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## Planning effective and efficient public transport systems

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### Abstract

As population increases and cities continue to grow, there is an urgency to provide efficient and cost effective Public Transport (PT). Globally there are enormous differences between transport systems; some countries have efficient systems while others appear to have no system at all. This research is undertaken with the express purpose of investigating efficient, well incorporated PT systems from around the world, for their specific application to Australian capital city transport hubs, but also for their adaptability to other global areas. The aim of this paper is to develop strategies for planning public transport.

The design of this paper relies heavily on extensive global research, seeking to discover appropriate PT systems and then investigating the benefits and feasibility in an Australian context. The paper examines case studies from Europe, Asia and Canada and focuses not only on efficiency and cost effectiveness, but also on sustainability. Case studies from major cities with cost efficient and effective public transport systems were examined and analysed to develop models of PT systems for Australian cities.

This research is limited by the large volume of public transport case studies that are available, the limitations on the size of this research paper and the lack of available specific data. The goal is to expand on this introductory research over a sustained period. This is an original study and although only in its infancy, this research will be of significant value to the Australian public transport industry to support improvements in infrastructure.

**Keywords:** Planning Public Transport (PT); PT innovation; PT Infrastructure; Public/Private Consortium; livability

### 1.0 Introduction

As cities grow in population along with increased economic development, there is a need for public transport (PT) to expand with it. Too often in the past this has been ignored and many cities have increased housing, schools etc. but have largely ignored new transport links. This is certainly true of Australian cities. This paper examines PT in Sydney and Melbourne and draws comparisons with PT in other major cities across the world. With both of these cities projected to have populations over 8 million people by 2050 (double their existing size) it is time to create a PT system equal to Paris, Seoul, Tokyo, London and other major cities who currently have over 8 million residences.

PT mainly consists of trains, trams and buses. The structure of PT is the network, the links, the infrastructure, the timetable and fares. Each component of PT is important and all of them need to work together to enable a city to have an efficient and sustainable transport system. Public transport in cities offer mobility to those who do not

have private transport and provides an alternative to private transport. It helps reduce traffic congestion, is more sustainable and may help in creating additional employment opportunities (European Metropolitan Transport Authorities 2017). Typically PT systems rely on government support in the form of subsidies to cover operational costs. This places PT at risk to reduced funding due to possible budget cuts. Most public transport systems are a balance between government funding and user contributions and meeting the balance is the challenge for all PT systems.

## **2.0 Literature Review**

### *2.1 Components of Public transport*

Public Transport (PT) refers to the movement of people by a passenger service using a PT vehicle such as a train, tram, bus or ferry (TRANSLink, 2015). PT provides the link for people to move around their city and must compete with motor vehicles to encourage residents to switch their behaviour from car usage towards PT, cycling or walking (Poliak et al, 2017). Effective PT requires efficient integration between the components of a PT system; being the network, PT infrastructure, timetabling, fares and ticketing, information and marketing. In order for people to want to use their local PT all the components of PT need to be able to deliver the optimum combination to their community (Poliak et al, 2017).

PT infrastructure is any item that has been designed, constructed and installed for the function of a PT system and may also include Support Access Infrastructure which includes pedestrians, bicycles, bus feeders and park and ride infrastructure (TRANSLink, 2015). PT infrastructure integration includes new routes and the reorganisation of transfer points, planning stops, stations and transfer centres. It is important to have organisational integration with network layout, synchronised schedules between different modes of transport and the relevant up-to-date information for the PT users. In addition there should be a common fare and ticketing system that allow the user to move between the different PT systems without additional charges (Poliak et al, 2017).

In general, efficient PT systems cannot be financed solely from fare revenue, but require relevant government intervention; usually by subsidies. This means that PT competes with education, health care, road infrastructure etc. for financial support (Poliak et al, 2017). Policy makers aim to improve the mobility of citizens via their PT systems and increase the overall attractiveness of their system. One major aspect of this that is important to PT users is travel time reliability. Transit system performance evaluation is an essential task for PT service providers. Key elements include user demand trends, operational constraints and changing service needs. This type of research needs to be ongoing and widely publicised (Swierstra et al, 2017). It is important to realise that reliable predictions are required before deciding on final PT strategies for any city (Li et al, 2017). Collecting data from residents and then applying this to relevant models is a way of building a reliable prescriptive tool (Hensher & Rose, 2007).

### *2.2 Sustainable Public Transport*

Since 1990, sustainable development has been high on the world agenda and national governments have been encouraged to produce sustainable development policies for their respective countries. In Europe, prior to 1990, transport policy in most countries was predominately demand-led, based on a 'predict and provide' approach to transport and infrastructure provision (Stead, 2016). Although no common definition of sustainable PT exists, it is agreed that there needs to be a balance between current and future environmental, economic and social qualities of life (Steg & Gifford, 2016). The needs of every country are different and it may be easier for countries such as Singapore and the Netherlands to make changes toward sustainable PT before larger countries such as Australia

and the US who have a heavy reliance on motor vehicles. For geographically larger countries to make changes in their travel methods will require stronger legislation (Steg & Gifford, 2016).

Stead (2016) found a new realism has evolved where it is accepted that projected traffic growth is not sustainable. Increased road schemes are not going to solve the problem. The only way sustainable transport can be improved is to limit the use of motor vehicles in certain areas. Despite what politicians may think, improved PT policies are much more highly accepted by the European population generally than regulatory or economic policy. Surveys of European cities over a period of 20 years show increasing concerns with regard to PT (Stead, 2016).

### 3.0 Methodology

This paper will use Case study analysis to determine the PT situations of both Sydney and Melbourne, which will then be compared to the PT situations in the cities of Paris, London and Seoul. Case study methodology is the examination of data within a specific context or environment (Zainal 2007).

### 4.0 Case Study Findings

#### 4.1 Paris (Ile de France)

The city of Paris (inner) has 2.5 million residents and Paris (Ile-de-France) 12 million. The Paris/Île-de-France PT network carries over 8 million passengers daily. Their PT systems are operated by more than 70 different companies (mainly the bus lines) and the network is divided between heavy rail, the Metro, tramways and buses (EMTA, 2018).

#### Type of networks

SUPPLY 2013/2015	HEAVY RAIL	METRO	TRAMWAY	BUS
Network length (km)	1,450	219	105	31,808
Number of lines	13	16	9	1,480
Number of stops/stations	449	302	184	33,436
Number of vehicles	1,182	693	238	9,412
Number of operators	2	1	2	more than 70
DEMAND 2016				
Number of journey (million)	1,441	1,519	223	1,420

Table One: Paris/Ile-de-France Networks

(Source: EMTA, 2018)

This PT system is administered by the Syndicate des Transports d'île-de-France (STIF) which has a 29 member board with representation from all the areas of Ile-de-France. The system is funded by 1,883 m. euros from public subsidies, 3,753 m. euros transport taxes, 275m.euros from advertising, fines and other revenue and 3,540m. euros from passenger fares, with 862.m euros refunded by law to employees from employers. The Paris fare system consists of five concentric zones with full integration between all transport systems and using a common swipe card (monthly pass 73 euros). Future improvements include extending and modernising the PT network and upgrading rolling stock by 9m.euros by 2025 and service quality improvement to be 1.7m. euros for the same

period. A clean bus system is in place with all buses to be fully electric by 2025. Extensions are being made to RER lines 4, 12 and 14 and underground extensions of line 14 and new lines 15, 16, 17 and 18 with 205 extra km. and 68 new stations by 2030 (EMTA, 2018).

#### 4.2 London

The population of Greater London is approximately nine million residents and their PT system consists of the underground (the Tube), buses, light rail and trams. The Tube has 12 lines covering 402 km. and 270 stations. The Tube carries up to five million passengers per day. There are approximately 9,300 buses in the fleet across 675 routes and most are operated by private operators. One quarter of these buses are hybrid and hydrogen fuelled buses are being trialled (Transport for London, 2018). Docklands light rail operates between City and Docklands and these are driverless, computer driven vehicles registering 99% reliability for punctuality. There is a small tram network in the Croydon and Wimbledon area with 28 km. of track and 39 stops. All fares are part of the common passenger fare card (Oyster) (Transport for London, 2018).

Part of new development for the London PT system will be the walk-through and air-cooled trains on the four 'Deep Tube' lines. This will replace trains and signaling systems across the four 'Deep Tube' lines - the Piccadilly, Bakerloo, Central and Waterloo & City lines. There will be 250 new Tube trains for the Piccadilly, Bakerloo, Central and Waterloo & City lines, with the first new trains serving the Piccadilly line from 2023 (Transport for London, 2018).

#### 4.3 Seoul

Seoul in South Korea has a population of approximately 10.5 million residents (Korea Institute for Advanced Study, 2018). Seoul has an international reputation for having a spectacular PT system and this is largely due to a complete reform and reengineering of their old PT system in 2004 (Seoul Solution, 2018). Prior to 2004 the major problem with the PT system was with buses. The bus system is now centrally controlled and administered and is completely integrated into the underground train system by timetabling and the use of common fares for passengers (Seoul Solution, 2018).

Looking to the future, Seoul is moving towards becoming pedestrian orientated and will discourage the use of private vehicles and encourage pedestrians by providing 30 transit malls. With median bus lanes and low speed limits, separate bike lanes and wide pedestrian walkways they hope to become more sustainable with PT (Seoul Metropolitan Government, 2018).

#### 4.4 Sydney

The population of Sydney is approximately 5.8 million residents and the PT system carries approximately 20% of residents to work; travel by car is still the highest percentage at 68% (ABS, 2018). The PT network in Sydney mainly consists of trains (double-decker), buses and ferries and light rail. The network is a hybrid suburban-computer rail system with a central underground core that covers 8 train lines, 178 stations and 815 km of track with 2,200 single train carriages (NSW Auditor General, 2018). Transport for NSW administers 6 bus networks that have 600 routes with over 1,000 buses. In a bid to improve efficiency Sydney buses are now divided into three classes, Rapid (13 routes into the CBD operating frequently), Suburban (28 routes feeding the Rapid system) and Local, making up the remainder of the 600 routes (NSW Now, 2013). In 2016 the budget for PT for NSW was \$10.5 billion including \$2.7 billion for the new Sydney Metro due for completion in 2019 (NSW Government, 2018).

The City of Sydney (2018) has identified that they need an integrated transport network with stronger PT links and they are aware that to encourage greater use of PT Sydney needs to provide better connections. Part of the future development of PT in Sydney includes an additional 30 km of underground rail line around the CBD with 30 trains per hour at peak times; increasing the network capacity by 60% (Infrastructure Australia, 2016). PT usage increased by 12% in Sydney during 2017 and the pressure on an already crowded system PT system indicates problems. The Sydney private bus companies rarely meet their punctuality targets and the new three tiered bus system is subject to significant customer dissatisfaction (NSW Auditor General, 2018).

#### 4.5 Melbourne

Melbourne has a population of almost 5 million residents and covers an area of over a 30 km radius around Port Phillip Bay. Like Sydney, private vehicles are the way the majority of residents travel to work. Less than 20% of workers in Melbourne regularly use PT (ABS, 2018). The PT network in Melbourne consists of trains, trams and buses. The metropolitan train system contains 16 train lines, over a distance of 869 km with 1,300 carriages. The tram system has 24 routes over 250 km of track and 500 trams and the bus system has 346 routes operated by 32 private franchised companies. The train and tram systems are also franchised and are all managed by PT Victoria (Public Transport Victoria, 2018). The PT system for Melbourne is financed annually by approximately \$4.5m., from Victorian Government subsidies and only \$880,000 from user fares (Public Transport Victoria, 2018).

In addition to upgrading existing infrastructure for PT in Melbourne construction has begun on underground twin tunnels which will deliver on average 45% more peak capacity rail travel, particularly to the North West and South West of the CBD (see Appendix One). This new underground system will add 5 new underground stations to the existing 3 city loop underground stations (Victoria State Government, 2018).

### 5.0 Discussion

Over the next 30 years both Sydney and Melbourne, Australia, are expected to double in size to populations of greater than eight million residents (Commonwealth of Australia, 2018). For this reason alone the case studies of Paris, London and Seoul, cities all with current populations greater than 8 million, are useful examples to illustrate the PT situations that Melbourne and Sydney need to be exemplifying. A comparison between the existing PT components of cities such as Paris and the existing components of PT for Sydney and Melbourne show that although not totally prepared for these dramatic changes, steps are finally being taken to prepare for change. Typically in the past PT in Australia has supported an historical “low-cost, low quality” paradigm given the current urban sprawl of both Sydney and Melbourne. Australia needs a broader system of transport pricing for both road and PT.

Currently there is an infrastructure maintenance deficiency as funding continues to be used to finance construction of new infrastructure rather than upgrading existing stock (Infrastructure Australia, 2016). Australia does not have a good record in infrastructure governance. Failure to select the best solutions causes unnecessary increased costs. There is a need to preserve infrastructure corridors in Melbourne and Sydney to ensure that cheap land is available for new PT infrastructure development to match the continuing residential development (Infrastructure Australia, 2016). Residents of both cities must make a decision to live in low density green field outer areas with large houses and yards but be a longer distance from the Central Business district (CBD), or live in higher density areas with smaller homes or apartments but be closer to jobs and amenities. Unplanned growth delivers the worst outcomes for Australian cities and PT is crucial to improving accessibility (Infrastructure Australia, 2018). Both cities need to increase their PT capacity by 80% to meet expected growth by 2050 (Victoria State Government, 2018).

As demand for PT increases and it is currently growing at between 10-20% per annum, upgrading will be a challenge between and within the state and federal governments. There is a need to use existing infrastructure more efficiently and the planning needs to be place-based approach with all parties cooperating. Motor vehicles continue to be important as currently 78% of public infrastructure spending is on roads. This problem is increasing as approximately 70% of workers drive to work and approximately 60% of school children are driven to school in both cities (Infrastructure Australia, 2018).

Currently in Sydney and Melbourne just over 20% of PT funding is provided by the users. In comparison the user contribution is 40% in Paris and 91% in London. Relatively Australia has one of the cheapest PT systems in the Western World. This will need to change if things are to improve and PT systems in Australia need to implement new methods of funding PT infrastructure. There needs to be greater recognition in Australia of the concept of “value capture” in the implementation and planning stages of developments. Changes also need to occur in the resilience of PT infrastructure to deal with greenhouse gas emissions (Infrastructure Australia, 2016).

## **6.0 Conclusion**

Cities such as Paris, London and Seoul offer examples of efficient and reliable PT as models for Australian cities. The reality is, while PT in the established inner areas of Sydney and Melbourne has had some planning success, the outer urban settlements of both cities are continuing to grow and need effective PT planning and implementation. The difficulty for these cities is how to plan housing and infrastructure so that the appropriate residents live close to and can easily access, their preferred work? This will require not only PT infrastructure planning, but the establishment of industrial and commercial centres in these outlying areas to ensure not all residents need to travel to the CBD for work.

The key element in PT satisfaction is the efficiency of such systems. To this end, this paper clearly highlighted high levels of customer satisfaction for the three case studies discussed and such determination is based on the comparison estimations provided. In conclusion, this paper clearly demonstrated that Australian cities need to continue to invest heavily in PT infrastructure, introduce disincentives for private motor vehicle use and promote the benefits of PT travel to its residents.

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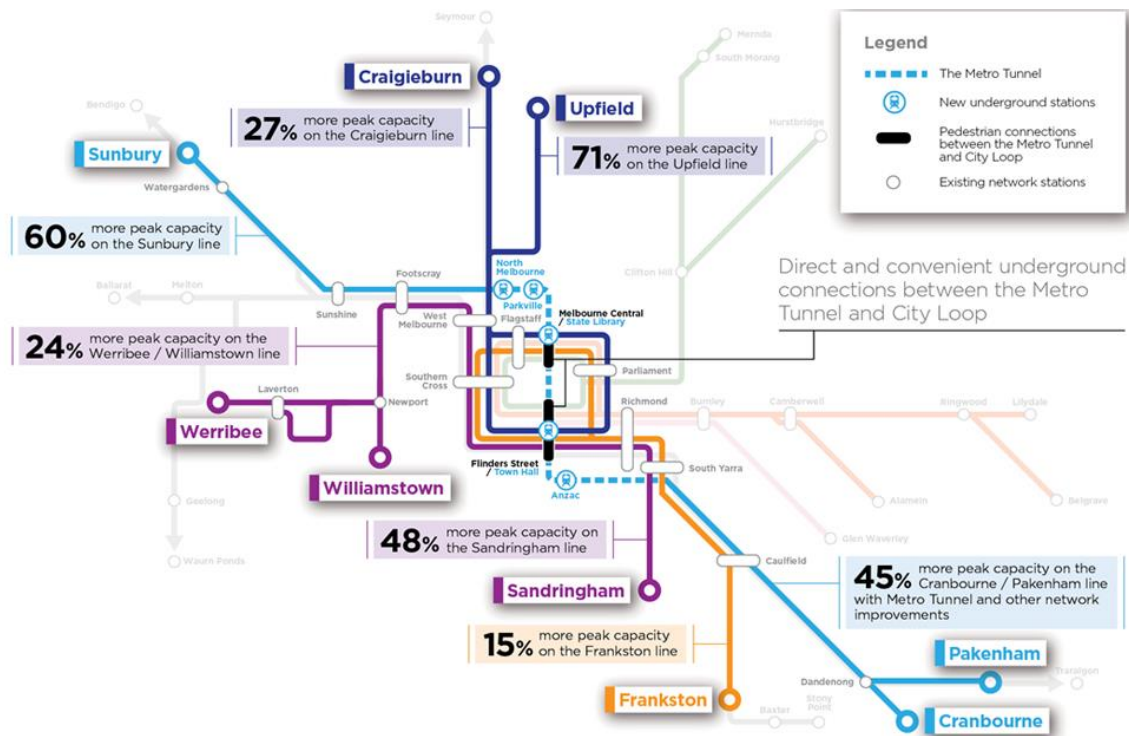
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Appendix

Underground tunnel in Melbourne under construction



Source: Victoria State Government, 2018