Selce,mlyn	...	...	...	6 01	...	...	...	7 34	12 33	...	...	...	15 14	...	...	...	...	17 33	18 37	...
	24	25		24		24				24	38		Hrnčiarska Ves,Nová ul.	...	...	...	6 05	...	...	...	7 38	12 38	...	...	...	15 18	...	...	...	...	17 37	18 42	...
	⟨	25		⟨		24				⟨	39		Hrnčiarska Ves,Jednota	...	...	...	⟨	...	...	...	7 40	⟨	...	...	...	⟨	...	...	...	...	17 40	⟨	...
	24			24						24	40		**Hrnčiarska Ves,rázc.na Vaľkovo**	...	...	...	6 10	...	...	...	...	12 39	...	...	...	15 19	...	...	...	...	...	18 43	...
	25			25						25	41		Hrnčiarska Ves,Pondelok	...	...	...	6 11	...	...	...	...	12 40	...	...	...	15 20	...	...	...	...	...	18 44	...
	27									27	42		Hrnčiarska Ves,Maštinec,rázc.	...	...	...	6 13	...	...	...	...	12 42	...	...	...	...	...	...	...	...	...	18 46	...
	28									⟨	43		Hrnčiarska Ves,Maštinec	...	...	...	6 18	...	...	...	...	⟨	...	...	...	...	...	...	...	...	...	⟨	...
	29									27	44		Hrnčiarska Ves,Maštinec,rázc.	...	...	...	6 21	...	...	...	...	12 42	...	...	...	...	...	...	...	...	...	18 46	...
	31									29	45	↓	Poltár,RD	...	...	...	6 27	...	...	...	...	12 43	...	...	...	...	...	...	...	...	...	18 48	...
	32									30	46	pr	**Poltár,žel.st.**	...	...	...	6 30	...	...	...	...	12 45	...	...	...	...	...	...	...	...	...	18 50	...

Source: SAD Zvolen, a.s., 2020.

Bus Depots and Bus Stations

The Banská Bystrica bus terminal is modern, large, and is enclosed within a new shopping center, without inducing a feeling of claustrophobia. It has good waiting facilities, although there is no provision of real-time information. The bus stations at Lučenec and Rimavská Sobota are new and have excellent, large indoor waiting areas, with a range of facilities adjoining them. They both have large digital departure screens in the waiting areas, with the one at Lučenec displaying real-time information. In summary, bus depots and bus stations are in the right (large) towns that need them, but the quality of bus stations varies significantly across the Banská Bystrica Region.

Bus Stops

Bus stops are a critical element in the delivery of digitalization to a public transport network. This is because they are 'markers' identifying not just points on the bus network, but that provide considerable amounts of metadata as well (for example, which lines stop there, the sequential order of bus stops in the bus line, and which nearby communities they serve). In the UK (and in countries, such as Denmark and Portugal) considerable effort has gone into constructing an official database of bus stops. However, there is no corresponding official national database in the Slovak Republic. Information on bus stops across the country is held by the suppliers of national journey planners (see Annex[17]) that they have compiled from a range of different sources. This indicates that there could be key gaps in the basic 'knowledge' infrastructure necessary for digitalization. It is advisable to compile this knowledge infrastructure according to a national program, with a nationally-mandated protocol, in order to achieve data consistency. However, the processes for doing this could be organized and carried out at a subnational level, for example, at the self-governing region (SGR) level.

If that basic infrastructure does not exist, then the planning and operation of existing services may be based on little or no data. Instead, it may end up being based on 'hunch', or on 'habit', or simply on what the operator needs to do to keep operating. This lack of real data may be an indication that the public transport services provided may not meet people's needs. To address this lack, the BBSK is in the process of launching a survey of all its 2,600 bus stops to collect several parameters, such as, geolocalization, pictures of the surrounding area, stop panels, shelters, the accessibility for people with disabilities, and so on. This survey will enable the BBSK to gain control of the public transport 'knowledge infrastructure', and allow it to set standards for the region's public transport system. This information will then be digitized. Unfortunately, lockdown has caused this whole process to be significantly delayed.

Fare Structure

We understand that fares are calculated on a purely distance-basis, and are set regionally, according to the Act of the National Council of the Slovak Republic No. 56/2012. In theory, fares could be different from one region to another.

Fares are paid with cash, or by a contactless chip card, from which the fare is deducted from its stored value. There are set discounts for specific types of travelers, where the fare, paid with a card, receives a discount from the cash fare. Contactless cards for SAD Lučenec can be purchased online on the Ubian application (see Annex 1 for details of this), or purchased at SAD Lučenec offices at their four bus stations. This application can also be used to add value to the card. While there is a similar card for SAD Zvolen, it cannot be linked to the Ubian application. The use of contactless chip cards between the two PTOs is already interconnected and the PTOs officially recognize each other. The MHD in Banská Bystrica City also has a smartphone application (CVAK), which can be used to buy a 45-minute or a 24-hour pass for public transport. The application generates a quick response (QR) code on the phone, which can then be checked to prove validity. Such passes can also be bought on the national Ubian application.

Multimodal Fare Integration

We are not aware of any fare integration in the BBSK across modes of transport, other than multimodal passes within the Banská Bystrica MHD (held on phones as a QR code, or an SMS code, or on operators' cards, or student cards), which can be purchased for fixed time periods (including online and by SMS). These are valid on buses and trolleybuses of DPM Banská Bystrica and SAD Zvolen.

Links between buses and trains are publicized at certain stations and on network maps, but these are not prominently displayed. Connecting times between buses and trains are not shown in timetables. Both buses and trains are included in the various internet and application-based journey planners for the Slovak Republic (see Annex[18]), so that multimodal journeys can be planned.

In conclusion, there is no integration of the fares and payments between the different public transport operators in the BBSK, except in Banská Bystrica City, and through the interoperability of the SAD Zvolen and SAD Lučenec cards. However, multimodal journeys can be planned on journey planning systems.

Bus Network Summary

The main finding is that there are significant contrasts within public transport provision in the BBSK area. First, there is widespread geographical coverage of the region by public transport operations, but this is combined with large gaps in service coverage with respect to time of day and destination served. A second contrast is that, while there is quite full information on public transport services, this is both very difficult for the user to understand and not designed to attract new users to public transport. A third contrast is between the generally low public transport fares for single journeys (and in some cases—for some classes of user, for some services—free fares) and the general absence of integrated fares on journeys where a change of vehicle is required. A fourth contrast is between service frequency and fare integration in Banská Bystrica city, and the situation that exists outside the city. The key overriding general theme is the lack of integration.

DIGITALIZED DATA – THE OBJECTIVE COMPARED WITH THE CURRENT REALITY

This section discusses the role of, and the relationship between, different data features within the public transport ecosystem, and specifically the bus ecosystem, in order to illustrate the central importance of digitalization in enabling public transport to be a quality operation which meets travelers' needs. Public transport is essentially a route-based shared mobility service where stop points, routes, timetables, service frequency, and on-time arrivals/departures define its attractiveness to its customers.

The bus operators in the BBSK were requested for information about their current systems in order to enable the researchers to understand the current extent of digitalization, thereby helping them to assess whether these provide a foundation for the future, or if a completely new solution is needed instead. The response was only limited.

An understanding of the current extent of digitalization also helps to assess the general quality of the existing public transport service that is likely supplied to users.

We requested information about the following systems from SAD Lučenec, and these are discussed in the sub-sections below. We think it is probable that SAD Zvolen adopts the same or similar procedures. We did not request any information from other (peripheral or minor) operators in the BBSK.

- Vehicle and driver scheduling systems
- Scheduled timetable information
- Real-time information
- Electronic systems for conveying information on delays
- Fares exchange systems
- Ticketing systems
- Payment cards
- Bus operators' interface with online journey planners/applications
- Bus operators' interface with online ticketing systems/applications

Suppliers of online journey planners (which generally cover all bus services in the Slovak Republic) are analyzed separately in Annex[19].

VEHICLE AND DRIVER SCHEDULING SYSTEMS

Scheduled timetables are the public-facing output of the bus operator's planned activities, but in any sort of digital world, they are the result of the underlying data of individual bus-line journeys, and at particular times, depicting a pattern of bus stops. The extent to which that data is transferable electronically (and the form which that takes) will be dependent on the degree of digitalization. Key elements of this are:

- The software used for storing scheduled timetables and for publishing those timetables
- The database of bus stops used
- Whether times are calculated for each stop or only for certain stops

We ascertained that the database of bus stops used is constructed by the operator itself, as there is no centrally mandated database of bus stops. However, we believe that there will be close liaison with INPROP, the journey planning provider of CP.sk (www.cp.sk), as this is produced at a national level with the agreement and support of ZAD, the bus operators' association. We believe that both SAD Zvolen and SAD Lučenec use M-Line for the production of timetables, and maybe for more. M-Line has the products EDISON and ISYBUS.

Scheduling systems are at the heart of a bus operator's activities. We asked SAD Lučenec for information on several aspects of systems, including software used, scheduling protocols, and connectivity between scheduling software and other systems. However, this information was not provided to us.

REAL-TIME INFORMATION

Real-time information is information on the extent to which the bus is following the planned (scheduled) timetable, and the expected (actual) arrival at individual bus stops. It flows from information about where the vehicle is at any particular time (automatic vehicle location [AVL] systems), and algorithms which use this and the scheduled timetable to predict estimates of arrival times at bus stops downstream along the bus route. It is important because regularity and punctuality are the core performance of an operation. Regularity is whether the exact journey is driven at all. Whether a bus and a driver are available at a given time and location is important here. However, punctuality is influenced by many external factors, such as traffic, weather, and so on.

In a planning context, if a bus always arrives on time, on stops between terminus stations, then too much buffer time is planned, which serves to increase the cost of operation; and if it is always delayed on arrival at the terminus, then it will have consequences for the subsequent operation, which also has financial consequences. Real-time monitoring does two things: one long term, the other short term. First, the continuous monitoring of small variations can be fed through to subsequent planning work. Second, sudden irregularities are monitored so that the consequences for the current trip, and in particular, the subsequent trip, can be ascertained and corresponding action taken, while at the same time informing passengers.

Regarding this second, short-term effect, this is crucial for remedial action, for performance calculation against KPIs, and for passenger information.

Remedial Action

An example of where remedial action is necessary is a road accident, where the driver must be advised of an alternative route and the passengers must be informed of the consequences. If it is the driver who reports the road accident, this is often done in cooperation with the PTO's operations organization. Conversely, the authorities who inform the operation of the road accident must operate in cooperation with the PTO operational organization to determine the consequences and possibilities for action. There is thus a need to define the intersections and competences of cooperation between the PTA and PTO, so that the drivers and passengers concerned can be informed and guided on a case-by-case basis.

When the dynamic elements change beyond/above what the operation has defined as acceptable, the operator must perform an action. The actions are shaped by the availability of resources, the situation, and the opportunities in the operational framework.

Here, a distinction is made between PTA- and PTO-options, where the PTA is usually only able to inform passengers of deviations and order the PTO to solve the challenge, with reference to the provisions of the operating contract. It is advisable to have agreements between PTA operational monitoring and PTO operational settlement, where it is important that the information base is the same; for example, that the real-time system and acting competences are clearly defined.

Performance calculation against KPIs

Real-time data also delivers factual evidence of the performance of each vehicle in the daily operation, and can be used to measure PTO performance against the key performance indicators agreed. The monitoring data should be shared between the PTA and the PTO in real time, as the PTO operation management has the obligation to minimize any deviations from the planned contracted operation.

Passenger Information on Disruptions

In an ideal world, the planned schedules would be sufficient information to utilize public transport services. However, in the real world there are many reasons as to why delays and even cancellation of a bus or train happens. Real-time information services are a means to keep customers updated on the planned services and any deviations.

As well as real-time information, alerts are essential to users being aware of service delivery problems.

SAD Lučenec supplies real-time information to the Ubian system, but only for city of Lučenec: there is no real-time information currently for the other towns in which it operates. We asked SAD Lučenec questions about real-time information processes but did not receive an answer. SAD Zvolen does not release real-time information for the towns and cities in which it operates, and we were unable to ascertain whether it has the capability to do so.

PASSENGER INFORMATION OVERVIEW

"How do I get from A to B and where do I need to go to start using public transport?" "Which bus/train do I need to catch and at what time?"

Passenger information in this context, is about the planned activities that can be distributed on digital communication platforms and is often planned and distributed through a content management system (CMS) on playlists that can be regulated by time, route, and geography.

It is the same information used on all platforms—only differentiated in whether it is visual or audio, and in the parameters, such as how many lines are relevant.

- What line? – In the bus it is dynamic, at the stop it is static
- Where is it heading toward? – In the bus it is dynamic, at the stop it is static
- When should the bus be here? – In the bus it is dynamic, at the stop it is dynamic
- Where will the bus be here? – In the bus it is dynamic, at the stop it is dynamic

Before travel

Digital travel planners can assist in planning end-to-end journeys using public transport. On top of the scheduled departure/arrival times and duration, information on foreseen delays or alterations is helpful for proper preparation of the journey. As examples: "Are there any early warnings for known delays or even weather conditions to factor into the selection of a travel plan?" or, "Should an alternative travel plan be made as a backup?"

As the scheduled departure time gets closer, another look at the travel planner may reveal that the actual vehicle is behind schedule. In the case of a substantial delay, you can replan the time you need to leave for catching your connection. You may also replan the whole journey if alternative travel plans are available.

Arriving at the bus stop, hub, or station, digital departure screens replicate the same information as found on the digital platforms. A delay, if any, is typically displayed as minutes from the shown planned departure time or as a countdown in minutes to the next bus departure.

Digital departure time screens are also beginning to be used to influence more people to use public transport. Examples are major event venues such as theaters, arenas, and even in apartment buildings (for instance, as used by the Swedish regional public transportation authority and operator, Skånetrafiken).

Customer service before travel is about receiving inquiries from passengers prior to the trip; these may be questions by phone or by physical contact at stations and points of sale. It often has the character of information delivery but can also involve coordinating tasks such as helping people with disabilities.

During travel

While on a bus, real-time information on screens can inform about estimated arrival times for next stops based on current real-time performance of the vehicle against the planned stop arrival times. Again, this would be a replica of the same data as found on real-time digital platforms and displays.

For multimodal journeys, delay on the current leg of the journey may result in missing the connection. Real-time information on connection performance and delays could be useful for decisions on alternative travel plans to minimize delay on the complete door-to-door journey.

Updates on the performance of the public transport service may also be delivered using voice, either by the driver, based on instruction from a control center, or from a control center directly, to guide the passengers in situations where this is deemed necessary—either for a particular route, or more widely in the public transport ecosystem.

During the journey, customer service information requirements from the real-time system are often centered around the current location of a bus on a given line as well as knowledge of where the bus/driver from a recently completed trip is located now.

After travel

As real-time information is recorded it is possible to validate claims for compensation for delay of the service quite precisely. However, this is only relevant if the PTA has a policy of compensation for delay of service. After completing the journey, the main customer service function is often to deal with inquiries about lost luggage and belongings, or complaints about a completed journey.

The role of Journey Planners

Journey planners are extremely useful to enable travelers to plan the whole of their end-to-end journey by public transport. In the Slovak Republic there is no legislative requirement to supply public transport information to a central database, unlike the model in the Czech Republic: this is detailed in Annex 1. However, because of the historical union with the Czech Republic and the Slovak-based heritage of the supplier of the Czech journey planning system (it originated in Žilina) the Czech-based system is available in the Slovak Republic through the CP application, and is widely popular. We believe that the Slovak company that produces and manages it (INPROP) also has arrangements to supply a feed to its application programming interface (API) to supply access to Circlegate for use in the latter's CG Transit application. We understand that data is also supplied separately by bus operators to Transdata for use in the Ubian application, which is supported by ZAD (see Annex 1). We do not know the relationship between CP.sk and Ubian, nor know whether public transport operators supply one set of data to CP.sk and Ubian together, via a single feed, or data to each separately. The three companies Inprop (for CP), Transdata (for Ubian) and Circlegate (for CG Transit) are described further in Annex 1 in a separate Appendices document.

Google Transit (which feeds into Google Maps) and collects data worldwide via its Google Transit Feed Specification (GTFS) protocol, does not have timetable information on public transport in the BBSK area, other than for rail (for which it gets international feeds), and for multicountry/long-distance coach operators such as Flixbus. We understand that it is the view of ZAD members that as CP.sk and Ubian are so popular in the Slovak Republic there is no value to them in supplying data to Google: also it is believed that Google's general policy is not to pay for public transport data (other than providing tools to deliver it). However, under the digitalization of public transport in BBSK, Google would be encouraged to seek out public transport data there itself, while it would be in BBSK's interests to supply it to Google via the GTFS protocol.

SALE OF TICKETS

Ticketing Systems

On-bus ticketing is a key element of a PTO's activities because it marks the 'gateway' point at which several different functions can take place—passenger recording, bus geolocation, fare calculation and payment itself. We asked SAD Lučenec about its on-bus ticketing systems but received no answer.

Payment Cards

While payment for bus journeys in BBSK can be made in cash, different cards are also accepted, and these will have different systems depending on the particular type of card protocol.

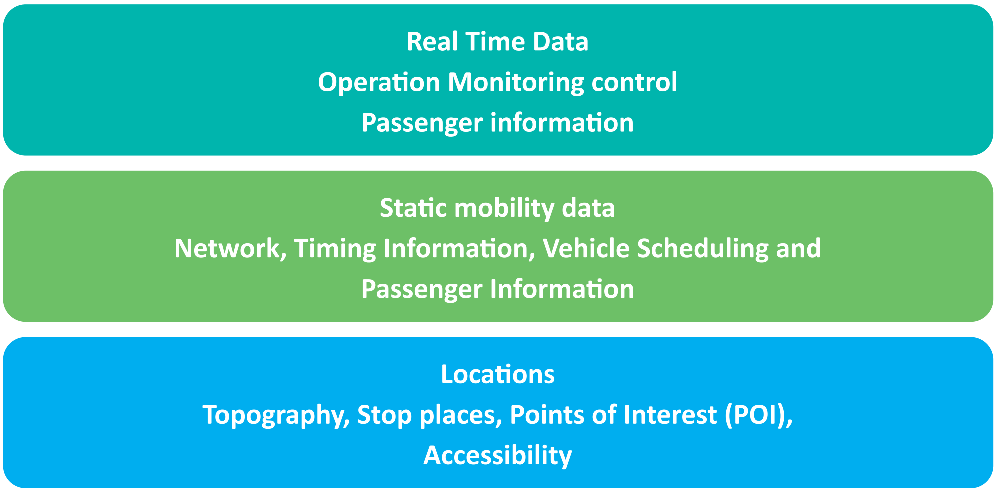
Fares Exchange Systems

The systems used for exchanging information about fares are key to the operation of online booking systems, available for some lines in the BBSK, and for electronic payment for bus travel. We do not know what systems the operators in BBSK use to exchange fares information, nor the interfaces with international online ticketing systems such as AMSBUS.

DIGITAL MOBILITY DATA ARCHITECTURE

The following diagram shows the digital mobility data architecture in three sections. Real-time mobility data is the top layer in the layered data model. The reliability and quality of the real-time information is highly dependent on accurate stop place data.

FIGURE 5. The Stack of Mobility Data



Source: Authors, 2020.

OPERATIONS DEPENDENCIES

The dependencies can be divided into before, during, and after the provision of services. In particular, the tasks under the 'before' and 'during' operations are the operators' main focus.

- **Before:** Customer service; sale of tickets; passenger information
- **During:** Regularity and punctuality; passenger information; bus stop and station
- **After:** Quality; customer service

These categories can be divided into planned activities and *ad hoc* – where *ad hoc*, in particular, is handled in an operations center.

Locations

Locations are linked to a topography (map) including roads, rail routes, physical addresses, city names, and so on. Locations include all stop places (bus stops, platforms on stations, and others.). Each stop place should be registered with its characteristics and services, including accessibility. Identification and representation of points of interest (POI) are helpful in planning journeys.

Bus stops and stations

Bus stops and stations are physical installations with differentiated communication and monitoring equipment. Thus, there will be stations with both visual and audio technical communication channels as well as CCTV monitoring, and there will be stops with only analogue static information equipment. Operationally, the tasks here are equal to those described in passenger information. However, there may be a surveillance and security task at the stations that have CCTV surveillance.

For a benchmark to operations related to bus stops and stations, please find "Market Report, Cleaning, Maintenance and Repair on Danish Public Transport Stations, Bus Stops, and Bus Terminals" in Annex[20].

Static mobility data

The static mobility data is the result of the planning operation of a public transport network. Passengers see the static mobility data in the form of routes and timetables. PTOs are more interested in how the vehicles are utilized efficiently, whereas fare management uses the stop places, routes, zonal structures, or other metrics as a baseline for fare calculation.

Real-time data

Real-time data or dynamic data is basically a representation of the actual vehicle position in real time and the deviation compared to the timetables. The PTA monitoring and control will focus on adherence to the planned journeys. "Is the bus starting a journey on time and does it stay on schedule?" Early departure is normally not desirable and is a key control point. The passenger information will let people know the actual time (on time or later) that they can expect to start or stop their ride as part of their travel plan from A to B. The frequency of updates of the real-time information to passengers should come as close to the real experience as feasible. The real-time passenger information should, in other words, be experienced as trustworthy ("the sign says that the bus is arriving now = I can see the bus").

NATIONAL AND EUROPEAN LEGISLATION RELATING TO PUBLIC TRANSPORT, AND ITS IMPACT

THE SLOVAK REPUBLIC NATIONAL LAWS

There are a number of separate areas where the state does, or could, regulate public transport. The ones relevant to digitalization are described below:

- General governance of the public transport sector and the role of local authorities
- Publishing of public transport information
- Bus drivers' hours (Labor legislation)
- Bus drivers' ages
- Bus scheduling agreements

General Governance of the Public Transport Sector and the Role of Local Authorities

This area is perhaps the most important to digitalization. We understand that Regulation 56/2012[21] is the main law governing the operation and control of public transport in the Slovak Republic. It has a number of provisions, which relate in some way to the transfer and publishing of data relevant to the digitalization of public transport.

While we are not legal specialists and cannot provide an authoritative legal judgment, we have examined Regulation 56/2012 and made comments on sections of it which we believe are pertinent to the digitalization of public transport.

The regulation categorizes 'regular' bus services (as opposed to 'occasional' or very short-term services) into urban, suburban and long-distance bus services, but does not appear to define exactly what those are. However, the definition of urban transport specifically allows for *"a single urban transport system with harmonized and interconnected lines and timetables on the basis of a single transport schedule with a single ticketing system"*.

This appears to give local governments the power to introduce an integrated, digitalized public transport system for an urban area—effectively making regional public transport a PTA-centric activity rather than a PTO-centric one. The regulation also requires the national Ministry of Transport to issue a single national code list of bus routes. These provisions appear to give the 'Transport Administrative Body' (the PTA) the powers to make a service plan for bus services in its area. There is also a specific requirement for the transport administrative body to coordinate bus and rail.

All these provisions imply that the self-governing region, by law, must be provided with data by the bus operators in such a form that it can plan bus lines and associated integration, in coordination with rail services; this is so whatever may be the form of contracts between the PTA and the PTOs.

National Legislation on the Publishing of Public Transport Information

The publication of public transport information, in a way that makes it possible for it to be incorporated into external control systems and used by developers of digital applications and electronic information hardware and software, is fundamental to the digitalization of public transport. In the Slovak Republic there is currently no legislation requiring public transport operators to publish public transport information, though in practice the Czech approach has been largely followed.

Bus Drivers' Hours

European rules now apply (see below). These are Regulation (EC) No 561/2006 (on the harmonization of certain social legislation relating to road transport) and Directive 2002/15/EC (on the organization of the working time of persons performing mobile road transport activities). And also Act no. 462/2007 Coll. on the organization of working time in transport and on the amendment of Act no. 125/2006 Coll. on Labor Inspection and on amendments to Act No. 82/2005 Coll. on Illegal Work and Illegal Employment and on amendments to certain acts, as amended by Act no. 309/2007 Coll. (regular passenger transport up to 50 km; public transport; trams, trolleybuses).

Bus Drivers' Age

The minimum age for being able to drive a bus in the Slovak Republic is 24—higher than in other countries. A news item on the ZAD website[22] explains the issue. This clearly has a downward impact on the number of people available to work as bus drivers generally in the Slovak Republic (and therefore on the service offered), and we know from discussions with SAD Lučenec that they have in the recent past faced challenges in getting enough bus drivers of the required quality.

Bus Scheduling Agreements

These are agreements between operators and bus driver unions, and while not part of legislation, these have a strong influence and determine the extent, and way, in which bus services can in practice be managed by control centers. We have seen indications that bus scheduling agreements in the Slovak Republic have traditionally imposed significant constraints on operators.

SLOVAK PUBLIC TRANSPORT LEGISLATION AND EUROPEAN DIRECTIVES

This section covers EU legislation regarding the following aspects of the public transport markets, and its translation into the Slovak Republic law:

- Public transport information to passengers
- Coordination and integration of public transport services
- Information for monitoring performance
- Open source data
- Fares integration and affordability

There are two types of European Commission (EC) / European Union (EU) laws that are relevant: regulations and directives.

'Regulations' must be implemented directly, while '**directives**' are EU rules for which, though they must be implemented, it is up to the individual member state to determine how this implementation is done.[23] In addition, 'communications' are statements of policy or intent, while 'action plans' and 'white papers' provide context for understanding but are not legislation.

The effect of EU law on the operations of markets is in two main areas: first, rules for managing individual contracts, and second, rules for establishing a national framework—that framework only becoming relevant in practice when contracts are implemented which can use that framework. In addition, the first area can itself be broken down into 1a) 'general' rules, and 1b) rules which only come into effect in 'specific' circumstances.

Regarding type 1b, this analysis covers the Open Data Directive, as that can be effectively enabled when passenger service contracts are implemented by local authorities with a requirement that data is to be provided to the local authority (see below).

1a) EU Rules for individual Contracts

The following rules are indirectly relevant to digitalization itself:

- Regulation (EC) No. 1370/2007—Contracts for Public Passenger Transport Services. This requires the PTA to specify clearly and openly, its contract requirements for operators, and thus enables it to make conditions relating to data. However, we are not aware of implemented Slovak legislation that enshrines this EC regulation in Slovak law, and existing contracts that were not agreed under its provisions, and which have not reached the end of the contract period, still continue in operation. The time limit of the original exemption to implementation of Regulation (EC) No. 1370/2007 has recently expired.

- Regulation (EC) No. 1371/2007, relating to rail passengers' rights and obligations.

1B) Other EU rules which apply only in specific circumstances

These rules are only indirectly relevant to digitalization itself:

- Open Data Directive—Directive 2019/1024/EU

This relates to the requirement to make 'public-sector information' open as well as any privately-owned 'High Value datasets' which the Commission may define (although it has not yet done so). Under current Slovak legislation and current contracts between the BBSK and the bus operators, public transport data does not fall under the 'Open Data Directive' because in these circumstances it is not defined as 'public-sector information'.

National Frameworks mandated by EU Legislation

We cover these because, although not directly relevant to the operation of individual contracts, they indicate the standards and the specifications that must be implemented in the travel information technology included in individual contracts.

Intelligent Transport Systems (ITS) Directive (2010/40/EU) and EU Regulation 2017/1926 of May 31, 2017 supplementing it—Provision of EU-wide Multimodal Travel Information Services

The EU continues to fill out the framework for the deployment of intelligent transport systems as started back in 2010 for road transport and other modes of transport, plus for multimodal travel information services.

The regulation calls for standardization of formats for all traffic and travel data from all public and private modalities and the creation of a national access point (NAP) in all EU-member countries to be the point where (professional) users of mobility data can be informed where to find data from all mobility actors in each country.

The regulation includes the potential to drastically improve awareness of alternatives to the use of privately owned cars for mobility, and the increased use of ground transport as an alternative to short and medium airline routes across borders.

The regulation is a giant leap forward in making it possible to deliver mobility as a service; all possible modality options including human-powered mobility can come into play when end users are looking for travel options. The only remaining obstacle now is the mandatory opening for third-party sales of tickets and other mobility services; here, Finland may provide inspiration.

REPORT ON TRAVEL BEHAVIOR AND NEEDS OF THE REGION'S RESIDENTS AND VISITORS

OVERVIEW OF TRAVEL PATTERNS IN THE BBSK

The assessment of travel behavior and needs is a key area of work within this report for a number of reasons. First, it helps show that the planned investment on improving public transport through digitalization is the right use of European Union funds for benefitting the BBSK's economy, particularly its lagging parts. It is well known that improving the level of access to mobility options improves social and economic welfare through better access to employment opportunities, social and health services, as well as recreational activities. It therefore raises the overall level of well-being.

"Improving the level of access" here refers not only to particular minority groups, but also to any sector of society that can suffer from exclusion from opportunities or receive a reduced quality of service relative to others. It is important in this regard to be alert to gender issues, as around the world women use public transport in rather larger numbers than men, including in the BBSK, and they can have different needs. The relevance of this to digitalization is discussed briefly in this section.

In the BBSK the unemployment rate is 9.83%, which is 2.3% higher than that in the Slovak Republic, as a whole.[24] However, the rate in some of the least-developed districts exceeds 10%, and long-term unemployment is a serious issue through which the improvement of the public transport network by the digitalization herein proposed can help address.

A study of travel behavior shows the particular travel needs of the area and therefore shows the target accessibility aspects to which public transport services improvements should be targeting so as to better meet those needs. It could also be used for drawing actionable recommendations for the region more widely.

Second, an assessment of travel behavior and transport needs shows how digitalization as the chosen cornerstone of public transport development can be focused on delivering that from which BBSK travelers will effectively benefit.

Third, an assessment of travel behavior and transport needs assists in giving tentative ideas of the dimensions of the requirements for digitalization.

TRAVEL AND MOBILITY INFORMATION SOURCES AND DATA COLLECTED

In order to assess travel behavior and needs we have used the following data:

1. **For general travel patterns in the BBSK:** Data gathered by the World Bank from various official sources (including 2015 data for the National Transport Model), that is:

   - Slovak Road Administration

   - Statistical Office of the Slovak Republic and Register of Territorial Units

- Institute of Transport Policy under the Ministry of Transport and Communication
- BBSK Department for Regional Development and Tourism

2. **To assist with validation of the above:**
    - Two household travel surveys carried out for the BBSK earlier in 2019.
    - One-month summary passenger traffic and revenue data for all lines of the two main bus operators in 2019.
    - A survey of passenger boarding/alighting count data for twenty lines carried out in April and September 2019 by the BBSK.
    - A small number of academic studies.

3. **For travel needs of bus users, for reasons why public transport is NOT used, and for digital literacy (see Chapter 6):** A survey of bus users and of non-users carried out by the World Bank in November 2019.

It had been intended to analyze the data of the mobile operators to track passengers' transport patterns in the region, to circumvent the inaccessibility of travel data from the bus operators in the region and provide another data source. However, in the event this proved not to be possible. In future, consideration could be given to engaging with existing international suppliers of value-added personal mobility data based on mobile telecoms use patterns, to see if they could supply it. The assistance of a BBSK-based national research organization such as the Research Institute of Posts and Telecommunications (VUS) could be sought to assist in pursuing this line of inquiry. If mobile datasets were still not able to be used, a research department of one of the well-respected technical Banská Bystrica universities might be able to propose innovative alternatives.

THE SURVEY OF BUS USERS AND NON-USERS

The survey was designed in two parts. First, a survey of 1,200 bus users carried out at bus stations, and then, a survey of those NOT using public transport. It was considered essential to obtain information about the travel behavior of non-users because their reasons for not using public transport would be of value in understanding the failings of the public transport network, as it stands now. These failings may be of both delivery and information. At the same time, the non-user survey would also ascertain the specific needs of the tourists in the area.

Regarding the users survey, based on the surveyors' experience, we were advised that, for best results, we should conduct our survey when travelers were waiting for their bus at the bus stations (that is, before their journey), rather than when they had alighted from the vehicle.

The users survey was only carried out with interviewees who did not live in that municipality, in order to focus on failings caused by the lack of integration.

Above and beyond asking questions about the traveler's needs and views on public transport, both surveys also enquired about the digital literacy of the interviewee. The results of both the surveys and their implications are presented in Chapter below.

For the non-users survey, various options were considered for the interview location. Because of the desirability of interviewing respondents in the public environment, it was decided that the best places were covered shopping malls. While it could not be guaranteed that tourists would be among those interviewed, this still seemed a likely possibility.

The non-users survey required a smaller number of interviewees (only 300), but the challenge in the non-users survey was to not focus on the lagging districts, but to instead capture a representative range of people who were not disposed to using public transport, and to try to find out why they did not use it. By this means, the features that would make public transport more in line with their needs could be identified, and then incorporated into the public transport digitalization platform. However, on the other side of the coin, the limited size of the survey and the logistical challenges in carrying it out, meant that it would inevitably have to be carried out in only a few (large) locations. Consequently, the results reflect, at least in part, the characteristics of the populations 'feeding' into those specific locations.

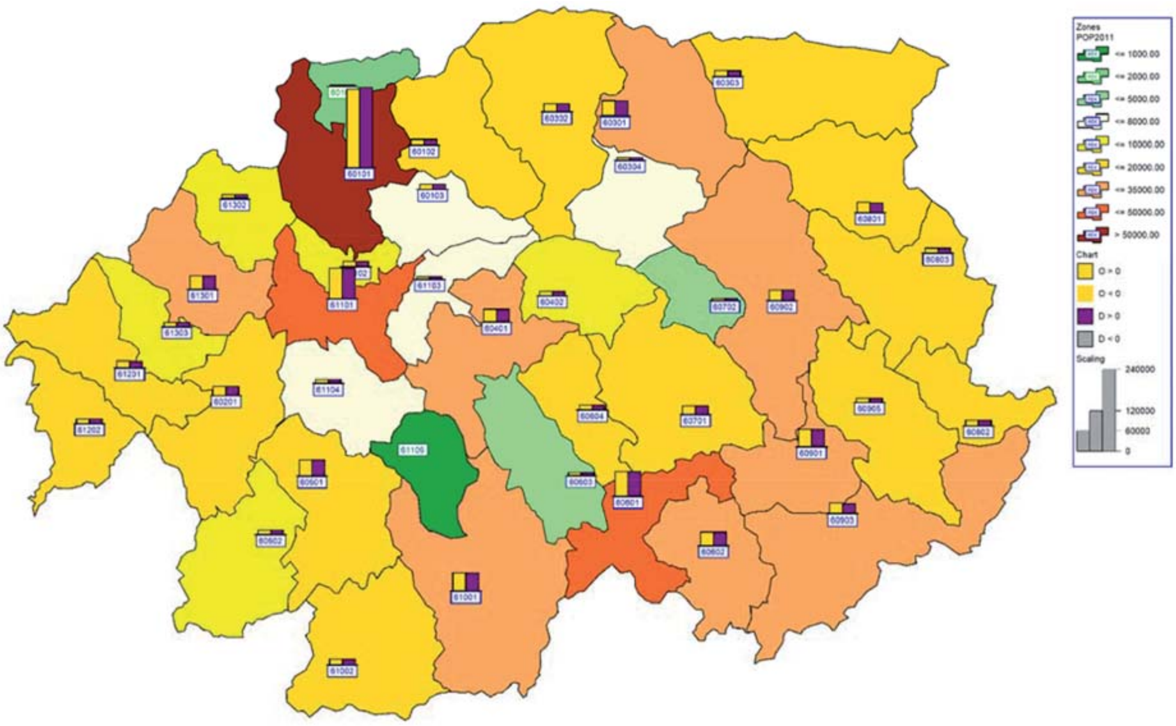
RESULTS: GENERAL TRAVEL PATTERNS IN THE BBSK

Mobility rate

Mobility rate, including trips by all transport modes, counting also nonmotorized modes, is available at the zonal level within the National Transport Model. There are 38 zones in the Banská Bystrica region. Trips are very unevenly spread among the 38 zones. The Banská Bystrica zone, which also has the highest population (estimated for 2015 at 92,630), generates and attracts the highest number of trips—about 468,000 trips a day. Four other zones generate and attract over 100,000 daily trips. The remaining 33 zones have less than 100,000 trips per day.

Excluding the Banská Bystrica zone, the average trip rate of the population living in the remaining 37 zones would be about 3.3 trips/day.

FIGURE 6. Population Density and Daily Trips Generated and Attracted per Zone



Source: Authors, 2020.

When we analyzed the five lagging districts in the Banská Bystrica Region, that is, the districts of Lučenec, Poltár, Revúca, Rimavská Sobota, and Veľký Krtíš, we found that while zones for the district center (that is, the main town) in those districts have a similar trip rate to the regional average, mobility rates in the other municipalities of the same district lag far behind the district center. While the evidence is not conclusive, poor accessibility in outlying zones away from the district center may be a reason for the low mobility rates there.

We also found that the split in transport modality strongly depends on the trip distance. In the case of intrazonal trips—trips that have both their origin and destination in one and the same zone—the main modes of transport are nonmotorized, with an average share of all trips at the region level of 70.2%. However, private transport is the second most preferred way of travelling within the zone (24.9%), while public transport use for intrazonal trips holds a minimal average share of five percent at the regional level, which is attributed to bus transport.

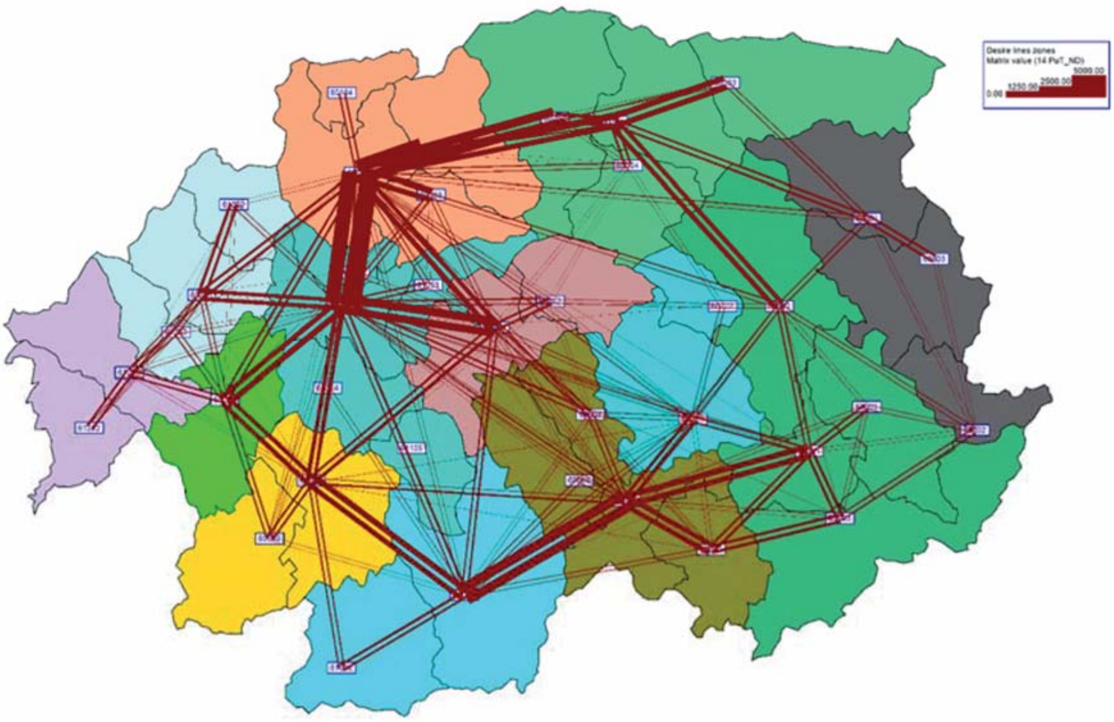
For interzonal trips—trips that have their origin in one zone and their destination in another zone—the modal split depends primarily on "generalized costs". These include not only the cost of traveling (either direct costs, such as the fare for public transport or fuel for cars, or indirect costs, like a vignette or third-party insurance costs for cars), but also the travel time. In this case, the trip duration is very important.

The most preferred transport mode for interzonal trips is car, while public transport modes account for 21.7% of total interzonal trips in the Banská Bystrica Region; almost all the public transport travel is by bus.

Distribution of interzonal bus trips per O/D

The following map shows the distribution of bus passenger trips between the different zones in the BBSK (zone pairs with a very low numbers of bus passenger trips were omitted).

FIGURE 7. Distribution of Trips by Rural Bus per O/D



Source: Authors, 2020.

It highlights the fact that the most heavily used travel corridors are corridors between district centers. There is an absence of high bus use to, and from, places that are off such main interurban corridors.

One feature of public transport in the Slovak Republic that has been studied by academics is a historic decline in public transport connectivity. Michniak and Szekely[25] show a decline in public transport connectivity from 2003–2017 and point to "some aspects of transport exclusion of peripheral centers in the southern of the central parts of the Slovak Republic that are closely related to economic and social exclusion".[26]

General Travel Demand per Trip Purpose

Data collected in 2015 for use in the National Transport Model was analyzed to derive transport mode preferences depending on the trip purpose. In the BBSK, the highest share is for trips to work—26.5%.

Trips to Work

The preferred transport mode of citizens in the Banská Bystrica Region for their trips to work is car, which accounts for 47.2% of all trips to work. This is followed by walking with 30.2%. The share of trips to work by rural bus services ranks third with 9.1%.

Leisure Trips

Leisure trips have different characteristics: it is important to enjoy the destination and the trip itself, and time is not the main factor when choosing the transport mode. This is confirmed by the survey data, which show that although rail provides for the highest speed, the preferred mode is again by car.

Trips for Shopping and/or Other Services

The survey data show that in the case of trips for shopping and/or other services, again the car and walking are the most preferred modes, which together account for almost 90% of the total trip number. The share of other modes, including urban and rural buses, is below four percent each.

Trips to School

Unsurprisingly, survey data shows that almost 50% of these trips are on foot, followed by rural and urban buses, and riding in a car as a passenger. The share of other modes is negligible. It is our understanding that buses in the rural areas of the BBSK are heavily used by schoolchildren, and there is often a peak in both service and demand in the early afternoon, when the school day finishes. This is a feature that has been analyzed by Vladimír Konečný et al, who studied the demand for bus transport by high-school children in the Žilina Region in 2017. They found that, while generally high, it was strongly correlated with both population and fare level. There was also a high number of pupils being driven to school as a passenger in the family car, whereas this applied much less in the afternoon, when travel times did not coincide. That study also found that the travel time by public transport was a determinant of demand by school children, and pointed out that a reduction in travel time is an expectation of an integrated transport system.

Modal Split per Economic Situation

The data showed that the share of public transport travel is not dependent on the traveler's economic situation.

Transport Demand per Time Intervals

The data provided for 20 regional bus lines by the Banská Bystrica Department for Regional Development and Tourism shows that the highest demand is for trips in the period from 9:00 am to 1:59 pm—6,590 passengers/day. The second highest demand is from 6:00 am to 8:59 am, with 6,009 passengers/day. In the early afternoon, from 2:00 pm to 3:59 pm, the demand is also moderately high—5,128 passengers. In the rest of the day the demand is below 900 passengers/hour.

Disparities in Bus Use between Districts in the BBSK

We analyzed the disparities in bus use between the districts in the BBSK using a simple gravity model, and found that the Poltár and Veľký Krtíš districts (two lagging BBSK districts) had less than the average patronage expected on the basis of its villages' population. The relatively low level of patronage could be because bus service provision is lower than warranted by the population, and could also be attributed to the buses being at the wrong times for the users' needs. Both issues would mean that the bus service would attract fewer passengers.

Transport results from the User and Non-User Surveys

There were some key takeaways from the surveys. First, there is a high percentage of regular users, who therefore are familiar with one bus service.

Second, there are key types of travel for bus users, which the bus service is not meeting. For instance, the most frequent complaint was about the lack of bus service in the evenings, where just under one-third of respondents agreed with that statement. The cross-tabulations of statements about problems with public transport to their village, with the change in intensity of public transport usage, also support this. When a question was asked about increases in bus use, if certain improvements were made to the service itself (that the user considered currently to be a problem), the biggest increase in usage was predicated on the improvement to evening services, where 25% of users would increase their use, anywhere from a small increase to a large increase. The second biggest response was to an increase in weekend services, where 15% would increase their usage to some degree.

Another key point was that interviewees—both users and non-users—do not recognize that the bus service is a network, and so they do not treat it as one. For users, this is reflected by people's familiarity with only one bus route—or with two, if they are using one bus to access a nearby town from their village, and then a second one, to further access a more distant town. This was evident from the users' lack of knowledge of the bus line numbers: they do not need to know them, because they always use the same bus (from the same stand at the bus station).

For non-users, this lack of recognition of the bus service as a network, is reflected by the fact that a significant number of people without access to a car, travel together to venues. The reason that they do so is because the bus is not recognized as offering the network capability of meeting their disparate needs with a single offering—not just with a network of bus lines, but also a multiline ticket product. Such a perception, of the bus services not offering a range of integrated possibilities, is commonly found in networks which are not digitalized, because without those features, integrated journeys are not feasible.

Another central point was that users give a high rating to bus services that are reliable and dependable. Their satisfaction can be increased by moving to a coordinated network.

For non-users, both tourists and shoppers perceive problems with the bus service. A general point (for both users and non-users) is that their 'network awareness' is low, and that they have low expectations of the bus service. Non–users had a general awareness of the bus service, but they had a number of complaints about its performance or its appropriateness for them (some complaints were based on the fact that the buses didn't go where they wanted to go). If these issues were resolved, it could lead to not-insignificant increases in use.

Both these points lead to the conclusion that the use of digital tools to plan services based on demand has the potential to lead to major increases in service demand. If the tourists' needs could be factored into the planning of bus services, through the service planning being done by the BBSK using digital tools (which has an interest in promoting tourism), rather than by the bus operator, it can be expected that this would make bus services more attractive to tourists.

DIGITAL LITERACY ANALYSIS OF THE POPULATION IN THE BANSKÁ BYSTRICA REGION

DIGITAL LITERACY IN THE SLOVAK REPUBLIC

Digital literacy in the Slovak Republic, as a whole, is high. Quotes from *Fintech in CEE*, published by the UK's Department of International Trade, in conjunction with Deloitte, in December 2016 include[27]:

- "(the Slovak Republic) …. has one of the highest indices of smartphone penetration (65%, just behind Austria's 66%). Its level of internet access is high at 79%."
- "The share of ICT specialists as a proportion of employed individuals (4.1%) is above the EU average."
- "Slovakia has one of the highest rates of cloud computing adoption in Eastern Europe".

Also, in 2018, the Slovak Republic was 10th out of the 28 total EU countries in terms of its population's participation in internet social networks.

THE PROGRESS OF DIGITALIZATION IN THE BANSKÁ BYSTRICA REGION

The existence and accessibility of the BBSK comprehensive (and detailed) database of all the companies having offices in the region,[28] is an indication of the awareness and use of digitalization in the Banská Bystrica region.

KEY RESULTS (FROM THE USER AND NON-USER SURVEYS) RELATING TO DIGITALIZATION

Smartphone Ownership is High

Both users and non-users have digital familiarity. The user survey identified that all interviewees between the ages of 16 and 26 had a smartphone, and this figure had a 95% lower confidence level of 0.98: very high indeed. There is clearly a high level of digital awareness amongst this age group. Even at age 61 to 70 the mean ownership level of smartphones is 0.62, with a 95% lower confidence level of 0.54. Only at age 71 and over does the 95% lower confidence level drop below 0.5. Not only that, but there is a high level of internet use to obtain information about planning a journey on public transport.

Familiarity with Journey Planners is High

Both users and non-users had comparable levels of smartphone ownership and similarly high levels of awareness of the major internet public transport journey planners available in the Slovak Republic. Sixty-seven percent of the transport users surveyed used the internet to obtain information about planning a journey on public transport.

The proportion of users who accessed the internet for public transport information is high for the younger generations (for example, 40% for the 16 to 26 age group) but much lower for the older generations, especially over 61, where it is under 5%.

Use of Digital Ticketing Technology is High

The fact that nearly 50% of users were using an electronic transport payment card (and only 50% cash) shows a high level of digital awareness. This high level of existing digital awareness provides a good basis for expanding electronic ticketing as part of the digitalization strategy.

There are several Opportunities that Digitalization offers

Simplify the Network Brands to Grow Use

In the user survey, only a very tiny number of interviewees knew the line number of the bus for which they were waiting. The lack of knowledge of the line number is significant, because it indicates that the interviewee probably only uses one bus line habitually, and does not use the bus network as a network. If they did use it as a network, they would have to differentiate in their mind between different bus lines. This gives another indication that under the current nondigital system, the bus network's potential is not fully realized.

With digitalization, the BBSK has the opportunity to rebrand the network by simplifying the line numbers to, say three or two, or even just one digit, thereby making them much more visible and easy to remember. There is no reason why the line cannot be known by its official the Slovak Republic national six-figure number in one back-office database, yet be known by another, simpler number for all public-facing publicity and communication. A relationship file will link the two, creating a permanent association. Simplification of the public-facing identity of the line has been proven in many cases to lead to the growth in passenger numbers, as people recognize the line more.

Introducing a brand name for a line, or group of lines, is also much more straightforward with digitalization, because it gives the possibility of producing, marketing, and advertising material for a group of lines together, as well as displaying them on a map together without any other lines. Both printed and internet-based material can be produced easily for only the lines required, together with features such as places of interest, bus stops, shops, and so on that are specified in the association menu. Geographical information systems (GIS) relate objects to each other and will allow particular objects to be displayed or hidden, depending on the specific requirements of the display medium or marketing campaign.

Particular logos might also be associated with a bus line number or name in marketing campaigns, and these can be printed out and affixed to the flags on specific bus stops which that bus line serves; such bus stops can again be identified within a geolinked database that matches the bus stops to particular geospatial codes.

Increase Use of Ticketing Technology

The high level of existing digital awareness evidenced above provides a good basis for expanding electronic ticketing as part of the digitalization strategy.

Promote Smartphone Applications—the Key Customer Medium for BBSK Digitalization

Because of the very high existing use of smartphones, it would seem that a smartphone application might be the best channel by which the BBSK could interface with actual and potential users of public transport. The existing public transport application with the highest usage is CP.sk. But only 67% of smartphone users who were interviewees in the survey use the internet for accessing travel information. While CP.sk is well known and is popular, it is limited (only showing the next two public transport connections) and its handling of bus stop locations does not always seem accurate. Bus stop locations are a subject where there is no the Slovak Republic national database and so are difficult to get right, but if a smartphone application is to be trusted it must have accurate information.

The fact that a smartphone application has to be of a very good quality to be trusted and used, is borne out by the fact that there is a clear difference between the percentage of people that have heard of CP.sk (72%) and the percentage that have used it (only 49%). This disparity is even greater for the 16–26 age group: as much as 86 % have heard of it, compared to only 57% who have used it.

One reason may be that the non-users do not see the need for it. They might only use one bus line (a common characteristic of bus systems where the network itself is not strongly branded, or does not have a clear identity or any integration) so they are only interested in that one line.

Development and promotion of a high-quality BBSK-wide public transport smartphone application would have significant benefits for tourism, and in a sustainable way. It would enable public transport connectivity to tourist attractions; through the clearer presentation of a network (including through the application of digital maps), it would enable visits to multiple tourist attractions using public transport; and it would be able to deliver personalization, including tying-in discounts and other benefits to the use of public transport to access the desired attraction. It should also be noted that digitalization would encourage the inclusion of all BBSK public transport within a well-known application, such as Google Maps, with which tourists are familiar.

The following features and characteristics should be incorporated into a good BBSK-specific, BBSK-wide public transport smartphone application.

Features:

- Journey planning
- Maps showing the position of the user in relation to his/her surroundings
- Maps of the public transport network with lines so the user can see what else is in the network. Ideally, it should automatically show real-time locations of all vehicles in the immediate network on the map.
- Real-time location of all available vehicles, at least as a ‘request’ service
- Ability to buy, store, and display passes for zones
- Ability to generate a quick response (QR) code when an amount is spent from the application to buy a pass—the QR code being read/validated by onboard readers
- Alerts to travelers about nearby attractions
- Ability to receive offers from nearby attractions
- Ticket purchase/ticket identifier and validation

- An easy link to a ticket/seat booking application
- Reception of alerts for delayed buses or connections
- Special information on interchanges (perhaps photos, and maps of the immediate local area)
- Some coordination/integration with student/ISIC cards to build on the extensive installed base of these cards, combined with the high digital awareness of the student-age group
- Links to/integration with, new modes (such as on-demand taxibus, taxi-share)
- Characteristics:
    - Accurate data
    - Fast operation
    - Be intuitive and easy to use
    - Supporting the BBSK interchange strategy in its design
    - Allow personalization
    - Be attractively designed, with bright colors

It is important to note that the BBSK application must have a clear (user-friendly) and attractive style that identifies with the BBSK Integrated Transport Network brand (whatever is chosen for that). A lesson can be drawn from the Ubian application which is quite fast and has quite a number of features (including ticket sales). It is endorsed by the bus operators and yet, it looks rather bland. Both awareness and usage from interviewees in the user survey are low: the recognition of it from the 16–26 age group is no different from the rest of the interviewees.

The presentation from Ruter shown in Annex[29] indicates the way that this particular (and ground-breaking) PTA designs its applications.

BRIEF ANALYSIS OF STRENGTHS, WEAKNESSES, OPPORTUNITIES, AND THREATS RELATING TO BBSK PUBLIC TRANSPORT

The ‘road map’ for the development of public transport needs to take into account the various strengths and weaknesses of the current situation, together with the threats and opportunities that public transport faces. Many of the challenges to the ‘status quo’ that can be seen on the horizon have both positive and negative potential effects for BBSK’s public transport.

Regarding **strengths**, BBSK has a reasonably good road network, despite poor road surfaces in some remote areas. The expansion of the road network that is being done currently (for example, extension of the R2 Expressway east of Kriváň village towards Lučenec) provides an **opportunity,** through the potential to enable faster bus journeys from towns just off the expressway to regional centers such as Zvolen. However, this also poses a **threat** in the form of enhanced competition from the private car.

Another **strength** is the good connectivity from long-distance and ‘suburban’ bus services to interregional and international bus services at the Banská Bystrica Bus Station (and vice versa). This is a well-regarded passenger facility in the heart of the region. It looks to provide a good platform on which a digital information structure could be planned to deliver a coordinated digital integrated service for travelers. The main railway station at Zvolen provides another example of a major public transport hub which has the potential for development through appropriate targeted investment (linked to the ongoing rail stations refurbishment program) and an integrated signage and information strategy.

On the other hand, this connectivity for public transport is considerably less in other parts of the region, such that the nature of the public transport network is then a **weakness**. One example is the World Heritage town of Banská Štiavnica which, while it has a branch-line railway service, albeit infrequent, only has low-frequency bus journeys to neighboring towns. Other aspects of the public transport network’s **weakness** is the six-digit bus line numbering system, which makes it nearly impossible to remember the line number of a bus route with which one is unfamiliar, and (together with the very badly-designed printed bus timetables) makes use of a digital journey planner application effectively the only way to plan interconnecting journeys.

Of course, the facilitated access to European structural and investment funds, thanks to the Catching-up Regions Initiative (CuRI) and the associated expert advice, provide key **opportunities** for the BBSK’s public transport network. The link through CuRI to the European-wide Technical Assistance and Information Exchange instrument (TAIEX) program, and the good relationships with certain cities in the nearby Czech Republic, which can be visited without great difficulty, also provide tremendous **opportunities** for learning from others’ experiences of effective public transport digitalization. In particular, these links will be very beneficial in the process of understanding the issues around new integrated and complex technologies, such as control room and public transport dispatch in a multi-operator environment. The fact that legacy technology for a single-operator bus control room system has never been implemented in the BBSK is also a **strength**, because it provides a ‘blank sheet’ from which to start with evaluating and assessing both state-of-the-art and also recent but well-tried technologies.

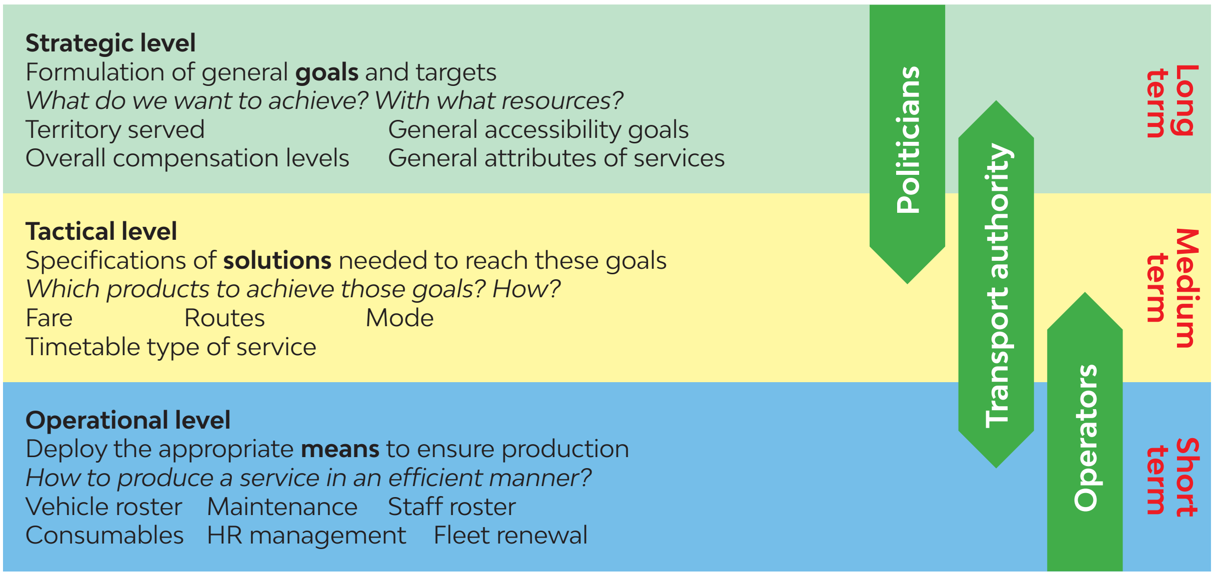
Weaknesses include the poor relationships between the BBSK and the bus operators. The operators have already made **threats** to withdraw bus services in the region as part of ongoing disputes with the BBSK. Other short-term **threats** relate to the continued refusal of bus operators to deliver data to the BBSK, in light of this ‘war’ between the BBSK and themselves.

HOW WHAT IS PROPOSED MEETS THE OBJECTIVES IN THE INTRODUCTION

Each aspect of the BBSK Public Transport Digitalization Strategy proposal is listed here, in turn, with an explanation of how the proposed plans and actions detailed in this report address those objectives.

The diagram below shows how the overall strategy for public transport leads directly to the development of operational plans.

FIGURE 8: **From Strategic to Operational Level.**



Source: Collective Innovation for Public Transport in European Cities, CIPTEC, 2016.

KEY OBJECTIVES OF THE PUBLIC TRANSPORT DIGITALIZATION STRATEGY IN THE CURI

1. To create a general proposal for a comprehensive solution to public transport digitalization in the BBSK

    - The strategy defined here will result in a design and specification for the tendering of the real-time part of the system.

2. Prepare gradual implementation of individual steps

    - A main part of the real-time system design is to make it modular and scalable in functionality to accommodate gradual implementation. Three levels of real-time system services are shown, with associated CAPEX and OPEX estimates.

3. To have a strategic means to use EU funding from 2021–2027

    - Based upon an approved strategy and design for the new public transport system in the Banská Bystrica Region, the real-time system project will provide technical input and CAPEX / OPEX building blocks for developing this strategy, subject to an EU funding application.

    - Elements of the objectives that involve real-time services will be identified. Other objectives are briefly discussed in this report but not covered further as part of the real-time system design project.

REASONS TO CREATE A DIGITALIZATION STRATEGY THROUGH THE CURI

1. Reorganize the functioning of public transport (reduce operating costs, possibility to increase level of service for the same cost)

    - By changing from a static public transport operator-centric controlled governance to a more central and agile public transport authority-centric governance, it is expected that opportunities will be found to optimize the use of vehicles and human resources to deliver more services for the same overall subsidy cost.

2. Improve public transport as a service (increase public transport reliability, leading to an increase in transported passengers)

    - Reliability is crucial in a service driven by timetables and an important element in people's view of the image and prestige of the services delivered.

    - Innovation in the monitoring and control of services, together with marketing and sales activities, should be planned so as to grow the attractiveness of the whole public transport ecosystem.

3. Improving passenger travel information for passengers (availability of online/real time passenger data, thereby increasing public transport's prestige)

    - Next to on-time departure according to plan, reliable real-time information on any deviation is important for waiting travelers. It turns uncertainty about the delay into knowledge and allows people to act based on facts, for example, to get a coffee, to replan the journey using other modes, and so on.

    - Real-time updated passenger travel information is a central deliverable for the real-time system project, hence it is further elaborated on in this report.

4. Recognize the overall cost and steps needing to be taken so that there is one functional, open system at the end of the CuRI project that will have the ability to manage public transport in the BBSK

    - This objective enforces the need for a consolidation of activities, which today are handled in a decentralized and closed way by the current public transport operators (PTOs), into a centralized open regional approach controlled by the BBSK. Examples of functions that benefit from a single open system approach are planning, marketing, sales, ticketing, customer service and operations, including real-time information and control.

- Strategies for creating one functional system, including the real-time component, are described further in this report based on open standards and best practices from leading European public transport administrations.

EXPECTATIONS FROM THE CURI STRATEGY

1. A tailor-made solution for a public transport digitalization system, in order for it to correspond to the needs and wants of the BBSK

   - Even though the solution should be tailored to the characteristics and ambitions of the BBSK, it will benefit from using open standard components and solutions to minimize vendor lock-in and closed digital infrastructure architecture.

   - The use of open standards and adherence to EU regulation will govern the strategies presented for the real-time system, in concert with other parts of the digital systems necessary to meet the BBSK's needs.

2. Digitalization of passenger information (online data—in vehicles, at stops, on the web, and in applications) and provision of additional information on the web and in the applications (price lists, maps, transport conditions, current information on emergencies, and so on)

   - With the very low level of digital passenger information available in the BBSK today at touchpoints before, during, and after travel, there is a great potential to improve information services. The relatively high penetration of digital platforms, especially smartphones, in the region is encouraging for utilizing digital channels as well.

   - Digital passenger information strategies are central to this report.

3. Digitalization of fleet, that is, fleet control (online overview of drivers' work, condition of vehicles, adherence to timetables, and so on, in order to have control over the performance of individual carriers).

4. Digitalization of traffic control (online data about vehicle position on map, delay, route, line, driver, and other parameters; with a possibility of communication between the dispatcher and the driver)

   - Currently, in the absence of a regionwide strategy, bus fleet digitalization varies between PTOs, from apparently none, through static timetable display, to online updates on vehicles.

   - The World Bank team is not aware of the level of control implemented today between vehicles, drivers, and PTOs' operation control. The BBSK does not have any (digitalized) information about fleet control for measuring performance itself.

   - The BBSK seeks more control of PTOs' operational performance. First, the KPIs for the contracted services from the PTOs need to be established through the forthcoming tender and new terms for contracts. This includes the specification of the level of real-time information required to be implemented in the vehicles operated by the PTOs on behalf of the BBSK.

5. Digitalization of ticketing (payment by bank card, possibility to purchase ticket online, or in the mobile application), thereby allowing the BBSK to have control and overview of passenger sales, and the ability to do analysis

- Smart ticketing is an important element of an efficient public transport ecosystem. Today tickets are sold for cash at the entrance to a bus. This is time consuming, and while ticketing is taking place, the bus is not moving, which means that ticketing time must be factored into the planning of timetables. Additionally, this passive waiting time irritates other passengers.

- Smart ticketing, including prepaid tickets and pay-as-you-go ticketing, allows people to enter the bus, possibly self-validate and go. Current kilometer-based fares can be handled by combining an application-based journey planner with ticketing. Pay-as-you-go ticketing, using check-in and check-out functionality, allows people to pay without any knowledge of fare system and limits.

- In this report, an introduction to ticketing for public transport (Chapter below) is included as a baseline for further work.

- Note that the digitalization of ticketing is highly dependent on high quality regionwide static mobility data, and the ability to create multimodal travel plans and associated ticket prices.

6. Digitalization of the central system and the collection of public transport data, in order to use it for analysis Collection of short-term and long-term data to further improve and optimize public transport

   - A digitalized public transport system will generate huge amounts of data representing the daily operation. The real-time system strategy will identify the main types of data for collection in a data pool within the control of the BBSK PTA. Examples of how such data can be turned into information for the improvement and optimization of the regional public transport network are discussed later in this report. However, the level of investment in the transformation of data into useful information for analysis is beyond the scope of the real-time project, as defined for this report.

7. Digitalization for enhanced security (CCTV in vehicles, voice info)

   - Enhanced security in the bus using digital means is discussed later in this report, as it is part of the in-vehicle architecture for the digital bus. The same goes for voice communication with the driver and voice messaging from control room, and so on.

8. A proposal for an open system solution (open data, API, and so on) ready to enable data transfer between the regional system (or the integrated system coordinator) and other carriers. Provision of the possibility to exchange information with neighboring regions. Provision of the possibility to make some selected data available to other subjects (cities, integrated rescue system, and so on)

   - The open system proposal in the real-time system strategy explained in Chapter 12 is based on open standards as defined by EU regulation, and by voluntary standardization efforts by the industry.

   - The EU regulation (EU) 2017/1926 for the provision of EU-wide multimodal travel information services is a reference for the proposal, where applicable.

   - Sharing mobility data is mandatory for public transport in the EU. Each PTA is responsible for publishing such data and making it known through national access points for mobility data (NAPs).

BENEFITS OF PUBLIC TRANSPORT DIGITALIZATION THAT WE EXPECT TO DELIVER BY THE END OF THE CURI—FOR CITIZENS, CITIES, MUNICIPALITIES, AND THE REGION

1. Implementing the digitalization of public transport will modernize public transport, move it to a higher technological level, and allow for greater passenger use. This can mean that public transport will become more attractive and accessible to visitors to the region, especially tourists

   - A key objective to note is the expectation of a higher utilization of public transport services: not only for the population in the region, but also for visitors and tourists.

   - Regional and national government policies and regulatory frameworks regarding the flow of open transport data and its multiple use can be a means of public transport becoming a stimulus to the digital economy and to innovation. The digitalization of public transport in the BBSK (and the associated release of data, such as real-time data, bus stop locations and features, and other related non-transport data) could stimulate innovative solutions to existing problems in the area of public transport, including self-service methods of citizens reporting problems.

2. Improving the quality of reliability and safety of public transport

   - Improved planning across the region, and the introduction of real-time information to users and to the PTA and the PTOs, aim to create visibility in the actual operation of public transport and the opportunity to optimize planning based on facts gathered on all vehicles in the region.

   - Public transport digitalization enables better information to be more easily gathered on users and their characteristics and needs (including, potentially, on parameters such as gender) and enables these user parameters to be included in service design. This is important when different groups of users have different requirements.

   - CCTV and other security measures can raise the perception of public transport's safety: this is particularly important for women.

3. Increase in the number of passengers

   - The creation of a single regionwide public transport ecosystem with a complete digital twin representation of the stops, routes, multimodal planning, and ticketing will lower the barrier of opting-in for public transport. The increase in the number of passengers will also depend on the level of investment in a higher-frequency public transport offering, both for urban and regional modes.

4. Simpler and accessible ticket purchase

   - A transition from cash-based on-bus ticket sales to digital ticketing will reduce the cost of ticketing directly. Also, driver time spent on ticketing at bus stops can be converted to driving time, thereby reducing overall time for a particular route—especially where many passengers enter the bus at several stops.

5. Higher fare revenue

    - A higher use of public transport will deliver more revenue from paying passengers. However, substantially more passengers will require investment in higher capacity and frequency. The use of operational real-time data to measure public transport's usage is an important feedback to the planning cycle for continuous service optimization at both the micro and the macro level.

6. Increase labor mobility as well as better commuting opportunities

    - Careful revisiting and replanning of the route network and timetables based on knowledge of commuter needs can increase mobility. However, another element is to encourage spatial planning of future places of work to be concentrated around identified mobility hubs.

7. Ensure sustainable rural development, that is, eliminate/reduce disadvantaged/excluded rural locations

    - Spatial planning of rural development should include planning for the public transport service. A school bus service is essential. The level of service otherwise requires good data and local knowledge of the home-work commuter travel patterns, and so on.

8. Reduction of regional road congestion

    - Converting existing habits of using private cars is a challenge everywhere. Oslo (Norway) and the Skåne region (Sweden) have both managed an overall increase in mobility by investing in increased numbers of public transport lines, vehicles, and service frequency. Oslo's increased service level is mostly financed by a toll on cars entering the city. Skåne has centralized public transport planning and financing at the regional level, and has raised regional taxes.

9. Saves money associated with the development and maintenance of regional roads

    - Planning for a more widespread transition from private car to shared mobility modes may reduce the need for expanding regional road capacity. However, some of the savings will likely be allocated on increasing public transport coverage, frequency, and quality. As the main local and regional public transport mode is the bus, the good quality of roads is an integral part of the overall quality of service delivered by public transport. Maintenance of existing roads, in particular roads used by buses, should be at a level adequate to support a smooth ride.

10. Reduction of parking provisions in cities will lead people to travel to the city by public transport

    - More European cities are actively seeking not only to increase payment for parking, but also to simply reduce the number of available parking spaces, with former spaces utilized to make the city center more attractive for citizens and visitors alike. Better public transport helps make this transition happen.

11. Public transport offers a healthier more sustainable lifestyle

    - Public transport using sustainable energy sources is a beacon for a region focusing on the health of its citizens and the environment. The message can be a key element in the marketing of the benefits of conversion to using public transport combined with walking and cycling.

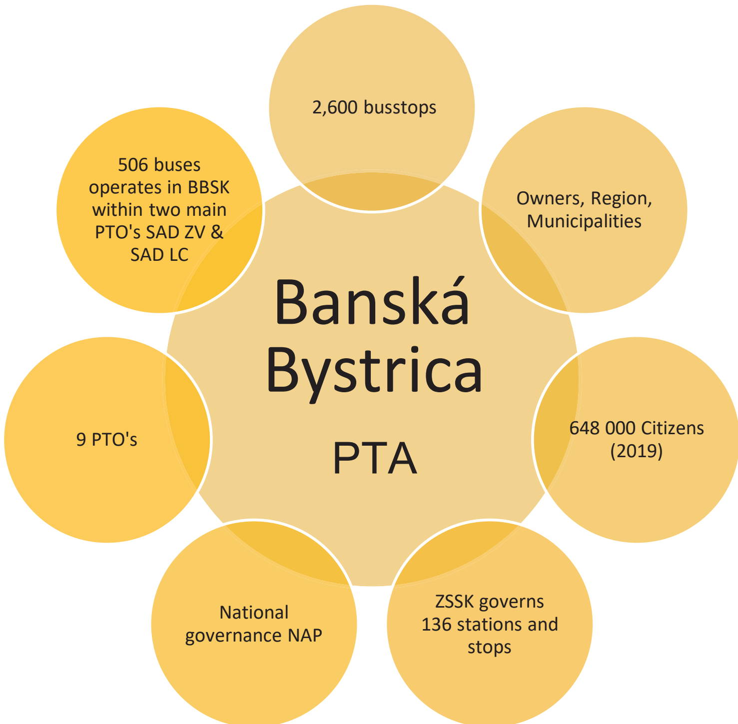
BBSK PTA–PTO GOVERNANCE AND ROLES, INCLUDING KEY PERFORMANCE INDICATORS

A main objective for the CuRI is to create a single regionwide public transport ecosystem with a complete digital twin representation of the stops, routes, multimodal planning, and ticketing. This will require substantial changes in the governance between the public transport authority and the public transport operators who deliver the bus operations today, and in the future.

PTA-PTO GOVERNANCE TODAY

Administrating a public transport network on a regional level includes managing relations with many actors. For illustration purposes, the public transport authority (PTA) portion of the BBSK is considered an organizational entity, even though it is our understanding that the PTA's role today is as an integrated function in the region's administration.

FIGURE 9. **Users, Actors, Facilities, and Equipment Defining the BBSK Public Transport Ecosystem**

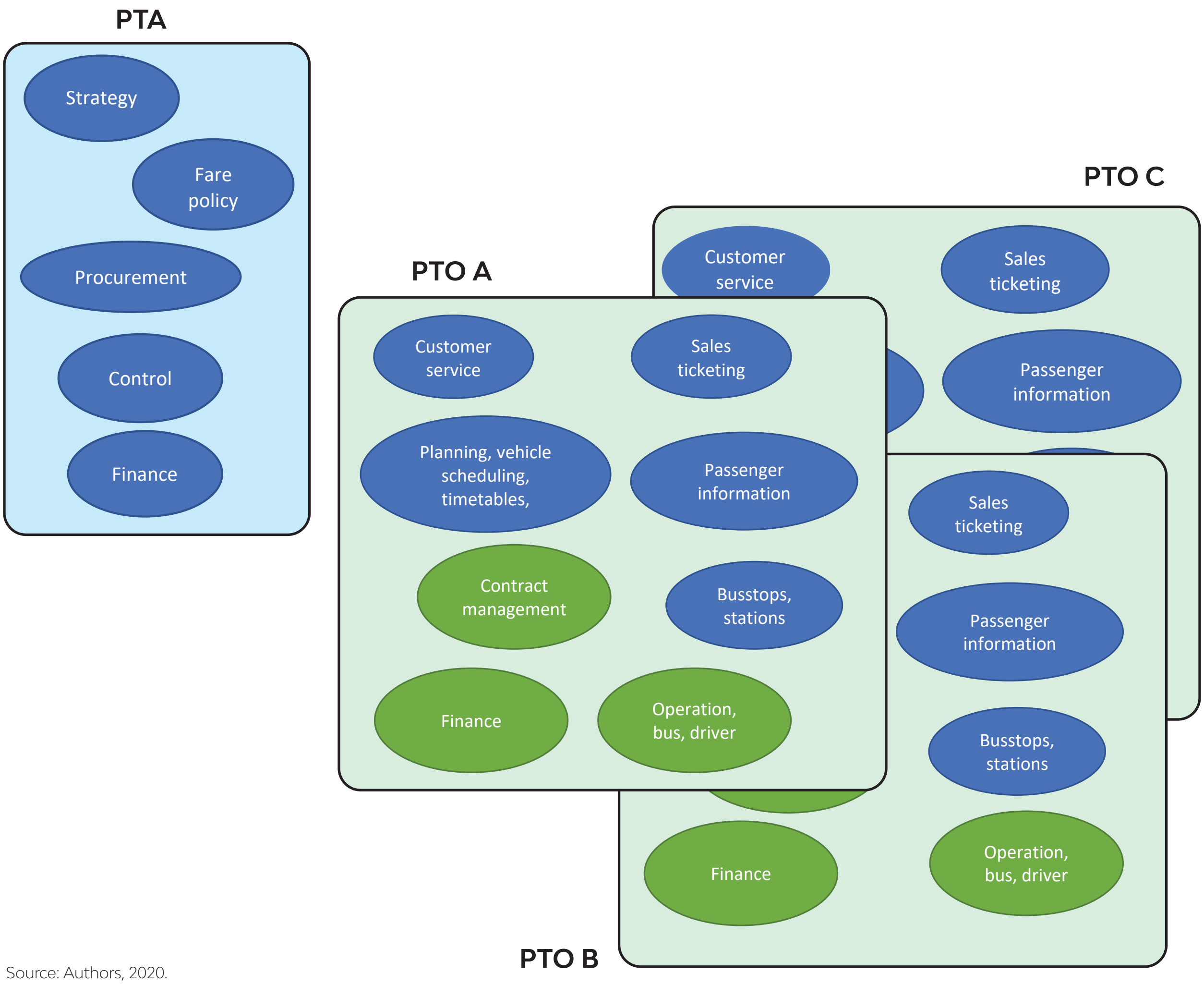


Source: Authors, 2020.

The current BBSK public transport network is described in Chapter 2 of this report, and the current governance between the PTA and the PTOs in the region is best described as PTO-centric. A PTO sells and keeps the ticket revenue to offset operational cost. The balance between the total operational cost and the ticket revenue comes from the BBSK PTA.

Figure 10 below shows how the roles are split between the PTA and the PTOs which deliver public transport services for the region.

FIGURE 10. Illustration of how the roles are split between the PTA and the PTOs, and who deliver public transport services for the region



Source: Authors, 2020.

Some of the functions in the PTOs are mostly considered PTA functions and responsibilities in other countries in Europe. In Figure 10, these are marked blue. Typical PTO functions are marked green.

Typical PTO functions

Daily operation of buses and drivers is the core business of a PTO everywhere, as well as for the PTOs operating in the BBSK.

The PTOs also include contract management functions to handle new agreements with the PTA and changes of operation, level of service, and investment in new buses. It seems that in the BBSK, PTOs also have ownership of some bus stations. It is unclear to us how CAPEX and OPEX for bus stations are handled in the subsidy schemes in place between the region and the PTOs.

The finance function is an important part of the general management of the PTOs. Key elements include cash flow, salary, investments in buses and bus stations, and management of required subsidies, in order to have a financially sustainable business. How the financial operation of the PTOs functions, and how subsidies are granted, are outside the scope of this report.

PTO functions typically seen as PTA responsibilities in most European Public transport governance models

Each operator has its own customer service functions. We have not analyzed the level of services delivered, nor if any coordination exists between operators and the PTA function on the level of service, contact points, opening hours, and so on.

Each operator also has its own ticketing functions. Ticket prices using regional buses are kilometer-based, which requires dialogue between the driver and passenger to find the right ticket. Consequently, time needs to be set aside for ticketing at each stop, especially at heavily used bus stops.

FIGURE 11. Two timetable signs showing the operator name and no reference to the region

Source: Authors, 2020.

Responsibility for sales and marketing is with the individual operators. We are not aware of coordination between PTOs and the PTA. The timetables displayed at bus stops include the operator logo rather than a regional identifier. As such, branding is toward current operators rather than a regionwide service, even though substantial financing comes from the region.

Passenger information services are PTO-centric. The quantity and quality of information vary between operators.

FIGURE 12. Two examples of information walls at major bus stations in the BBSK

Source: Authors, 2020.

A few major bus stations include information walls. Mostly static time-plan information for arrivals/departures are shown. Examples of real-time information have also been seen. However, we do not yet know how this information is generated. Further information on passenger information is shown in Chapter 3.

Planning, vehicle scheduling, and timetables are performed by each operator. It is reportedly difficult, or even impossible, for the PTA or other third-party actors to get access to up-to-date planning and real-time data from the current operators. For that reason, planning and optimizing the regional network and frequency of services is very impractical and fragmented, if not impossible.

Bus stops and stations seems to be managed (owned) by the PTOs who historically have delivered service in the area. Signs and plan information is PTO-centric, rather than signaling an entry point to a regionwide public transport service. Real-time information is mostly nonexistent, and the static schedule information typically printed and posted at bus stops using various methods, is dependent on the PTOs' policies rather than on a regionwide standard.

The PTA roles today

In the current operational situation, the BBSK PTA's roles seem relatively few compared to other European PTAs.

- **Strategy:** Strategic planning requires access to the plan data which is understood to be under the control of the current PTOs.
- **Fare policy:** The setting of fares in the region is assumed to be under the PTA control.
- **Procurement:** The World Bank team has not had the opportunity to understand how procurement or changes to services in the current setup works.
- **Finance:** It is understood that the region is partly subsidizing the PTO operation for the part that cannot be paid by the PTO's ticket revenue. The World Bank team has not investigated how the need for subsidies is established.
- **Control of PTOs:** The World Bank team has not studied how the PTA controls current PTO operations regarding punctuality, service quality, and so on. However, it is understood that one of the objectives of digitizing the operation and instruction of real-time information is to better control the performance of the regional public transport, and thereby, the PTOs' contribution to the quality of service.

PTA-PTO NEW GOVERNANCE

The objectives as stated by the CuRI (see Chapter 1 of this report) calls for the adoption of a revised split of roles between the PTOs and the PTA in the BBSK.

In the following section, a generic governance model for a European regionwide public transport ecosystem is discussed in a BBSK PTA-PTO context.

- The PTA defines the level of service it requires, specifies it in measurable terms, and goes through public procurement following the (EU) regulations. The measurable terms are also referred to as key performance indicators (KPIs). The KPIs included in the contract with the winning PTOs are central to managing the expectations on the fulfilment of obligations from the PTOs. Identifying and specifying the right KPIs are crucial to transforming the ambitions of the PTA to deliver high-quality public transport service with up-to-the-minute real-time information into uniform operation across the PTOs operating the services.

- A typical public transport operator is a private company which sells bus transport services to publicly owned public transport administrations (PTA).

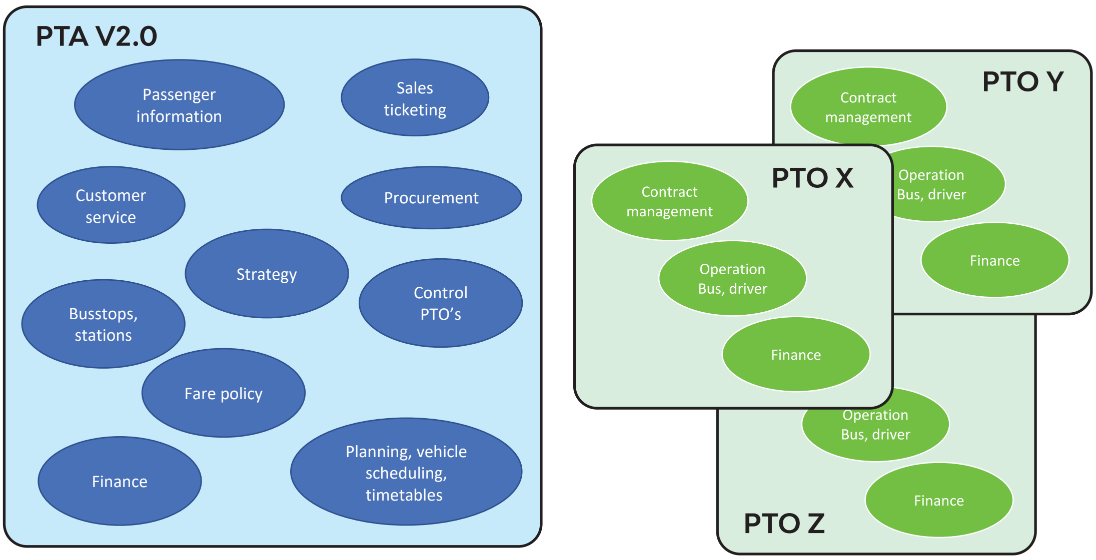
- The PTO bids for delivering the services tendered. As such, tender and contract management is a core discipline of a PTO operation. Fleet management, staff management, and process optimizations are key disciplines for a successful PTO as well.

- Going from a distributed digital infrastructure to a centralized digital infrastructure for public transport in the BBSK requires a buildup of roles and skills in the public transport authority, some of which today are executed by the PTO operating the buses for the region, while others (for example, how to release data to a wider public community) may be totally new.

- For discussion purposes, the revised organization is called BBSK PTA V2.0 (PTA 2.0).

The following diagram shows a PTA-centric governance model for the split of roles between the BBSK PTA and the (new) PTOs.

FIGURE 13. **Roles currently distributed in the PTO organizations are consolidated in the PTA V2.0.**



Source: Authors, 2020.

Bus stops and stations

Digital planning and real-time information systems are dependent on digital representation of the physical location in high quality. It makes a difference for time calculation if (for example) a bus stop at a cross section is situated on one side or the opposite. A central register of bus stops, bus hubs, bus stations, and train stations are the foundation of digital planning for public transport as defined in EU standards for open mobility data (NeTEx). Moreover, a true digital representation of the bus stops allows digital navigation tools, such as a travel planner on a PC or on a mobile phone, to help people get correct directions and assure them that they are in the right place to catch the bus.

Planning, vehicle scheduling, and timetables

This is a cyclical process repeated yearly. Based on a political decision and direction, the planning process revises and updates the complete plan for the bus operation for the next year. These modifications are communicated in a timely fashion to the PTOs, according to the processes and timelines defined in the contracts, or through tenders when contract terms with a PTO come to an end. Planning on a regional level allows for a holistic approach and an opportunity to plan the network to follow changes in commuter and school habits.

Operation (Passenger Information and Control of PTOs)

The roles of passenger information and the control of PTOs' compliance with the KPIs are both supported by real-time information. The real-time information is all about deviations from the planned operation of public transport based on information on an individual vehicle's position during its journey from stop to stop. Based on the vehicle's actual position, estimates of deviation from the schedule can be computed and made available as real-time passenger information. The real-time information is also central for a PTA V2.0 control room operation.

The quality of the real-time information is dependent on its ability to show a true digital picture of the real deviations of, for example, the arrival time of a bus. However, true real-time information is dependent on the quality of the stop-point mapping and the static planning process. The PTOs' adherence to the processes around selecting routes, and ensuring that the real-time system is actually working, are other obvious necessities of delivering reliable real-time information.

Moving the role of passenger information from the PTOs to PTA V2.0 allows for a unified level and quality of information—both static and real time. Also, the source and transmitter of the (real-time) information is now the authority and it covers the whole network, thereby stimulating use of multimodal journeys across PTOs and train services.

Customer Service

Customer service in a PTA V2.0 setting will likely include the following channels:

- Call center
- Web and application-based mail and chat services
- Promote services through web, application, and SMS
- Personal services in service centers at major hubs
- Real-time information on the operation of the regional public transport allows customer service staff to see up-to-date status on the performance of the services

In the case of customer complaints on delay, or the nonappearance of a scheduled bus, historical data on performance will make it easier to respond based on facts.

Sales and marketing

Selling the regional public transport services includes the branding of the service and making it easily recognizable in all the touch points, whether physical or digital. The real-time components and screens at stop places and in vehicles should play an integrated role in the branding strategy for the BBSK regional public transport services. As a branding strategy can have influence on the physical design of signs and so on, a dialogue should be established between the design of real-time components and the marketing and branding design.

Ticketing and fare policy

The objectives of the digitalization of ticketing, and simpler and accessible ticket purchase, is typically seen implemented with a ticketing authority being the lowest level. A few countries even support national ticketing schemes as a supplement. Examples of national schemes include Denmark (Rejsekort), The Netherlands (OV-Chipkaart) and Switzerland (FAIRTIQ and SBB Easyride). All three national schemes are pay-as-you-go schemes, and are dependent on reliable static data for stop places (GPS positions) and routes. All digital ticketing schemes will, in general, lower the time to enter the bus compared to buying tickets at the driver with cash or another means of payment.

A real-time system implementation is, in principle, independent of the range of ticketing methods. However, reliable static data and stop-place locations are as relevant for digital ticketing as for the real-time information services.

Digital ticketing schemes in a PTA V2.0 setting are a means to lower the barrier of opting to using public transport. Multimodal ticketing for bus-bus and bus-train combinations are technically and practically feasible. However, they require ticket agreements and revenue-sharing models to be in place between the region and the regional train services.

Digital ticketing following the stated objectives requires careful strategy and design work, in its own right, and is not included in the stated scope of the real-time system design work. The real-time system design will not create any restriction on digital ticketing systems. If a ticketing scheme requires onboard equipment in a bus, the generic strategy of using the ITxPT standard should be helpful in further work.

For continuing sales of cash tickets, it is suggested that the onboard cash ticket system be online, with the PTA V2.0 back-office providing real-time updates on tickets sold. This allows for a check and balance of PTO-reported revenue for the sale of tickets through the driver.

Procurement

Preparing for the procurement of public transport bus operations through a public tender is a critical role of the PTA V2.0. Careful planning and good static data are both crucial for a successful procurement process. The awarding criteria need to be sharp and unbiased, living up to best practices and formal EU procurement regulation. The procurement team needs to get input from most other functions of the PTA V2.0 to set up the KPIs and other specifications in the tendering documents. Key KPIs typically seen in tendering documents are analyzed in section below.

PTO roles in a PTA V2.0 scenario

Obviously, the PTO roles in a PTA-centric governance model are fewer than seen today. However, they represent the typical roles seen in most PTOs operating in the European public transport ecosystems. By centralizing some of the roles in the PTA V2.0, a more efficient and lean planning and operation is likely to be the result. Also, the PTA V2.0 can create a critical mass of expertise to plan and execute the objectives set by the political level in the region. The current PTOs may need to understand the new split of roles; however, it will become clear in the procurement process. An open communication of the objectives and game plan from the PTA V2.0 is encouraged. This should also address the possibility that the current operators do not win the same level of operation as today, or maybe even lose most or all their business. In particular, the current staff of the operators should be informed about the practices and rights they have, as a consequence of a bid win or loss.

As some bus stations today, as we understand it, are owned by the main PTO in the area, the BBSK PTA V2.0 needs to find a method where ownership of stations and so on, are out of the equation for the procurement process.

PTO KPIS

Most often, the most important KPI in public transport is expressed in customer satisfaction. At the same time, customer satisfaction is also the most difficult and resource-intensive to measure, not to mention the difficulty of defining which parameters of customer satisfaction should be measured.

Many PTAs commission a survey of customer satisfaction by independent consultancies to run one to four times a year. These measurements are often included in a performance bonus for the PTO. Typical parameters included in a customer satisfaction survey can be the following:

- Punctuality and compliance with the timetable
- Driver's driving behavior/skills
- Driver's service and appearance
- Interior cleanliness standard
- Indoor climate in the bus

A more classic KPI is the level of service—degree of execution. The degree of execution means the percentage of the timetable hours performed typically above 99.90%.[30]

Other examples of how the level of service can be measured include:

- Actual driven journeys
- Operating irregularities
- Bus maintenance
- Bus use
- Compliance with emission limits

In traditional public transport, measuring these KPIs is resource-intensive and often random. For example, noncompliance with the timetable is only recognized by the PTA if a customer complaints or if the PTA happens to register it in the context of manual physical control.

When implementing a real-time system, the most important KPI will be that each bus is properly logged onto the system and provides real-time data. From here, many measuring points deliver complete data for the duration of operation, depending on the level of digitalization chosen in the operation of the buses. Therefore, it is often seen that a lack of log-on triggers a penalty to the PTO, rather than the old KPIs concerning service level that could only be discovered physically by the PTA's staff.

Proposed KPIs associated with the introduction of a real-time system implementation are shown below. Please note that these are an outline only and do not include elements, such as associated data storage requirements, or the detailed methodology for collecting them. These will be covered in the year 2 Requirements Analysis Sheet.

'Real-time system implementation' KPI Level 1

'Level 1' is a basic level of KPI, and comprises the following:

- Real-time system-log-on
    - Missing log-on on the real-time system; proper log-on includes correct choice of journey and trip
- Compliance with timetable/driver behavior
    - Run too early from the stop or terminus
    - Late departure from the terminus of more than, for example, 120 seconds
    - A driver changeover time *en route* of more than, for example, 120 seconds (typically, only applicable to urban traffic)
- If the PTA has chosen to extend the real-time system to include information channels in the bus
    - Incorrect signage on the bus
    - Missing zone and stop advertising
    - Wrong time and zone given on interior signs
    - Missing or out-of-date customer information on the digital infotainment screens in the bus
- There will also need to be KPIs relating to adherence to the mandated procedures of the PTA regarding failed equipment (for example, what actions PTO staff should take if a ticket machine fails)

‘Real-time system implementation’ KPI Level 2

‘Level 2’ is a more sophisticated level, using the KPIs as measured in ‘Level 1’ above, plus the following:

- Bus use
    - Use of a bus type other than that which is in the contract
- Bus maintenance
    - If the bus does not meet the requirements of the contract in terms of appearance, maintenance condition, and functions, including, for example, the noise, heat, and inadequate lighting, as well as safety equipment (some of these elements can be discharged from the Fleet Management System Interface (FMS) via the bus’s Controller Area Network (CAN) bus)
    - Failure to replace defective ticketing equipment after, for example: one hour in city buses; and after three hours in other types of bus lines; and where the error makes it impossible to perform ticketing properly
- Operating irregularities
    - Late reporting of operating irregularities according to contract terms

STANDARDS FOR THE PUBLIC TRANSPORT OPERATION

The public transport market is highly regulated in the EU, when it comes to how to digitalize the operation and deliver planning and fare information to users.

Below is an introduction to four sets of regulations and standards which are all compatible and intended to be interoperable:

- Transmodel: European set of standards for interoperability between public transport information processing systems.
- ITxPT (Information Technology for Public Transport): Provision of standards for IT implemented in public transport vehicles and their communication with central back-office components.
- EU-wide real-time traffic information services (EU) 2015/962: Provision of real time road-based traffic information published in open formats and made available through national access points (NAP). The level of compliance has not yet been verified.
- Multimodal Travel Information Services regulation (EU) 2017/1926: Provision of static and dynamic (real-time) data published in open formats and made available through National Access Points.

TRANSMODEL

A general introduction to the concepts of the Transmodel standard can be found at http://www.transmodel-cen.eu/wp-content/uploads/sites/2/2015/01/TUTORIAL_Part8_v2.1.pdf.

Also, an introductory video can be found at http://www.transmodel-cen.eu/video.

FIGURE 14. A Brief Guide to Transmodel

OVERVIEW

Transmodel » is the short name for the European Standard **«Public Tranport Reference Data Model»** (EN12896). It contributes to improving a number of features of public transport information and service management : in particular, the standard facilities **interoperability between information processing systems** of the transport operators and agencies.

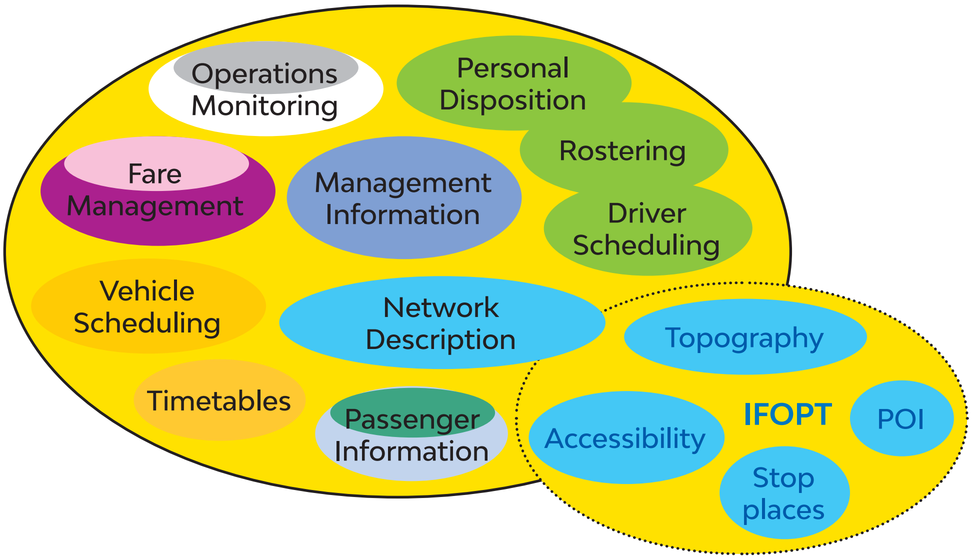
EU REGULATORY CONTEXT

Transmodel has an important strategic role for European Public Transport data. Under the ITS Directive (Priority Action A), by 2019 all EC member states must make their data available under Transmodel based standard formats such as NeTEx and SIRI. Transmodel is also being used to harmonise the TAP TSI rail standards into a uniform pan-European model, so is of direct relevance to rail cariers.

Source: Transmodel-cen n.d., 2020.

The Transmodel standard defines how interoperability between public transport digital systems should be established. Transmodel links seamlessly into several EU directives and regulations covering how public transport data shall be made available using open standards, such as NeTEx (or rail TAP/TAF TSI) for static data, and SIRI for dynamic (real-time) data.

FIGURE 15. Transmodel – A framework for defining and agreeing on data models for the various types of digital data necessary to plan and operate a public transport ecosystem



Source: Transmodel-cen n.d., 2020.

A digitalized public transport ecosystem contains various sets of digital data covering all aspects of planning, operation, and control. Without any framework or common standards, each implementation would have to rely on whatever a supplier came up with. The result is known as vendor lock-in, where it would be too expensive to select alternative providers for part of the solution, as the interface methods are proprietary.

Open standards allow suppliers to excel on the main functionality of their offerings and not have to concern themselves with inventing interface-adapting software which adds no value to the user.

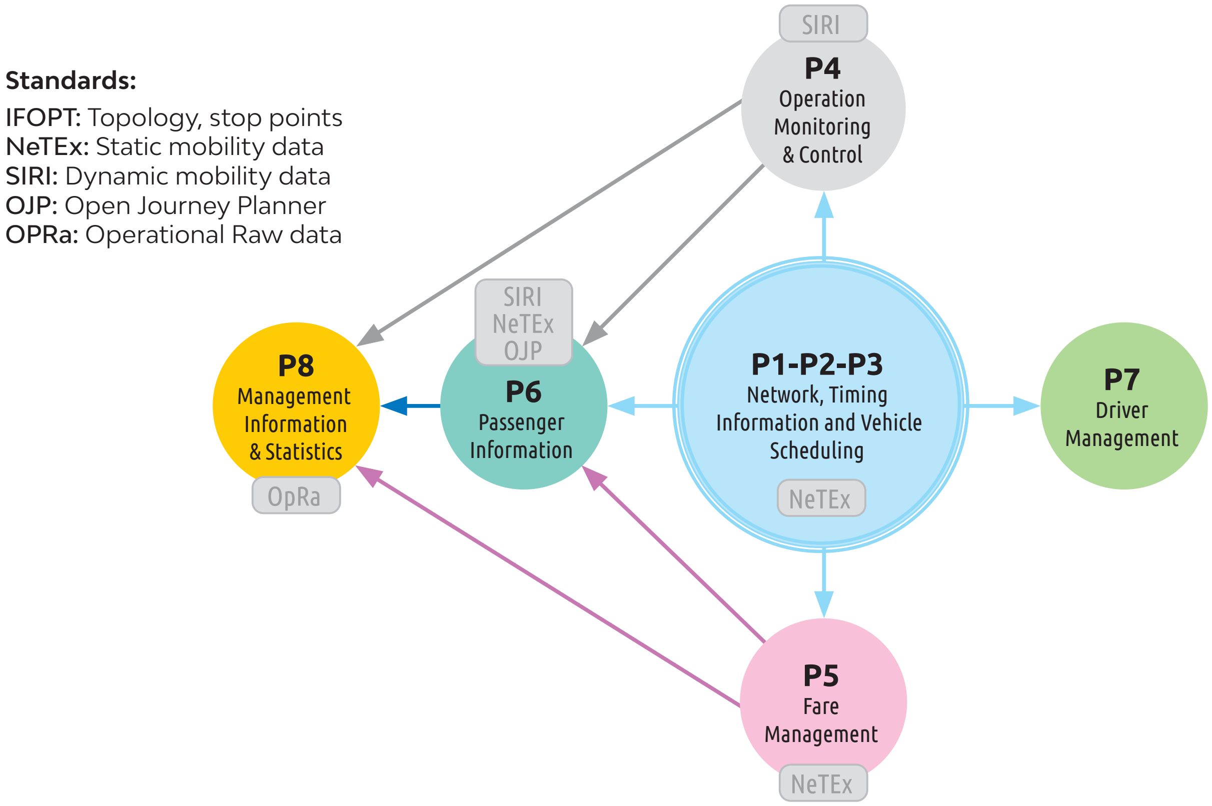
In the Transmodel network, timing information and vehicle scheduling is defined through the use of the NeTEx standard, based on a model for identification of fixed objects in public transport (IFOPT).

Static mobility data in the NeTEx format is used by the PTA as a source for passenger information on travel planning. NeTEx data also forms the basis for fare management and calculation. Finally, the NeTEx plan data for the operation of the public transport is an integral part of the specification documentation for procurement of bus services.

Real-time data within Transmodel

Operation monitoring and control is highly dependent on real-time data from the vehicles in operation. This goes both for vehicles under the PTA's control as well as other actors' services (rail, and others).

FIGURE 16: **Transmodel standards and information flow in and between functions of a public transport ecosystem**



Source: Transmodel-cen n.d., 2020.

Real-time data is also a key source of planning data in passenger information.

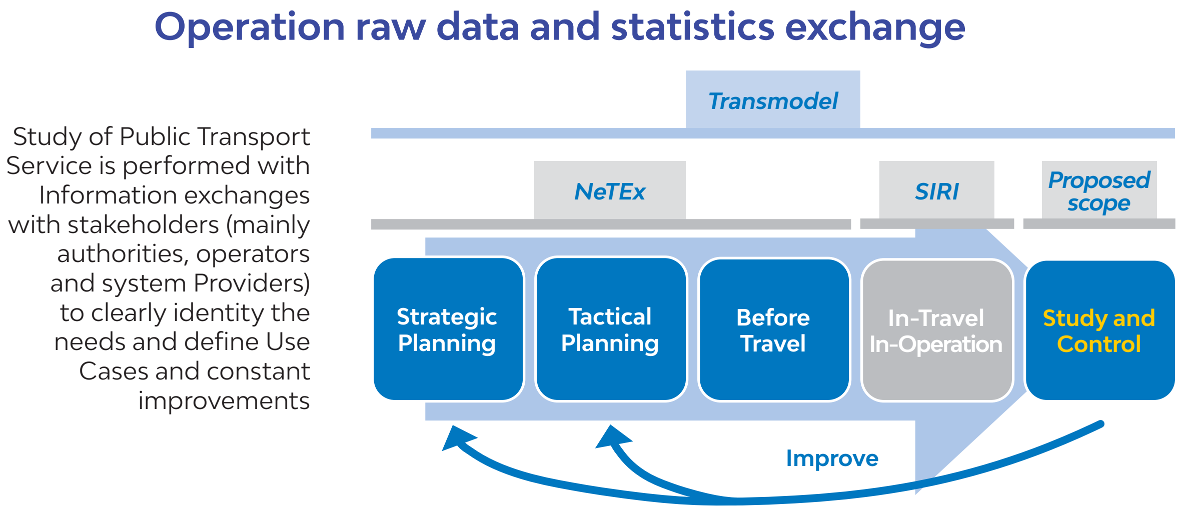
The standard interface for real-time information (SIRI) is a European Committee for Standardization (CEN) technical standard that specifies a European interface standard for exchanging information about the planned, current, or projected performance of real-time public transport operations between different computer systems.

Travel planning, including both static and dynamic data, is an important element of passenger information. Transmodel points to the open journey planner (OJP) API for exchange of accurate and timely information about public transport (PT) services, and to implement systems able to provide multimodal information for longer distance journeys.

Recording of real-time data and incidents from daily operations in a Transmodel architecture creates a data pool of all data for study and feedback of experience, for further improvements on both the strategic and tactical planning level.

The handling of operational data is standardized in the management information and statistics package in Transmodel named OPRa (Operating Raw Data). See more about OPRa here: http://www.opra-cen.eu/overview/.

FIGURE 17. Feedback Loop from Operating Raw Data (OPRa) to Planning



Source: Transmodel-cen n.d., 2020.

The PTA will thereby be able to constantly improve future services and performance based on facts from the sum of all operational data stored. The PTOs will have access to the same level of data for their respective operations and can use this data to benchmark performance with other PTOs for optimizing their own operation. As a result, users will enjoy better overall public transport services in a digitalized public transport ecosystem.

ITxPT – INFORMATION TECHNOLOGY FOR PUBLIC TRANSPORT

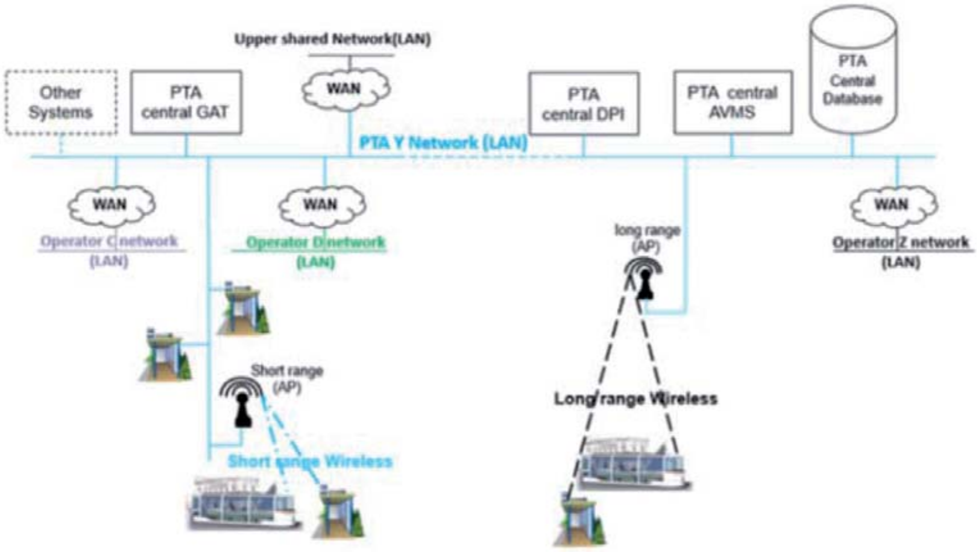
In this section, we focus on the collection and distribution of data in vehicles and back-office systems and the advent of standards for bus-IT, which has subsequently come together in the concept of ITxPT.

For many years, various bus-IT integrators have defined their own proprietary 'standards', with the consequence for the PTA and PTOs that once a supplier was selected in connection with a given investment of, for example, ticketing equipment, it was associated with high costs to purchase new equipment. Often the suppliers then developed into monopolists to the PTA/PTO concerned, with a risk, in consequence, of higher costs, than actually needed, if there had been free market competition.

Therefore, there has long been a desire for a common and open standard in which the PTA/PTO could safely invest at a given level and subsequently be able to upgrade the investment without having to replace, for example, hardware which has not been fully depreciated.

ITxPT has its roots in the European Bus System of the Future (EBSF) project (2008–2012) which was coordinated by the International Association of Public Transport (UITP). For the first time, EBSF brought together the five leading European bus manufacturers and 42 other partners in 11 EU countries.[31] In 2013[32] the results were anchored and further developed in ITxPT.[33]

FIGURE 18. ITxPT overview for PTA back-office IP network



Source: itxpt.org, 2020.

ITxPT is an open standard defining the general IT-architecture in the individual buses used in public transport, from cabling and connectors across power supply to data output and input format. Description of the ITxPT standard is grouped together in the following headings:

Installation requirements for vehicles and onboard ITS

- S01- Installation Requirements specifications v2.1.0

Architecture requirements for on board ITS modules.

- S02P00 v2.1.0 Networks and Protocols
  - Describe how the modules in a bus is connected and communication with PTO/ PTA back offices.
- S02P01 v2.1.0 Inventory
- S02P02 v2.1.0 Time
  - Describes how time is specified and interpreted - ensuring that all services use the same and correct time.
- S02P03 v2.1.0 GNSSLocation
  - Describes how location is specified and interpreted - ensure that all services use the same and correct location.
- S02P04 v2.1.0 FMStoIP
  - Describes how data is retrieved from the bus's CAN bus, using the FMS standard.
- S02P05 v2.1.0 VEHICLEtoIP
  - Describes how data is retrieved from the bus's CAN bus, without using the FMS standard.

- S02P06 v2.1.0 AVMS
    - Describes the monitoring of vehicle data and how generic messages are generated for the passengers. This service can also be used for large parts of the real-time system.
- S02P07 v2.1.0 APC
    - Describes the distribution of data from Automatic Passenger Counting (APC).
- S02P08 v2.1.0 MADT
    - Describes the interaction between the driver and the system on-board/ back office.
- S02P09 v2.1.0 MQTTbroker

Architecture requirements for back office systems.

- S03P00 v2.0.1 Backoffice Overview
- S03P01 v2.1.0 TiGR NEW!
- S03P02 v2.0.1 NeTEx

Architecture requirements for Over-the-Air

- S04- Over-the-Air Architecture specifications v2.0

The documents mentioned are regularly updated and are available from the website https://itxpt.org/ - registration is at no cost.

Over the past few years, ITxPT has become a widely recognized standard and is used in more and more public tenders within the EU, with principals indicating that the condition must be followed for everything related to bus-IT.

The market for bus-IT has responded positively, which means that there are already several suppliers of hardware that meet the ITxPT standard, and more are added to this list each year. The same goes for software suppliers. It is therefore indisputable that it is the ITxPT standard that must be used in any real-time project in a European context, and thus, this is also the recommendation of this report.

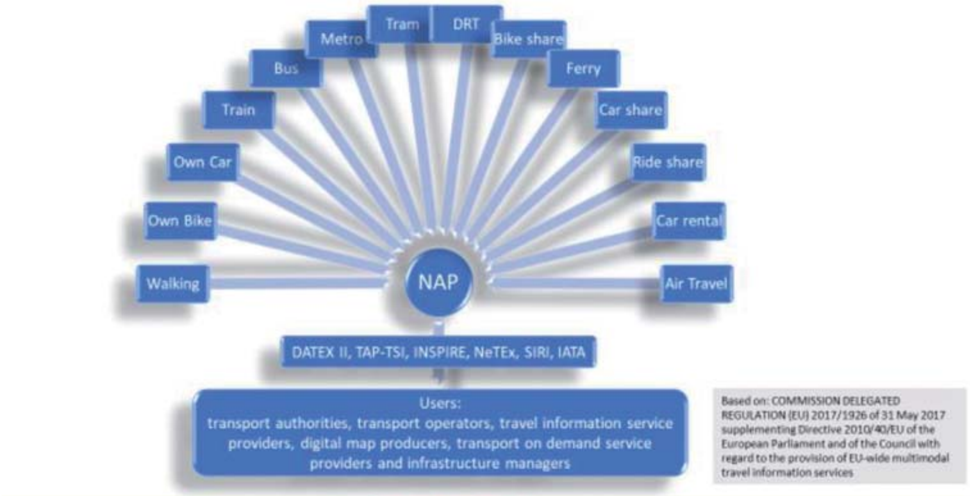
EU-WIDE REAL-TIME TRAFFIC INFORMATION SERVICES (EU) 2015/962

The services are typically seen by the public through various travel planners or GPS systems in cars.

MULTIMODAL TRAVEL INFORMATION SERVICES REGULATION EU 2017/1926

The purpose of national access points in EU countries is to create a catalogue for open data, covering all modalities from all transport actors, as a basis for creating multimodal travel information services. A national access point (NAP) is a digital interface providing access to open mobility data either directly or through reference to the data sources. All transport actors are required, as a minimum, to make static travel and traffic data available as open data.

FIGURE 19. National Access Point Delivering Travel and Traffic Data to Users in a Defined Set of Common Standards



Source: SFMCON ApS, 2018.

The open and machine-readable data and metadata must be made available following standard formats, be accurate, and to a known quality. This is necessary to make it possible for travel information service actors to deliver multimodal travel suggestions to end users within, or across, national borders in the EU zone, as well as creating digital maps for where, and how, one can get access to both scheduled and demand-responsive modes of transport.

The regulation also covers information for privately owned modes of transport like the car, motorbike, bicycle, as well as walking. Service providers are encouraged to promote the environmental and health benefits of walking as part of multimodal travel chains. When all data are in a well-defined set of standards, it becomes easier for the users to source the data for creating multimodal service, digital maps, and many more applications and services, as they can plug into the data they need.

The national access point for open mobility data is a digital catalogue of travel and traffic data from all modalities available in a country. As a minimum, all transport actors must register their basic data, as well as relevant travel and traffic data, in the same quality as used internally on the actors' own digital platforms.

The regulation calls for use of a specific set of standards for the data to be made available. Some of the standards are well established, but the NeTEx and SIRI standards are relatively new open standards for scheduled and demand-responsive data.

BEST PRACTICE FROM ACROSS EUROPE

The following show some examples of best practice of public transport digitalization from across Europe.

RUTER (NORWAY)

Ruter covers the Oslo and Akershus counties of Norway and is a collaboration between the two local authorities of these counties. In 2014, 1.4 billion journeys were made in Oslo and Akershus (all modes combined). Economic and population growth is leading to growing traffic congestion, which Ruter aims to address. To do this, it designs and provides an easy-to-use network, which as far as possible provides 'turn up and go' frequencies and a user-friendly service.

There is strong branding across all promotional materials as well as on vehicles. In terms of information, Ruter provides real-time information at stops and stations, and via an application. Fares are based on distance travelled (the number of fare zones crossed). They can be bought at a wide range of outlets, including via an application, onboard vehicles, at kiosks and service points, and at ticket machines. Single trip, daily, weekly, monthly, and annual tickets are available as a stored-value smartcard. Tickets are valid on all modes of transport, including trains (except the express train to the airport). The level of service is highly rated: 97% of passengers were satisfied with their journey in 2014.

While passenger numbers in Akershus county (which is somewhat similar in its geography to the BBSK) fell in the period 2000 to 2002, they have since grown substantially and are now rising at a pace that is outstripping population growth.

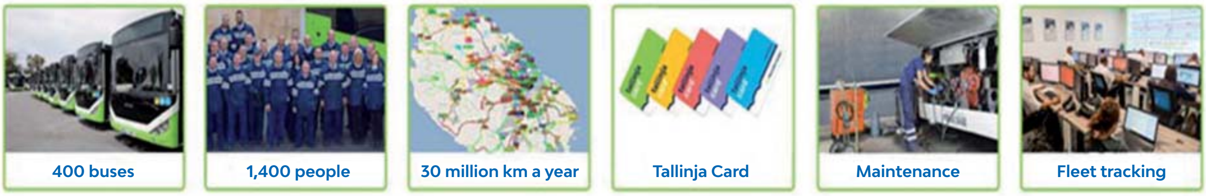
Ruter's customer base has high digital literacy and high 4G mobile telephony coverage. The attitude of Ruter's IT development staff is very much 'can do', as they use publicly available open systems to develop new mobile applications for their customers.

The World Bank team received a full presentation from Ruter on its digitalization strategy and this is available in a separate document as Annex.[34]

MALTA PUBLIC TRANSPORT

Malta Public Transport has demonstrated some remarkable results from digitalizing its operation. Information herein has been gathered from a video meeting held with Operations Manager, Mr. David Alvarez, of Malta Public Transport.

FIGURE 20. Malta public transport key facts and figures



400 buses
- One of the youngest fleets in Europe
- Clean Euro 6 engines
- Narrower for better manoeuvrability
- Two doors for quicker boarding and alighting
- Safe and accessible with CCTV on all buses

1,400 people
- Mix of local and foreign management
- Invested in training and development
- New driving simulator
- Offering incentives promoting safety and excellence

30 million km a year
- Network, frequency and fares regulated by Government
- Over 5,600 trips per day

Tallinja Card
- Revolutionized how people buy their tickets
- Over 300,000 people have a tallinja card
- More than 80% of passengers use a card
- Over 126,000 people use their card every month

Maintenance
- We employ over 60 mechanics and electricians
- Buses are serviced monthly
- Most work is done overnight for efficiency
- We clean and fuel buses during the night

Fleet tracking
- All buses are tracked in real time
- We track 200,000 stops per day
- System allows for better service planning and management
- Government has real time access to data

Source: Malta Public Transport, https://www.publictransport.com.mt/, 2020.

Malta Public Transport is a privately owned single PTO operation under contract with the Malta Government (PTA). Malta decided to procure a complete public transport operation from a single operator.

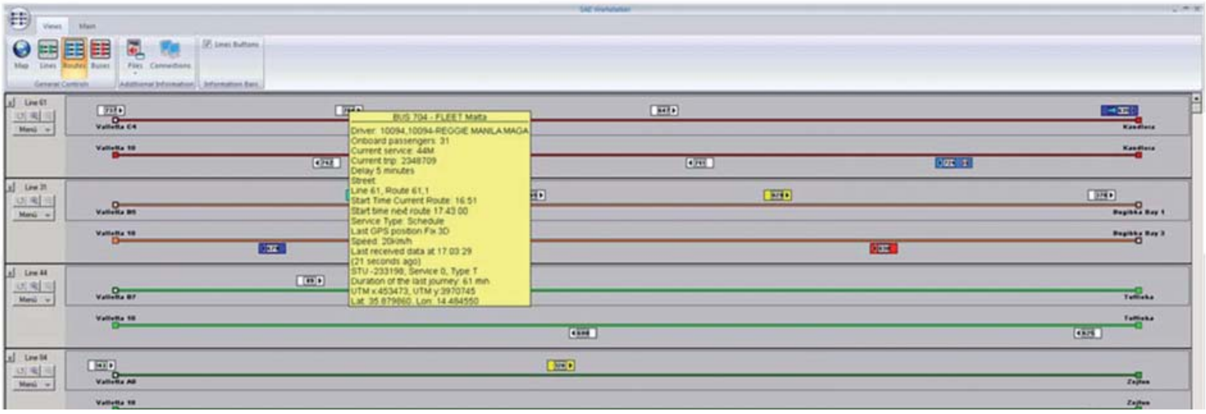
FIGURE 21. Controller's view of the network

Source: Malta Public Transport, https://www.publictransport.com.mt/, 2020.

FIGURE 22. Malta PTA control room

Source: Malta Public Transport, https://www.publictransport.com.mt/, 2020.

FIGURE 23. Real-Time bus positions viewed on a digital line chart, showing full information about one vehicle's operations



Source: Malta Public Transport, https://www.publictransport.com.mt/, 2020.

FIGURE 24. CCTV in bus as seen from control room

Source: Malta Public Transport, https://www.publictransport.com.mt/, 2020.

STA – SÜDTIROLER TRANSPORTSTRUKTUREN AG PTA, ITALY

Information is based on a video meeting with the management of the IT-system department of STA, using screen shots supported with, and information from, the STA homepage: www.sta.bz.it

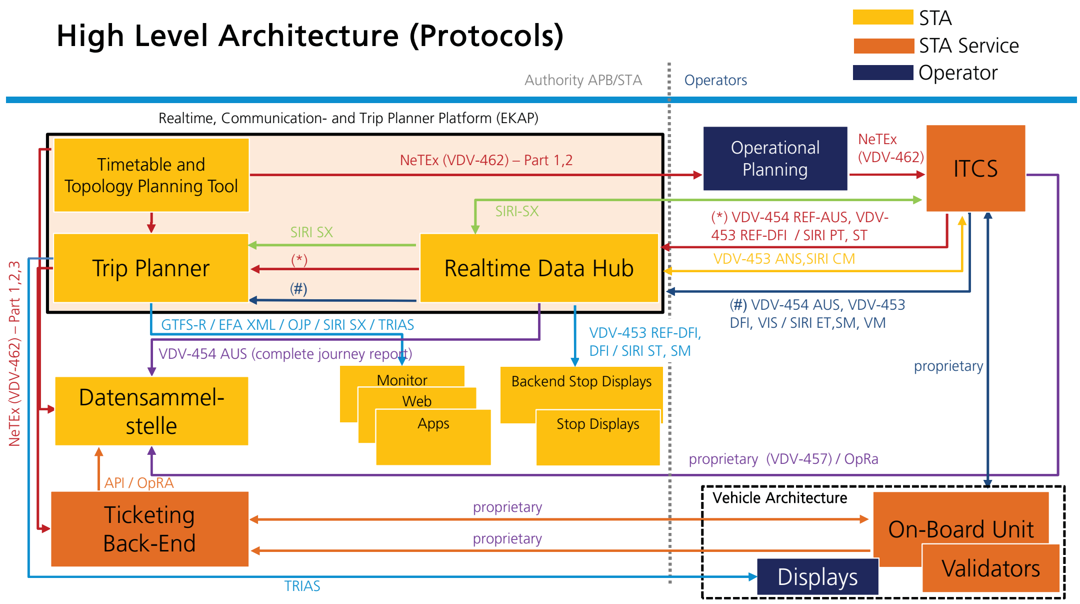
STA is in the process of rolling out a new real-time system based on NeTex, SIRI, and ITxPT standards.

STA specifies the interfaces between the STA PTA and the PTOs using NeTEx and SIRI standards.

In the new procurement of PTO services, the PTOs are to procure, install, and operate real-time system components in the buses, fulfilling the STA specifications (the blue elements in the architecture).

However, the onboard ticketing system is owned by the STA PTA, again regulated in the operator contract (brown elements).

FIGURE 25. STA planned high-level architecture



Source: STA - Südtiroler Transportstrukturen AG, 2020.

The PTA part of the planning and real-time system includes:

- Timetable and network topology planning tool for static planning of routes and use of vehicles
- Real-time data hub for receiving real-time data from vehicles through the active operator's real-time system using SIRI. The real-time data is used for stop displays and distributed to the travel planner system and the services reporting tool.
- The travel planner combines static and real-time data to deliver useful information to customers through digital channels, such as Web, applications, and other digital screen services.
- The services reporting tool records all data from the operation and ticketing, to enable the calculation of the KPIs for performance monitoring, and other characteristics relevant for securing a high quality of operation, and for delivering feedback to planning for service optimization.

A benchmark for what it takes to support a digitalized PTA procurement and operation can be seen on the STA website, where the IT System organization of STA is laid out at https://www.sta.bz.it/de/ueber-sta/

From the STA homepage, it can be seen that the following roles are at play in the IT-system group:

- Twenty-four out of a total of 103 employees (32 employees are associated with local train services)
- Management and administration: 2; IT systems: 5; travel plans: 5; ticketing: 3; customer service: 9

It is interesting that customer services is part of the IT-system organization. As such, all customer information and interaction is teamed with the planning and IT elements supporting these interactions. This can create good feedback loops, from customer experiences and complaints to adjustment of systems and plans.

The STA—Südtiroler Transportstrukturen AG—PTA can be a good reference for what it takes to operate a digitalized PTA, as the size of operation is comparable with the BBSK. In fact, the STA is implementing the digital infrastructure that is proposed for the BBSK. So valuable knowledge sharing may ease the creation of the BBSK PTA and the procurement of the digital components, as described in the STA high-level architecture.

MOVIA PTA, DENMARK

The World Bank team visited the Movia control room in Copenhagen.

Movia is the largest PTA in Denmark, serving Copenhagen and the whole of Zealand, Lolland, Falster, and Møn.

TABLE 1. Data Relating to Movia

Employees	308
Scope	Capital Region + Zealand Region
Size of region km^2	9,841
Population	2,657,000
Web	www.movia.dk
Turnover M EUR	473.9
Ticket sales M EUR	228.6
Subsidy M EUR	1,887
Ticket share of OPEX	48%
No of buses	1,233
Bus hours (1000)	4,296
Bus km (1000)	111,106
Bus stops	15

Source: Movia, 2020.

As well as the bus operation, Movia also manages a number of local train operations.

The control room at Movia is mostly focused on handling disruptions from a customer perspective. This typically relates to sudden traffic conditions along the bus routes. Examples are accidents blocking the road, temporary blocking of a road due to construction work, weather, and so on. The control room also acts as a contact point for the police to public transport. Examples include the temporary stop of traffic, as required for police work, and using bus drivers in the search for missing persons, and so on.

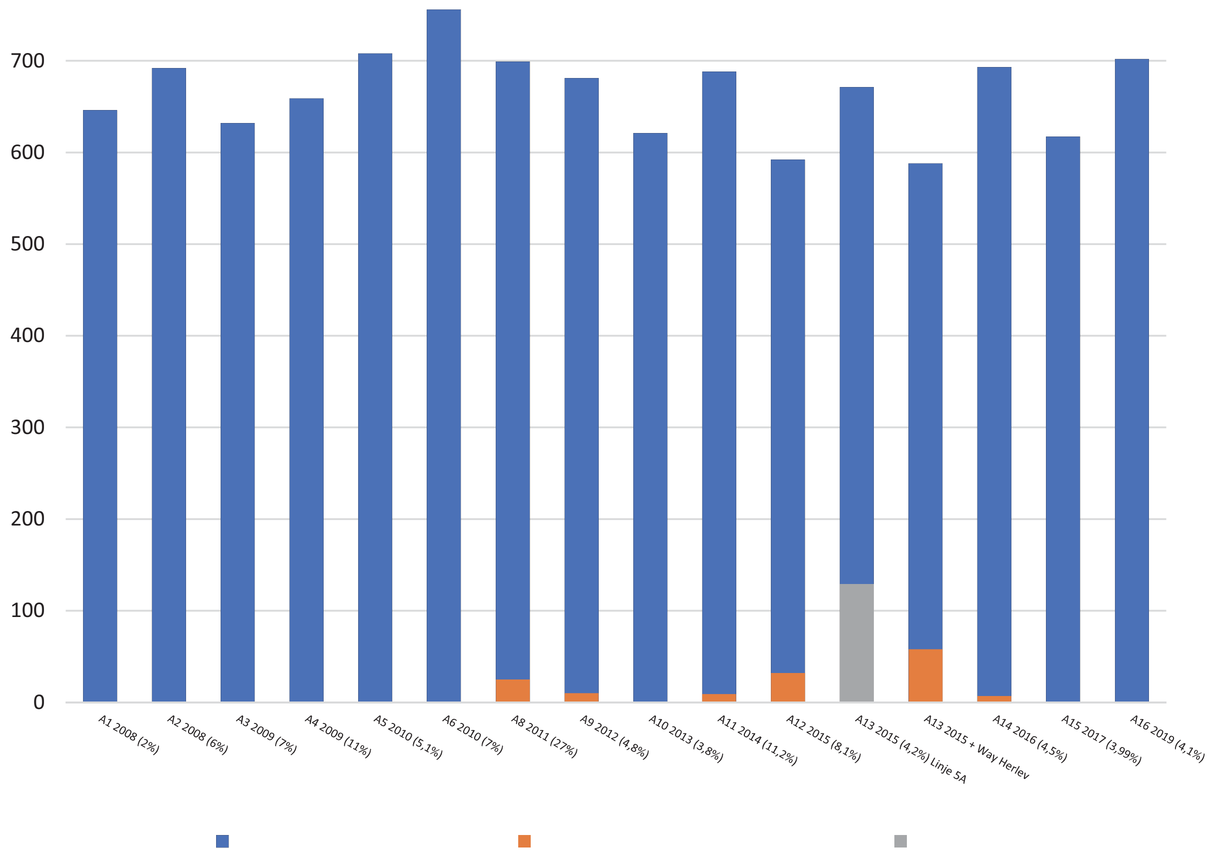
Buses in operation contain real-time equipment and customer information screens. From the control room, specific information in relation to deviations from normal operation, can be transmitted to bus information screens and to signs at the bus stops and stations affected.

Typically, one to two people are on duty, plus an operational manager. In total, the organization has around 10 people to handle a seven-day operation.

Movia publishes some key statistics for its public operator contracts informing the PTO market about what it historically takes to win a bus operation contract. See Figure 26 below.

It is interesting to see that the cost per hour is quite similar today to what it was back in 2008 (EUR 100 is around DKK 745).

FIGURE 26. **Movia bus cost per hour in DKK**



Source: https://www.moviatrafik.dk/om-os/statistik-og-noegletal

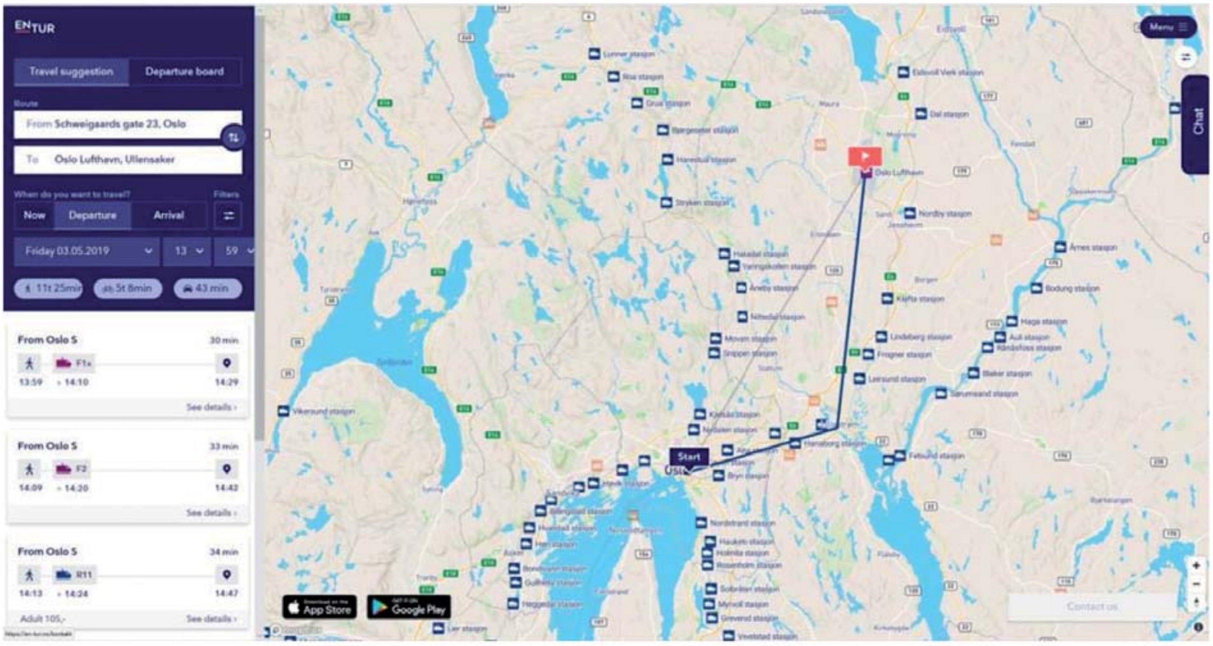
Note: Realized cost per hour on bus contracts since 2008, on bus contracts. Blue: basic payment. Grey: payment for bus takeover. Orange: incentive payment.

ENTUR NORWAY

Norway probably leads the migration to NeTEx, as its new national planning and ticket sales platform ENTUR uses NeTEx for all data exchanges with the associated public transport operators and administrators. Detailed information is provided at https://en-tur.no/.

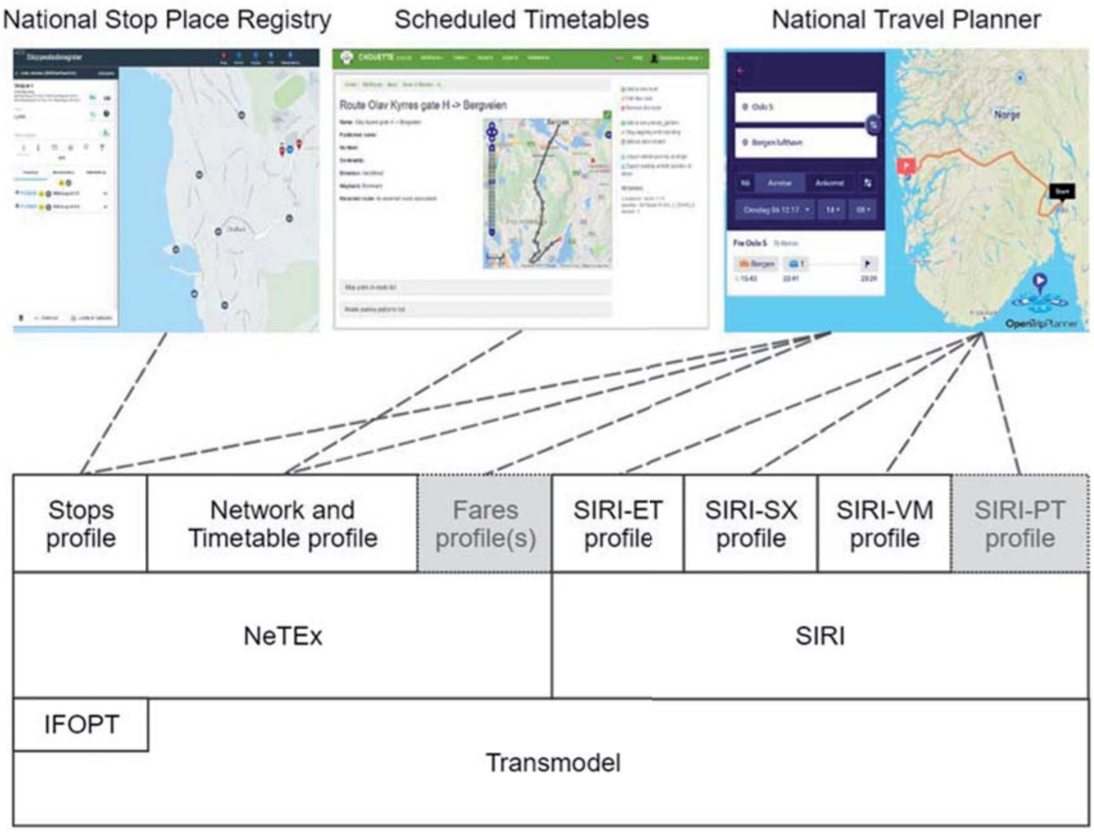
Another interesting point is that ENTUR uses open source code for its solutions. Paradoxically, it is a non-EU member country, yet it is a pioneer in adopting the new EU standard for open mobility data. Norway has adopted the multimodal travel information services (MMTIS) regulation within its own laws. Its real-time data is exchanged in SIRI format.

FIGURE 27. A sample journey planner page in Entur App



Source: Entur AS, 2020.

FIGURE 28. The full transmodel standard stack in operation at Entur AS, Norway



Source: Entur AS, 2020.

All regional PTAs in Norway make their static planning data available in the NeTEx format and follow a common Nordic profile. All changes and deviation from the static data (real-time data) are communicated using the SIRI standard.

STRATEGY AND 'BUILDING BLOCKS' FOR REAL-TIME SYSTEMS

This chapter outlines the recommended strategy for implementation of a real-time system in the BBSK. Full discussion of subsystems and of the steps in the initial planning and sizing of the real-time system are given as Annex 4 in a separate Annexes document. Recommendations for a digital channel strategy (by which various channels, real-time and other information, are given to travelers and potential travelers) are presented in Annex.[35]

BASIC CONFIGURATION

First, the bus is connected through an antenna, which is often a combination of a global positioning system (GPS) and a global system for mobile communications (GSM). From there, cables go to the vehicle communication gateway (VCG),[36] which is the computer that receives and distributes data. From there they go to the MADT,[37] which is the control unit that handles the different applications and services in the bus. This basic configuration allows most other features to be straightforwardly designed into the system. The MADT should provide user-friendly and seamless interaction to bus drivers to minimize distraction. This is combined with an IP voice connection to the PTA control room, which can also input the information.

EXPANSION SCENARIOS

Once the bus is connected, it allows for many expansions and features. It is especially here, that the choice of ITxPT standard as the system architecture, comes into its own right. The PTA / PTO will not be locked into a proprietary setup and may, subsequently, easily expand the system.

An obvious extension is to integrate with the destination sign, as this requires no more hardware than VCG and MADT, and thus can often be handled with cabling and an application on MADT (see Destination sign management in Annex 4).

Voice announcement (VA) and voice over internet protocol (VoIP) often require an audio module. This can be part of the VCG, but it depends on the supplier. Nevertheless, the bus's microphone must be integrated at the driver's seat, and the foot pedal or another on/off breaker, must be in place as well. The extension is close to the basic configuration on the hardware side, in terms of CAPEX, and it is therefore logical to have it as an additional extension. It is by VoIP that having a manned operational monitor is achieved. Likewise, the VA, along with a combination sign, is an affordable way to show passengers where the bus is headed. In Annex 4, see Voice Announcement - VA on VA and Voice message on the communication module.

Automatic passenger counting (APC) and digital passenger infotainment screens (DPIS) are costly in hardware and installation and are therefore often the last to be added.

APC is handled today using a stereo camera at each door. However, projects are underway in Norway where the company FourC AS[38] is working on an algorithm that, using the Wi-Fi modem, calculates the number of passengers using their mobile phones. By waiting to invest in traditional APC solutions, a significantly cheaper solution can be expected on the hardware side.

DPIS, like ACP, is costly on the hardware and installation side. However, the advantage is that if a business case containing commercial advertisements is built up, then the solution can be self-financing (an infotainment system (DPIS) can be financed partly or wholly by attracting commercial advertisements). The different configurations for DPIS are described in Annex 4 under Digital Passenger Infotainment Screens – DPIS.

CAPEX AND OPEX COST DRIVERS

This section describes what features of a real-time system are the main cost drivers of CAPEX and OPEX.

In bus

First and foremost, the driver for CAPEX is whether the bus-IT equipment is installed from the factory, or retrofit at the PTO's depot, or is a semi solution where the factory has installed cabling and antenna and the depot only needs to install the VCG and MADT. As a rule of thumb, we can estimate installation for a basic setup in each bus to be three to four hours. With expansions this rises to eight to twelve hours per bus.

With a proper description in the tender of (for example) pipes for cabling (always ask for an extra 36 millimeter empty pipe!) and a rack shelter for bus-IT, then there is a lot to save on CAPEX.

At stops and stations

The primary driver for CAPEX is whether there is power at the location or not. If there is power, the PTA can choose among all sorts of digital information screens and pylons. If not, it basically needs to find a solution with solar panels, often combined with a battery. In addition to this solution, the PTA will have to build up some sort of monitoring of the battery and operational processes, to change them at regular intervals (influencing OPEX).

The second issue for CAPEX is about data connection and bandwidth. The solution does not require high levels of data transfer, but it must be stable. In an urban scenario, the modem will typically call for data every 60 seconds, because the frequency of buses is often down to 10 minutes of operation between buses on the same line. In a rural bus line, where the frequency is perhaps 60 minutes between the buses on the line, the modem only needs to update approximately every 10 minutes (this also has an impact on the power consumption, in for example, an e-paper solution). Once these two elements are in order, it is only a matter of which level the PTA wants to offer to their passengers.

Control room at PTA

It is often advantageous to have a wall with several screens that all the operators can see. The number of screens depends on the number of features that everyone should be able to see at the same time.

Often there is one screen with:

- Journey overview
- Line overview
- CCTV at stations and bus stops
- Disposable screen with, for example, a map as a placeholder

Besides this wall with screens, the control room also has several operator spaces. These are identical, as all the operators should be able to handle each other's tasks.

What each individual operator must handle is determined by the standard operating procedure (SOP). But every workplace should contain three screens with a keyboard, mouse, microphone (VOIP), and telephone, with access to the various features of the real-time system.

FIGURE 29. Control room in Malta Public Transport (400 Bus Operation)

Source: https://mtip.gov.mt/en/Government/press%20releases/Pages/2018/PR181611.aspx

The first line is the wall of information screens. The second line is a series of operator spaces that should be one more than the number intended for peak loads, so that a new entrant can set up his workplace before the outgoing operator switches off. The third line contains the operations officer—who leads the operation.

INTRODUCTION TO TICKETING FOR PUBLIC TRANSPORT

Digital ticketing schemes or smart ticketing schemes are being rolled out in public transport ecosystems everywhere. The objective is to make the payment for public transport as seamless as possible, to lower the barrier of opting-in for public transport. Another objective is to reduce the cost of selling traditional paper tickets, and the handling of cash at ticket-sales points, onboard vehicles, and from conductors.

However, as no standards have been mandated, all systems can sell tickets within their domain, but passengers going through modalities with different fare structures, need to understand and use new ways of ticketing. Only a few countries (The Netherlands, Denmark, Switzerland, and Norway) have so far managed to introduce ticketing schemes with national coverage. The technologies are available, but the complex governance and lack of guidance and standards have been shown to be formidable barriers for the advent of more national ticketing schemes.

The following areas will need to be considered by the BBSK, when planning its transition to a smart ticketing system. These areas are detailed in Annex 6.

- What to consider when embarking on a smart ticketing program
- Evolution of ticketing methods
- Smart ticketing schemes—what to consider
- The concept of the ticket in the 'cloud'

Meanwhile, the following are immediately relevant to the BBSK, and are discussed below:

- BBSK strategic considerations
- Planning a smart ticketing project and next steps

BBSK STRATEGIC CONSIDERATIONS

In the BBSK objectives description (within Chapter 1) three points are focused on ticketing:

- Digitalization of ticketing (payment by bank card, possibility to purchase ticket online, or in the mobile application—to have control and overview of passenger sales and the ability to do analysis)
- Simple and accessible ticket purchase
- Higher fare revenue

The strategic design should deliver on these objectives, but there are several areas to be considered:

- Which fare model should be used? Today, it is kilometer-based, and sales are predominantly from the bus driver at the bus entrance.

- The choice of ticketing sales channels will have an influence on planning for timetables, as time needs to be set aside for ticketing, if there is a driver action (sale of cash tickets or finding the right price to be charged from a smartcard, as today).

- How do the various smart ticketing schemes deliver regarding an overview of tickets sold and ticketing data for analysis?

- Is kilometer-based ticketing a fair pricing model or should the change to a smart ticketing scheme include a revision of the fare model? This can also include ways to encourage travel in off-peak hours, day/week/month/ passes, tourist passes, capping, and so on.

- Can a smart ticketing portfolio increase fare revenue, or does that require higher cost per ticket, irrespective of technology?

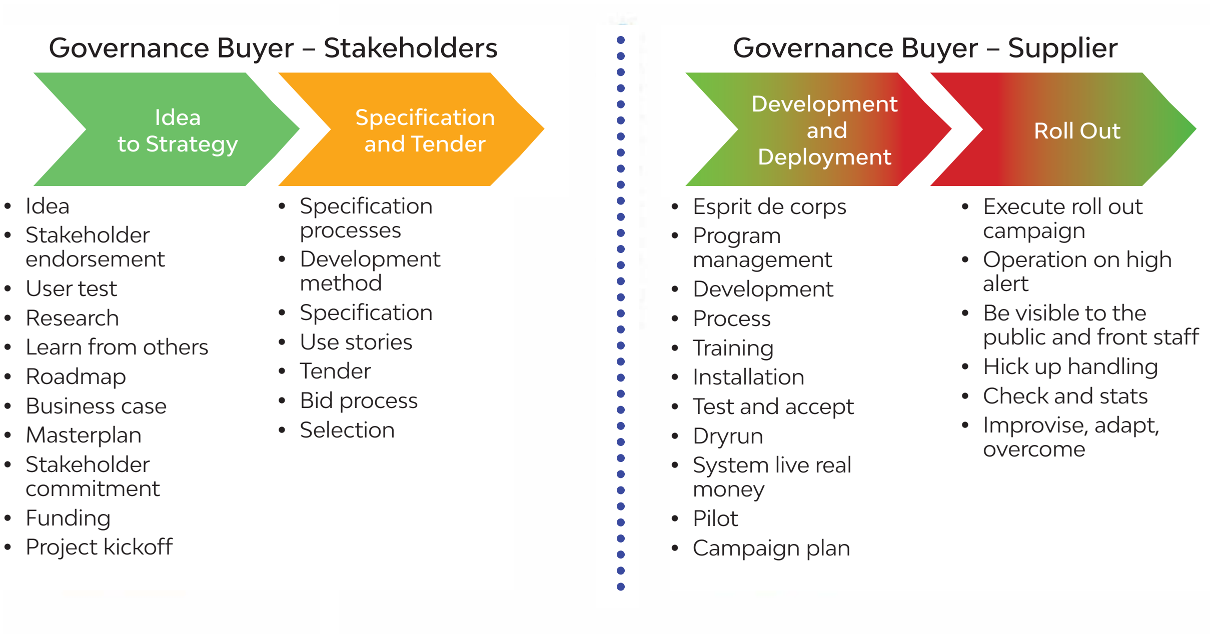
- Can the use of public transport be increased by integrating it with city public transport systems in the region and the regional train, for the planning and seamless purchase of multimodal tickets across the region?

- Can integration with third-party public transport buses operating in the region be delivered?

PLANNING A SMART TICKETING PROJECT AND NEXT STEPS

Having managed to agree on the principles for cooperation to create a smart ticketing system, the focus then shifts to specification, procurement, and implementation.

FIGURE 30. The implementation phases of a ticketing project



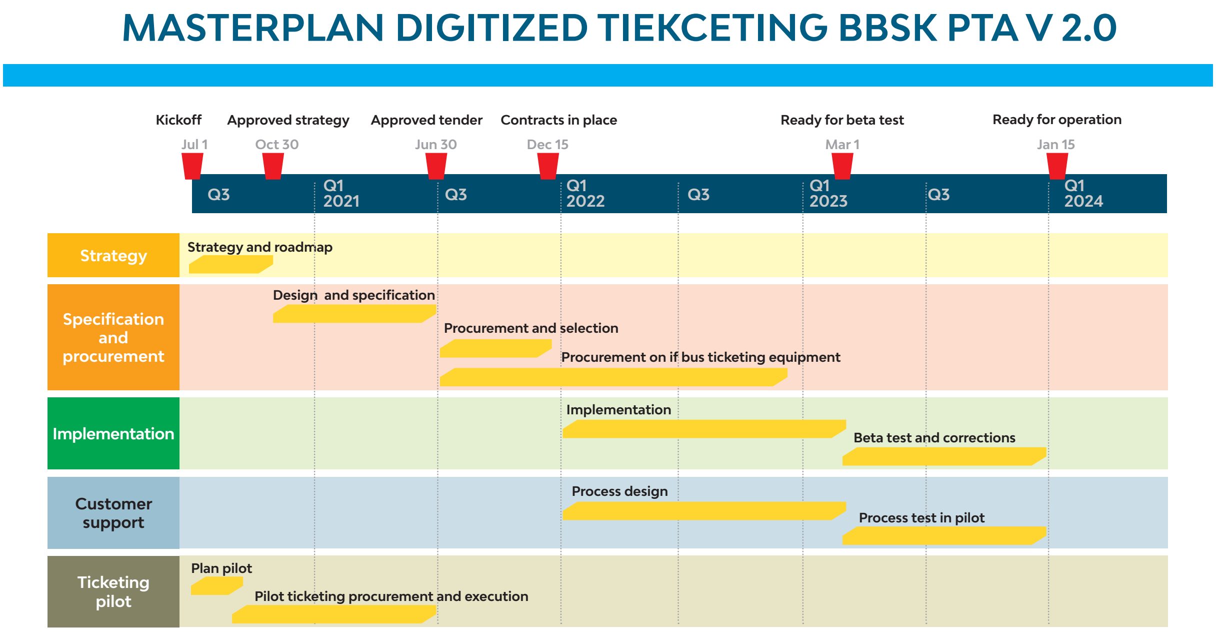
Source: SFMCON ApS, 2017.

The history from other projects shows that the implementation of multimodal smart mobility can be a bumpy ride. It is necessary to be careful and manage the risks inherent in reducing the investment, and the risks inherent in the creation and implementation of these complex systems.

Masterplan for digitalizing ticketing for the BBSK PTA V2.0

Please see below to find a suggested masterplan for the ticketing digitalization, as part of the overall masterplan for the sustainable mobility plan, in line with the CuRI Public Transport Digitalization project.

FIGURE 31. Suggested masterplan for a ticketing project including a pilot and the customer support processes



Source: Authors, 2020.

Strategy, design, and specification are aligned with the plan for the approved tender for public transport operators, as in-bus ticketing will need to be specified as part of the bus operation procurement.

The procurement process is split into two. One relates to the ticketing system and elements not physically installed in a bus—back office, digital ticketing solutions (Web, application), handheld validation tools, and so on.

The other procurement includes in-bus equipment, according to approved strategy and design (cash ticket sales equipment, validators, and others). This is part of the in-bus equipment specification in the bus-operator procurement.

Dependent on the choice of ticketing methods, time is needed to implement the ticketing systems and test them before going operational at the beginning of 2024. Hence, the system parts of the procurement have a more aggressive schedule to allow for a safe implementation plan.

A beta test is assumed to take place during 2023 to validate the correct operation of ticketing. A customer support track is identified, to cater for the development of the processes necessary to provide customer support for the chosen digital ticketing schemes. Finally, a pilot track is included for testing various ticketing technologies and gaining feedback from the test users.

Both the beta test and pilot test require a willingness from the current operators to run parallel ticketing schemes.

The masterplan shows that the ticketing project, as part of the overall plan, needs to be kicked off now to meet the overall objectives and deadlines. As it is unlikely to go from pure in-bus sale of tickets for cash or using prepaid cards to pure digital ticketing methods, at least the cash purchase of tickets should also be available in the new buses. The new element is that the in-bus ticket systems should deliver ticketing data to the PTA dynamically and utilize open data formats.

Checklist for digitizing ticketing in the BBSK as part of the new operation in January 2024

1. What is the starting point? Research of current ticketing methods is needed.

2. Fare structure strategy: Kilometer-based, as today, or other schemes: Zones, straight line (as the crow flies)? Incentives for commuters, tourists, and others? Day, week, monthly pass, and/or capping?

3. Strategy for handling in-bus ticketing purchase?

4. Strategy for conversion from in-bus ticketing purchase for cash to digital channels, including validation and control, user test, best practice, and business case analysis

5. BBSK smart ticketing strategy and road map

6. BBSK smart ticketing specification and tender

Ticketing strategies' impact on other elements of the BBSK PTA V2.0

1. **Planning:** Percentage of ticket sales transactions by the driver determines the 'dwell time' at a bus stop to be included in the static journey planning.
   The quality of planning data for routes and stop points is important to ensure correct ticketing calculations—especially if based on pay-as-you-go ticketing methods.

2. **Customer Service:** Digital ticketing schemes reduce manned sales transactions. However, digital solutions require easy access to customer service for questions, support, and complaints handling. Processes to support digital ticketing schemes will need to be developed.

3. **Control PTOs:** In-bus ticketing equipment, validation, and required driver ticket handling processes, all need to be included in the bus operator procurement specifications.

4. **Finance:** Use of credit cards and other digital means of payment requires financial supervision and handling of incomplete payment transactions.

5. **Commercial:** Travel planner, fare calculation, and ticketing integration on digital channels (application and Web) need to be delivered. There needs to be information for the public about the new ways of paying for public transport.

6. **Strategic:** Multimodal fares between the BBSK regional buses, city buses, and regional train services.

7. **Organizational:** The issues of fare integration and the role of a clearing house will need to be considered and assessed.

COST OF INVESTMENT AND OPERATION – CAPEX AND OPEX

CAPEX AND OPEX

To build a credible and valid investment projection, prices are based on input from suppliers in Europe. For each component type, prices of two, and preferably three, different suppliers have been obtained. In addition to prices, installation times have been collected and validated on the individual solutions.

All the results are grouped together in a model, to be able to conduct impact simulations distributed across CAPEX and OPEX, depending on which functions are selected.

The model has been validated by one (Danish) PTA and the factual results of a 2019 tender. As such, we have a pricing model which reflects the current state of the real-time system market. It should be noted that the concept of real-time systems is still a young, dynamic, and immature market. Also, the effect of, for example, recent standardization, such as ITxPT, on solution mix and prices can change price points in the coming years.

ONBOARD EQUIPMENT, REAL-TIME BACK OFFICE, AND CONTROL ROOM

Based on the **configuration matrix** at the end of this chapter, and the **strategies and building blocks for real-time systems** (see Annex 4[39]), three investment scenarios are priced.

- **Minimum—basic real-time**—"Where is the bus in time and space in relation to the static timetable?" For this, ANT, VCG, MADT, and the associated features according to the configuration matrix are included.
- **Medium scenario**—an extension to the basic real-time that includes the purchase and installation of microphone and speaker, and the associated functions according to the **configuration matrix** below
- **Maximum** solution—includes items such as APC, DPIS, and CCTV. Again, refer to the **configuration matrix** below and the features available.

TABLE 2. Operation room and back-office system handling 500 buses and 62 spare buses (one spare bus per eight buses in operation)

	CAPEX HIGH	OPEX HIGH	CAPEX LOW	OPEX LOW
5 operator setup + back office	142,000	231,000	112,000	177,000

Source: Authors, 2020.

It is recommended to add 15% for general risk to all these figures.

TABLE 3. Onboard solution for 562 buses

Prices in EUR ex VAT	CAPEX HIGH	OPEX HIGH	CAPEX LOW	OPEX LOW
MINIMUM	1,062,000	156,000	780,000	115,000
MEDIUM	1,421,000	295,000	1,040,000	191,000
MAXIMUM	5,902,000	924,000	4,696,000	679,000

Source: Authors, 2020.

It is recommended to add 15% in general risk to all these figures.

STOPS AND STATIONS

Based on **stop types,** three levels of stops are priced (see Annex 4).

- **Stop in a line with no other connection**: This stop type is configured with an analogue stop poll that is prepared for a digital solution. The BBSK estimates the total to be 2,000 stops.
- **Stop with more than one line**: This stop type is configured with an e-paper solution. The BBSK estimates the total to be 3,100 stops.
- **Stop or stations with multimodal travel options:** This stop is configured with several pylons on each stop. The BBSK has estimated the number of pylons needed to be 600. However, to date, a number of stations have not been provided with pylons.

TABLE 4. Stops and stations

Prices in EUR ex VAT	CAPEX HIGH	OPEX HIGH	CAPEX LOW	OPEX LOW
2,000 analogue stops, prepared for a digital solution	3,348,000	254,000	2,714,000	204,000
3,100 stops with e-paper	10,717,000	837,000	9,003,000	699,000
600 pylons	5,580,000	436,000	3,947,000	305,000
Total	19,645,000	1,527,000	15,664,000	1,208,000

Source: Authors, 2020.

It is recommended to add 15% for general risk to all these figures.

CONFIGURATION MATRIX

TABLE 5. Configuration Matrix

	HARDWARE IN THE BUS							
Functions in back office	GPS/GSM ANT	VCG	MADT	CCTV	APC	Microphone	Speaker	DPIS
Map module	X	AB	AB					
Look up modul	X	AB	AB					
Communication modul	X	AB	AB			AB	AB	
Journey overview	X	AB	AB					
Line overview	X	AB	AB					
Bus overview	X	AB	AB					
Alarm modul	X	B	B	(X)		X		
CCTV modul	X	X		X				
Statistics modul	X	ABC	ABC		ABC			
Reports modul	X	ABC	ABC		ABC			
Administration modul	X	ABC	ABC		ABC			
System status	X	ABC	ABC		ABC			
Functions in the bus, driver								
Communication modul	X	AB	AB					
VoIP			B			X	X	
Destination sign management	(X)	A	A					
Functions in the bus, passenger								
Voice Announcement	X	A	A				A	
Digital Passenger Information	X	A	(A)					A

Data integrated in the real-time system from: A = Planning system; B = Dispatching system; C = Ticketing system.

Source: Authors, 2020.

The specification as shown in the configuration matrix is at a basic level of detail. More detailed specifications for the procurement of the IT-infrastructure will be provided as part of CuRI—Year 2.

‘ROAD MAP’ FOR THE PATH TO IMPLEMENTATION

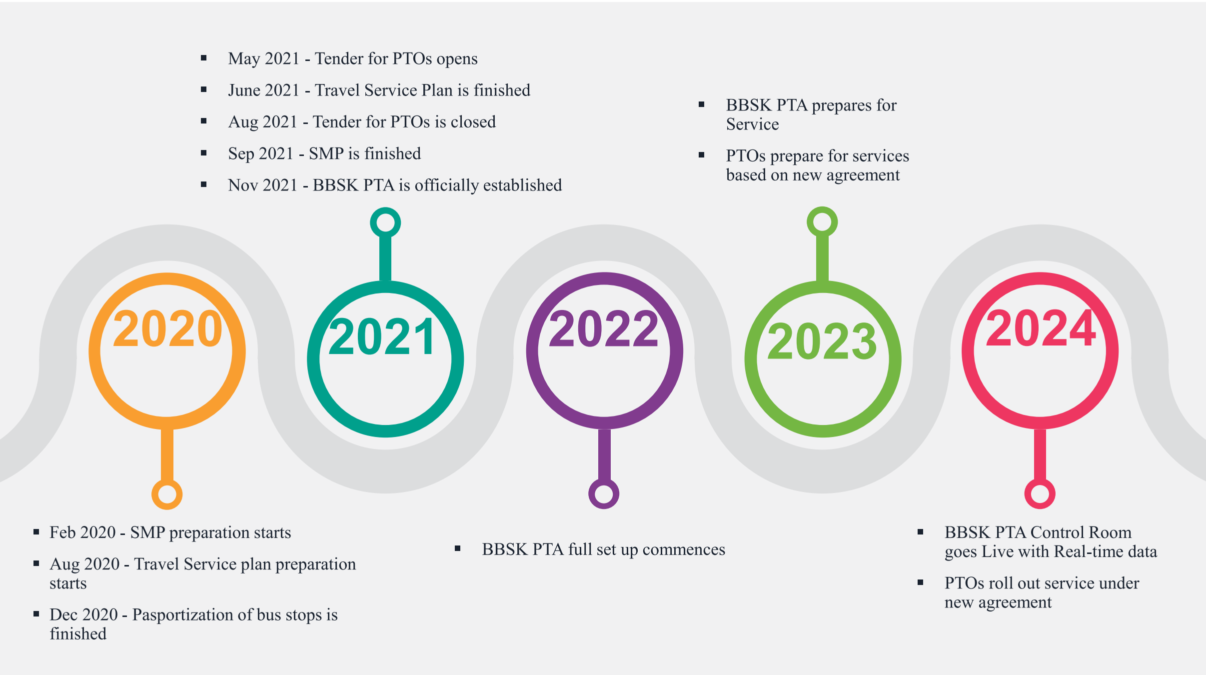
CONTEXT: CONFIRMATION OF THE BANSKÁ BYSTRICA REGION'S SUSTAINABLE MOBILITY STRATEGY AND PLAN (SMP)

The review and adoption of the BBSK's Public Transport Digitalization Strategy will be done in the context of confirming and finalizing its Sustainable Mobility Strategy and Plan (SMP) (from 2020 Q1 to 2021 Q1). The digitalization of the BBSK public transport is an integral part of the timeline for the SMP.

TRANSITION TO NEW GOVERNANCE STRUCTURE

Building on the strengths, and taking advantage of the opportunities previously identified earlier, requires not just investment but restructuring, so that the potential of investment can be fully realized. Below the timeline is shown for the setup of the new PTA V2, (with a proper PTA-PTO governance model that contains new bus operator contracts to be operational in January 2024).

FIGURE 32. BBSK PTA creation timeline



Source: BBSK Office, 2020.

CURI – WIDE STRATEGY ACTIONS

Confirm Standards and Data Exchange

- Transmodel standards and terms are used for the entire program
- Static and dynamic data are made available as specified by (EU) 2017/1926
- NeTEx and SIRI profiles, according to the Slovak Republic authorities, are mandated as a means of interface between all actors. In case the Slovak Republic's set of profiles are not officially adopted, profiles following other leading EU countries are assumed.
- OPRa—public transport operating the raw data and statistics exchange, with the main focus on the identification of public transport raw data to be exchanged, gathered, and stored in order to support study, control, and improve the operational service delivered
- The control room expects other transport actors and road authorities to use open data. Other standards, such as Google transit feed specification (GTFS) or closed vendor interfaces, can only be used following program level approval, including a plan for living up to the BBSK program open standards.
- The data exchange will be governed by protocols that will be developed during year 2, as part of the PTA's institutional development. The protocols will regulate the data format and confidentiality.

Make System strategy decisions

- Decide between the two options on the ownership of real-time equipment in buses:

    a. Owned by the PTA: Real-time system components procured by PTA. PTOs are obliged to install, operate, and partner in the maintenance of this equipment in contracted buses.

    b. Owned by the PTO: Real-time system components procured by the PTO—living up to specifications in PTA procurement for bus services and the interfaces to the PTA—for use in the control room and for passenger information.

The World Bank team recommends 'option a', where real-time (and ticketing) equipment is owned by the PTA. This ensures that the PTA is in full control of the whole data path. It also eliminates the need for compatibility testing with the PTO-selected real-time solutions, and ensures that passengers will see exactly the same information screens across the fleet of buses. It also makes it easier for the operators to bid on the bus contracts, as they do not need to have expertise in finding vendors for real-time systems that meet the BBSK PTA requirements.

Financially, the CAPEX of real-time (and ticketing) equipment will be the BBSK PTA's responsibility, confining the operating cost of bus kilometers/hours to classic bus operating functions only.

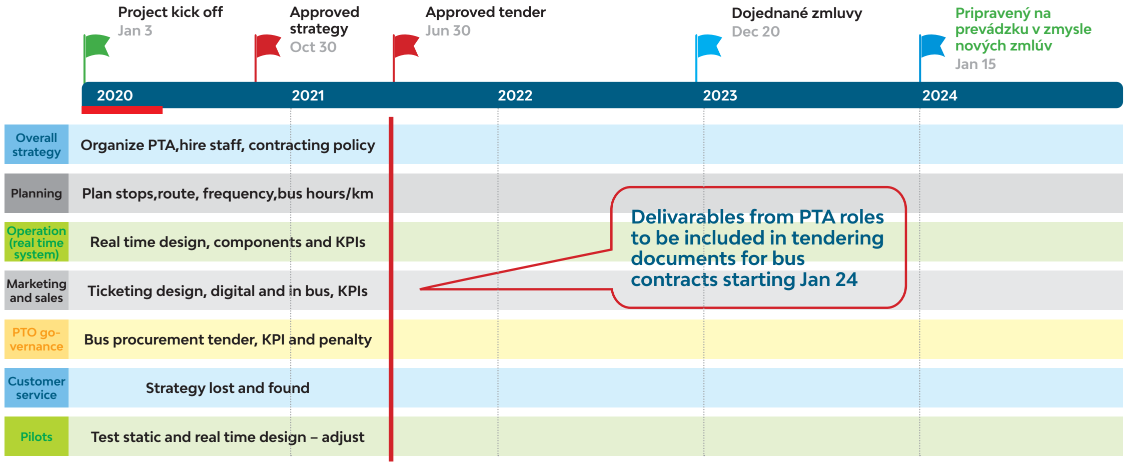
- Evaluate and decide on system software.

Some software for parts of an open Transmodel architecture are available in open source formats. The program should evaluate, for each system component, whether an open-source application is available, practical, and recommended by other public transport administrations.

KEY DELIVERABLES NECESSARY FOR BUS OPERATOR (PTO) TENDERING DOCUMENTS

Another vitally important element is the preparation of the PTO documents. There are key deliverables required before this can happen, and these are shown in Figure 33 below. 'Swim lanes' have been identified for the preparation work for the various functions of the BBSK PTA.

FIGURE 33. Deliverables from the PTA roles needed for the operator tendering

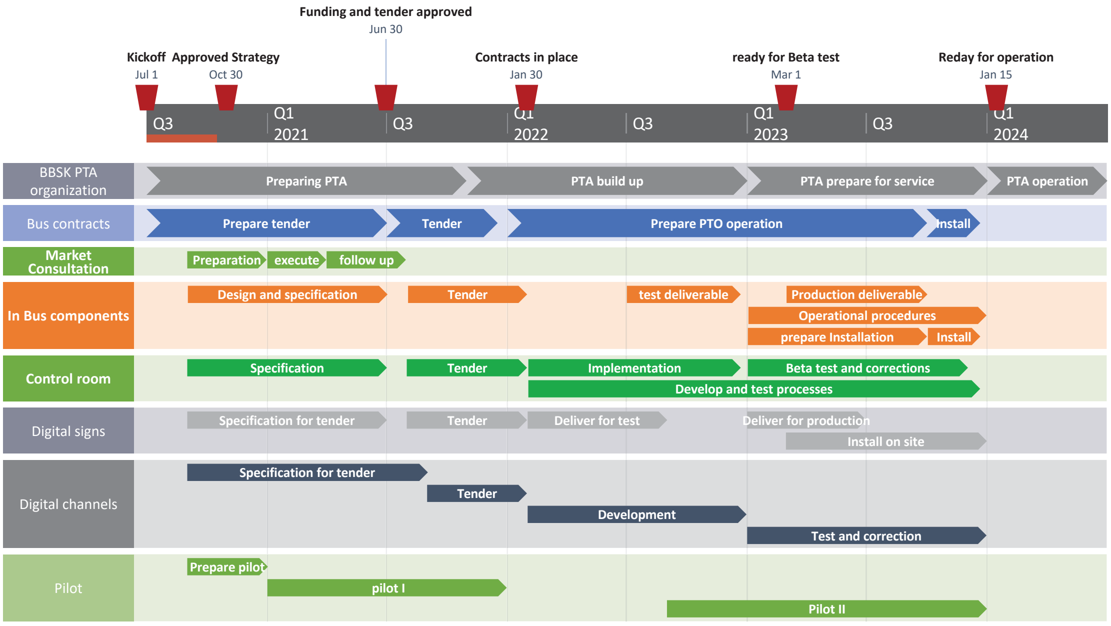


Source: Authors, 2020.

OVERALL MASTERPLAN FOR THE BBSK REAL-TIME SYSTEM IMPLEMENTATION

A key element of the new Public Transport Digitalization Strategy is the implementation of a real-time system. The World Bank team recommends careful planning of the real-time system implementation as illustrated below.

FIGURE 34. Masterplan for the BBSK Real-time Implementation



Source: Authors & the BBSK Office, 2020.

The real-time implementation project is illustrated in the context of the BBSK PTA organization build up and the bus contract main phases.

Some major considerations within Implementation

All digitalization projects have two major **deadlines**, which in the case of the BBSK project, will be as follows:

- **Approved tender specification summer 2021:** All operational plans and KPIs to deliver regional public transport in 2024 will need to be defined. Also ticketing methods and in-bus equipment that needs to be included in the bus tender specifications, will need to be defined. Before tendering, it is required that funding for the CAPEX part is secured and the budget for the OPEX is accepted by the BBSK PTA.

- **Ready for operation January 15, 2024:** This is a hard deadline which, for obvious reasons, needs to be kept, and all risk management of the program should focus on ensuring that meeting this deadline is the top priority.

Bus contracts: For the bus contracts, special focus should be put on the length of time required to install real-time (and ticketing) equipment in the buses before the operational start. The PTOs will naturally try to keep the delivery time of the new buses as close to the operational start as possible. The BBSK needs to minimize the payment of the cost of buses that are not in active duty. The amount of buses (500+) will put constraints on capacity and on qualified and trained personnel.

Market consultation: The World Bank team recommends that market consultations are held before tendering commences. The objective is to inform the market of the BBSK's intentions and strategies. At the same time, actors can ask questions and the BBSK will ensure that both questions and answers are made public.

In-bus components test deliverable: This should be identified for the pilot operation and development of operational procedures for drivers, maintenance, and other PTO and PTA procedures. The pilot installation (even if not in the new buses) will provide input to optimize the full bus fleet installation.

Control room installation: Most of the project work relates to receiving, and learning how to use, the back-office systems of the supplier who won the tender. This includes the development of operational procedures and processes, and the test of these, using simulations and pilot setups, with real-time components for stops, stations, buses, and digital channels.

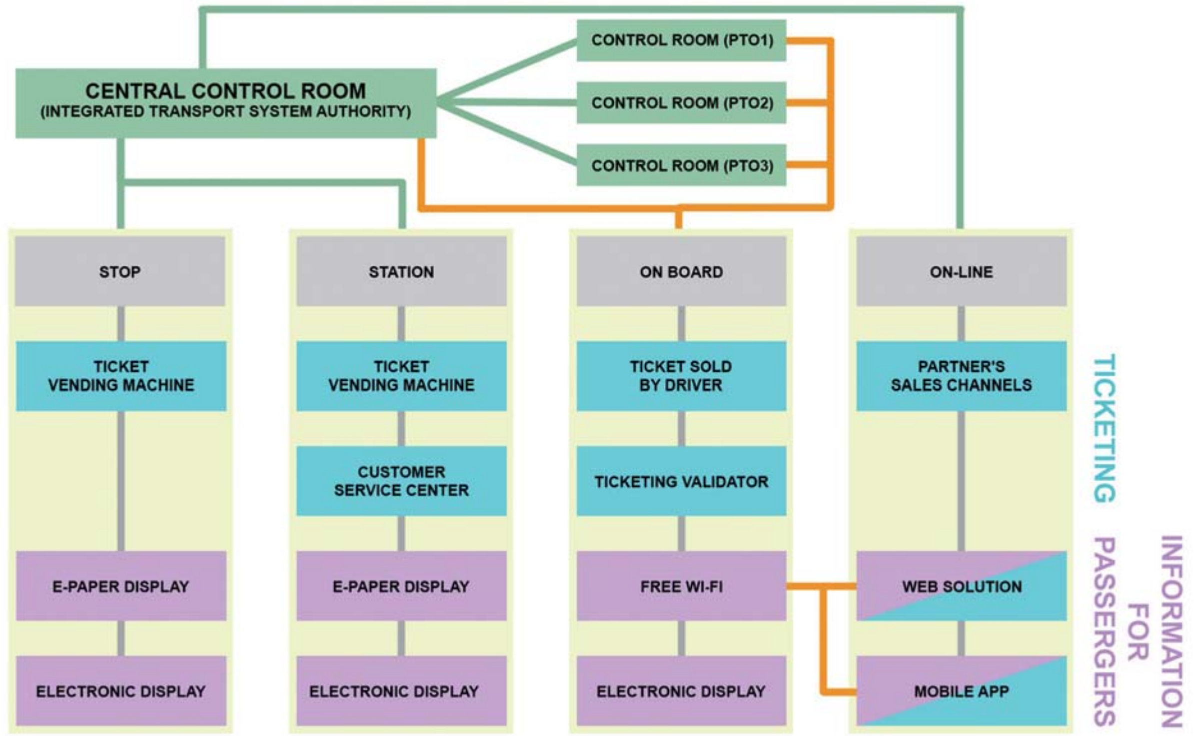
Digital signs test deliverable: It is recommended for the different digital sign components to be included in the pilot and to be used for practice and training. Also, the installation time can be measured for planning the full-scale installation.

A key risk area: A special focus should be on securing sufficient time to get all the installations complete for the final test before the operational start in January 2024. Weather conditions for digging should be factored-in, where applicable. As some of the signs will be installed well ahead of time, ways of concealing them, plus protection against vandalism, should be considered.

Digital channels: While the emphasis should be on functionality and user-friendliness, it is advised to use an agile approach, where operational flaws and missing functions can be added quickly, even after the start of production. For the testing of digital channels, it is recommended that the data provided by other tests and in the pilot be used to validate the digital representation of the physical operation.

Customer contact points: The BBSK has made a good illustration of the various customer contact points related to schedules, real-time information, and ticketing.

FIGURE 35. **Passenger Contact Points for Ticketing and Information**



Source: BBSK Office, 2020.

Annexes to this report are available only in electronic form at:
https://www.bbsk.sk/%C3%9Arad/Organiza%C4%8Dn%C3%A9jednotky%C3%9AraduBBSK/OddelenieCatching-UpRegions/Komponent1.aspx

NOTES

1. Source: The BBSK CURI Action Plan, available at: https://www.bbsk.sk/%C3%9Arad/Organiza%C4%8Dn%C3%A9jednotky%C3%9AraduBBSK/OddelenieCatching-UpRegions/Komponent1.aspx
2. Available at: https://www.bbsk.sk/%C3%9Arad/Organiza%C4%8Dn%C3%A9jednotky%C3%9AraduBBSK/OddelenieCatching-UpRegions/Komponent1.aspx
3. Statistical Office of the Slovak Republic, Census of Population, Houses and Dwellings, 2021. Note: Data from the Atlas of Roma Communities 2019 show much higher share: 12.5% to 17.5%.
4. The website of the Banská Bystrica Regional Government is: https://www.vucbb.sk/eng.aspx and https://www.BBSGR.sk/
5. The city government's website is: http://eng.banskabystrica.sk/
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7. The Ministry of Transport and Construction website is: https://www.mindop.sk/en
8. The ŽSR website is: https://www.zsr.sk/
9. The ZSSK website is: http://www.slovakrail.sk/en.html
10. Available at: https://en.wikipedia.org/wiki/Rail_transport_in_Slovakia
11. Including track no. 900 - Čiernohronská railway.
12. Ministry of Transport and Construction of the Slovak Republic, https://www.mindop.sk/files/statistika_vud/zd_osobna.htm. Note: However, overall public transport fell by 7.4% during the period.
13. Real-time rail passenger service map is: http://mapa.zsr.sk/
14. The OLTIS Slovakia Ltd. website is: https://www.oltis.sk/
15. The website for real-time arrival and departure passenger train boards for each station is https://aplikacie.zsr.sk/infotabule
16. Information on ticket types and fare types was taken from the ZSSK website.
17. Available only in electronic form at: https://www.bbsk.sk/%C3%9Arad/Organiza%C4%8Dn%C3%A9jednotky%C3%9AraduBBSK/OddelenieCatching-UpRegions/Komponent1.aspx
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19. Ditto
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21. Available at: https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2012/56/20190701.html
22. News item is at https://zad.sk/poziadavka-dopravcov-naplnena-nebola-v-nr-sr-nepreslo-navrhovane-znizenie-veku-vodicov/
23. See https://europa.eu/european-union/eu-law/legal-acts_en
24. As of December 31, 2020; unemployment rate in the Slovak Republic is 7.57%. Source: UPSVAR, https://www.upsvr.gov.sk/statistiky/nezamestnanost-mesacne-statistiky/2020.html?page_id=971502
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26. Data calculated and mapped specifically for the work in this report. Original data provided by the Ministry of Transport of the Slovak Republic/Institute of Transport Policy.
27. See https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/755975/FinTech_in_CEE.pdf
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29. Available only in electronic form at: https://www.bbsk.sk/%C3%9Arad/Organiza%C4%8Dn%C3%A9jednotky%C3%9AraduBBSK/OddelenieCatching-UpRegions/Komponent1.aspx
30. Page 198 tender for bus traffic in Copenhagen: https://www.moviatrafik.dk/media/7631/udbudsmateriale-a19-af-23-januar-2020.pdf
31. https://www.uitp.org/sites/default/files/European%20Bus%20System%20of%20the%20Future.pdf
32. https://www.youtube.com/watch?v=aa815DDA8Sg & https://www.youtube.com/watch?v=cmAORN5-J58
33. https://www.uitp.org/itxpt

34. Available only in electronic form at: https://www.bbsk.sk/%C3%9Arad/Organiza%C4%8Dn%C3%A9jednotky%C3%9AraduBBSK/OddelenieCatching-UpRegions/Komponent1.aspx
35. Both, Annex 4 and Annex 5, are available only in electronic form at: https://www.bbsk.sk/%C3%9Arad/Organiza%C4%8Dn%C3%A9jednotky%C3%9AraduBBSK/OddelenieCatching-UpRegions/Komponent1.aspx
36. S01—Installation requirements, specifications v2.1. page 8, 14, and 36.
37. S02P08 v2.1.0 MADT page 6.
38. https://www.fourc.eu/news-pfa-patent
39. Annex 4 is available only in electronic form at: https://www.bbsk.sk/%C3%9Arad/Organiza%C4%8Dn%C3%A9jednotky%C3%9AraduBBSK/OddelenieCatching-UpRegions/Komponent1.aspx