UITP ADVANCING PUBLIC TRANSPORT

ACTION POINTS

CAPTURING DIGITAL VALUE WITHIN PUBLIC TRANSPORT

MAY | 2024

INTRODUCTION

Digitalisation is often described as the integration of digital technologies into everyday activities. In the sphere of public transport, digitalisation can mean using technology and data to update business processes, generate new revenue streams, create new business models, achieve efficiencies, reduce costs, and improve safety and services for passengers. At its core, digitalisation is the process of changing business through technology and data.

Digitalisation is, however, not a new development, and public transport passengers are placing increasing demands on operators and authorities to offer digital services and information that meet their personal needs. The 2018 UITP paper,

'The Value of Data for the Public Transport Sector' highlighted the need for a data strategy, with use cases demonstrating the value of treating data as an asset. Since then, data has become a priority for most public transport operators and authorities (PTAs and PTOs) as well as a key component for business growth and strategic development.
In addition to growing passenger demands, PTAs and PTOs must have a digitalisation strategy for delivering operational efficiencies and equally for attracting and retaining talent.

Passenger expectations, coupled with the rapid evolution in technology, digital systems, data exploitation and the availability of resources, are having considerable impact on organisations. To fully realise on the potential benefits, organisations must be clear on their priorities for digitalisation and alignment to their business strategy. Why is this important?

Following the COVID-19 pandemic, many PTAs and PTOs have seen a change in passenger expectations and travel patterns, often leading to a revenue shortfall. This poses a significant challenge to organisations, requiring them to offer their passengers integrated digital services and optimise operations. Digitalisation is a key enabler for addressing

competing demands; organisations need to be clear on their priorities and where they should focus their often scarce resources.

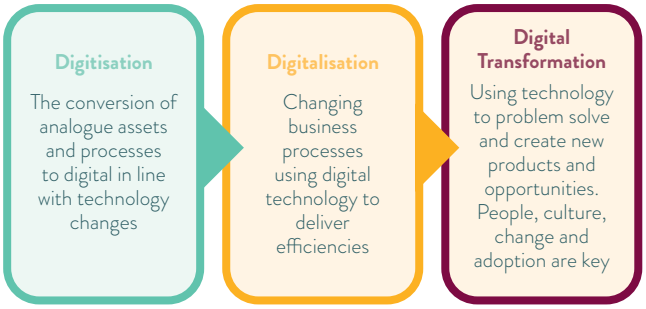
- *Using digital tools to capture data to predict and prevent incidents creating safer public transport services.*
- *Delivering digital experiences that help passengers make informed and safe transport choices.*
- *Passengers now want more than real-time information; they want location based real time information (RTI) specific to their personal journey needs, while organisations require the digital capabilities to meet these expectations.*
- *Digitalising processes and products such as ticketing can greatly improve the passenger experience and deliver efficiencies within the product lifecycle. Digitalisation requires investment in technology, along with developing a business case outlining the wider operational, societal, and business benefits, are key.*
- *Transportation as a sector is one of the leading causes of CO_2 emissions in cities. Public transport, however, is one of the lower generators of CO_2 within the sector and digitalisation can support Greener Cities and lower CO_2 emissions through better vehicle performance, optimised routes and greater fuel efficiency. In addition, an improved public transport passenger experience will encourage people to move from cars to public transport.*

Further challenges include the ageing workforce with PTAs and PTOs and how to attract new talent. Digitalising business processes and automation, as well as the further exploitation of data, will be key to mitigating this resourcing risk.

SETTING THE CONTEXT

A shared objective of public transport is to provide mobility that is safe and cost-efficient. Digitalisation has both enabled and complicated this objective by taking advantage of emerging consumer trends, whilst balancing digital disruption and mitigating digital exclusion. Therefore, certain factors need to be true in order to derive benefits and value from digitalisation:

- Consolidated, standardised, and simplified technology estate.
- Accessible information and data for colleagues to use effectively and confidently.
- Reliable and sustainable products with the right tools.
- Platforms and frameworks for data professionals and stakeholders.
- Connectivity (i.e., WiFi, 5G and location-based services).



As each industry becomes increasingly digitalised, public transport needs to adapt and plan for the latest digital capabilities. Digitalisation can also help in ensuring hyperconnectivity between devices by using sensors and alarms. It can assist organisations in supporting decision making by connecting devices via sensors that share critical and decisive data over a common network.

Technology is continuously evolving, and leaders need to be suitably informed and to plan for digitalisation. Artificial Intelligence (AI) is developing rapidly, and organisations need to respond and take advantage of this maturing technology, not only for meeting growing passenger expectations but also for improving operational efficiencies and safety.

This paper showcases four key themes of digitalisation that are relevant to public transport operators and authorities and explains why it is important for senior leaders to prioritise investment in, and development of, digital capabilities.

CAPABILITIES NEEDED TO DEVELOP AND OPERATE THE DIGITAL STRATEGY

In the realm of public transportation, the digital transformation landscape offers two primary avenues for impact: (A) enhancing the passenger experience and, (B) optimising operational and maintenance efficiency. Navigating this transformation requires a strategy that balances these dual objectives, without prioritising cost reduction over efficiencies or falling prey to industry hypes.

To guide C-level decision-makers effectively, it is vital to stress the importance of following a well-defined course, ignoring distractions and avoiding the allure of excessive cost-cutting measures. Through recognising that numerous opportunities lie within the digital realm, there is the potential to unlock new revenue streams and, at times, boost ridership levels.

One such strategy involves a dedicated focus on transforming the passenger experience. By introducing new digital features or products, companies can address both stated and unstated passenger wishes. While this process may incur additional costs, the resulting increase in passenger satisfaction can translate into improved passenger loyalty.

The flipside of this is that concentrating solely on initiatives geared towards operational and maintenance cost reduction can enhance efficiency. Each delivery incrementally contributes to cost effectiveness, fostering a culture that values optimisation. However, such a tight focus on cost reduction may inadvertently neglect opportunities for revenue growth or fail to prioritise passenger experience.

Balancing these perspectives is essential, establishing metrics for evaluating opportunities in both passenger experience enhancement and operational efficiency. Valuable insights can prove helpful. In this paper, UITP members cases showcase several valuable initiatives on prioritising either efficiency or passenger experience.

Other challenges on the digital transformation journey include addressing reskilling needs, attracting top talent and deciding whether to hire external expertise or develop an in-house team.

TFL SMART STATIONS

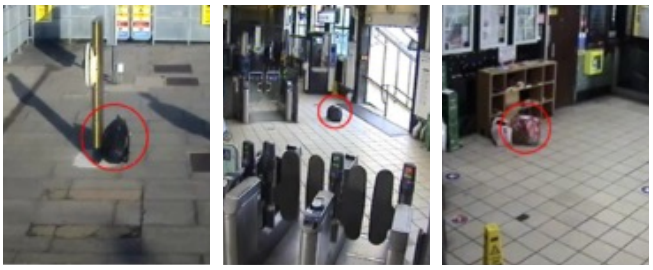
Safety and security are paramount to Transport for London (TfL) and in 2021, TfL's Technology and Data department, in collaboration with operational frontline colleagues, began exploring the use of smart technology at Willesden Green Station.

This uses existing CCTV images (24 cameras in total), Artificial Intelligence (AI) algorithms and numerous detection models such as image recognition and machine learning are used to identify trends and hazards. These provide station staff with real-time notifications and insights on incidents via a dashboard that presents the information visually. TfL agreed on 11 use cases, such as crowd movement, mobility assistance, person on track, crime and anti-social behaviour, fare evasion and unattended items.

Following a 12-month trial, the system detected over 140,000 triggers, which included real-time alerts and data for insights only. Smart Stations was designed by station staff, enabling an agile response to ongoing changes as required.

Feedback from staff suggests that smart technology has a key role to play in the future, by helping and protecting them and improving the overall passenger experience within stations.

Unattended Items



Fare Evasion

The Role of Cybersecurity

As public transportation becomes increasingly digital, the integration of connected infrastructure and IoT creates cybersecurity risks. It is imperative to map these risks and implement robust cybersecurity measures to safeguard against potential threats. For that, early engagement with cybersecurity teams in the digitalisation design is required.

It is therefore more important than ever for public transport operators and authorities to develop strategy for cyber risk and embed good cybersecurity governance principles at the core of all digitalisation projects and processes. This will ensure that public transport assets and services are protected from cyberattacks. Cybersecurity awareness is therefore a key accountability of the entire organisation, including executive committees.

To support the sector on this challenge, the UITP Cybersecurity Committee is developing recommendations, guidelines and building awareness and the overall capacity of our sector for facing this challenge. The list of available reports can be found at https://www.uitp.org/topics/cybersecurity-in-public-transport/

Failure to progress with digital transformation in the public transportation sector risks significant impacts. The evolving digital economy is introducing new ways for companies to conduct their businesses and earn revenue. Overlooking this shift may leave transportation services isolated from the interconnected network of passengers and partners, missing out on opportunities to build value for both as a result.

DATA – DEMYSTIFYING AND DERIVING VALUE FROM DATA

Digitalisation is not simply about data. However, there is virtually no aspect of digitalisation that is not related in some way to data. Thus, data and data processing can be seen as the foundation of digitalisation.

THE VALUE OF DATA

It is often said that data is the 'new oil/gold of the 21st century'. This has led to serious misunderstandings and – on occasions – dangerous consequences in the public transport sector:

Data holders claim exclusive 'ownership' to generate the greatest (commercial) profit from the data. This is in sharp contrast to the fact that added value can only by generated by using and combining data. However, if data generates the greatest value through sharing, it is claimed that all public transport data should be provided 'free and open', because it 'has been paid for by the public anyway'. Such a view completely neglects the cost of providing data and maintaining data quality.

Thus, neither strict data privacy nor completely unrestricted open data is the right approach for data in public transport – there needs to be a reasonable balance maintained.

LEGISLATIVE FRAMEWORK

Legislation sets the framework for the duties, restrictions, and opportunities relating to data. Usually, regulations cover aspects such as data protection/privacy, open data, and competition.

A particular problem of data legislation is that - in contrast to physical goods - there is so far no generally accepted concept of 'ownership' of data. In many cases, this can lead to a pragmatic approach where the 'data holder' controls the further processing and distribution of the data. For PTOs and authorities, this means that data access and control for the respective data sources must be carefully defined in the procurement contracts.

DATA MODELS AND INTERFACES

The foundation of digitalisation (thus the name) is a digital representation of the world.

The details of the low-level technical 'data representation' is less important for the concept of digitalisation, but of course can have a significant impact on how the technology is used.

For the construction and interoperability of data processing systems, the simple agreement on digital data is not nearly sufficient. We need:

- a data model that describes how an object from the 'real world' is represented by data. Usually, there is no single way of casting a 'real-world' object' into data; there are a number of options.
- a data representation, which specifies how the data is technically stored and transferred. For the same data (model), different representations are possible.

As long as data is encapsulated within a single software system, the data model and representation are a detail known to the software manufacturer but irrelevant and hidden otherwise. However, as soon as data is shared and transferred between systems, an interface is required, which defines a

common data model and a common data representation to be used by both systems for the data exchanged.

To facilitate the implementation of interfaces and enable a modular and flexible system architecture, the availability of interfaces following open standards is essential. Some important sets of open standards for public transport data exchange include data model Transmodel (EN 12896) and the interfaces NeTEX (Network and timetable exchange, CEN/TS 16614), SIRI (Service Interface for Realtime information, EN 15331), ITxPT, VDV recommendations, GTFS (General Transit Feed Specification) and GTFS Realtime.

DATA QUALITY

If business processes depend/rely on data, then data quality is important for internal, as well as for external, reasons – particularly where it affects revenue or reputation. Elements of data quality are completeness, consistency, accuracy, validity and uniqueness.

Data quality can vary widely within organisations depending on the data culture and maturity within the business processes, systems, and ways of working. This can often lead to disparities in the quality of data for an asset type from depot to depot. When developing a business case for digitalisation, it is hugely important to understand the maturity and quality of data in all areas of scope (as it really is). This will help to avoid potential pitfalls – such as inefficient automated processes and erroneous decision making – that can arise from poor data quality and risks disrupting the benefits of digitalisation.

REDUNDANCY

Redundancy means that data stored or transmitted contains elements that could be omitted without any loss of information. Clearly, redundancy should be avoided wherever possible, to maximise the economic use of storage space and transmission capacity.

Nevertheless, there are good reasons why – in practical systems – redundancy is often tolerated or even introduced intentionally:

- Redundancy can make data transfer failproof.
- Redundancy can reduce interdependencies between data sets.
- Making data directly readable by humans implies redundancy, because the coding of data for human reading is usually rather inefficient.`

ARTIFICIAL INTELLIGENCE AND DATA

Artificial intelligence (AI) summarises a whole field of methods that are expected to have a game-changing influence on nearly every aspect of private and public lives in the near future.

The link between AI and data is strong; all AI methods need data to 'train' their models. The greater the quantity and variety of training data, the better the results. Thus, AI has started a new rush on data. For public transport actors this means that:

- the collection of comprehensive data becomes more important.
- The application in AI becomes a new aspect of the 'value' of data.

GRUPO CCR DATA DECISION ENGINE

Grupo CCR operates highway concessions, airports and metro systems in Brazil and other countries. The main objective of the Data Decision Engine project was to develop a solution for handling the maintenance orders of the assets of ViaQuatro Line 4 Yellow in São Paulo Metro, a task required by the concession agreement. The solution should be able to store and retrieve all maintenance-related information in a database, creating an asset history and monitoring the service quality and performance.

The solution consists of a set of digital applications that perform three main functions. First, a collector connected to SCADA to capture the failures and alarms. Second, a data decision engine analyses the inputs and detects patterns. Third, the application triggers actions based on the analyses results, automating the dispatch of maintenance tasks to SAP.

As a result, there are project-enabled (1) automated maintenance notifications in SAP; (2) alarm and occurrence indicators that are centralised on a dashboard, allowing for simple monitoring and control; (3) transparent reports to the granting authority, ensuring compliance and accountability.

PASSENGER EXPECTATIONS AND PTAS – MANAGING AND DELIVERING AGAINST THEM

When it comes to the passengers, capturing value in public transport through digitalisation centres on attracting and retaining them through exceptional services. Digitalisation is not merely a matter of adopting innovative technologies; it's part of a strategy of enhancing the passenger experience. This will increase the appeal of using public transport as a convenient, reliable, and efficient mode of travel.

PASSENGER PERSPECTIVE: KEY DRIVERS FOR ATTRACTION AND RETENTION

Passengers seek four fundamental aspects from public transport:

Ease of Planning	Multi-modal journey planning should be straightforward, leveraging digital tools that simplify the process.
Convenient Payment Options	Diverse, user-friendly payment methods are essential to a hassle-free experience.
Relevant, Real-Time Information	Access to timely and pertinent information both before and throughout the journey is vital.
Perceived Safety	The public transport system must be recognised as a safe mode of travel. As well as personal safety, perceived safety is created by meeting the above key drivers, combined with clear wayfinding assistance (particularly during service disruptions) and – of course – a reliable and stable operation.

Engaging passengers in network planning and service evaluation is also critical; this demands access to intuitive digital platforms that allow them to interact with the providers.

DIGITALISATION IN PTAS: ENHANCING PASSENGER EXPERIENCE

PTAs must embrace digitalisation if they are to meet these passenger needs effectively. Key areas include:

NETWORK AND TIMETABLE PLANNING

Advanced scheduling systems, integrated with Geographic Information Systems (GIS), simplify route planning and maintenance. GIS offers map-based tools for efficient planning, consulting and decision making. Furthermore, in unexpected situations, these digital tools help facilitate rapid dissemination of detour information for passengers across various channels.

JOURNEY PLANNING AND TICKETING

Based on the network, timetables, and current operations, digital platforms must enable seamless journey planning and related ticket purchasing. This requires integrating data across various transport modes for a unified experience. Digital ticketing methods – including travel cards, mobile applications, and contactless payments – should be implemented in the system to improve passenger convenience.

REAL-TIME INFORMATION

Digitalisation transforms how information is conveyed, allowing a shift from static timetables to dynamic, real-time updates. Digital displays, websites, and mobile apps should provide up-to-the-minute information on schedules, disruptions, and alternate routes. Providing personalised, real-time information to passengers on a push basis via digital channels enhances their journey experience and provides them with a better basis for making alternative decisions.

Live maps showing the exact position of buses and trains moving in real time aids passengers not only with information, but also by helping them feeling safe; "the bus is just around the corner".

PASSENGER COUNTING

Gathering real-time occupancy data helps PTAs optimise service planning. In addition, distributing the data on a suitable platform allows our passengers to make informed decisions based on vehicle fullness, improving their travel experience.

CONNECTION PROTECTION

Through using real-time data – and based on a set of rules – PTAs, together with the operators – the PTOs, can protect planned connections between different transport modes. This enhances journey reliability and improving passenger confidence in our system.

WAYFINDING

Innovative solutions such as augmented reality or QR-code readers on smartphones assist passengers in navigating complex terminals, enhancing accessibility for all, including those with visual impairments. In general, and specifically outside complex terminals, PTAs must offer solutions for wayfinding on our passenger's mobile devices: 'How do I get to the bus stop or the station?'

INSTANT FEEDBACK AND LOYALTY PROGRAMMES

Easily accessible digital feedback mechanisms allow immediate passenger responses, enabling prompt PTA (and PTO) action, should it be required. Where the solution can automatically link the reported incident to its location - or where the passenger is - makes the action or the follow-up work even easier.

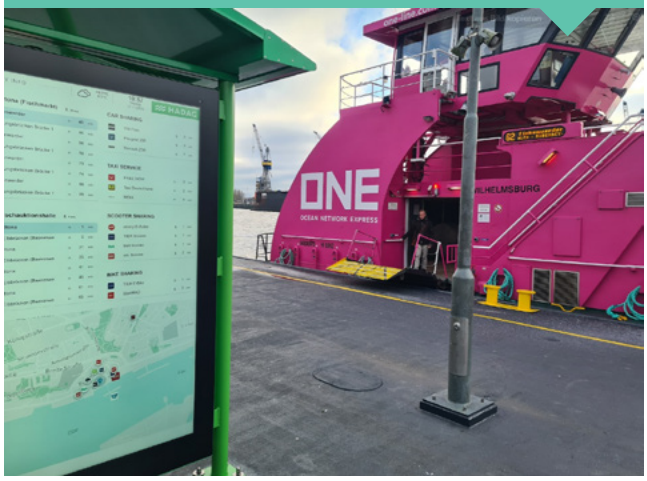
Another way to tie passengers closer to your organisation is through loyalty programmes. Many PTAs have implemented digital loyalty programmes. These incentivise passengers through rewards, discounts, or exclusive offers, encouraging repeat business and fostering a sense of loyalty among travellers.

HADAG MULTIMODAL REAL-TIME PASSENGER INFORMATION FOR WATERBORNE PUBLIC TRANSPORT IN HAMBURG

HADAG operates the waterside public transport in the port of Hamburg. Currently, real-time data for ferries is missing in mobility apps as well as on the piers and ferries. Passengers and authorities expect real-time data sharing.

HADAG is working on a project to implement a pure SaaS setup that is modular, easy to maintain, and scalable without proprietary hardware components.

Operational planning is carried out using the data driven Optibus software platform. This allows timetable planning, captain shifts, real-time ferry arrival data and enables multimodal passenger info on piers, including on accessibility options for disabled people.



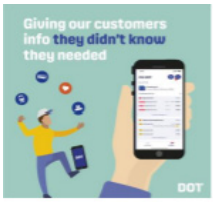
DOT PROVIDING PERSONAL TRAVEL INFORMATION AND PUSHING PLANNED CHANGES

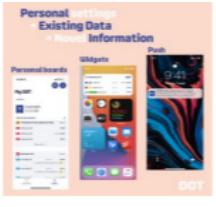
DOT is a collaboration between MOVIA (PTA), DSB, and Metro, operating in the east of Denmark. DOT wanted to share information on planned changes to schedules for buses, metros and trains with their passengers, something that wasn't currently undertaken digitally.

DOT operates a ticketing app, and it was decided to use this as an efficient, cost-effective, and scalable method of delivering information on planned changes, through passengers building personal 'Departure Boards' with beneficial traffic information. The boards were integrated in the app, providing real-time traffic information at a glance, where passengers can retrieve planned changes in different public transport modes.

Since its implementation over a year ago, the Departure Board feature has helped the DOT ticket app to become a live traffic tool. It has become a novel way of delivering traffic information using existing data.

In future, passengers in Copenhagen will see new features, including journey boards and a simple method of making boards from tickets and vice versa, as well as eventually greater live traffic integration.





OPERATIONAL EFFICIENCIES – IMPROVING PUBLIC TRANSPORT OPERATIONS AND TAKING COSTS OUT OF THE ASSET LIFECYCLE

In the area of digital transformation in public transport operations, the emphasis is on a comprehensive understanding of digitalisation. This covers a wide range of activities and responsibilities, from route and timetable planning to infrastructure and fleet management and maintenance. The aim is to guarantee an efficient, safe, reliable, and sustainable mobility solution.

THE ROLE OF DIGITALISATION IN OPERATIONS

It is in this complex ecosystem that Digitalisation, guided by an efficient strategy, becomes crucial. Its goal is to implement improvements in the way business works (Operations), combining information, digital technologies, and communication to create value for passengers and the attractiveness of Public Transport. The journey must involve the entire organisation in a culture of Digitalisation. A shared digital vision is essential.

OPPORTUNITIES FOR DIGITALISATION SUCCESS

Public Transport Operations are multifaceted environments featuring many elements, such as people, infrastructure, rolling stock/buses, OT/IT systems, procedures, and legal aspects. Digitalisation offers significant opportunities for improving efficiency without increasing the complexity of existing workflows or processes.

OPTIMISING ASSET VALUE

Digitalisation allows for decision making based on data analysis, increasing efficiency, and identifying areas for improvement, such as predictive maintenance, operational efficiency, automated diagnostics, and intelligent resource allocation. It supports the leveraging of technologies and data, optimising the overall lifecycle of assets and Total Cost of Ownership (TCO).

DIGITALISATION IMPLEMENTATION APPROACH

A balanced approach can be designed around three distinct layers of opportunities:

Exploitation of Existing Systems and Technologies: assessment of current systems, management tools and technologies, identifying easily realisable digitalisation opportunities.

Introducing New Digitalisation Solutions may be necessary to overcome process constraints that have been previously identified in operational or functional assessments, and upon which the previous layer is unable to resolve. Digitalisation initiatives geared towards operational processes often face resistance to change, which can be challenging. It is important to always take time to understand the logic behind technological process. Training and change management are essential to allow people to feel confident and understand the process and direction.

Synergy and Integration: this is an advanced stage of digitalisation, where employees can apply the technologies themselves and improve their skills. It is where digitalisation becomes an inherent part of operations and the decision-making process.

KEY ASPECTS FOR SUCCESSFUL DIGITALISATION IMPLEMENTATIONS

Digitalisation is not a matter of simply bringing in technology and expecting it to solve all needs and problems. Implementing digitalisation is a challenging task and is more likely to fail than succeed. The support of the Board and senior management is essential for bringing the vision of digitalisation to the entire organisation. Moreover, organisations should

- Take ownership of digitalisation and provide governance, with the support of suppliers or system integrators. A powerful sense of ownership promotes a deeper understanding of organisational needs and ensures alignment with strategic objectives.
- Creation of cross-functional teams with technological experts, operations specialists, data analysts and project managers is essential.
- And finally, the adoption of open standards and open interfaces is crucial to the success of digitalisation, as well as the prioritisation of the User Experience (UX) in the design and implementation of solutions.

RISK AND CHALLENGES

Cybersecurity must always be a consideration at every step of digitalisation deployment.

Lack of Expertise among public transport operators and suppliers/integrators is a challenge.

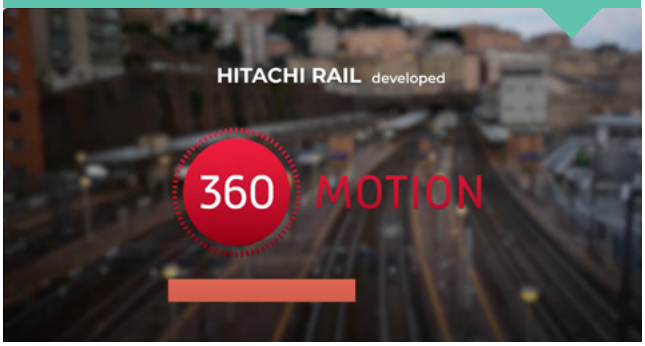
Compliance with the various rules and regulations on data governance must not be underestimated, for example the GDPR in Europe.

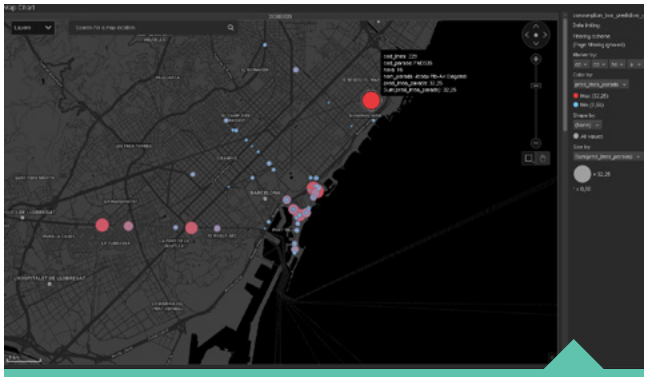
HITACHI RAIL MOBILITY ORCHESTRATOR – 360MOTION

The challenges for the city of Genoa in Italy were to optimise and improve the overall efficiency, congestion management and environmental sustainability as well as to improve the passenger experience.

The integrated approach of the Mobility Orchestrator 360 Motion Platform creates a digital ecosystem that simultaneously monitors and manages critical events in real-time and uses historical data, predictive analytics, and environmental insights to optimise the entire transportation network. This is done through the use of advanced sensors, IoT devices, smart displays, mobile applications, data analytics, simulation tools and real-time analytics.

The Mobility Orchestrator, coupled with the 360 Motion platform, ensures transportation is available precisely where and when it is most needed, providing passengers with a seamless travel experience. The implementation of the project has delivered a revolution in Genoa city's public transportation system.





TMB BUS DEMAND PREDICTION

Transports Metropolitans de Barcelona (TMB) is the city's main public transit operator; it runs most of the metro and local bus lines in the city and the metropolitan area.

During the summer months, TMB needs a daily demand forecast on lines and stops to and from the beaches in the areas of Barcelona, covering a time horizon of up to three days in the future.

A supervised machine learns techniques using big data generated from the ticketing system from the bus business. This is combined with contextual information such as meteorological data from the Barcelona area and massive events in the city of Barcelona. It is all robustly solidly supported via a fluid and intuitive interface.

The solution paved the way for a prediction of demand up to three days in advance, as well as making available data of geo-located demand in the territory (by line/stop) and defined in time (when it has happened).

CONCLUSION

Technology and data lie at the heart of transport services and operations; they are no longer the exclusive concern of IT departments. Digital capabilities and services are part of our passengers' and colleagues' expectations and are an imperative for PTOs and PTAs to deliver safe and reliable public transport.

Digital transformation will only come about through a clear digitalisation strategy, an understanding of data, capabilities, and the business case to be delivered. PTOs and PTAs cannot achieve this alone and will need to work with industry colleagues to realise benefits.

RECOMMENDATIONS

Digitalisation in public transport enables new opportunities for customers through integrated digital services and optimisation of operations. To realise this:

- PTOs and PTAs need a digitalisation strategy with a clear understanding of their business processes (with defined process ownership) and where the benefits can be derived. There should be a prioritised roadmap and an associated change and adoption plan.
  - There should be digital maturity assessments and benchmarking undertaken in support of the strategy and roadmap development.
  - Process design, optimisation and adoption are integral to digitalisation in readiness for digital transformation. This process needs to be led by the business and not by the technology.
- Digitalisation is a journey, and PTOs/PTAs will need to be clear on the priority of actions within the strategy; think big and start small.
  - In financially constrained environments, clarity over the outcome and likely benefits is critical. Understanding current processes and data quality is a key prerequisite.
- To capture value from digitalisation, an organisation needs a digital mindset. Meaning, IT awareness, support, knowledge, and skills throughout the whole organisation, starting from C-level.
  - Attracting and retaining talent and skilled technical resources is a significant challenge within public transport and needs to be addressed within the affordability of the sector. This requires a strategy for digital capabilities and talent management.
  - Many key roles within public transport face the challenge of an ageing workforce. The digitalisation strategy should consider automating repeatable processes in conjunction with AI and - where applicable - robotics to mitigate this attrition risk.
- Organisations need to understand their existing processes to fully realise the benefits of digitalisation.
  - Developing a business case with clear benefits and acknowledging the level of change required (people, process, culture, and technology) is key.
- Digitalisation will create both new business models and disruptions; organisations need to be aware of this.
- Creating the capacity and capability to innovate and run proof of concepts and digital pilots are key to implementing and adopting digitalisation (learn and evaluate the capability).
  - Developing and upskilling resources in innovative technologies.
- PTOs, PTAs, and vendors need to establish binding rules on data sharing and digitalisation when contracting.
  - Defining and adhering to data standards, regulations and legislation for IT and OT.
  - Making best use of and sharing existing data (OEM and asset) before creating new use cases.
- Collaboration between PTOs and PTAs and industry is key to minimising the costs and investment required for digitalisation as well as maximising the benefits of knowledge sharing.

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