

MOVING FORWARD WITH ARTIFICIAL INTELLIGENCE IN PUBLIC TRANSPORT

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INTRODUCTION

It is undeniable that artificial intelligence (AI) is growing its importance in every sector, including public transport. The use of AI applications in public transport could be one of the critical solutions that efficiently unlocks the value of data to improve the quality and efficiency of the public transport sector. This Brief is based on the findings from UITP Asia-Pacific Centre for Transport Excellence's study on Artificial Intelligence in Mass Public Transport, co-funded by Land Transport Authority of Singapore¹.

UITP's position is not to advocate the use of AI but to raise awareness, demystify the technology and outline the current landscape of AI applications in public transport. It is important that all stakeholders have a clearer understanding of the technology, better preparing them for the transformation and of their role in shaping the AI-integrated society we live in today.

GROWING IMPORTANCE OF AI

Numerous reports have emerged estimating that AI will bring significant economic growth and improvement in productivity. Unsurprisingly, many governments are racing to claim the title 'leader in artificial intelligence' alongside their announcements on AI-centred national public policies and substantially funded action plans.

The substantial evidence of the growing importance of AI encouraged UITP to investigate. The project found that AI is increasingly being adopted by the public transport sector.



¹ For more information on the report: www.uitp.org/news/demystifying-artificial-intelligence-public-transport

WHAT IS ARTIFICIAL INTELLIGENCE?

There is **no universally accepted definition of artificial intelligence**. The concept of intelligence is arbitrary and constantly evolving. Technology continuously outperforms itself as society processes.

Despite of many terms and classifications for AI, the public transport experts consulted² believe that AI should consist of the following qualities:

- Ability to **learn**
- Ability to **adapt**
- To mimic as well as **exhibit creativity**
- To fulfil its purpose to **improve existing processes**

WHY DO WE NEED TO PREPARE FOR AI?

Provide better customer experience

Customers are subconsciously exposed to the convenience of AI on a daily basis. From digital assistants in smartphones, to personalised online shopping and entertainment experience through recommendation engines, natural language processing of automatic translation, and facial recognition for social media, payment and security check-ins. The daily commute is a significant part of citizens' everyday lives, and so it is inevitable that they begin to expect these conveniences during their journeys.

Public transport service providers need to recognise the rising expectations from customers who are surrounded by providers using AI to improve their experience and service efficiency.

Cultivate value from an overwhelming sea of data

Organisations are combatting the challenges of data deluge, meaning more data is available than we can process. AI elevates big data analytics to the next level by creating intelligence from the processed data. Combined with increasing computer processing powers, AI systems today can instantaneously analyse large amounts of data and interact in real-time, presenting many opportunities to the public transport sector.

The public transport sector should look after their data by setting management processes for the collection, storage, cleaning and standardisation of data.

DID YOU KNOW PUBLIC TRANSPORT IS DROWNING IN DATA?

- In 2016, during a four-week trial analysing Wi-Fi data on the London Underground, Transport for London collected data from over 500 million connection requests made on 5.6 million mobile devices, constructing 42 million journeys.
- Strava collects over 11 million activities uploaded every week from cyclists, runners and pedestrians to provide government agencies with insights into transportation planning.
- In Hong Kong, Thales is decoding over 10 million data points every day from passengers.



Be at the centre of Smart Cities development

Urbanisation, growth of mega cities and aging population are pushing cities to become smarter and sustainable. Government agencies are turning to solutions with internet-of-things (IoT), AI and many advanced technologies to stay ahead. In April 2014, UITP's official position on Smart Cities made the case that public transport is essential to a smart city because there is no business case to invest in the future of cities without a strong, connected transport system.

With many sectors investing in AI developments and solutions, it is critical for the public transport sector to review and investigate how AI can support the mission of providing seamless, safe and inclusive mobility.

² UITP AP CTE's study on AI in Mass Public Transport consulted over 100 experts through various channels: roundtable, workshops, survey, use-cases and blog articles.

CURRENT STATE OF PLAY

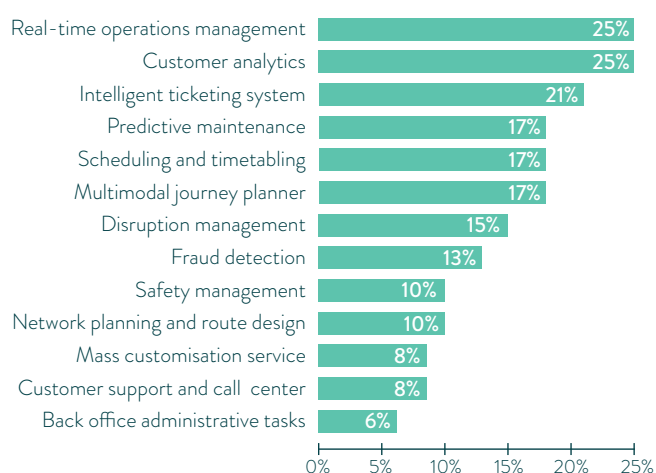
UITP AP CTE's study engaged over 100 experts from public transport and IT sectors to understand the current status on the use of artificial intelligence in the context of four main areas:

- Customer Excellence
- Operational Excellence
- Engineering Excellence
- Security and Safety Management

AI APPLICATIONS IN PUBLIC TRANSPORT

The UITP AP CTE's survey³ gave indicative insights into the current landscape of the current use and future trend of AI;

PERCENTAGE OF SURVEYED ORGANISATIONS USING, TESTING AND/OR OFFERING AI



► Applications of current use of AI in public transport

Currently, the most common applications of AI have been in the areas of real-time operations management and customer analytics. In the near future, one in three public transport organisations expressed they would be considering the integration of AI-driven applications in customer analytics, predictive maintenance, and network planning and route design. The current adoption rate of AI applications in network planning and route design, customer and call centre support, and safety management is relatively low but the sector should expect to see significant uptake in the near future. Commuters are ultimately the beneficiaries of any innovative projects that improve efficiencies and safety of public transport systems excellence.

The study also identified some of the key applications of AI through detailed case-studies:

- Use of digital assistants to improve efficiency and quality of customer service
- Optimisation of public transport operations
- Use of AI in low-value tasks and unsafe work environments
- Use of AI-powered video analytics to improve safety and security of urban public transport networks

A SAFER WORK ENVIRONMENT FOR ALL

Based on the 17 use-cases collected by UITP AP CTE, the primary objective for the use of AI was not to replace the workforce but rather deployed to optimise operations, fill in service gaps and empower staff with timely information. This overwrites the myth that AI will take over the future workforce. However, AI is to be seen as a sustainable solution in sub-sectors or cities where growing aging population with a diminishing workforce and improvements in lifestyle are deterring the younger generation from entering specific jobs of the public transport sector.

In many developed Asian cities, being a bus driver is not an attractive profession for educated youth therefore autonomous buses are seen to be a solution to maintain the quality and efficiency of the bus industry. Using AI and sensor technologies, Shenzhen Public Bus Group trialled their autonomous 19-passenger public bus on public roads (1.2 km loop) in 2018 with the aim to improve road safety. The railway sector also poses its own challenges as many tasks are dangerous and graveyard shifts in track and train maintenance are not attractive to younger workforce. Railway Technical Research Institute (RTRI) and Transport for London (TfL) commenced trials on using AI-powered image and video analytics for tunnel crack detection, track inspections and condition monitoring. The mission of 'no boots on track' can provide safer working environments for railway maintenance workforce.

³ The survey was conducted from December 2017 to February 2018 and collected 48 responses from public transport related organisations, including authorities, operators, industry providers and research institutes.

CHALLENGES & KEY BUILDING BLOCKS OF AI

As organisations seek to embrace AI, it is necessary for public transport organisations to understand there are inherent challenges with AI and key building blocks for the public transport sector.

KEY CHALLENGES

Source funding to invest in AI solutions

Public transport authorities and operators revealed that sourcing funds for AI-driven solutions can be difficult because, like any innovation projects, the business cases, expected outcomes and return on investment cannot be easily quantified.

Most public transport operations are funded partially or substantially through public subsidy, which constraints the procurement of funding for investment into innovative solutions such as use of AI without government support. Furthermore, in cities with tendered or contracted operations, the duration of the operating contracts or the business model often does not provide enough incentive for the public transport operators to invest in such solutions.

Traditional procurement process hinders 'high risks' projects

Most procurement processes are currently driven by specifications to give evaluators a degree of quantified measurability and objectivity. By its very nature, AI-based solutions cannot adhere to the same approach.

AI-based solutions are often better suited to a **collaborative approach** due to the diversity of skills required and the need for lengthy implementation process to train and fine-tune the algorithms.

Develop a legal and policy framework for AI in public transport

Adopting any AI tool requires a strong business case. The success of such a business case is contingent upon an environment that enables and complements change. The legal and policy environment surrounding AI in public transport is one such enabler which, if properly crafted, can proactively address the breadth of legal challenges posed by AI.

Develop unbiased AI

According to *IBM Research*, there are over 180 human biases that have been defined and classified. One of the threats in AI is the existence of data bias, as data is gen-

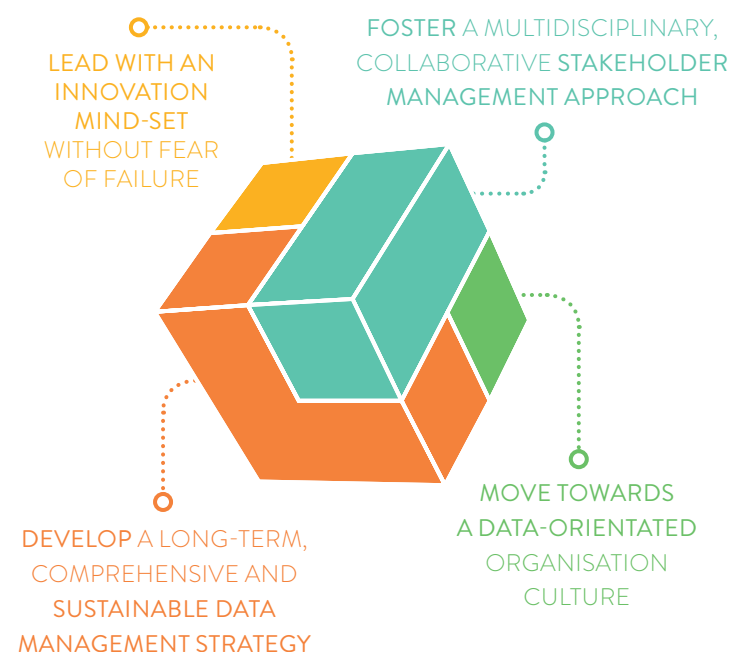
erated by humans for the machine to learn. Artificial intelligence is about recognising patterns in data, and limited data will direct AI to a discriminated decision-making process. Biased AI will not only lead to erosion in trust between human and machine but also solutions that may contain implicit discriminations or ones that compromise the integrity and ethics of the underlying process.

Over-reliance on AI

Like any technical systems, AI-based systems are prone to hacking or denial-of-service attacks, possibly by other AI systems developed with malicious intent. The risk is when public transport operators have rationalised the manpower with over-reliance on AI, which led to abandonment in training to manage situations previously handled by human intervention.

BUILDING BLOCKS OF AI

The four building blocks were identified through lessons learnt from public transport experts.



► *Building blocks for a successful deployment of AI*



Collaboration is a key enabler for success in innovation projects such as artificial intelligence technologies: **86%** of surveyed public transport stakeholders are engaged in partnerships with multiple stakeholders to develop and adopt AI. Early adopters of AI and other innovation technologies expressed there is a **need to reform traditional procurement processes and consider new business models which foster a multidisciplinary, collaborative stakeholder management approach.**



Most of the expertise on data analytics and artificial intelligence is industry-agnostic, meaning technical and/or IT experts can be brought in from any other industry. Ideally, data scientists work together with subject-matter or domain experts (here mainly public transport professionals) to identify business problems and create befitting technical solutions.



Building a data-oriented organisation culture is critical to all industries as every sector is surrounded by data. Harvard Business Review revealed that large organisations need programmes to achieve data-related cultural change through new management data-orientated roles and a clear enterprise data strategy, while start-ups genuinely adopt this mind-set from day one.



The key to **lead with an innovation mind-set without fear of failure** is to learn how to innovate and ‘fail safely’. It is not in the nature of public transport operators to ‘fail’ as it can bring catastrophic results. Large organisations are unwilling to give projects a green light without months of deliberations and confidence in return on investment. However, innovation-driven developments require the testing of ideas. To identify those concepts with promise, innovation teams need to be comfortable working in an environment where ideas can fail. Many innovative companies often accept, embrace and value failure as these experiences enable early learning from errors to recover and/or inject energy in the next stage of experimentation. Strong leadership from management can support the try-and-fail methodology and set bold visions for the future of AI in the public transport industry.

feedback during beta versions of applications. In regard to inclusivity, AI algorithms based on Wi-Fi or smartphone data, for example, may overlook specific customers such as the elderly, who depend heavily on public transport.

Utilise a risk-management based approach to manage AI systems to avoid over-reliance on AI. Similar to any technological systems, it is important that organisations have business continuity plans and ensure human elements of the critical decision making have not been eliminated or completely replaced by machines.

“AI bias is a well-known problem in some consumer applications. For public transport, a possibly greater issue is that the segments of the population who are not producing data using their mobile phones (elderly people, primarily) may be hard to reach using dissemination mechanisms to be able to leverage the benefits of the AI.”

Expert Panel at SITCE 2018

Take advantage of the free trusted resources on AI to better understand the technology, its potential and available grants. Large technology companies provide basic resources to guide organisations, such as IBM Research, Google AI and Microsoft AI.

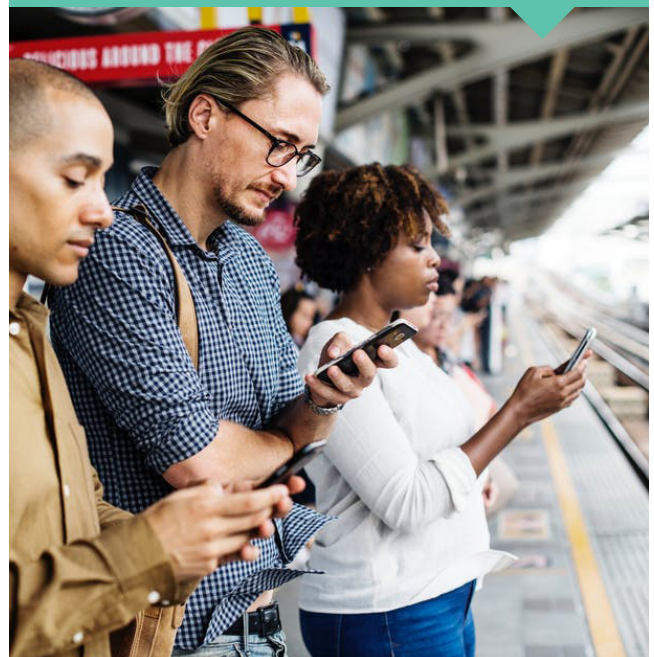
RECOMMENDATIONS ACTIONS FOR TODAY



There are a number of actions required if the public transport sector wants to be ready for AI:

► GENERAL PUBLIC AND ALL PUBLIC TRANSPORT PROFESSIONALS

Be inclusive and mindful of human biases in data input for AI because incomplete or skewed data can contain implicit racial, gender, or ideological biases. These can make their way into the AI systems, and influence decisions made by many public and private organisations. It is important that end-users provide appropriate and constructive



► PUBLIC TRANSPORT AUTHORITIES (PTA)

The study revealed that AI developments and skillsets in public transport are predominately driven by industry suppliers, but without guidance and regulatory frameworks from authorities, the adoption of AI may be hindered. Authorities can either be a gatekeeper or nurturer (or a balance of both) to any transformational innovations for the industry.

Provide legal and regulatory framework for AI in public transport can proactively address the breadth of legal challenges posed by AI. The framework needs to consider the nature of AI to enable organisations to test, manage, and benchmark integration challenges against the proposed benefits of a particular AI tool. This is because the success of a business case is contingent upon an environment that enables and complements change. The framework should encompass:

- An approach to data governance (including data sharing)
- Definition of accountability over the technology's outcomes
- Scalability of regulations in related domains

LTA'S FLEXIBLE REGULATORY FRAMEWORK

In February 2017, Land Transport Authority (LTA) was granted a five-year regulatory sandbox to provide the necessary flexibility to test autonomous vehicles (AV) on public roads. Decisions on times and areas for testing, design standards of AV equipment and data sharing requirements from trials are enabled more quickly and with adaptability. New rules can better factor in the experimental needs of operators of AVs and the people taking part in trial. In exchange, developers must present validated safety assessments and road accident mitigation plans. After the five years, more permanent rules could be enacted or the Parliament should decide to extend and/ or amend the regulatory sandbox.

Source: Land Transport Authority, Singapore

Play an active role in providing guidance on funding sources. In addition to large technology organisations providing guidance, there are many non-profit or government agencies that advocate AI developments. PTAs can provide support to the public transport sector by securing funding through collaborating with these agencies or providing direction to organisations who require funding.



► PUBLIC TRANSPORT OPERATORS (PTO)

Review current procurement approach and avoid prescriptive and guaranteed quantifiable outcomes. AI solutions are commonly referred to as a black box and AI vendors are often reluctant to reveal their algorithms, which makes it difficult to establish trust between humans and machines. Innovation requires thinking outside the box and taking risks. These risks can be shared with vendors through collaborations or partnership agreements.

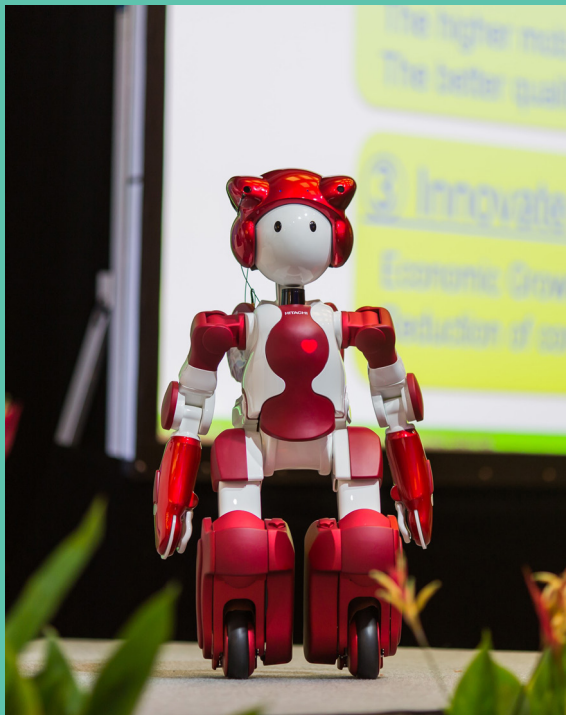
Think big but start small. Large scale and complex AI projects require large investment and resources. Once the AI solution is activated, it continuously requires on-going monitoring and feedback to maximise its potential, meaning there is always room for improvements and future plug-ins. It is not necessary to look for an ideal solution up-front and attempt to automate every step. For example, MTR chose to start its chatbot to address only directional inquiries but perfecting in three different languages (Cantonese, English and Mandarin) to ensure the AI algorithm can perfect this task before expanding the database to other common inquiries such as train schedules and fares.



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“There needs to be a business model to support AI deployment. Technology is merely a tool; communication is critical to obtaining stakeholder support.”

AI in Public Transport Survey response



JR East Communication Robot © SITCE

► PUBLIC TRANSPORT PRODUCT & SERVICE PROVIDERS

Industry suppliers are undoubtedly the most agile players in the sector, with the ability to quickly formulate innovative solutions.

Focus on PTAs and PTOs’ business challenges and break the task down into smaller chunks to find opportunities for AI applications. Before diving into providing AI technology as part of the solution package, one must ask the question: can we take the problem and break it down into a number of clear small serial or even parallel tasks?⁴ Industry providers should support PTAs and PTOs to understand how to break down a job into many small defined tasks in the context of AI applications and identify gaps where AI solutions can add value into the process.

“AI is a tool to solve any other business problem. It should be part of the solution provided, but not specified as a need. AI is not the forefront of the project.”

Insights collected at Expert Roundtable, 2018

Provide ethical and sustainable AI solutions for PTAs and PTOs. PTOs often rely on IT vendors to build the foundation of the AI solutions as they do not have such in-house expertise. It is important that the AI solutions provided are based on unbiased and normalised data. Furthermore, industry suppliers need to educate or advise PTOs and PTAs about the learning curve and resources required in monitoring once they adopt the AI solution, so they are well prepared for a successful deployment.



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⁴ B Zech, ‘Taking on Tasks that can be broken down into Smaller Chunks’, UITP Asia-Pacific – Centre for Transport Excellence Blog & Articles, 31 August 2018

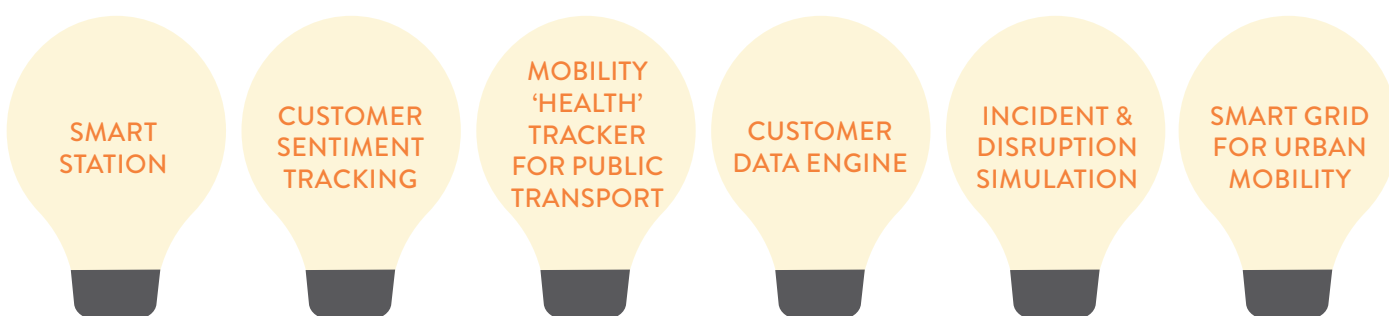
CONCLUSION

Media coverage and articles relating to developments and breakthroughs in AI appear across the globe. The world is waiting to see which country or sector will make further advancements. However, there remains a general distrust in AI, with many public transport authorities and operators, as well as the general public. Experts believe use-cases of AI applications in public transport sector are likely to become widespread in the near future. The power of AI multiplies when it combines with other advanced technologies such as IoT and blockchain.

The experts who took part in UITP AP CTE's study believe that plausible AI solutions can revolutionise the mobility landscape. Furthermore, the prediction of AI applications can reach beyond software

and become integrated into public transport infrastructure such as Smart Stations and Smart Grids. As artificial intelligence may hold many possibilities for the public transport sector, the fundamental foundation of this technology is in data. The sector must consider deploying a robust data governance framework and fostering a sustainable data sharing ecosystem as superior AI solutions depend on diverse and inclusive datasets from multiple sources.

For more details on the use-cases, guidelines and future concepts of AI-solutions for public transport sector or to order a copy of the report *Artificial Intelligence in Public Transport*, please contact asiapacific.cte@uitp.org.



► Plausible concepts of AI applications in public transport

This is an official Action Point of UITP, the International Association of Public Transport. UITP has more than 1,800 member companies in 100 countries throughout the world and represents the interests of key players in this sector. Its membership includes transport authorities, operators, both private and public, in all modes of collective passenger transport, and the industry. UITP addresses the economic, technical, organisation and management aspects of passenger transport, as well as the development of policy for mobility and public transport worldwide.

This Action Points document was prepared by Gayang Ho, Leader of Research and Policy Development and Clémence Morlet, Researcher.

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