**PAPER TITLE: TOMORROW’S TRANSPORT TODAY: MOBILITY ON DEMAND**

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**ABSTRACT**

AECOM, Keolis Downer, University of New South Wales (UNSW) and our technology partners, have developed a new public transport offering to make travel more efficient for passengers and more efficient for government to operate.

This new ‘on-demand’ transit service, using technology enabled minibuses running on flexible routes, has been developed under the NSW Future Transport Technology Initiative to support Sydney’s response to the transport challenges we are experiencing through rapid population growth.

The service is being tested and will be launched in early 2018 for people traveling to and from the Macquarie Park precinct, one of Sydney’s employment, education and leisure hubs. It will transport people within a 7-8 kilometre radius of the precinct, who will schedule, pay for and track their journey to and from the precinct using a mobile application (app).

For customers, it puts them in the driver’s seat. It creates a more convenient, responsive and accessible transit service model. The additional flexibility and convenience offered by a door-to-door service will complement the existing public transport network, encouraging modal shift away from single occupancy private vehicle use for commuting, reducing traffic congestion and pollution. It will also increase convenience for public transport users and increase their confidence in public transport service reliability.

For government and operators, the system creates great potential for operational efficiencies, optimising government spending and taxpayers’ investment in public transport operations. This will effectively lower rates of subsidy by optimising fleet efficiency and reducing running costs, allowing the optimal prioritisation of services to customers.

This is an exciting collaboration between public and private sectors to develop fully flexible, innovative transit solutions for the people of New South Wales, with enormous potential to be scaled up for use elsewhere.

The pilot will provide valuable insights for the future development of similar services throughout Australia, New Zealand and internationally. This presentation will further discussion on this topic.

**1. INTRODUCTION**

The populations of Australian cities, like most cities globally, will grow significantly over the next 15 years. By 2031, without new infrastructure and services, congestion is forecast to cost the Australian economy over $50 billion a year.[[1]](#endnote-1) Australia’s metropolitan road networks and public transport networks are already struggling to cope with a growing population, and while major infrastructure projects and new planned mass transit services will support continued urban growth, these are costly solutions to an efficiency problem.

By reprioritising our networks and services towards the efficient use of resources, we not only reduce congestion, we can ensure our cities are for our people, by promoting healthy and vibrant communities.[[2]](#endnote-2) In New South Wales, Australia, on-demand public transport services have been developed under the NSW Government’s *Future Transport Technology Initiative* to support Sydney’s response to the transport challenges being experienced through rapid population growth.

On-demand public transport is an emerging solution towards achieving efficient use of resources, transcending the use of our metropolitan road networks and our public transport networks. The focus of public transport is to ensure effective and efficient use of public resources with the aim of providing equitable access for all people to employment, education, health and entertainment.

Developments in technology are an enabler to new ways of conceiving the public transport system (networks, infrastructure and services) and of delivering a service proposition which meets the travel demands of modern society.

Enabled by developments in data capture, processing and analytics, the accessibility of mobile phones, mobile applications and mobile payment technology solutions, and our understanding of technical algorithms to deliver services to people, this places us in an era where we can leverage these enablers to reshape and refocus our public transport services.

The ultimate aim is to deliver more efficient passenger services and more efficient operations ensuring best value of public investment, as well as promoting healthy, liveable, productive cities.

This paper presents information from AECOM research and thought leadership, along with that of other parties with whom we have been developing thinking in this field. It sets the scene of the urban and societal trends leading us to the fit of this solution; brings together definitional aspects of what **On-Demand Public Transport Services** are, and what they could be; it outlines current trends towards a society where Mobility is a service; it defines the reasons this form of public transport is gaining popularity and has a role to play in our transport ecosystem; and sets out emerging lessons learnt from the current On-Demand Public Transport Service trials underway in New South Wales, Australia, in conjunction with the NSW Government and other parties.

**2. MOVING TO A COMMON UNDERSTANDING OF TRANSPORT ON-DEMAND**

**What is Transport ‘On-Demand’?**

There are many forms of transport which fall under the umbrella of on-demand transport, in various guises. These are set out below grouped into government-owned and privately-owned transport:

* **Public Transport** – Bus, Community Transport i.e. Dial-a-Ride services
* **Private Transport** – Car, Van, Motorbike, Car Share, Taxi, Uber, Bicycle
  + Different Ownership Models i.e. Private or Shared
  + Different Experiential Models i.e. Chauffer or Self-Drive

This primary focus of this paper is **On-Demand** **Public Transport Services** and the evolving nature of our public transport networks and services. The public transport proposition is emerging into a new and exciting era where the public transport proposition itself is fundamentally shifting into a more dynamic and customer driven model, one that is enabled by technology, and encouraged by the shifts towards other point to point mobility solutions, such as Uber.

**Trends in Mobility: Setting the Scene**

Our society has evolved into a service-sector dominated era, where people are time poor and highly mobile and ownership models are evolving. People’s expectations on services, reliance on accessibility of information and reliability of service have radically changed. As Chris Choa, AECOM Director of Cities and Urban Development has stated: *In every part of our lives, people are increasingly valuing access and experience over ownership*.[[3]](#endnote-3)

This trend can be attributed to the ‘third industrial revolution’ and the advent of, and ease of access to, mobile applications and technology. It has long been recognised by government policy makers and planners, as well as public transport operators, that meeting customer needs is fundamental to the success of public transport networks and services. However, only now are we developing clever ways of bringing together these wider trends in society into the planning, design and delivery of public transport operations.

Peak time travel demand is the focus in transport planning, as this is where investment decision making addresses the largest problems of need (demand) and capacity (supply). The peak period is where our public transport infrastructure and services make investment logic. It is however widely acknowledged that to build a customer focused service we need to focus our services on regularity and consistency in public transport provision, across all times of day and across all days of the week. ‘Turn up and go’ is an oft used phrase, which describes the availability of service both at a time at which someone wants to travel and which serves their journey need.

We commonly understand in our service-based society that access to a service and consistent ease of use of the service is what generates demand. Ease of use and customer satisfaction can encourage changes in behaviour. In a transport sense, these changes in behaviour can be re-timing of travel, travelling by alternative modes, and, where we get the service provision right, this can mean a reduction in congestion and pollution, increases in productivity and liveability, and more efficient use of our infrastructure and assets.

Alongside an understanding that consistency, regularity and reliability of access to services drive customer choice, we must recognise that governments have a public policy obligation to provide spatial accessibility to a public transport service. This creates two-speed public transport networks typically characterised by: highly utilised core, frequent, direct, trunk services, which make rational investment decisions and meet customer service needs; and a range of spatially accessible public transport services which provide network coverage, typically at reduced spans of operation, low service headways and poor customer experience. And these *accessible services* are everywhere!!

In Sydney, as in many other government jurisdictions, the NSW government has a well-founded, yet ultimately flawed, public policy obligation for a public transport “service” within 400 metres of every household. I explicitly note the word “service” in inverted commas, as this can be anything but a service as we would recognise it by modern service standards. This is not a criticism but a reality of investment decision making and the balance of public spending with policy objectives.

Public transport services to provide catchment accessibility are characteristically operated by buses with circuitous routes, with long journey times, at low and irregular headways. These are service characteristics unattractive to the customer and uneconomic to government and operators. Although there may be no other option available to the customer, so they are forced to accept low service standards, as government is equally accept the need to provide low services standards, so no-one really benefits from the service. Therefore, these services are typically categorised by low patronage and high cost subsidisation, in exactly the areas these services are designed for.

All these trends are drivers towards the suitability of the solution presented by on-demand public transport services by government to meet unmet demand and customer service expectations.

**Defining On-Demand in the Public Transport context**

The NSW government, through its transport agency, Transport for New South Wales (Transport for NSW), is leading the way internationally through the delivery of eight separate geographic trials of on-demand public transport services across metropolitan Sydney. A readily accessible public definition of On-Demand Public Transport is defined as: *Services (that) allow you to book a vehicle to pick you up from home or a convenient nearby location, and take you to a local transport hub or landmark. It's easy to book using an app, online or by phone.[[4]](#endnote-4)*

The agency also defines the key service aspects of On-Demand: *a flexible alternative transport service, which allows you to book a vehicle to pick you up from home or a nearby convenient location and take you to a local transport hub, shopping centre, business park or hospital.[[5]](#endnote-5)*

In Australia we have seen few other examples of on-demand public transport services developed. Only one actual trial has been operated, in **Logan, Queensland**. In this example, the public transport on-demand service is actually being delivered as a Demand Responsive Transport (DRT) service, a similar and overlapping, yet subtly differing service and terminology.

DRT services are “flexible and adapt to customer demand. Unlike a typical bus, DRT changes its routes and vehicles to suit the number of passengers who want to travel and where they're going”[[6]](#endnote-6).The operational difference is a nuance in that most trips, and hence the origin-destination pairs, are known well in advance of launching the services, therefore the optimisation of fleet and drivers to trips is a lot easier as it is still a pre-planned service, albeit with a few hours or a few days’ notice. This differs to the true nature of on-demand services, which would typically use near real time prioritisation and optimisation of fleet and services to passengers to service trips, similar to a point to point private transport operator such as a taxi hire company or Uber.

In **Canberra, Australian Capital Territory**, an on-demand public transport service was conceived through the CSIRO as a prototype project, albeit not actually delivered on the ground. This project aimed to target low patronage routes with poor demand, enhancing customer service and growing demand by operating *an effective and efficient off-peak public transport (service) for Canberra[[7]](#endnote-7)*.

There are also global examples, as McKinsey reported: *Across the world, cities are enhancing and expanding public transit networks. Eventually, autonomous features may reduce operating costs while network optimization can yield significant benefits in terms of reliability and capacity.*

*New shared-vehicle networks solutions could help cities reduce the cost of underperforming public transport routes, as is being explored in Florida, where Pinellas Park’s transportation agency is offering 50 percent discounts on Uber rides along two bus routes that were recently eliminated. Furthermore, on-demand services provided by minivans and buses create the opportunity to improve first- and last-mile options, and so channel more passengers onto existing routes[[8]](#endnote-8).*

The key themes derived from these global developments in on-demand public transport services, and the related conceptual research into their potential use, present a range of key functional characteristics but which we can describe on-demand public transport services. These pertain to the ability for public transport customers to:

* Define the **service pattern** *as opposed to travelling on a fixed route*
* Define the **service time** *as opposed to travelling at a set time*
* Travel from a **chosen origin point to another onward transport node or an attractor**
* **Utilise technology to book** (and pay for) a trip **through a mobile application**

Therefore, the customer service offering can be summarised as one which is easy, quick, direct and reliable, all of which are essentially key tenets of modern customer service, and which are directly applicable to a successful, modern, efficient, customer-centric public transport system.

In all these aspects of a person trip the “*Flexibility*” or “*Demand* *Responsiveness*” is the key. It is this flexibility, whilst meeting an accepted level of service standard, as a public good, i.e. it is still a *public* transport service rather than a private point to point service, which defines the service and customer experience of on-demand public transport.

I will reflect later on the success or otherwise of trials in responding to this challenge and delivering this service response, and customer experience, and the lessons learnt for future trial applications or public transport services.

**3. WHY *ON-DEMAND?* ITS ROLE AND BENEFITS**

**The Role for On-Demand Public Transport**

On-demand public transport can perform a variety of roles, but its primary function must be conceived as one which sits within the broader transport ecosystem, supporting and supplementing other services, whilst also meeting a defined need in its own right.

This helps to further define its purpose and to realise the expected benefits. The broader transport ecosystem includes the:

- Strategic public transport network – including a range of public transport services and modes such as passenger rail, light rail transit, bus rapid transit, bus and ferry.

- Broader transport mobility network – including all modes and all forms of transport. This is commonly defined as the Mobility as a Service (Maas) ecosystem.

The author recognises and supports the ongoing role of the mass public transit network as the backbone of the strategic public transport network and broader mobility network in a modern global city. This backbone or trunk transit network would be based around passenger rail, light rail transit and bus rapid transit or bus, depending on the local context, local circumstances and factors.

It is the author’s view, as well as that of numerous researchers and industry-experts, that this will continue to be the future of our urban landscape. No matter what technology or transport ownership options present themselves in future. As Andrew Salzberg, Head of Mobility at Uber, states, the role of on-demand is fundamental to the success of our public transit networks, “when city residents have the option of pushing a button and getting a ride, they are more likely to use public transit, own fewer cars and spend less on transportation overall”. There are also inherent financial incentives to the individual, which reinforce the opportunities for the deployment, and success of, on-demand public transport within this strategic context.

To reinforce the point regarding the seamless integration of on-demand, we can turn to the research report on the future of mobility presented by McKinsey, 2016, who stated that: *In a Seamless Mobility system, mobility may increasingly become a door-to-door, on-demand, multimodal service with blurred boundaries between private, shared, and public transport.*[[9]](#endnote-9)

Undoubtedly there is a potential future transport nirvana, once all legal and commercial aspects are defined, understood and accepted by society, whereby we all have access to a fully flexible, shared ownership Connected and Autonomous Vehicle fleet, which is fully integrated through one single payment mechanism, but this is some way off and may not be relevant to, or feasible in, all circumstances. Even when this future is revealed, the mass public transit network will continue to provide for the majority of passenger journeys in an efficient, coordinated and sustainable manner.

On-demand public transport services will therefore play a future role as one service, of potentially multiple forms, within the overall mobility ecosystem. On-demand public transport services will integrate with the mass transit network and plays a role alongside a range of other modes such as walking, cycling, car and bicycle sharing, and other private on-demand modes, such as point to point transport (which can take many forms) and private vehicles.

Each mode has its own accessibility and travel characteristics, including a diverse range of costs and benefits. All these modes and travel alternatives will continue to fit together, as they do now, to create a ‘mobility ecosystem’ within which people are customers with access to a range of options to suit their travel purpose, their travel patterns and their wallet.

**The Benefits of On-Demand Public Transport**

The potential benefits to be realised from on-demand public transport services are varied and significant. These present a compelling case for refinement of the role of on-demand public transport services in the broader transport ecosystem to address the emerging mobility trends which have been outlined earlier.

The key potential benefits can be grouped into four categories:

* **Efficiency** – efficiency in service delivery and customer experience. Efficiency in the use of fixed and operating assets and therefore costs both for government and for public transport operators. In this case the solution presents, subject to good service design, the potential for Win-Win outcomes, whereby both user and provider benefit, which is compelling and presents well-founded optimism for expansion in deployment as a solution in our cities and regions.
* **Leveraging Technology** – to deliver a high quality service response to the mobility demands of modern society, supporting service provision in line with customer need, where and when desired, and with an ease of use and reliability which will drive further demand. Utilising mobile applications, mobile payment systems and providing data driven services, which can operate in, or near real time for maximum efficiency and benefit.
* **Benefits for customers** – potential customer benefits are significant, especially where addressing areas of service deficiency, and focus on the key service aspects of convenience, flexibility and accessibility:
  + A near ‘door-to-door’ service that can complement existing public transport
  + Onward accessibility between major destinations or mass transit nodes
  + Service availability at a desired time of travel
  + A price point which is relative to existing public transport modes
  + Increased confidence in service reliability
* **Government and operator benefits** -operational efficiencies through optimised asset use and service delivery and sustainability:
  + Optimising government and tax payers investment in public transport
  + Ensuring higher cost returns and lower rates of subsidy by optimising fleet efficiency, reducing running costs
  + allowing prioritisation of services to customers
  + Encouraging modal shift away from single occupancy vehicle
  + Potential of reducing traffic congestion and pollution

From an economic perspective we see further optimisation of the potential for reducing access trips (‘access modes’), by removing the potential need for multiple modal transfers. This has a knock-on effect of freeing up resources or ‘room in the system’ for others. This should reduce congestion both in the public transport system and on our road networks, thus increasing economic productivity through improvements in travel times and more efficient use of assets.

Further, as McKinsey described in their balanced paper on perspectives for future mobility, we should utilise the benefit of strong partnerships between the public and private sector and also plan now for a future which is already here. *To best capture the benefits, the public and private sector - at a local and global level - need to prepare for the future, not wait for it. Governments may want to anticipate these new mobility models by crafting regulations consistent with consumer-friendly technological developments that also promote larger public goals, such as clean air and reduced congestion. They need to think ahead, with regard to both replacing the possible loss of fuel-tax revenue and reviewing their connection with the private sector. Strong partnerships that make it easy to blend public transit and private mobility will likely produce the best solutions[[10]](#endnote-10).*

Furthermore, the significance of this to global cities in terms of their competitiveness on the global scale: *getting mobility right could be a significant competitive advantage for cities. This shift can help clear the air of pollution and reduce traffic deaths. It is an opportunity to improve the quality of life - day in, day out - for billions of people.*

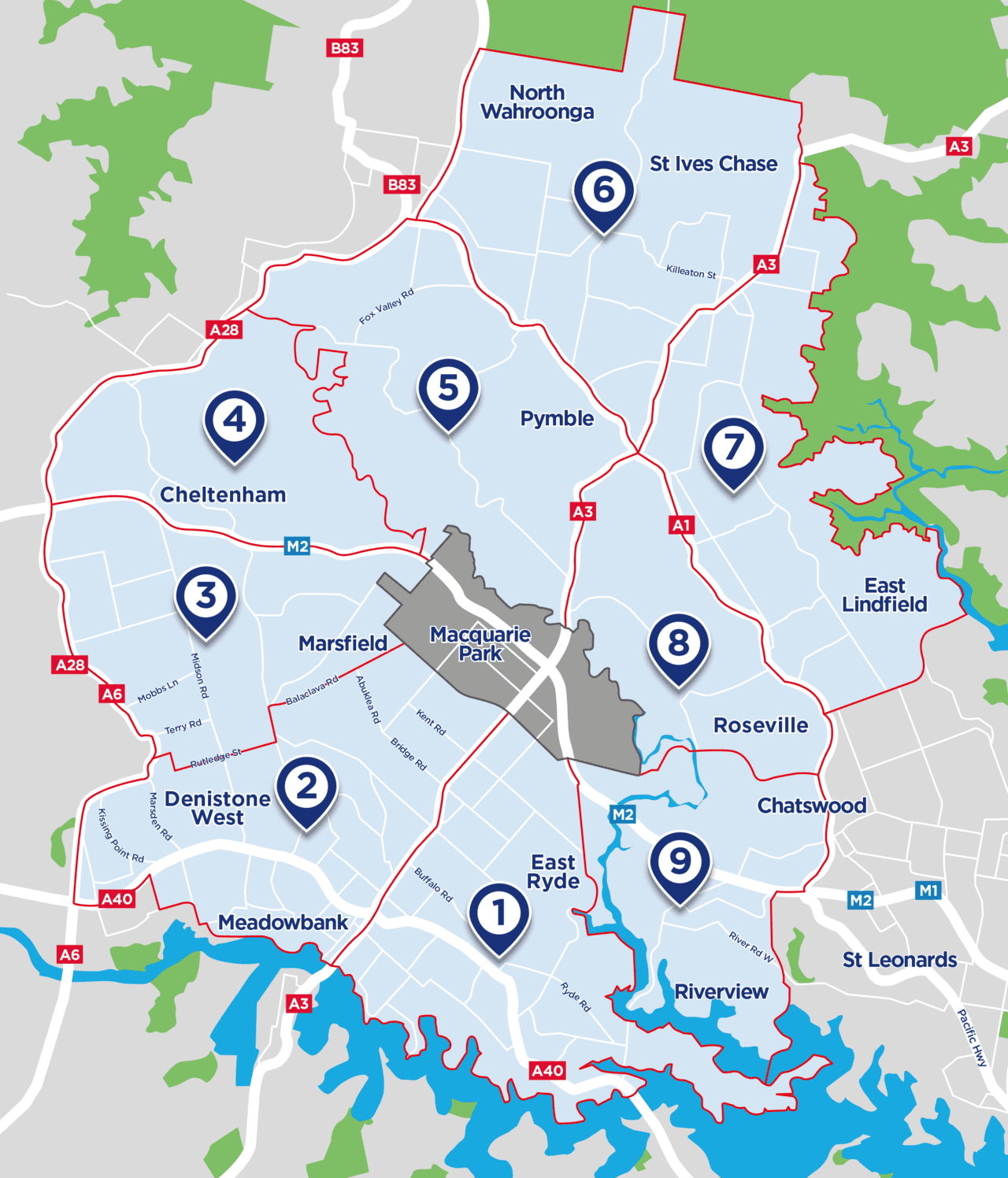
**4. NSW ON-DEMAND PUBLIC TRANSPORT TRIALS: WHAT HAVE WE LEARNT SO FAR?**

**What are the trials?**

AECOM, Keolis Downer, the University of New South Wales and our technology partners have been heavily involved in the development of new on-demand public transport services in New South Wales (NSW), Australia. The service has been developed in conjunction with the NSW government transport agency, Transport for New South Wales (Transport for NSW), under the NSW Government’s Future Transport Technology Initiative.

The service supports Sydney’s response to the transport challenges of rapid population growth and increases in travel demand across a range of markets and geographic areas. One of the services developed is to transport people within a 7-8 kilometre radius of the Macquarie Park employment, education and leisure precinct, as shown in Figure 1 below.

**Figure 1: On-Demand Public Transport Service Zones - Macquarie Park, NSW, Trial**



The service is designed around the key functional aspects defined earlier, to make travel efficient, easier and more convenient for passengers and, in time, through the lessons learnt during the trial operations, will help drive public transport service delivery efficiency for government.

The service uses technology enabled minibuses running on flexible routes, adapting to customer demand, and allows customers to schedule, pay for and track journeys using a mobile application, supported by website and telephone booking service options.

The service was developed through innovation collaboration between public and private sectors and is already starting to provide valuable insights for the future development of similar services throughout Australia, New Zealand and internationally.

A key tenet of the trial was the ability to capture lessons learnt. This is done through an empirical evidence base captured on a continuing basis through monitoring and reporting, as well as continual operational optimisation during the trial, using machine learning and simulation, to provide service improvement during the trial. The monitoring and reporting will utilise a raft of data on emergent customer travel demands allied with typical public transport service metrics, such as in service kilometres, farebox revenue and adherence to service key performance indicators (KPIs) such as booking, collection and drop off time windows and successful completion of trip requests.

**Emerging lessons learnt**

The ability to learn and adapt the service is critical to the on-going success and rollout of similar services. There is much to be learned in any particular locality by running a new type of service, this includes the ability to better allocate vehicles to passengers, especially during peak travel demand periods and the ability to re-prioritise vehicles within a broader zoning system to adapt the service to meet customer demand, rather than fixing the same fleet or fleet mix to one zone within a broader zoning system of operations.

Getting the technology solution right is critical and this takes time. Even existing technology providers and off-the-shelf technology systems need considerable development to adapt the tool to the intended purpose to deliver the right results for customers and to provide the functionality of the system to meet locally-desirable characteristics. The stand-up time for software development and delivery should be a minimum of 9 months. This would allow sufficient time for critical bug- and user acceptance- testing as well as pre-opening live optimisation on the ground.

There will be a fundamental interest by the travelling public in the service. People are genuinely excited by the opportunities offered by technology, especially when this presents opportunities to enhance their daily lives, making them easier, simpler and potentially saving time and money. Therefore an operations centre, with a customer call centre, is an essential part of the solution.

Customer feedback by early adopters of the trials has been hugely positive and relates well compared to customer satisfaction with existing scheduled public transport services.

On-demand public transport services have the potential to significantly optimise investment in public transport. Partnerships with the private sector can deliver market-based, but still regulated competition which can provide much better return on investment by 10% (or more) and hence reduce public subsidies whilst at the same time delivering a better service outcome for customers. On-demand partnership can also reduce the barriers to entry into the market for a range of service providers to work with the public sector to deliver services to target a variety of travel needs across different communities, for a range of different travel purposes and at different geographical scales.

Utilising complex mathematical simulation tools and running iterative scenario and sensitivity testing, similar to that supporting the planning of other public transport infrastructure and services, is critical to enable an understanding of operational parameters in the given location to support successful go-live operations. This has certainly been our learning of the trials underway in New South Wales. Understanding road travel times, congestion and the ability to utilise priority lanes on major corridors as well as local roads to deliver service reliability is critical to stand up a successful service which meets customer expectations whilst also delivering aspirational operational efficiencies sought. We have successfully developed tools to run iterative scenario testing matching potential customer demands to known fleet and service parameters to successfully plan and deliver an operational model which delivers on the aims of the service proposition. **5. CONCLUSIONS AND RECOMMENDATIONS**

**Customer service delivery - expectations and benefits**

For customers, on-demand public transport services can provide a convenient, flexible and responsive travel option and service model. The additional flexibility offered by a near door-to-door service complements mass public transport networks and services. These services from our experience have already shown potential to encourage modal shift from single occupancy private vehicles for commuting, and to support the reduction of traffic congestion and pollution.

On-demand public transport services increase confidence in service reliability for the travelling public, the access to live data on service location and the confidence of the booking system and personalisation of service are critical. This adoption then reinforces the integration and uptake of a range of connected transport modes, focused around core, fixed public transport services which are supported by dynamic, flexible on-demand public transport services.

In providing a customer service, you must always recognise that success depends on customer satisfaction and ‘what the customer wants is key’. An understanding of this service expectation is critical to success. This can have big impacts on the service delivery model and contracting models, this in turn creates a clear learning on the need for contract flexibility between private operators and public agencies. This is not a traditional public service offering, so we need to consider the mechanisms for flexibility to deliver service flexibility for the end users. Inflexible contracts create inflexible services.

Mechanisms for customer incentives i.e. non-monetary rewards or loyalty should be considered to build brand and customer acceptance and this can also encourage travel behaviour – i.e. if people allow themselves to be grouped at pick up stop, increasing their walk distance, they could be rewarded with a free coffee at a local coffee shop.

**Government, Operator and Technology service delivery considerations**

For government and operators, on-demand solutions have significant potential to deliver real operational efficiencies. The ability to optimise public investment in public transport infrastructure and services can have a significant impact on the ability of government to continue to deliver improvements in infrastructure and service offerings. By reducing effective subsidy rates for public transport, we can see, and realise, the opportunity to optimise fleet efficiency, reduce running costs and prioritise services to customers.

A critical factor in the successful delivery of on-demand public transport services is the technology systems which sit behind the service. These are fundamental to the service delivery. This may sound obvious, but the complexity of building in, and potentially adapting, key operational parameters and functionality in the software system and application is a critical consideration.

Application logic needs to be thoroughly considered and needs appropriate time for user testing, quality assurance, and development of micro-functions within the software itself. The software system is a separate ecosystem which needs to seamlessly integrate with the transport ecosystem its supports and the customers and clients it benefits. For example the system needs to deliver key service parameters such as passenger grouping, dwell times, pick up and drop off windows, with supporting logic. The software must also provide a seamless driver interface and customer interface linked to the booking engine.

**The future role of on-demand public transport services**

On-demand public transport services will play a future role within the transport mobility ecosystem. If planned well integration with mass transit networks, walking, cycling, car and bicycle sharing, and private on-demand modes (i.e. point to point transport) will reinforce efficiency and mobility.

Each mode has its own accessibility and travel characteristics, including a diverse range of costs and benefits. All modes and travel alternatives will continue to fit together, as they do now, to create a ‘mobility ecosystem’ within which people are customers with access to a range of options to suit their travel purpose, their travel patterns and their wallet.

**Scalability**

With enormous potential to be scaled for use elsewhere, the on-demand public transport service trials underway in New South Wales, along with other research and developments in this space, locally and globally, provide valuable insights and present significant optimism for the future development of on-demand public transport services throughout Australia, New Zealand and globally. It is the author’s view that these are highly adaptable and suitable to meet a variety of geographic and temporal circumstances and a variety of transport tasks, within the broader transport ecosystem, through a range of operating models, under the public transport banner to support enhanced mobility for people, delivering great customer service and operational efficiency.

**6. ACKNOWLEDGEMENTS**

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Further notable collaborators and colleagues on this journey, include (in no particular order): my hugely supportive colleagues, Devina Hassanaly, Ernest Wong, Cecile Wang, Andrew Arendsen, Andrew Hall and Peter Jensen at AECOM; Sue Wiblin and Emily Davies of Keolis Downer; David Rey, of rCITI (the Research Centre for Integrated Transport Innovation) at UNSW; and not forgetting the inimitable Emma Reedy, and her dedicated team, at Transport for New South Wales.

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