Life in the fast lane

How public sector-led smart mobility solutions can transform urban transportation across Asia-Pacific

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pwc

Understanding the smart mobility landscape

Major cities across Asia are seeing rapid population growth, resulting in unsustainable demands on road and public transportation infrastructure. This negatively impacts the overall convenience and productivity of the residents, and has an adverse effect on commuter safety and the environment. Therefore, the reform of urban transportation systems remains one of the biggest challenges confronting policy makers around the world.

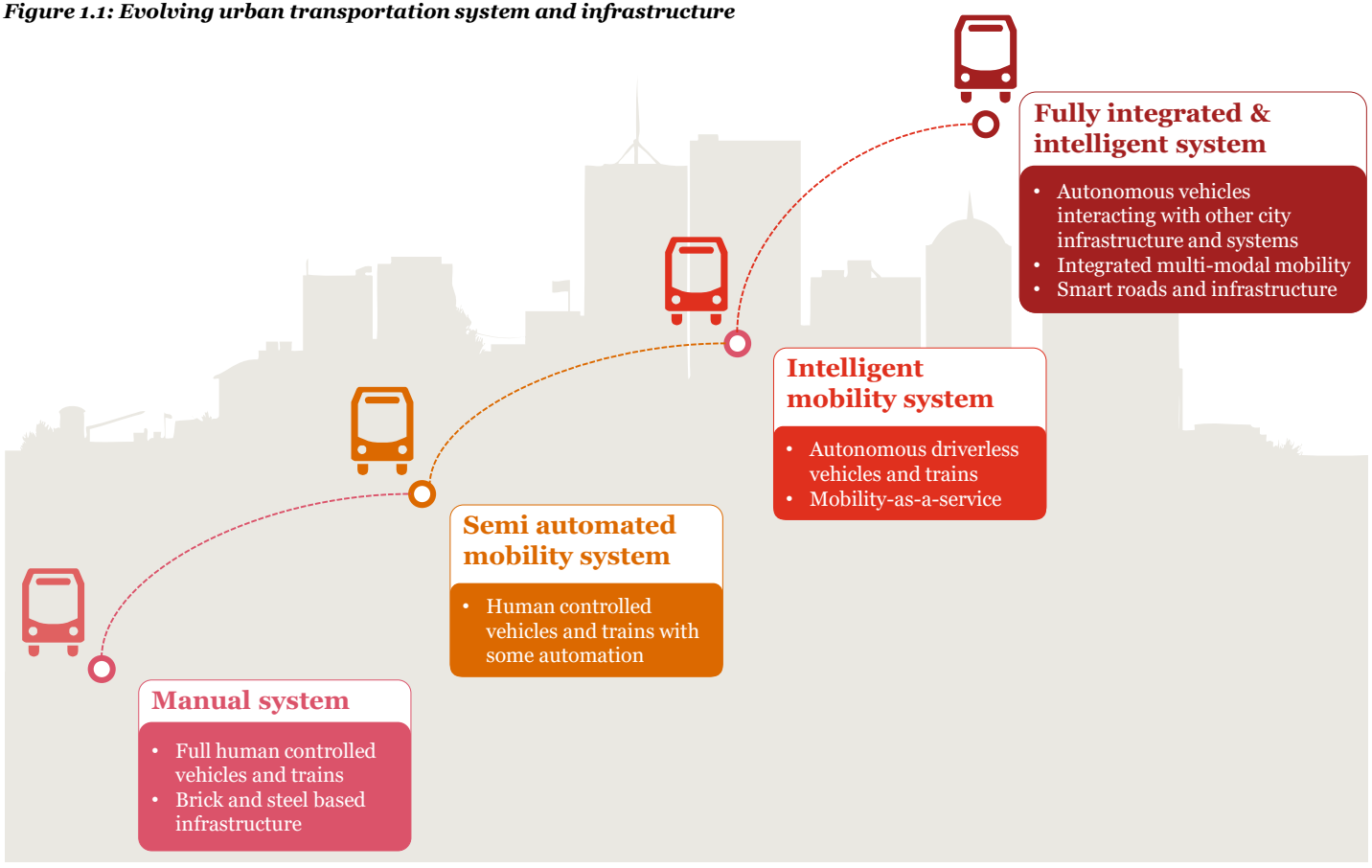
"Smart Mobility" initiatives lay the foundation to achieve cheaper, faster, safer and environmentally friendly travel in the city. It is enabled by integrated multimodal transportation, which combines the city's current modes of public and private transport, with new ones (e.g. autonomous vehicles), to create a seamless, customer-centric travel experience that also accommodates the needs of the elderly and the disabled.

1

Evolution of the smart mobility industry

Urban transportation systems and infrastructure are evolving, becoming more and more connected, automated and intelligent (as shown in Figure 1.1).[1] Technology such as data automation, Internet of Things (IoT), big data and analytics/cloud enabling virtualised control, and cloud computing real-time decision support systems are being incorporated into vehicles as well as overall transport infrastructure. By 2021, in Asia-Pacific (excluding Japan), IoT related spends on intelligent transportation systems and connected vehicles is likely to reach US$12.3 billion and US$16.8 billion, respectively.[2]

Figure 1.1: Evolving urban transportation system and infrastructure



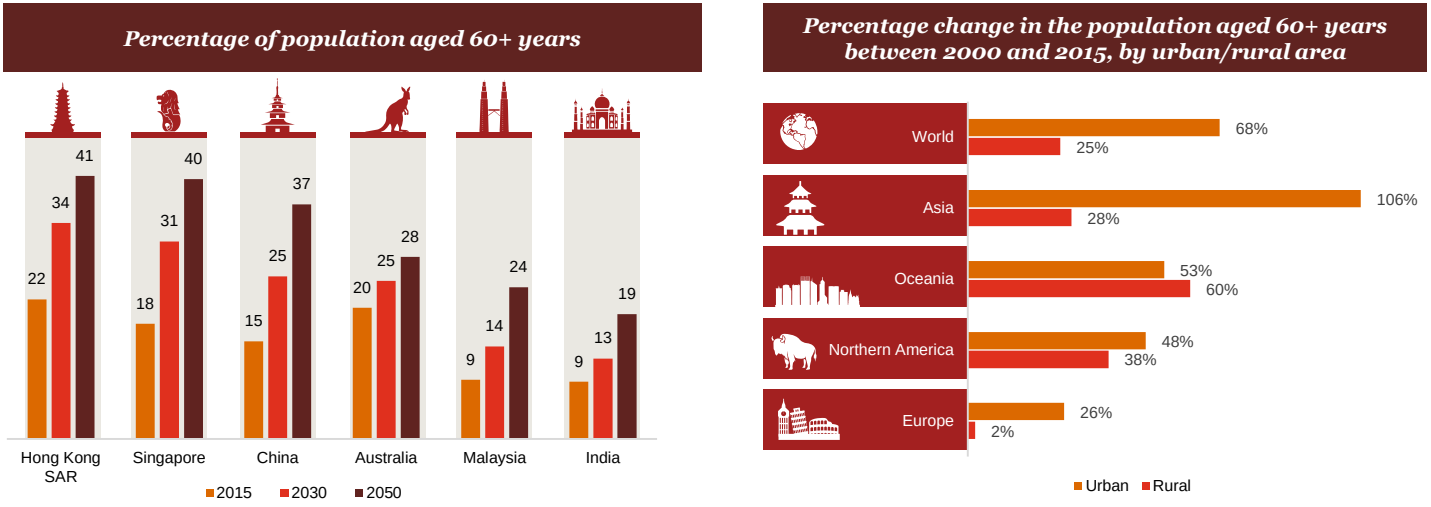
Source: Siemens, 'Smart Mobility – A tool to achieve sustainable cities', February 2015; PwC Analysis

Drivers of digital adoption

Demographic shifts

Across Asia, the number of people aged 60 and above are expected to grow significantly over the next few decades, from 508 million in 2015 to 1294 million by 2050.[3] According to a United Nations forecast, Malaysia's median age will increase from 28.5 in 2015 to 40.5 by 2050, and the percentage of population over 60 in Singapore and Hong Kong will also exceed 40%. This growth is significantly greater in urban areas across Asia (as shown in Figure 1.2),[4] creating an urgent need for the development and deployment of smart mobility technologies to provide individual mobility in large cities, especially to those who cannot drive or access certain terrains, such as the elderly or people with disabilities. These technologies would also help promote better civic engagement and access to medical and general services.

Figure 1.2: Ageing population in Asia-Pacific

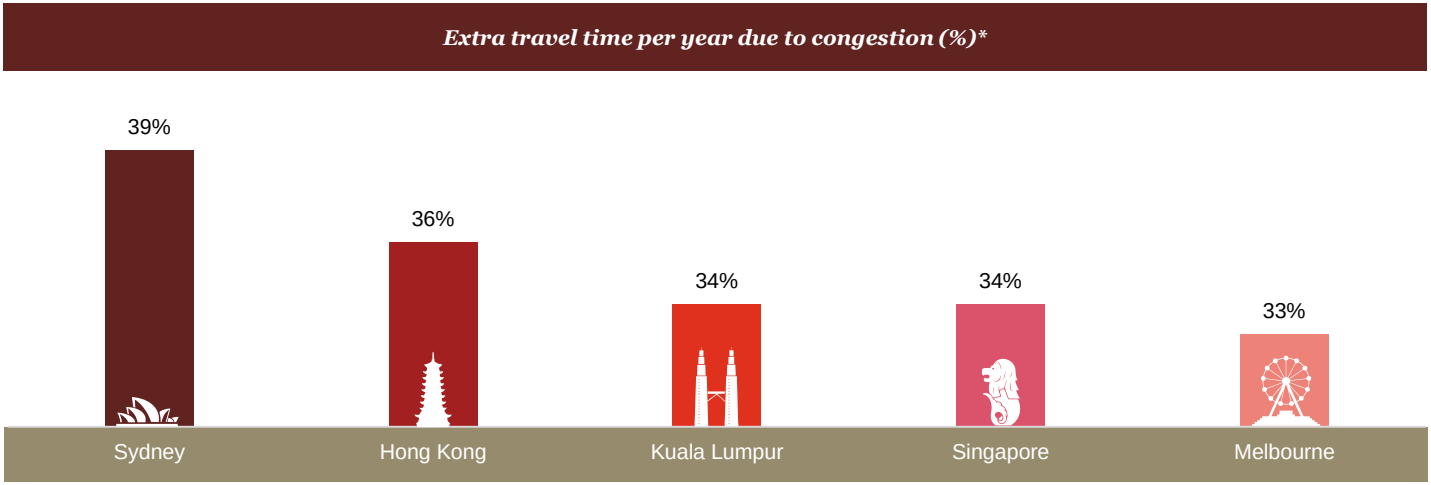


Source: UN Report, World Population Ageing, 2015

Increasing traffic congestion

With increasing urban population and wealth, car ownership is on the rise, placing a growing strain on the existing transportation infrastructure in most Asian cities. According to a 2018 survey, commuters in the Indian cities of Delhi, Mumbai, Kolkata and Bangalore spend 1.5 times longer to travel a given distance during peak traffic, as compared to non-peak hours. This traffic congestion is estimated to cost the economy more than $22bn per year.[5] To tackle this, improved public transportation systems are a critical need for major cities, helping reduce the number of vehicles on the road, thus easing congestion and parking issues. In addition, new technologies like autonomous vehicles can also make travel more efficient, by accessing real-time traffic information and changing travel routes based on factors such as congestion, accidents and on-going construction. Overall, self-driving vehicles are expected to save more than 250 million hours of commuting time a year, across the world's 50 most congested cities.[6]

Figure 1.3: Traffic congestion problem in Asia

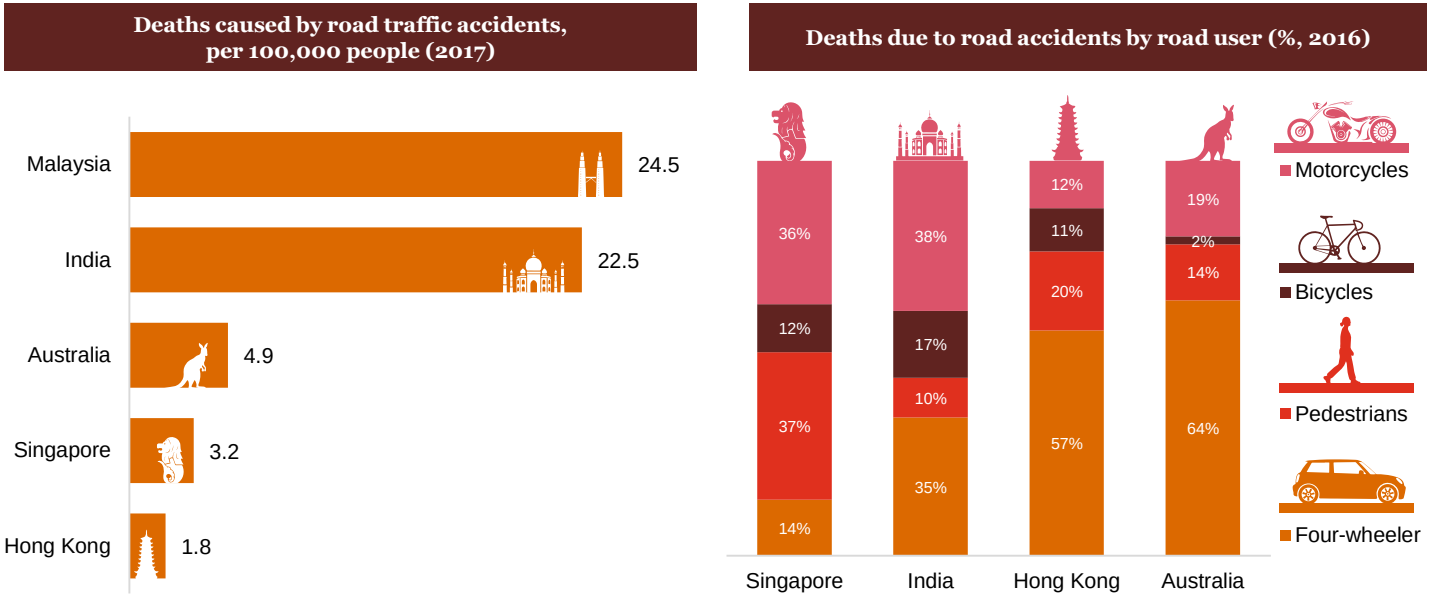


** Increase in overall travel times when compared to a free flow situation. For example, a congestion level of 36% corresponds to the additional 36% in travel time for a trip during peak hours, as compared to a free flow situation*
Source: TomTom Traffic Index, 2016

Growing concerns related to public safety

Globally, it is estimated that approximately 1.3 million people die in road crashes each year, with an additional 20-50 million injuries and disabilities resulting from vehicle accidents.[7] These have a commercial impact as well – a recent government report estimated the annual economic impact of road accidents in Australia to be 27 billion dollars.[8] However, most of these road accidents take place at traffic junctions or pedestrian crossings, and can potentially be prevented with smart junction management, autonomous vehicles and intelligent public transport systems. In India, it is estimated that over 50% of road deaths occur at traffic junctions, while in Hong Kong, 58% of accidents take place at pedestrian crossings.[9] Therefore, improving the safety of junctions and crossings, as well as the reliability of private vehicles and public transport systems is necessary to avoid the economic and social cost of road fatalities and casualties.

Figure 1.4: Road accidents in Asia



Source: World Life Expectancy, Death Rate Per 100,000 2017; Transport Department website of each country

First-mile and last-mile (FMLM) connectivity issues

A common issue across the Asia-Pacific region, irrespective of existing transportation infrastructure, is the limited first-mile and last-mile (FMLM) connectivity. This has consistently been an inconvenience for users, leading to a greater preference for private vehicles as compared to public transportation. However, Personal Mobility Devices (PMDs) and bicycle sharing-systems are now bridging the gap, and increasingly being used to create a seamless experience for passengers.

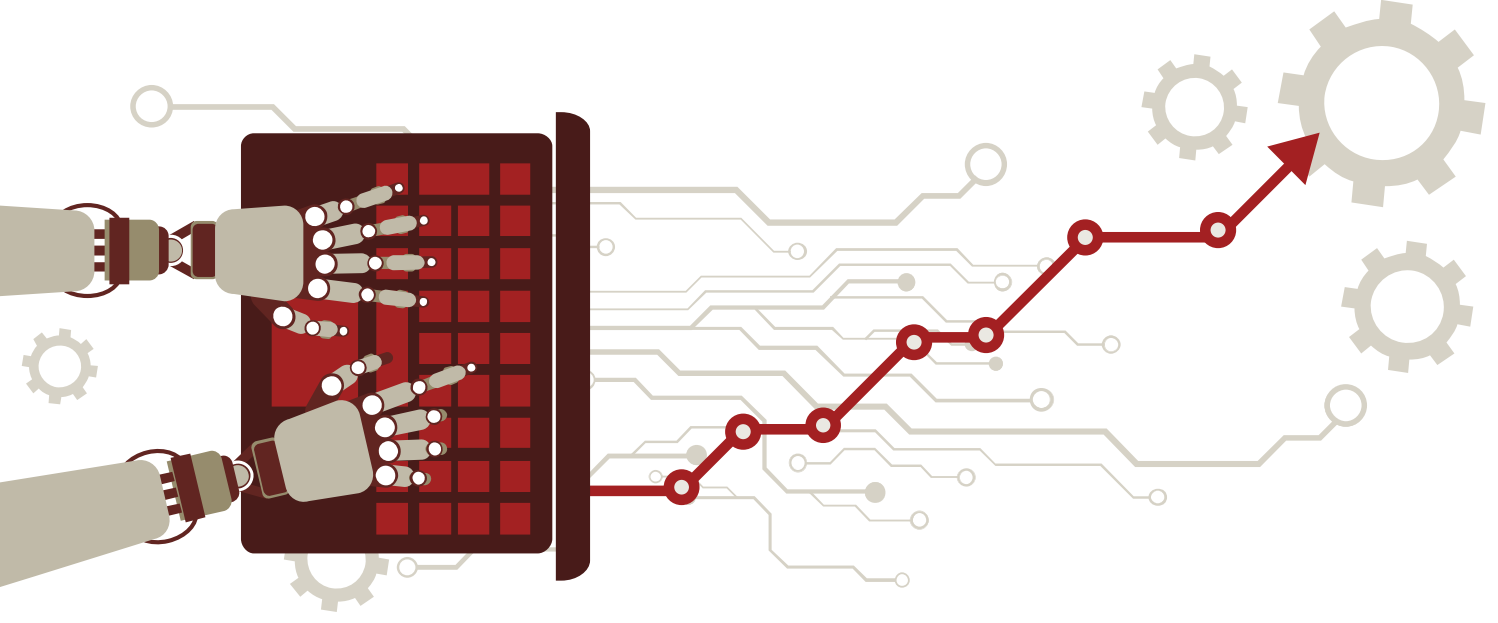
Despite the emergence of these new options, factors such as slow-speeds and exposure to weather conditions still limit FMLM connectivity. Also, increasing usage of PMDs and bicycles require consideration of pedestrian/cyclist/rider safety, security and efficiency. Innovative smart mobility technology could significantly improve FMLM accessibility, and provide equitable access to historically disadvantaged public transport users, including the elderly.[10]

Environmental pressure

The transport sector accounts for approximately 20% of greenhouse gas emissions and is a major consumer of fossil fuels. [11] Preventable pollutants include sulphur dioxide, carbon monoxide, oxides of nitrogen, volatile organic compounds, greenhouse gas, and particulate matter with small diameters.

For urban centres, cars are one of the biggest sources of pollution. It has been observed that regions with the highest number of vehicles on the roads experience higher levels of air and noise pollution, on average. According to a study, the environmental impact of traffic congestion, such as vehicle emissions and reduced air quality, has led to excess morbidity and mortality for drivers, commuters and individuals residing in close proximity to major roadways.[12] Governments across the globe are now looking to significantly reduce the emissions from cars as well as lower environmental pressures due to traffic congestion.

Overall, the focus is for governments and industry to work together in deploying advanced digital solutions for enhancing the flow of people and traffic across major metropolitans, in an environment-friendly and safe manner.



Next generation digital solutions for smart mobility

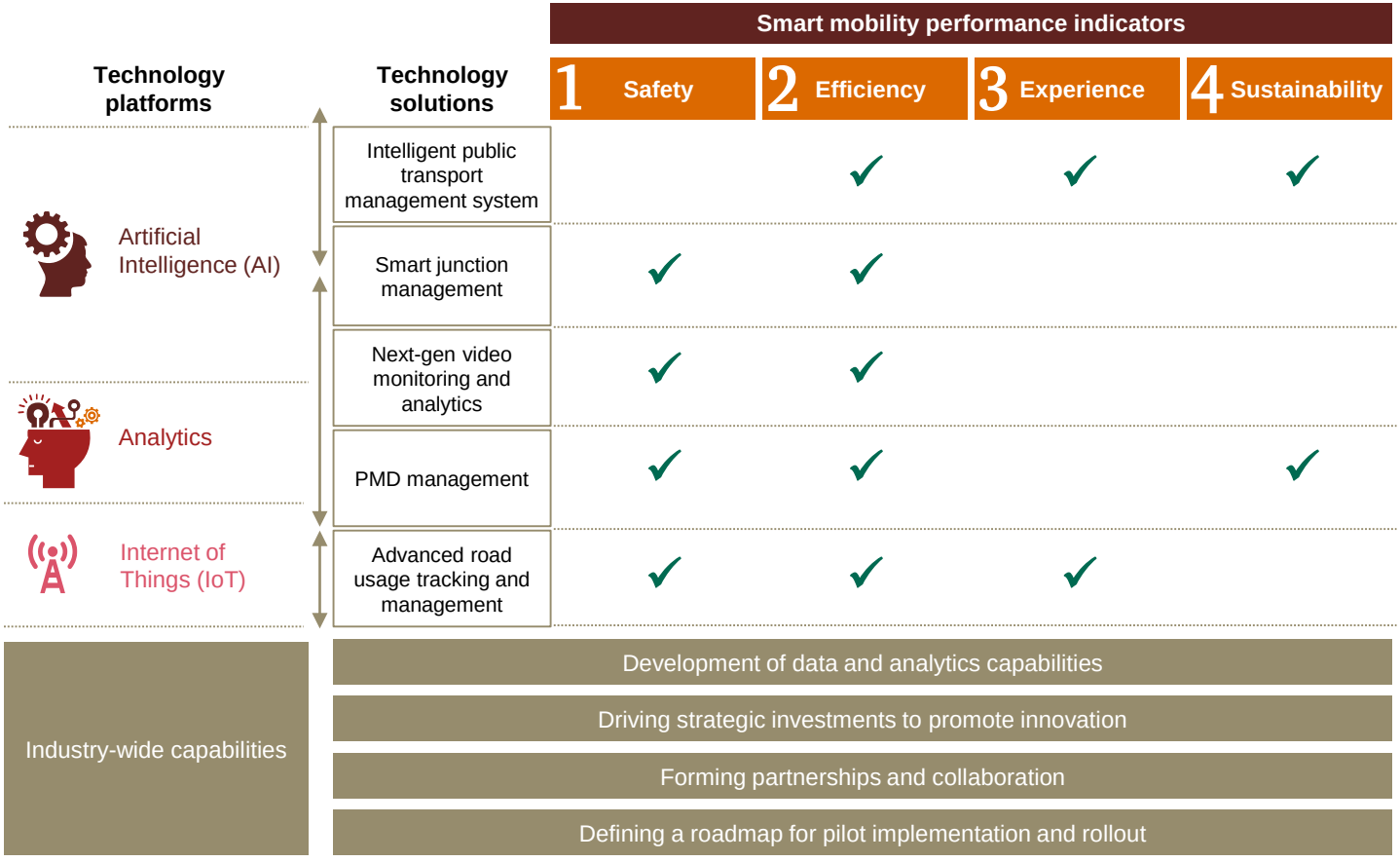
2

Next generation digital solutions for smart mobility

Digital solutions based on emerging technologies such as advanced sensing, IoT, Artificial Intelligence (AI), and data & analytics can help the public sector address the challenges mentioned in the previous section. Figure 2.1 highlights some of these new digital solutions and their impact across different performance attributes, to help improve the overall mobility across urban landscapes. These performance attributes, including safety, efficiency, experience and resilience, are defined as under:

1. **Safety:** making overall road and public transport systems safer by reducing the number of accidents involving pedestrians, passengers, drivers and other parties such as cyclists.
2. **Efficiency:** reducing travel time and/or cost, reduce journey disruptions and improve productivity.
3. **Experience:** improving commuter comfort and convenience or provide more personalised information related to the journey.
4. **Sustainability:** minimising the impact on the environment and reduce the burden on current urban infrastructure.

Figure 2.1. Technology-driven mobility solutions and services in Asia-Pacific



Source: PwC analysis

The following pages detail some of the new digital solutions that are expected to gain significant traction in APAC markets.

Intelligent public transport management systems[13]

Mobility challenge:

- Buses and other modes of public transport typically run on pre-determined schedules and routes that cannot be adjusted based on real-time demand and traffic conditions. As a result, passengers are subject to uncertain waiting times and extended delays, especially during peak hours.
- Currently public transport systems and shared private transport services being used by the commuters are not integrated. Commuters need to have separate mobile apps for individual operators/service-providers, each with different registration and payment methods. A seamless door-to-door experience is not being offered in spite of the infrastructure being available.
- Current public transport systems only analyse the aggregated passenger data, leading to an absence of integrated route planning and personalised services based on individual needs.

Smart solution:

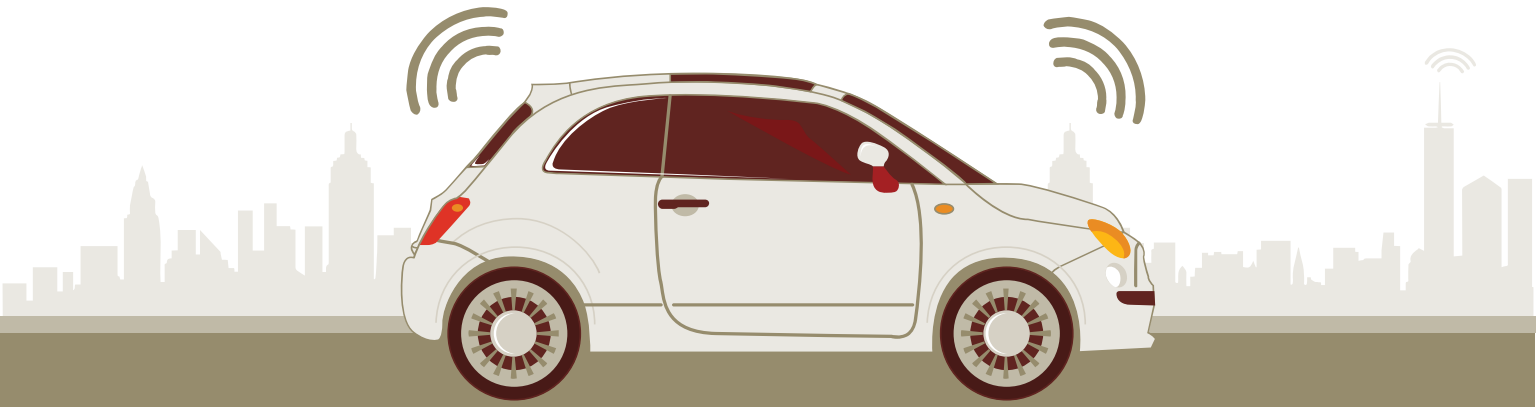
- Intelligent public transport systems will comprise of automated trains and buses supported by shared self-driving shuttles or pods. The entire IoT-enabled system will have AI-planned individual routes to maximise ridership and minimise trip times.[14]
- Commuters will be able to book their entire multi-modal journey through a smartphone and make payments using a single mode of payment.[15]
- Predictive intelligence technology will allow public transport users to receive a personalised service based on 'real-time behavior, interests, preferences, and individual data'. Commuter choices may change from day to day depending on, say, the weather. Analyzing this data will allow governments to build a degree of flexibility into bus and rail capacity.[16]

How it helps:

Efficiency:
Public transport will run at more optimised schedules, routes and capacities. Commuters will be able to take a more direct path to their destination, thus reducing the travel time.

Experience:
Commuters will benefit from shorter waiting times and better route planning. The seamless door-to-door journey will help improve comfort and convenience for the commuters.

Sustainability:
Greater use of shared vehicles will reduce road congestion and the need for parking spaces. It will also help lower emissions and pollution levels in the city.



Smart junctions management[17]

Mobility challenge:

- Traffic lights at the junctions currently run in sequences but are not designed to react to passing vehicles and the traffic situation around them. In addition, junction lights currently do not have the capacity to recognise emergency vehicles and prioritise their passage accordingly. It also fails to consider slower commuters, such as the elderly, the disabled as well as school children.
- Traffic monitoring and management is still done manually in many locations, making it difficult to obtain a complete view of the traffic situation in the city, resulting in a sub-optimal flow of vehicles and pedestrians.

Smart solution:

- AI-powered cameras can be installed into traffic lights, which utilise efficient algorithms and real-time traffic data at junctions to help prioritise ambulances, buses and cyclists and generally ease the flow of traffic. They are also able to identify pedestrians and their relevant characteristics (e.g. handicapped, senior citizens and children) to manage their movements at the junction accordingly.[18]
- These smart traffic lights can also be used to automate the traffic monitoring process. The videos from cameras across junctions can be processed in a central cloud environment to obtain a complete view of the traffic situation across the city. This will allow for a better green corridor effect (i.e. a car getting green signals across consecutive junctions) with an improved view of potential bottlenecks, resulting in more efficient city traffic management. It will also be able to detect accidents and automatically notify police and ambulance services.

How it helps:

Safety:

Technology can make junctions safer by removing the need for cumbersome manual interpretation and significantly reducing the potential for human error. Smart junctions will allow for safe passage of vulnerable road users (such as cyclists) by giving priority.

Efficiency and Experience:

The City of Copenhagen installed 380 new smart traffic lights in 2017. It is estimated that these intelligent traffic lights will allow drivers and public transport users to save between 5% and 20% of their travel time. Cyclists can expect to save up to 10%. This will improve the overall commuter experience as well.

Next-gen video monitoring and analytics[19]

Mobility challenge:

- Manual interpretation of mass video data is time and labour intensive. There is high probability of human error and possibility of missing events when monitoring cameras in real-time or assessing videos after an incident has happened.
- Traffic, commuter and transport infrastructure surveillance is primarily being done through fixed cameras which have limited data collection abilities. Also, with current assessment technology, it is difficult to predict any infrastructure breakdowns such as a rail track fault.

Smart solution:

- Intelligent video analytics technology can automatically and quickly interpret large data volumes from fixed cameras to generate reports and insights. Powered by AI, these solutions can also conduct real-time monitoring and send alerts in case of events such as the committing of a traffic offence or the presence of an unidentified object in a crowded station. For example, Singapore is using video analytics to detect illegal parking even in busy roads with continuous traffic. Any vehicle parked or stopped in a specified zone in the camera view would initiate an alarm if it stays there for more than a defined period of time.[20]
- Enabled by video analytics, drones can also be used for predictive maintenance. This technology can continuously monitor the transportation network and identify infrastructure hazards that may increase the likelihood of an accident, such as overheating or metal decay. For example, the Dutch railway company ProRail uses drones equipped with infrared sensors to check the switch point heating systems on its tracks. Using the drone's images, the company can see whether the switch point heating systems are operating correctly.[21]

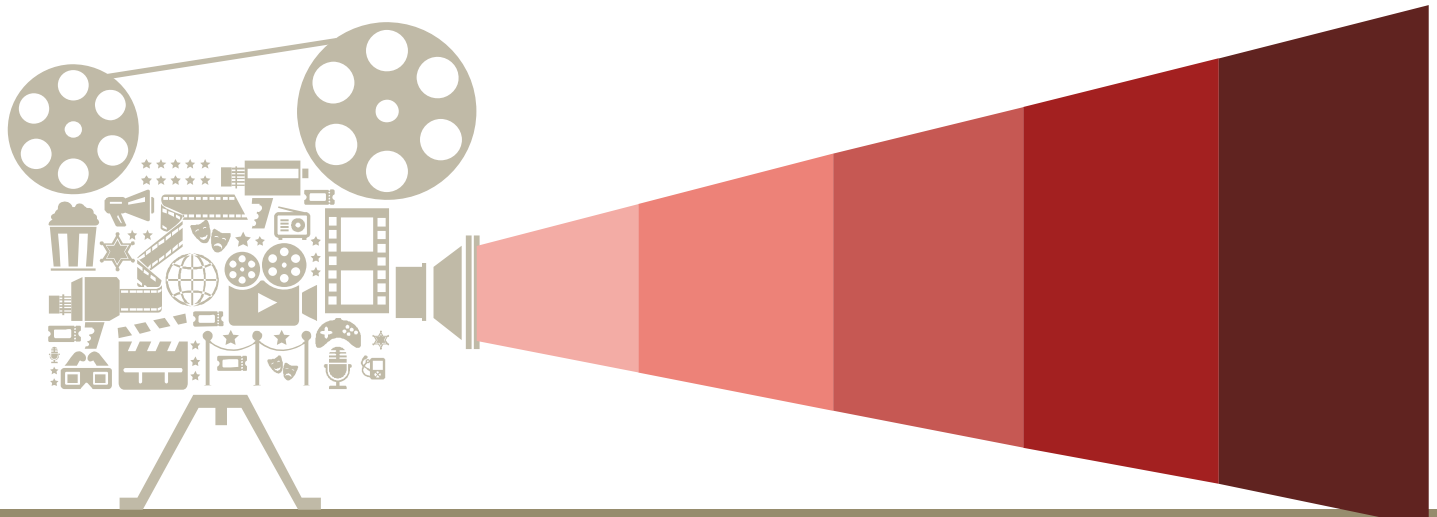
How it helps:

Safety:

Video analytics can detect anomalies in real-time and raise an alarm to prevent any unforeseen situations. It can also help in predictive maintenance, helping prevent potential accidents due to infrastructure breakdown.

Experience:

Next Gen surveillance allows for higher uptime of the transport network. It also reduces costs and the time required for continuous monitoring and surveillance.



Personal mobility device (PMD) management

Mobility challenge:

- There have been an increasing number of accidents involving PMDs. In Singapore, there were a total of 128 reported accidents involving personal mobility devices (PMDs) in 2017 (compared to 19 such accidents in 2015 and 42 in 2016).[22] These accidents occurred on public paths, or at road junctions when PMD riders were crossing the road, or where PMD riders were illegally riding on roads, parallel to vehicular traffic.[23]
- There have been issues around indiscriminate parking of shared bicycles. The bicycle sharing operators have exacerbated this problem by growing their fleets too quickly, in a bid to capture market share. There are also inconsiderate and irresponsible users who leave bicycles outside the designated parking areas.[24]

Smart solution:

- Roads and street lights can be equipped with facial recognition systems and speed-trap sensors could be used to track speeding bicycles or PMDs. Singapore is looking to a use a network of wireless sensors in about 110,000 lamp posts across the city. These "smart lamp posts" would allow for monitoring and law enforcement for the PMDs and shared bikes.[25]
- Analytics can be used to assess the distribution in demand for shared bicycles. This can be used to move assets to the right areas and provide additional parking spaces. Video analytics can also be used to identify improper parking and use of these mobility devices.[26]

How it helps:

Safety:

Stricter law enforcement and use of speed trap sensors can help reduce the number of accidents involving PMDs. Better sharing of space on roads and pavements will streamline the movements of pedestrians, slow vehicles and cars/buses.

Efficiency:

More efficient distribution of PMD assets according to demand (from big data assessments of demand areas) will allow for greater FMLM connectivity.

Sustainability:

Decreased reliance on motor vehicles will help reduce car park usage, enabling major cities to free up space for more practical use, such as schools or housing.

Advanced road and parking usage tracking

Mobility challenge:

- Currently, street lights are mostly pre-programmed to turn on/off at scheduled times. They do not respond to changing needs, roads and weather conditions.
- Road usage charges are fixed and are usually applied during specified periods at certain locations (toll booths/gantries). However, they do not change in real-time based on traffic conditions and congestion. Car users are mostly charged for entering the congested areas and for car ownership and not really charged based on their road usage and contribution to congestion.
- Inefficient parking systems also contribute to traffic congestion within urban transport networks. Currently, drivers lose time in perusing parking bays to find an unoccupied parking slot, manually parking their vehicle, redeeming parking tickets and then paying with cash or card.

Smart solution:

- Smart lighting on roads use high-tech sensors to automatically adjust lighting levels in response to changing conditions. Sensors can detect the type of movement (pedestrian, cars or animals) as well as weather conditions. The data is then processed through a cloud-based platform, which connects to the automated system controlling the street lights. Similarly the road signs can also be dynamic, changing according to the existing traffic situation. When there is heavy traffic, the lane markings (dotted lines) can be also changed (to continuous lines) to prevent cars from switching lanes.[27]
- Road pricing can be done dynamically based on traffic conditions. The traffic is monitored using road and street sensors as well as through satellites. The charges are levied based on distance travelled rather than by entry. It also provides motorists with more real-time information about which roads are most congested, and could help change their driving behavior.[28]
- Use of IoT can provide real-time information on vacancies in off-street parking lots and guide drivers to the nearest available space. It could also allow reserving of parking spots and include smart payment for new parking meters. Sensors could also help in assisting parking at tight parking spots. In Australia, there are a few companies who provide cloud-based parking solutions using in-ground, surface-mount, and above-space parking sensors, also connected to mobile apps. The system also allows for mobile payments in a seamless transaction and supports enforcement capabilities of cities, while providing analytics and details on usage.[29]

How it helps:

Safety:

Better street lighting can improve pedestrian visibility and reduce the number of vehicle accidents and pedestrian collisions. Smart roads and lights can also warn drivers and authorities of road hazards and conditions well in advance.

Efficiency:

Using dynamic pricing and smart parking can reduce traffic congestion, leading to lower travel times and costs. Use of smart lighting and roads can help save energy and lower the costs of running.

Sustainability:

Drivers will be directed to empty parking spaces reducing the wait times involved. Alternative toll and parking payment options (cashless and ticketless systems) allow drivers to settle bills in a convenient manner.

Capabilities for success

3

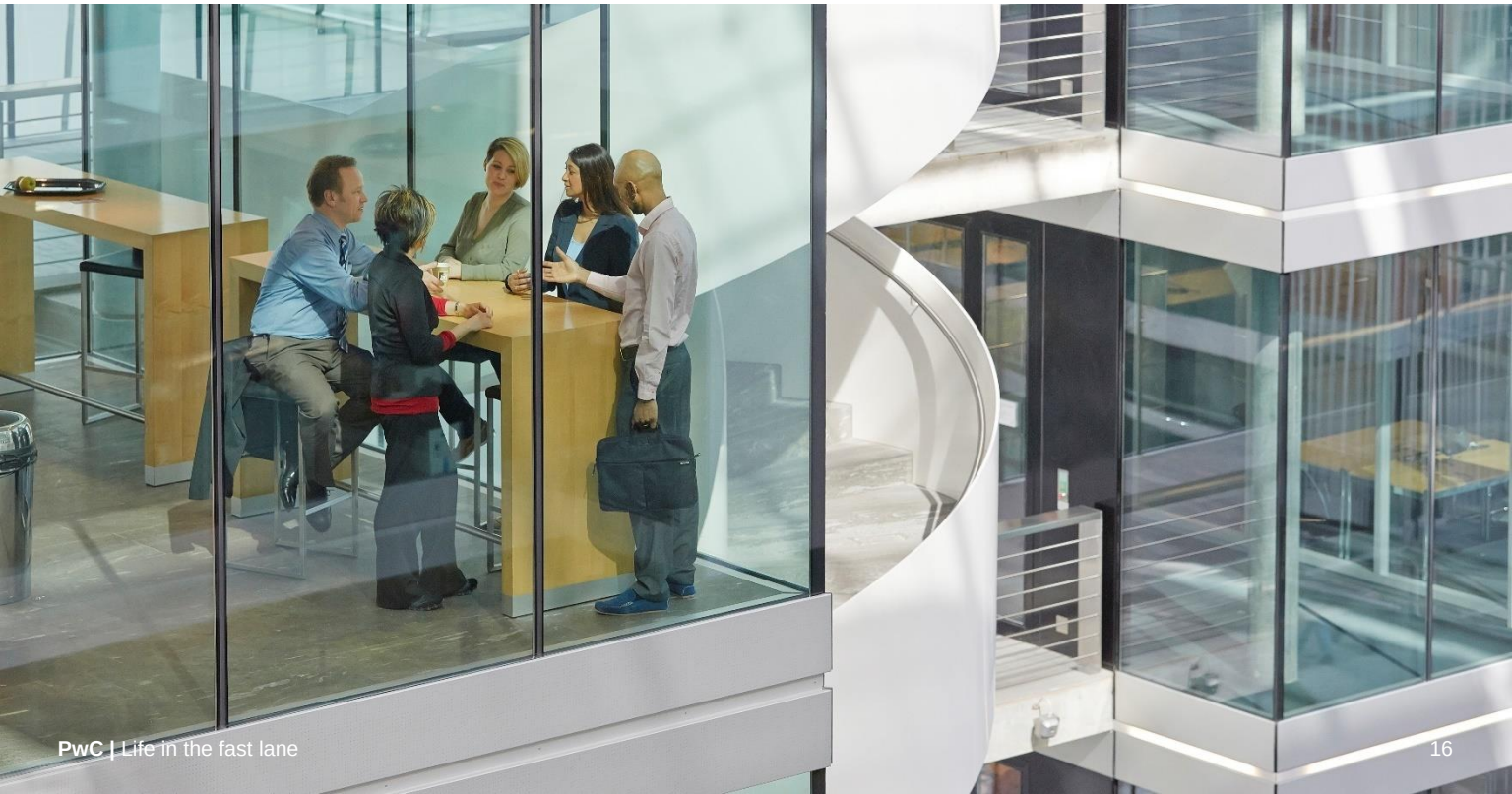
Deploying these new solutions alone will not be enough to maximise the impact of digital adoption. Public sector departments and enterprises will also need to build a set of supporting capabilities, focused on data and analytics, strategic investments to promote innovation, forming partnerships and collaboration, and developing an integrated roadmap for pilot implementation and rollout. This set of capabilities will be essential for driving the digital transformation of the urban transportation system and infrastructure across the Asia-Pacific region.

Developing data and analytics capabilities[30]

To be effective, smart transportation systems of the future will require real-time processing and analysis of information from numerous sensors and cameras throughout the city. Therefore, a critical success factor for the adoption of these solutions will be to develop world-class data and analytics capabilities within the public sector – those who are funding and implementing the technology for the wider public. Some cities are already taking steps in this direction - for example, the Hong Kong Smart City Blueprint states that the government will build a new big data analytics platform by 2020 which will enable real-time data transmission and sharing among government departments.

In addition to building platforms, there is also a need to adequately train public officers and build core teams having digital capabilities to help leverage more analytics and data science in policy formulation and service delivery. The public sector will need to work closely with local universities and industry to conduct experiments and create new products and services. Finally, a general recognition of the possible risks, alongside a prioritisation of data privacy and safeguarding of critical systems and networks, must occur. This will require training the public officers on safeguarding against phishing and other cybersecurity threats.

Case study: In Singapore, 10,000 public officers will be trained over the next four years in digital capabilities to use more data analytics and data science. Government is collaborating with the National University of Singapore to provide this training via an exchange program involving public servants and students. Singapore is also looking to develop a core group of 250 professionals in the Government Technology Agency (GovTech) and Cyber Security Agency (CSA) to build up capabilities in areas such as data science and cybersecurity. Besides using available technologies, these professionals will work closely with local universities and industry to design and deploy new products and services, as well as enable further policy innovation.



Driving strategic investments to promote innovation

To promote innovation, it is important to have a healthy start-up ecosystem. Challenges often faced by start-ups include a lack of finance, technology and skilled labor. The 2018 Global Start-up Ecosystem Report found many of the APAC countries lack connectedness between founders, experts and investors in start-up ecosystems.[31] To promote technology innovation, government should act as a bridge and help connect 'technopreneurs' with industry mentors.

Targeted and strategic investments in Centres of Excellence (CoEs) can also promote innovation. These CoEs will help local enterprises capitalise on AI, IoT and sensor technology. For example, India is deepening its technical capabilities by encouraging involvement and innovation through CoEs. India's first CoE for IoT was launched in Bengaluru in July 2016. It has been built as a joint effort between the Government of India, Nasscom, Department of Electronics & Information Technology (DeitY) and Education and Research Network (ERNET). Indian IoT firms have already received around $60 million in funding. The CoE also provides IoT start-up incubation programs that mentor participants and helps to connect them with enterprises.[32]

Several other CoEs, start-ups and accelerator programs have also been developed with the aim of leveraging the strength of Indian IT for accelerating technologies related to sensors, cloud, analytics and AI. For example, Genpact and Cisco have launched a Global Centre of Excellence in Jaipur as part of the Cisco Lighthouse City project, designed to deploy next-generation technologies to impact citizens and society. The initial pilots include applications for real-time identification of vacant parking slots in the city, foot fall forecasting for timely optimisation of promotional events, visitor pattern identification for public campaign efficacy, and real-time way-finding and tourist recommendations. [33]

Forming partnerships and collaboration

The key ingredient in rolling out successful smart mobility initiatives is the implementation of long-term partnerships and collaboration. A culture of collaboration will see city leaders from public and private enterprises, philanthropic bodies, and academia leveraging their influence to increase the city's value through collective impact.[34]

Public transport initiatives are currently developed and rolled out primarily by the transportation departments in cities, and they mostly operate in silos with limited collaboration across departments and external agencies. Going forward, governments will need to actively eliminate such silo-cultures among departments, and instead opt for greater visibility and information sharing between offices and departments to effectuate smart mobility.

There is also a need for formalised collaborations with start-ups to tap into their agility, creativity, and ability to generate disruption within the smart mobility sector that traditional private contractors cannot achieve alone. Similarly, start-ups will also benefit from the scale, capital and industry expertise of large enterprises. In addition, collaboration between private contractors and 'non-traditional' partners will hasten the creation and implementation of smart mobility.[35]

Finally, informal collaboration should not be overlooked – hackathons, start-up competitions and incubators provide university students, young professionals and start-ups the opportunity to address smart mobility challenges under the purview of sector experts.[36]

In Ipswich, Australia, 'Smart' programs are a testimony to what public-private partnerships can achieve. Under its Smart City Program, Ipswich has projects which include smart parking and transport, smart lighting and energy management, autonomous lawn mowing and automation. Its ability to do so is attributed to the success of its 'Open Data' plan, which provides open access to over sixty sets of data. These data sets are accessible to the public through online portals so anyone can participate and co-create solutions that benefit everyone. Key benefits include improved innovation, new solutions, and opportunities for schools and entrepreneurs to break down policy siloes by working together with the council.[37]

Defining a roadmap for pilot implementation and rollout[38]

Whilst many territories in APAC have strategic roadmaps for specific technologies, such as AI and IoT, an all-encompassing smart mobility plan is needed. Upon the creation of smart-mobility solutions as a result of strategic investments, collaborations and partnerships, a clear implementation roadmap will also be required to detail how the digital solutions can be rolled out.

At the 2018 ASEAN summit, 26 cities from 10 ASEAN countries were named for pilot cities for the ASEAN Smart Cities Network. Member cities are required to develop specific action plans, containing projects and action lines to be undertaken between 2018 and 2025. Such a framework should be implemented by all countries upon commercial acceptance of digital solutions.[39]

Small-scale pilot trials are crucial to ensure solutions meet user-needs in practice, under local environment and operational constraints. The citizen's current and forecasted future needs must be identified and prioritised throughout these processes. By focusing on the user experience as an important aspect of the implementation plan, companies will develop a thorough understanding of how users are accepting the new technology. The final step of the implementation will involve a willingness to recalibrate, with a mechanism for solutions to be regularly updated based on changing user behaviors, new technologies, new entry-market competitors and success rates.

Singapore's Land Transport Authority (LTA) recently conducted a four-month account-based ticketing pilot with MasterCard, which enabled commuters to use mobile payment methods such as Android Pay, Apple Pay and Samsung Pay for contactless fare payments. Commuters did not require their CEPAS EZ-Link cards, which negated the hassle to top-up personal cards. Instead, mobile devices were used to tap in and out of trains and buses. Singapore's demonstration of a successful public-private partnership and pilot is highlighted by its inclusion of elderly citizens (comprising 30% of consultation groups), the number of sign-ups since the initial launch, and plans to invite additional partners to participate in the system.[40]

Conclusion

The necessity for innovation in APAC's urban public transportation systems is already well-documented. Asia's ageing population, region-wide untameable congestion levels, inability to achieve seamless FMLM connectivity, and the ever-present environmental impact of vehicular mobility, has created a time-sensitive need for regional, state and global digital solutions.

The smart mobility market in APAC is expecting significant growth. Platforms such as AI, analytics and IoT will pave the way for technology solutions, including intelligent public transport management systems, smart junction management, Next Gen surveillance, PMD management, and advanced road usage tracking and management.

Going forward, safety, efficiency, experience and sustainability will be key markers of success for smart mobility technology. The prevalence of human error will be diminished, if not removed. Public transport will become more reliable and personalised for its users, leading to better commuter experience. The environmental impact of emerging solutions will also be at the forefront of new designs. Reduced congestion levels and freeing up of parking spaces will make cities more liveable, efficient and attractive while still being easily accessible.

However, technology adoption will need to be a more collaborative effort. Non-traditional investments involving start-ups, governments and NGOs will lead to more bottom-up innovation and a breakdown of governmental silos. Cities need to build data and analytics capabilities as well as make strategic investments to develop a culture of innovation. Finally, it is critical to have a detailed roadmap and more importantly, flexibility, in order to re-calibrate the plan based on changing needs and technology.

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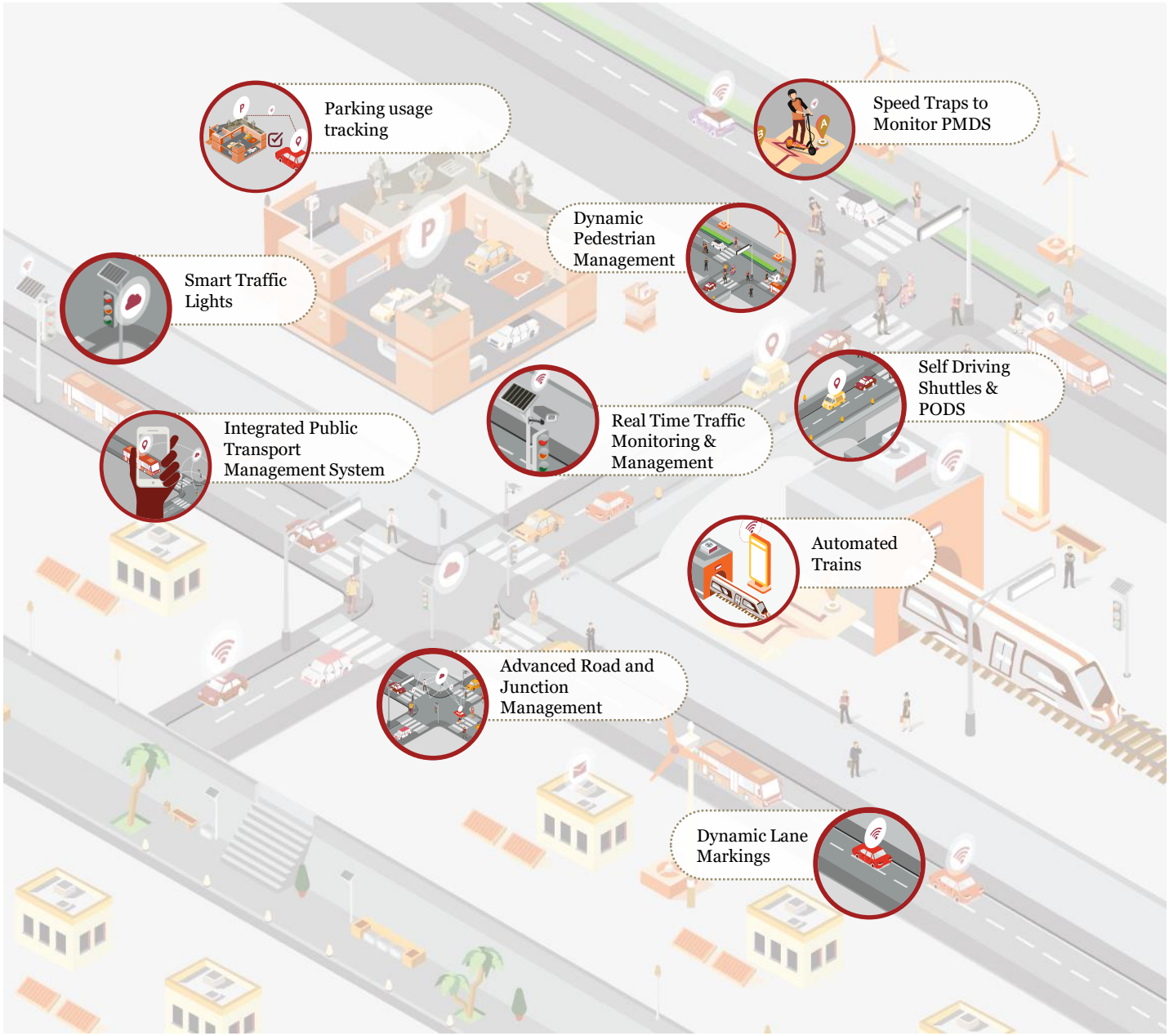

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