ARTIFICIAL INTELLIGENCE IN MASS PUBLIC TRANSPORT

Executive Summary

THE STUDY

The research topic: **Artificial Intelligence (AI) in Mass Public Transport**, is the first study to be conducted by UITP Asia-Pacific Centre for Transport Excellence (AP CTE) under a joint-funded research programme between International Association of Public Transport (UITP) and Land Transport Authority (LTA). The year-long project commenced in late 2017 with the following insight collection approach: review of literature, quantitative survey, use-cases, experts' blogs, expert roundtable and ideation workshops.

The recent boom of artificial intelligence (AI) over the last decade has been triggered by advances in machine learning and deep learning. Many industries are adopting AI and integrating this technology into their services and products, impacting peoples' everyday life. The objective of this study is to **demystify AI**, **raise awareness** in the public transport sector by landscape analysis and **provide insights** to organisations who may be considering AI-powered solutions.

The report outlines current use-cases of AI applications in public transport and what the future might hold for AI in public transport systems. Early adopters and progressive public transport stakeholders anticipate that artificial intelligence is, and will be, further embedded in the future of mobility.

Our approach was to build upon the extensive network of UITP membership to get first-hand data and insights from authorities, operators, industry providers and research institutes on the current and future uses of AI in mass public transport. AP CTE received direct feedback on key lessons learnt and challenges to overcome for successful implementations of the AI technology.

The study focused on the use of artificial intelligence for customer excellence, operational excellence, engineering excellence, and security and safety management, while the use of AI in self-driving (private) vehicles was out of scope. The report equips the industry with a comprehensive collection of concrete examples and best practices to enable public transport stakeholders to be better prepared for the mobility of tomorrow.

This study is led by AP CTE in collaboration with Land Transport Authority of Singapore, and Trans-consult Asia as the lead partner.

FUNDING ACKNOWLEDGEMENT

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The present document includes:

> An overview of the content of the report.
> The list of organisations that contributed to the study.
> An executive summary with key take-aways.

If you would like to purchase the full report, please contact asiapacific.cte@uitp.org.

INTERNATIONAL ASSOCIATION OF PUBLIC TRANSPORT (UITP)

UITP is a passionate champion of sustainable urban mobility and is the only worldwide network to bring together all public transport stakeholders and all sustainable transport modes. Established in 1885 and headquartered in Brussels, UITP has 16 offices across the world and 1,500 member companies giving access to over 18,000 contacts from 96 countries.

UITP ASIA-PACIFIC CENTRE FOR TRANSPORT EXCELLENCE (AP CTE)

The Asia-Pacific Centre for Transport Excellence was officially launched on 2 July 2012 with joint efforts between the International Association of Public Transport (UITP) and Land Transport Authority of Singapore (LTA). The Centre's mission is to share and consolidate knowledge, conduct research and educational/training programmes to support the development of efficient public transport policies/solutions, and foster sustainable mobility systems, which meet Asia-Pacific needs, and enhance life standards.

LAND TRANSPORT AUTHORITY OF SINGAPORE (LTA)

The Land Transport Authority (LTA) is a statutory board under the Ministry of Transport, which spearheads land transport developments in Singapore. LTA plans, designs, builds and maintains Singapore's land transport infrastructure and aims to provide convenient options for walking, cycling or riding the trains and buses. LTA also leverages innovative technology to strengthen its infrastructure to provide exciting options for future land transport.

TRANS-CONSULT ASIA

Trans-consult Asia is an advisory enterprise specialising in urban transport operations and management, green transport solutions, and smart mobility solutions. Adopting a data and technology driven approach to enhance efficiency, performance and/or experience, it is committed to creating human-centric solutions and better living environments. Head-quartered in Hong Kong, it works on projects around the world.

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EXECUTIVE SUMMARY

Today, the world has entered the **Fourth Industrial Revolution**, which is driven by seamless automation, endless connectivity and characterised by merging physical and digital advanced technologies such as artificial intelligence, big data analytics, the internet of things, and blockchain.

The growing importance and maturity of artificial intelligence (AI) bring **opportunities** to people and economies. As a disruptive technology, AI also poses risks and challenges to existing markets.

According to PwC's analysis, the **global GDP will be up to 14% higher in 2030** as a result of the accelerating development and take-up of AI.

Accenture predicts **AI could double annual economic growth rates** in terms of gross value added (a close approximation of GDP) by 2035 across 12 selected countries.

44% of 203 senior executives (from various industries and countries) say **delaying AI implementation will make their business vulnerable to new, disruptive tech start-ups.**

AI – A MOVING DEFINITION

There is no universally accepted definition of 'artificial intelligence' because the meaning of 'intelligence' is arbitrary.

Definitions of AI are debatable and some are even "self-defeating" (Antonio L. Elias, John D. Pararas). For instance, the World Economic Forum defines AI by its ability to "do things traditionally done by people", which makes the definition subject to change as technology progresses and takes up more tasks.

What do our Public Transport Experts Think of AI?

Experts suggest that artificial intelligence 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.

GROWING IMPORTANCE OF ARTIFICIAL INTELLIGENCE

AI in Industry Sectors

Artificial intelligence is impacting all industry sectors with some industries, such as financial services, leading in AI adoption. The report highlights the impacts AI has on health care, retail, agriculture and the legal profession, all sectors that the public transport industry can learn from.

AI in Government Policies

The US and British governments were the first to heavily fund artificial intelligence research back in the 1960s.

In the recent years, there has been a growing interest, supporting policies and investment in AI by national governments. In particular China, a late adopter, announced the fundamental role of AI in its 13th Five-Year Plan in 2015.

The map highlights **countries/regions that have made major public announcements to support the development of AI technologies.**
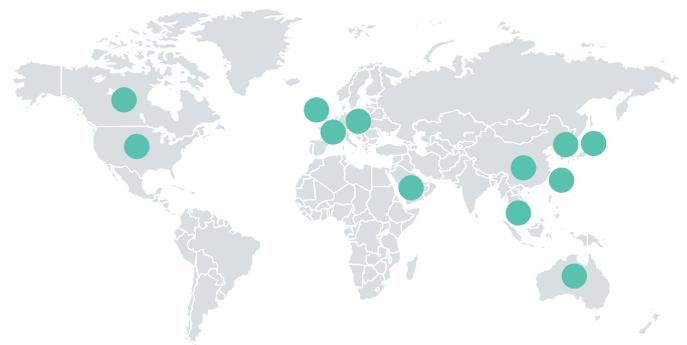
OUR RESEARCH METHODOLOGY

Over 100 contributors

AI experts/adopters

Public transport stakeholders

first-hand information → Research

Deliverables
> Present research report
> Training programmes on AI in public transport

Audience
> Wider AI and public transport sectors
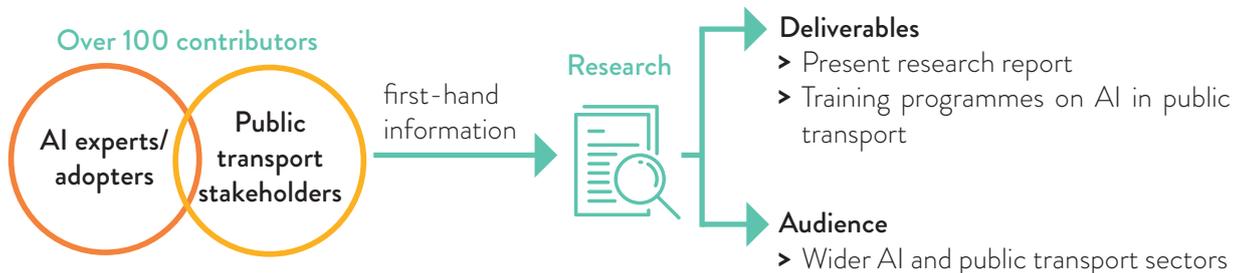
What we did....

> **Quantitative Survey**
48 companies across the public transport sector

> **Expert Roundtable (Karlsruhe, Germany)**
Attended by 28 public transport experts in IT, Innovation and Product R&D.
Objective: To gain deeper insights on challenges faced and lessons learnt from experts who have experience in deploying or are currently considering deploying AI projects.

> **2 Ideation Workshops (Hong Kong & Singapore)**
Attended by 57 experts from public transport and the field of AI.
Objective: To bring two worlds of experts to brainstorm the future of AI in public transport.

> **17 in-depth use-cases**
Contributions from organisations & CTE research

> **7 experts blog entries**
Expression of views and opinions

Photo Credit: UITP

Photo Credit: UITP

Photo Credit: UITP

Where we focussed...

The project focussed on the use of artificial intelligence in the context of four main areas:

Customer Excellence:
Use of AI applications to achieve better customer service and intelligence amongst authorities and operators.

Engineering Excellence:
AI-powered solutions for inventory and asset management and predictive maintenance.

Operational Excellence:
Using AI to improve system and operational efficiencies through business process optimisation.

Safety and Security Management:
AI applications to improve operational safety and security measures, including offences that involve revenues and property.

The scope of the study excludes AI technologies relating to autonomous passenger vehicles whilst autonomous shuttles/buses (as mass public transport) were included.

QUANTITATIVE SURVEY

The **online survey** conducted by UITP generated 48 responses from public transport related organisations, including 9 authorities, 15 operators, 22 industry providers and 2 research institutes. Key survey findings are outlined below.

Adoption of AI is gaining momentum in public transport...

62% of the surveyed public transport organisations are involved in AI technologies projects and solutions.

Among them:

> Half are at trial and R&D stage.
> Half have adopted AI technologies.

11% of the surveyed organisations are
AI adopters who started their AI journey between January 2017 and March 2018.

... and currently led by industry providers.

4 in 5 surveyed industry providers are **offering or trialling AI-powered solutions to public transport clients.**

Four key applications of AI in public transport

| Real-time operations management |
| Customer analytics |

1 in 4 responded public transport stakeholders are currently using AI in both of these applications.

| Predictive Maintenance |
| Network Planning and Route Design |

In the future, **1 in 3** are considering the integration of AI technologies in these three applications.
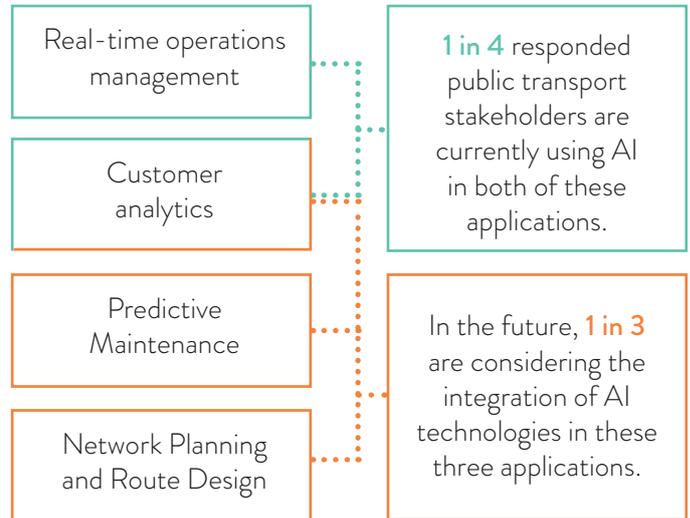
Five main challenges faced by public transport authorities and operators

1. Improve **data quality** (i.e. reduce fragmentation and incompatibility of data)

2. Build **capacity and knowledge** in AI deployment

3. Overcome **data privacy** issues

4. Meet the requirement of **data volume** (i.e. sufficient data-sets)

5. Establish **commitment from top management** to drive the cultural and process change required

OVERVIEW OF CURRENT APPLICATIONS OF AI IN PUBLIC TRANSPORT

The study collected **in-depth information on 17 use-cases across the four key areas of focus**, with the applications and main stakeholder organisations listed below. AI is clearly gaining traction in the public transport sector.

AI for Customer Excellence

> MTR Chatbot
> TfL TravelBot
> JR East-Hitachi Communication Robot
> JR East-IBM Call Centre Support System

AI for Operational Excellence

> RTRI Predicting Method of Train Delay and Train Congestion
> SBB Reinforcement Learning for Railway Dispatching
> NEC Predictive Optimisation for Bus Operations
> Shenzhen Bus Group-Haylion Technologies 'Alphaba' Intelligent Driving Public Bus Trial
> RATP Dev 'Interstellar' Mass Transit Data Analytics System
> Siemens Mobility Data Analytics for Mobility Demand Prediction
> Axon Vibe-SBB Smart Travel Assistant and Travel Cockpit
> Alibaba ET City Brain
> LTA Automatic Traffic Monitoring on Drone Images

AI for Engineering Excellence

> RTRI Automatic Tunnel Lining Crack Detection
> Yutong Bus-Shanghai Bus Group Intelligent Charging Control System

AI for Safety and Security Management

> SMRT Buses 'ProLearn' Data Analytics and Accident Risk Prediction
> AWAAIT-FGC 'Detector' Fraud Detection System

Key outcomes from use-cases

AI applications have been deployed in public transport to:

> Improve the quality and efficiency of tasks undertaken by employees.
> Reduce employee workload from mundane tasks to focus on more value-adding activities.
> Tackle specific problems, in particular those that require solutions relying on complex analysis of data and predictions in dynamic, ever-changing environments.
> Provide efficient, safer and cost-effective services to customer.

Current AI applications in public transport have *NOT* been designed to replace staff.

The mindset of **"Start small and grow incrementally"** helps to the successful deployement of AI. It also allows organisations to source funding progressively and minimise risks.

Low hanging fruits

Not all AI applications require multi-million dollars investment. **AI powered video analytics** and **chatbots** are two types of applications that are relatively easy to deploy with fewer barriers to development. They can be viewed as a place to start when thinking about deploying AI technologies, with a view to developing more complex applications in future.

THE EVALUATION OF AI TECHNOLOGIES

During the evaluation of AI projects, there are a number of distinct areas that need to be considered to ensure a robust and relevant assessment has been undertaken:

> AI is new in public transport: **be cautious of early results and adopt an inquisitive mind.**

> AI is a self-learning technology that feeds on data: **be aware of the learning curve.**

> AI is only a tool: use common **key performance indicators (KPIs) to measure its impact** of solving a right problem statement.

KPIs

Study of the impact of the 17 use-cases on KPIs revealed the following:

> AI applications have **the greatest positive impact on customer service and operational reliability.**

> Use of AI is expected to improve financial efficiency and uptake of public transport.

> Experts expect more safety- and security-related AI application to be developed.

TOOLBOX: LEARNING FROM AI ADOPTERS

The study collected knowledge from the public transport industry and UITP provided opportunities for extensive peer knowledge sharing that helped identify building blocks and commonly faced hurdles.

Four building blocks to follow for a successful deployment of AI

Lead with an innovation mind-set without fear of failure

Foster a multidisciplinary, collaborative stakeholder management approach

Move towards a data-orientated organisation culture

Develop a long-term, comprehensive and sustainable data management strategy
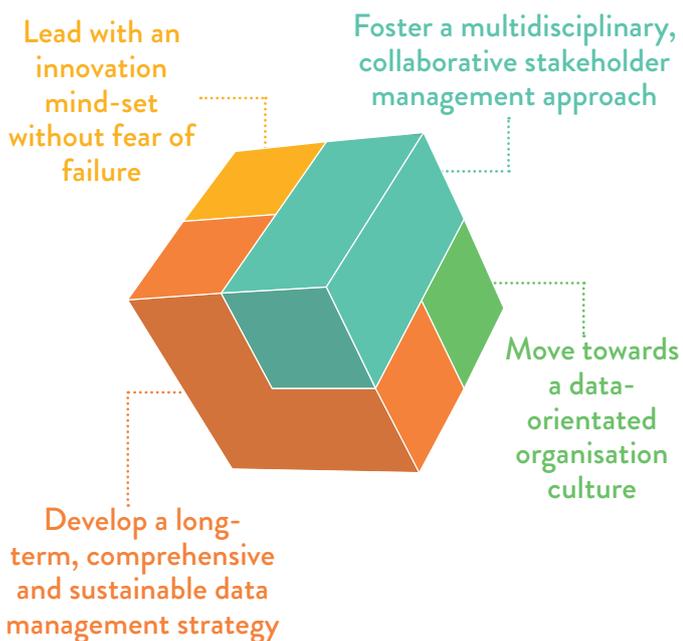
Challenging requirements of AI in mass public transport projects

Develop Legal and Policy Framework

Avoid the Trap of Over-Relying on AI

Develop Unbiased AI

Reform Traditional Procurement Processes

Source funding
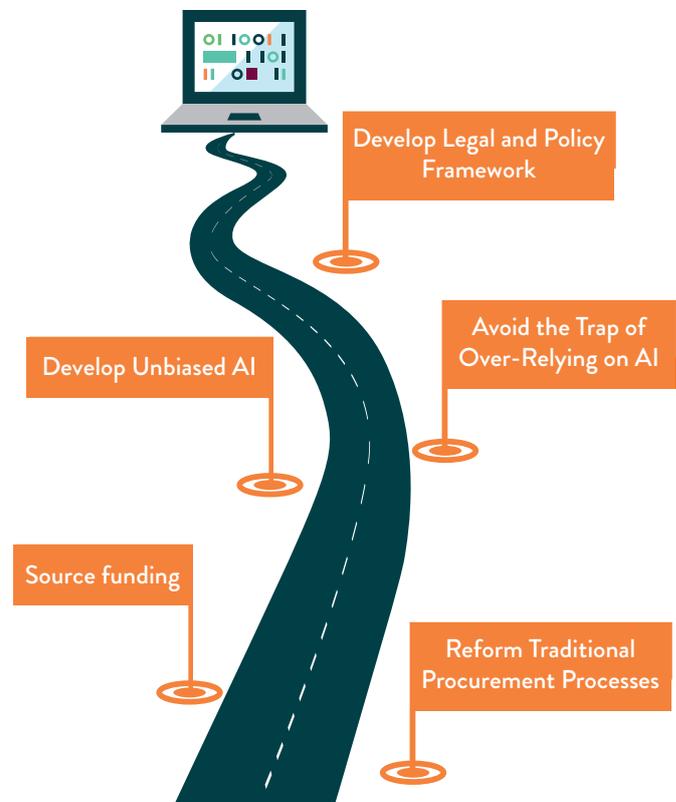
WHAT IS NEXT?

AI is already positively impacting the public transport sector and the technology is evolving and improving rapidly over time. Experts gave their valuable insights on the likely **short to medium-term trends of AI in public transport**.

...underpin Mobility as a Service (MaaS) platforms.

...be embedded in most customer touchpoints.

...enable Smart City initiatives to succeed.

...make on-demand public transport services a reality.

IN THE NEXT 5 YEARS, AI WILL...

...power the deployment of autonomous shuttles and buses in cities.
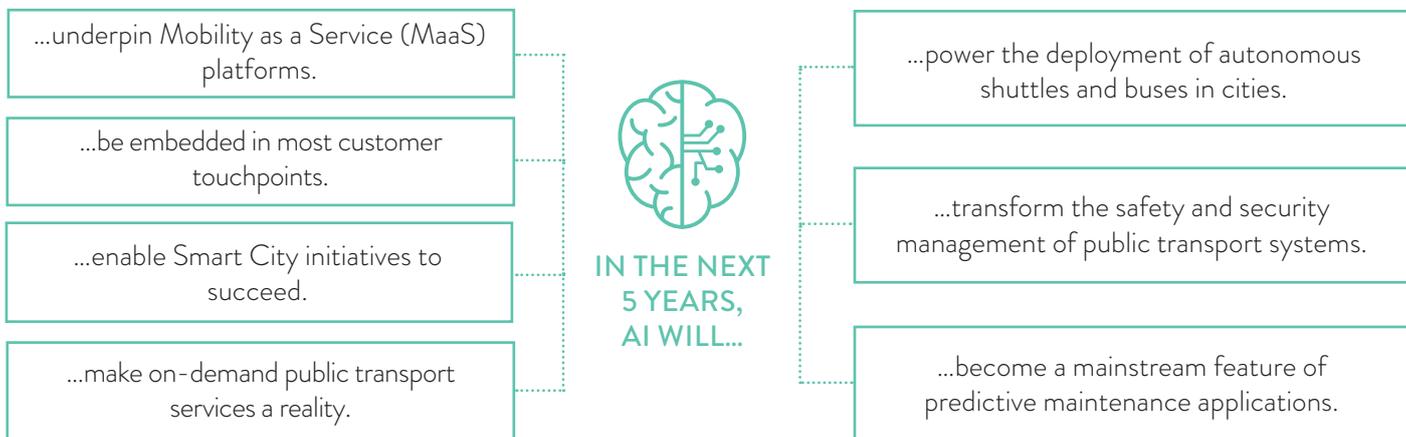
...transform the safety and security management of public transport systems.

...become a mainstream feature of predictive maintenance applications.

Combining AI with the internet of things or blockchain can give rise to further opportunities...

Internet of Things (IoT)

Devices and sensors connected through the IoT generate a significant amount of unstructured data, which AI can:

> Make sense of, or recognise patterns in.

> Provide optimised outcomes to specific problems and predict likely future outcomes.
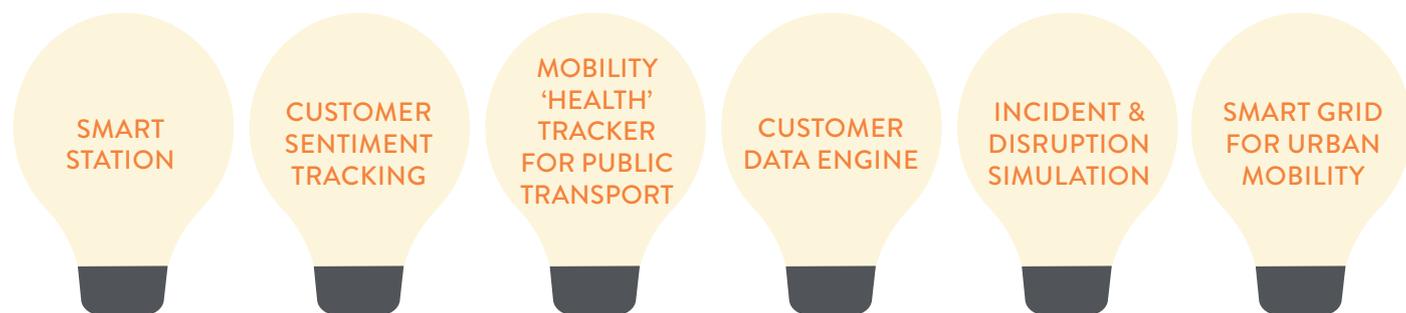
Blockchain

Blockchain can:

> Improve security of AI-enabled tools.

> Track, understand and explain decisions made by AI.

WHAT COULD THE FUTURE OF AI LOOK LIKE?

AI experts and public transport stakeholders brainstormed the AI-driven innovative concepts that could help overcome the rising challenges of the industry such as building intelligent transport systems, responding to the growth of on-demand mobility and sharing economy solutions, achieving safety and security of public transport systems and solving workforce shortages.

SMART STATION

CUSTOMER SENTIMENT TRACKING

MOBILITY 'HEALTH' TRACKER FOR PUBLIC TRANSPORT

CUSTOMER DATA ENGINE

INCIDENT & DISRUPTION SIMULATION

SMART GRID FOR URBAN MOBILITY

LIMITATIONS

AI, like any other technology, faces limitations. There is an important role for humans to play to maximise the benefit that can be realised from AI solutions and avoid undesirable pitfalls, there remains an important role for humans to play. These are summarised as follows:

Artificial is not Human:

> Public transport systems need human interactions.

> AI is task-specific; humans should manage the bigger picture.

> AI is only a tool and enabler to unlock creative ideas.

External Constraints:

> AI is human resource intensive: the right capabilities need to be strengthened and/or built to enable and exploit full potential of AI applications.

> AI cannot get smarter than its training data sets.

> Overly strong data-protection regulations or inadequate framework on data ownership and usage may slow down the progress of AI technologies.

OUTLOOK ON AI

Artificial intelligence is developing and its capabilities are advancing over time.

AI will inevitably transform the public transport sector. It is key to **understand the impact** or **potential of AI for the industry.** Public transport stakeholders should proactively look at the opportunities brought by AI to improve their services and build the mobility of tomorrow.

The report highlights the following expert conclusions:

> **Data is the foundation** of AI systems.

> **All public transport stakeholders have a role to play** including end-users because AI is a living application, which learns from user input.

> Stakeholders should engage in **collaborative partnerships** to build synergy and form **highly-skilled multi-disciplinary teams.**

> **Management should lead the change** to foster innovative culture and adopt 'try-and-fail' mind-sets. Most importantly, organisations should learn to 'fail safely' because AI requires a trial and error approach.

> With AI's potential in taking over mundane and repetitive tasks, **human resources must be continuously upskilled** to respond to the needs of future public transport.