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**Bridging Urban Transport Infrastructure Gap in the Context of Smart
and Resilient City - Role of Private Sector and Public-Private-
Partnership (PPP)**

(Background Paper for EST Plenary Session-3)

Final Draft

This background paper has been prepared by Prof. Peter Newman, Curtin University, Australia, for the 12th Regional EST Forum in Asia. The views expressed herein are those of the author only and do not necessarily reflect the views of the United Nations.

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Bridging the Urban Transport Infrastructure Gap

In the Context of Smart and Resilient Cities – the Role of Private Sector and Public-Private-Partnerships.

By

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Executive Summary

Cities across Asia are growing at unprecedented rates with over one billion people born in Asian cities between 1980 and 2010 and a further billion expected by 2040. Many of these cities are quickly becoming megacities, with populations over 10 million people. Increasing urbanization has led to many benefits and is consistent with the ‘Rise of Asia’ that has occurred in recent times, lifting millions out of poverty, increasing average incomes, and improving quality of life. However, taking the lead from Western cities, much of this urbanisation has been based on the assumption that automobiles, mainly cars, are the best primary mode of transport for cities leading to what is known as ‘Automobile Dependence’ (Newman & Kenworthy, 1989; Newman & Kenworthy, 1999; Newman & Kenworthy, 2015).

This approach may be effective for low density cities in early stages of development but it has been shown to be unable to cope with rapid increases in population and urban density. This often results in implementation of stop-gap measures such as lane expansions, bypass freeways, tunnels, and even vertical multi-layering of roadways with only minor improvements in mobility but significant impacts.

The approach leads to a number of adverse outcomes that affect the economy, environment and communities, such as: increasing levels of congestion and delays due to induced demand; reduced accessibility due to increased trip times as cities begin moving outwards; risk of injury and fatality from road accidents; reduced physical activity leading to health related issues; and significant increases in local air pollution and global greenhouse emissions as well as oil dependence. In short, there are impacts on liveability, safety, resilience and sustainability – the core goals of SDG 11. Hence, growing cities in Asia and around the world are seeking ways to offer an effective transport system that can accommodate rapid increases in urban density while continuing to provide improvements to the key parameters in SDG 11.

Many cities are now turning to ‘Smart City’ technologies in an attempt to make their cities achieve these goals. This paper looks at how this new approach may work or not. Smart city technologies, like any technology, need to be directed and city governance systems will need to make choices about how best to implement the various sensors, information systems, and control services that are now available. We are going to look at two extreme scenarios for how smart city technologies can be applied to cities: the Smart Automobile Dependent City and the Smart Transit City.

A Smart Automobile Dependent City uses ‘Smart’ technologies to increase flow, to enable greater awareness of how to avoid congestion, to offer greater opportunities for cars to

compete with other modes, and to facilitate development of the city at its fringes but not around the high capacity roads. Such a city may indeed see some short term improvements in mobility but these benefits will inevitably be lost as population and traffic density increases, ultimately leading to the exacerbation of the issues that called for a new approach in the first place.

Hence if a city is primarily automobile dependent the application of Smart City technologies and approaches will have diminishing returns until eventually the negative impacts will outweigh the benefits, creating even stronger 'lock in' to the automobile dependence regime. Such outcomes may not be seen when major companies with smart city technologies present their products as a total solution to almost any urban problem as long as their particular brands of smart city technological systems are adopted.

On the other hand, a *Smart Transit City* uses 'Smart' technologies to help prioritise transit services and make them faster than cars. Such a system, better connected for last mile accessibility, is more affordable, promotes walkability and density around stations, provides information services for simplicity, and enables the funding/financing through effective partnerships. This city is not only better in terms of short term transport goals but long term goals that include all the SDG 11 characteristics of an 'inclusive, safe, resilient and sustainable city'.

A Smart Transit City is more aligned to long term planning goals but to attract political support will often be competing with the automobile-oriented solutions that are heavily promoted but are not part of long-held understandings of what makes a good city. Such an approach can leverage similar technologies that are promoted for 'Smart automobile cities' such as smartphone applications, sensors and control systems – however the core planning ethos must prioritise transit and sustainability rather than cars.

So how can transport and land use investment in cities be better directed to avoid mis-using the opportunities provided by smart city technologies? This challenge is not new but the issues need to be understood now or else there will be much loss of opportunity and waste of investments if cities just seek the branding aspects of being a smart city. This paper will attempt to address the challenge by suggesting ways of proceeding that are practical and useful. It will attempt to show how automobile-type smart city technologies can play a role but will need to be less of a focus than including smart city technologies in transit and active transport. The key to achieving such a transport system is to integrate transport and land use planning in a transport strategy that focuses on transit activated corridors, calling for new partnerships between government agencies and between government and the private sector to deliver such corridors.

These partnerships would use new dedicated lane corridor transit services to activate greater land value all along the corridor, to attract development investment around stations and pay for the transit service – rather than simply using this space for car parks. In effect the transport service provides the patronage for the station developments and the developments provide destinations for travellers – a synergistic relationship that can make such transit activated

corridors a primary method of urban transport and urban development, is often overlooked due to a lack of understanding about how to do the partnership model.

The second key element is to harness ‘Smart City’ technologies to improve efficiency, quality and modal interconnectivity – effectively creating a transit system supported by private vehicle use, or a ‘Smart-Transit City’. A number of Asian cities foresaw this eventuality and along with a focus on providing infrastructure for cars have also long embedded public transport options into their urban form, with differing degrees of success.

Below is a summary table to show the different attributes and performance leading to the ultimate level of sustainability and resilience of a city, from a transport point of view.

<i>Attributes of City Transport Network</i>	<i>Smart-Car City</i>	<i>Smart-Transit City</i>
Spatial efficiency for moving people	Low	High
Ability to cope with increasing urban density	Low	High
Ability to cope with increasing congestion	Low	High
Ability to cope with interruptions to the network	Medium	Medium
Ability to create people focused walkable spaces	Low	High
Energy efficiency per passenger	Low	High
Level of dependence on oil	Low	High
Level of Safety	Low	High
Level of Liveability	Low	High
Level of Climate Transformative Development	Low	High
Level of Resilience to climate change impacts	Medium	High
Level of achievement of SDG’s	Low	High
Level of ‘Smart Technology’ applied	Medium	Medium

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1. Background

Introduction

Much of the urbanisation around the world in the last 70 years has occurred with the private automobile as the central transport mode (Newman and Kenworthy, 1989, 1999, 2015) resulting in growing congestion, safety and pollution issues. While many American and Australian cities have sprawled outwards around freeways, this has been less obvious in European and Asian cities. Many Asian cities have grown upwards and to some degree outwards without little consideration of alternatives to the automobile, meaning that the only real alternative to using a car is generally poor public transport services, again designed around the dependence on cars.

Thus although many Asian cities are ideal for both shared and non-motorised transport options in terms of their density the lack of consideration for alternatives to car-based transport has resulted in heavy traffic, long commute times, and increasing levels of pollution, all leading to economic, social and environmental impacts. However as this report will show, those cities that have provided effective alternatives to automobile dependent-high density urbanity, through the provision of effective shared transit services embedded in high density station precincts have found strong economic, social and environmental outcomes - the cities just function better (Newman and Kenworthy, 2015).

A key question posed in this report is: *‘How can current automobile dependent cities effectively transition to higher quality modes of transport in a manner that creates multiple benefits including the ability to cope with increasing density?’*

Transport infrastructure facilitates the movement of people between places in cities, and the decisions that cities make about what types of transport infrastructure they build has a lasting legacy, as transport infrastructure usually impacts where and how urban development occurs around it. Therefore, transport agencies have a significant role to play in shaping the coming decades of urban growth in Asia, learning from the mistakes and successes from other cities around the world. Given Asia’s fast economic growth, relatively young populations and rapid urbanisation, the choices made in Asian cities will have a strong influence on global transport trends.

Transport infrastructure not only affects those using it but also impacts environmental and human health more widely. The World Health Organisation reports that 92 percent of the world’s population are living in cities with levels of air pollution in excess of the recommended limits by the World Health Organisation (WHO, 2016). According to the Asian Development Bank, 80 percent of the air pollution in Asia is attributed to the transport sector (ADB, 2018). This issue has been worsening, with vehicle numbers doubling every 5-7 years in Asia, and based on current forecasts, Asia’s share of global transport emissions are expected to rise from 19 percent in 2006 to 31 percent by 2030 (ADB, 2018).

Asian economies are also suffering from the inefficiencies caused by automobile-dependence. Asian economies are currently suffering a loss of approximately 2-5 percent of their GDP from road congestion (ADB, 2015). As mentioned above, although Asian cities have lower rates of automobile dependence than cities say in America and Australia, and to some extent Europe

(Newman and Kenworthy, 2015), the rapid population growth in Asia means that current infrastructure is under significant strain and new investment is needed. How this investment is secured and used will have significant implications, should cities construct more freeways and roads to cope with growing car levels or should a different more system approach be taken? In short, many cities are now asking 'What is the smart and sustainable way forward?'

Making 'smart' choices about transport infrastructure

With the rapid growth in digitisation of cities around the world there are calls for a focus on achieving 'Smart Cities' as a solution to many of these issues, however it is important to understand what this term implies as it is often misinterpreted.

At its core a 'Smart City' is one that provides its inhabitants with systems and infrastructure that can accommodate rapid growth and high densities while providing accessibility, safety and quality of life.

When considering the transport system, in the case that a city persists with an assumption of automobile dependence no matter how much technology it employs it will still ultimately fail to achieve this goal, despite using 'smart technologies', as the model does not work in space constrained cities, or perhaps anywhere that automobile dependence remains as the first priority. We are calling these cities 'Smart Automobile Dependent Cities'. Alternatively, cities that replace automobiles with smart shared transit systems as the primary transport mode will cope well with rapid urban densification. These cities are becoming known as 'Smart Transit Cities'. When well designed and operated, shared transit options, such as railways, subways, or trams, have been shown to effectively and comfortably provide mobility and accessibility despite the high density of travellers. It is well understood that this type of development also leads to a number of urban design co-benefits compared to increasing coverage of roads and freeways.

Primarily, urban transportation systems are intended to provide people with affordable access to the parts of the city that they want to go to. In order to facilitate economically productive and socially inclusive cities, the system needs to accommodate for large numbers of people to quickly move into and out of areas of the city with high activity density. Hence at its core transport decisions are about selecting the right combination of shared and private transit infrastructure to suit the availability of space. However as it is inevitable that most large cities will quickly grow in density, meaning that space will continue to be a premium, a combination that offers effective shared transit services as the primary form of transit complimented by private options stands to deliver the best outcomes in the longer term (Ewing and Bartholomew, 2013; Newman *et al* 2018; Sharma and Newman, 2017).

Cities that have emphasised shared transit infrastructure have found that effective partnerships between government and the private sector are needed to combine the new transit infrastructure with new development opportunities along the route, known as a 'Transit Activated Corridor' (TAC) (Davies-Slate *et al*, In Press). For instance, Figure 1 below shows both an automobile dependent city and a transit dependent city. In the first case trip times are acceptable and accessibility is convenient until population levels grow too high leading to lengthy commute times and difficulty parking vehicles when arrived. In the second

case accessibility is provided by offering a local shared transit service to bring travellers to station precincts built around shared transit stations that can continue to offer accessibility and convenience despite growing population levels. And further can attract new investment in station precincts that is not possible in the automobile dependent model that sees development focused around a few nodes rather than along a corridor.

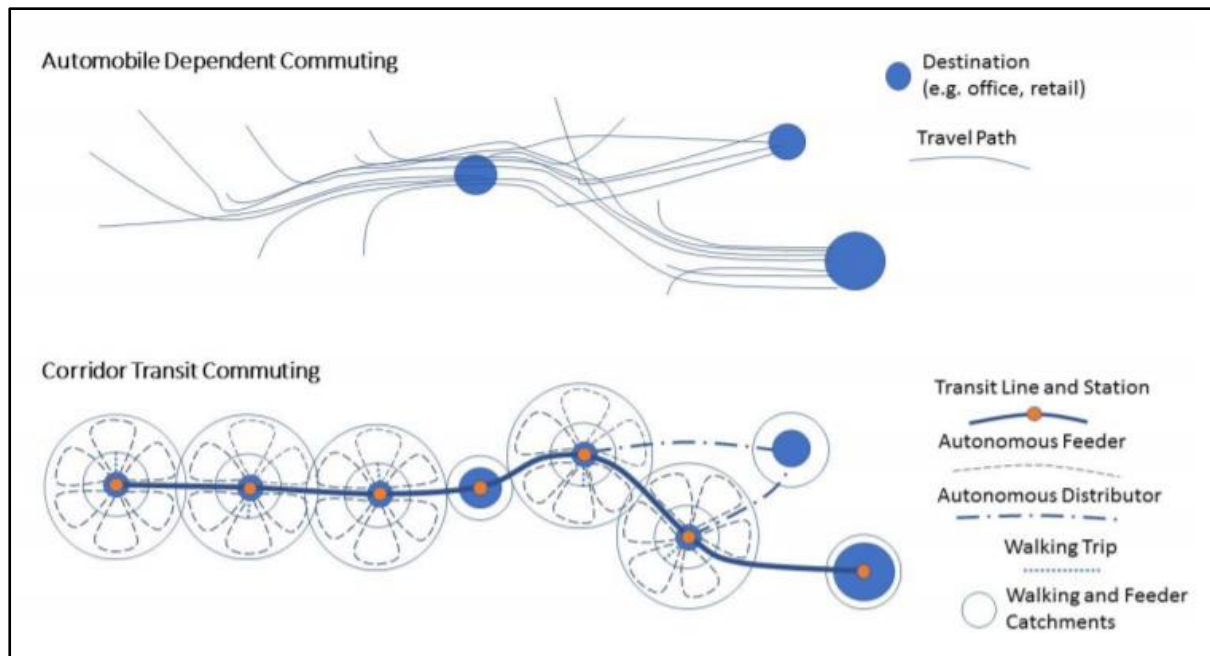


Figure 1: Comparison of traditional 'automobile dependent commuting' to 'Transit Activated Corridor commuting' with quality transit lines, last mile connectivity and integrated stations underpinning development. Source: Glazebrook & Newman, 2018.

Hence in order to achieve sustainability and resilience in cities as they continue to grow, cities need to shift to the corridor transit approach to create Transit Activated Corridors, both in cities already experiencing space constraints and congestion issues and in cities that are likely to face such constraints in the near future, and are currently automobile dependent. The main focus of the Transit Activated Corridor approach is to prioritise high quality, efficient corridor transit with last mile connectivity running between a series of dense station precincts. This then allows for fast, high quality mobility along the corridor that can then harness emerging technologies to improve efficiency and reduce costs that are built in as part of the urban regeneration process.

In order to enhance the functionality, sustainability and resilience of a city it is important that the city has got the fundamentals right so it can cope with growth before employing smart technologies.

Making 'smart' choices about transport technologies

As described previously smart technologies are being applied to cities that have been designed around cars and private vehicles and despite best intentions progress to improve conditions is likely to be stifled by the sheer size of growth in population and urban densities, calling for shared transport options to be integrated into the urban form. A number of

technologies can then be employed to enhance operation of the system and ensure that accessibility, safety and quality of life are maintained despite rapid urban growth, such as:

- *Information and Communication Technology (ICT)*: The use of ICT can help cities by providing real time information on mobility options for cars or for transit users or those using bikes and pedestrians. ICT can help with ticketing and payment for transit or for road user charges.
- *Internet of Things (IoT) Sensors*: These sensors can be used for road safety along roads to ensure cars do not lose their direction. Or the IoT can be used to create safety for a fast moving Trackless Tram and its associated last mile connectivity shuttles as part of a Transit Activated Corridor.
- *Mobility as a Service (MaaS)*: New, app-based mobility platforms will allow for the integration of different transport modes (such as last mile travel, shared transit, and even micro-transit such as scooters or bikes) into easy to use platforms. By integrating these modes, users will be able to easily navigate from A to B based on what modes are most efficient and all necessary bookings or payments can be made through the one service. With smart city planning, these platforms can steer more users towards shared and rapid-transit (which should be the centre-piece of these systems), rather than encourage more people to opt for the perceived convenience of booking a single-passenger ride. In low density car dependent cities however MaaS services such as the use of electric scooters/bikes are less effective as the distances are too long and they do not enable the easy sharing that can happen in dense station precincts.
- *Artificial Intelligence (AI) and Big Data Analytics*: These technologies are used together to enable decisions about what kind of transport planning is used down particular corridors. Options such as predictive congestion management of roads and freeways along with advanced shared transit scheduling can provide value to new and existing transit systems.
- *Blockchain or Distributed Ledger Technology*: Blockchain can be the basis of MaaS or any local shared mobility as it facilitates shared activity. As the future city is going to have distributed solar energy it can be applied to that and to how urban regeneration along a TAC can be sharing mobility opportunities, especially the payments for tickets on a transit system and its last mile connectivity shuttles. This technology can also be used for road user charging along any corridor and by businesses accessing any services and in managing freight.

Thus smart city choices can help with traffic management and other issues in a city's transport system however they can only do so much if the primary mode is via automobile as eventually the smart city options will be over-run with increased traffic. Hence the real smart choice is to transition to shared corridor services complimented by automobiles. In fact given the trends in growth there isn't really a choice. This process starts with smart planning that facilitates a transition away for automobile dependence that harnesses smart city technologies. However this new agenda also needs a new financing model as we will now discuss.

Asia's urban infrastructure funding gap

Whether Asian cities choose to remain automobile dependent or not the growth in cities will call for greater levels of funding to provide the associated infrastructure. Understanding that automobile dependence is a stop-gap measure as cities grow many cities in Asia are struggling with the need to invest in efficient shared transit corridors and station precincts in order to enhance sustainability and liveability. Considering that governments do not always have the funds available to fund transport infrastructure at the scale needed, and that often shared transit services do not pay for themselves through ticket revenues, it is important that governments focus on opportunities to collaborate with the private sector to source new forms of investment for urban infrastructure.

Currently in many Asian countries the public sector funds the majority of transport infrastructure – approximately 78.6 percent compared to 21.4 percent sourced from the private sector. Figure 2 below highlights that current infrastructure investment in Asian countries is approximately between 1.7-6.8 percent of GDP, and that the majority of this comes from the public sector (ADB, 2018).

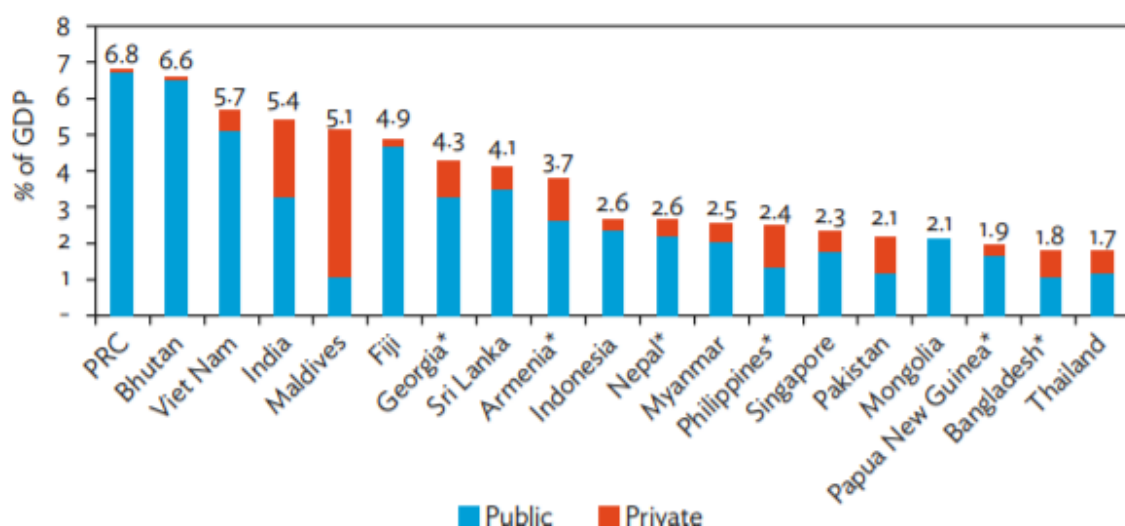


Figure 2: Current infrastructure investment in Asian countries as a % of GDP, by countries and source of finance (Asian Development Bank, 2018)

Of the various infrastructure finance gaps across different sectors, the largest in Asia is in the transport sector, estimated at \$600 billion per year in ADB member countries, calculated from an annual need of \$982 billion and a current investment of \$386 billion per year (ABD, 2017). If Asian cities are to meet infrastructure objectives in-line with targets such as those set out in the Bangkok 2020 Declaration then partnerships with private investment are essential. Traditionally the private sector has been more willing to fund telecommunications and power infrastructure than transport infrastructure. This is partly due to unattractive returns from road expansion and freeway projects and partly due to the typically sub-optimal provision of shared and rapid transit services again resulting in unattractive returns. However, now cities desperately need transport investment new models of private sector involvement are needed to achieve win-wins for investors, governments and society.

The role of the private sector in driving sustainable infrastructure provision

Privately funded shared transit infrastructure is not a new concept. Many of the original train and tram lines of the 19th and early 20th Century around the world were privately developed as a way to unlock new opportunities for real estate and land development (Davies-Slate and Newman, 2018). Once it was shown that by taking an entrepreneurial approach and investing in a train line to provide access to new land that resulted in lucrative real estate opportunities such projects became popular across the United Kingdom and the United States. Given that today the majority of infrastructure spending is in real estate, linking this with transport provides a lucrative new funding option.

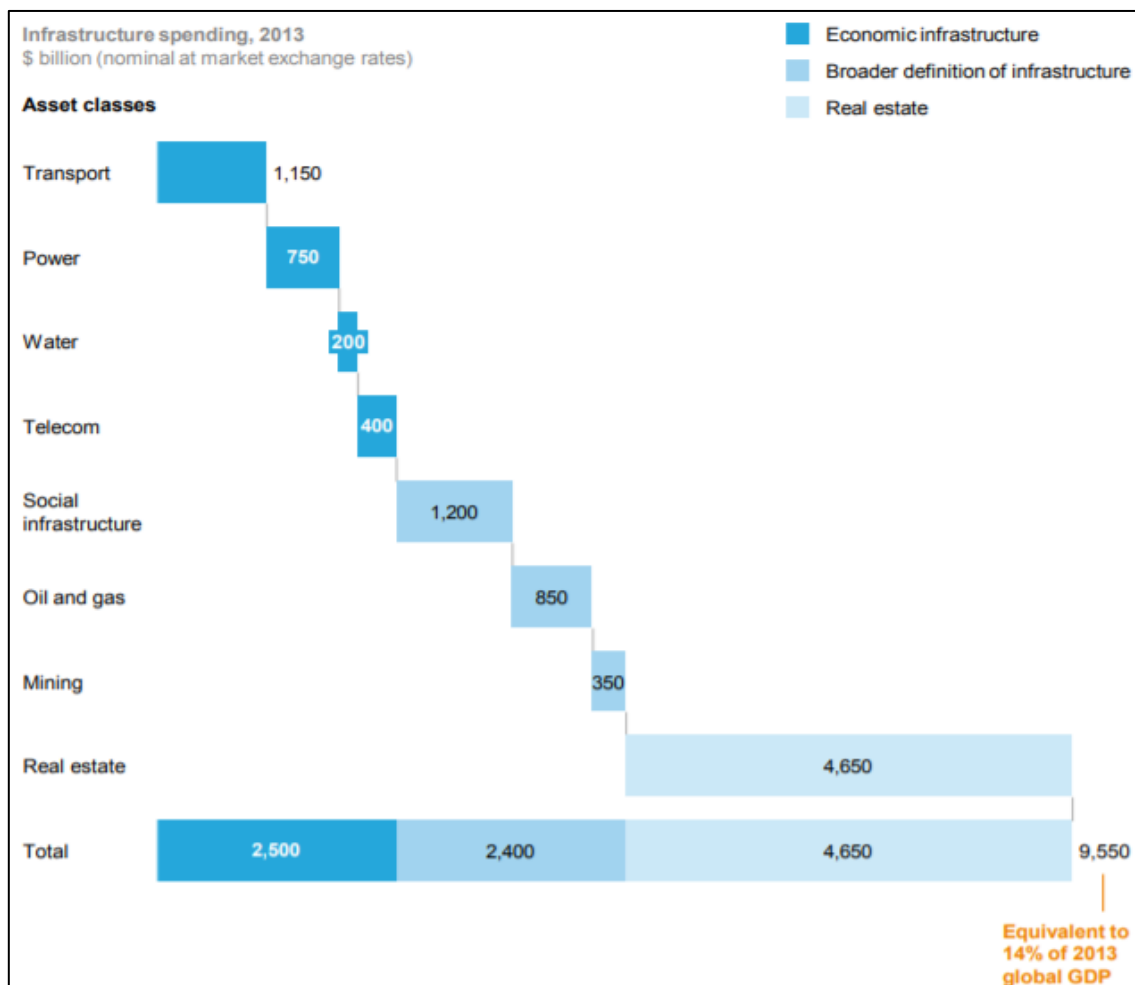


Figure 3: Global infrastructure spending compared with real estate investment.

Sources: IHS; Euroconstruct; IMF; World Bank; OECD as found in McKinsey Global Institute analysis, 2016.

In essence, reviving the model where land development opportunities underpin transit infrastructure provision will be key to attracting private sector investment in 'Smart Transit Cities'. Although, this model is not always properly implemented with a tendency to focus more on the transit infrastructure and less on the land development opportunities, leading to a 'value capture' approach rather than a 'value creation' approach. In a value capture approach a portion of the public funds spent on new transport infrastructure is recouped using mechanisms such as greater land taxes applied after the stations have been

constructed. As can be expected this approach is not well supported by land owners and developers. In a value creation approach government engages with private sector developers early in the planning process to identify opportunities for new stations to activate greater land development opportunities rather than just apply greater land taxes – and thus maximising the margin for private contributions to the costs of the transit. This approach is represented in Figure 3 below, and will be discussed in greater detail in Section 3 of this paper.

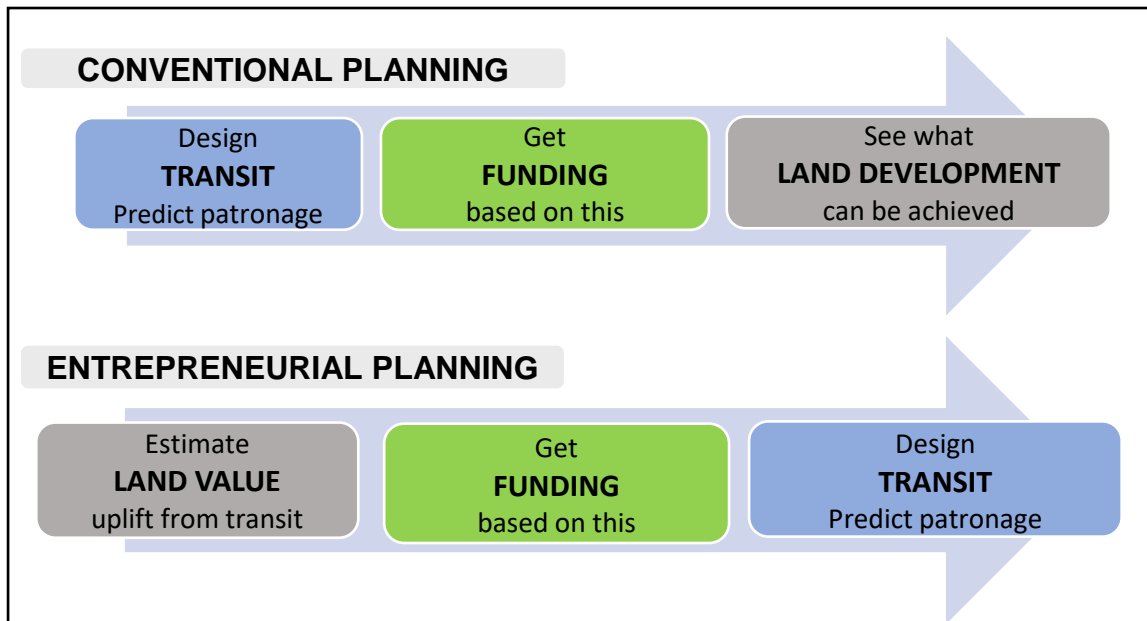


Figure 4: Schematic representations of the conventional transit planning process (above) and an entrepreneurial transit planning process (below) (Newman et al, 2017).

Taking this approach to the provision of shared transit allows for a series of station precincts to be developed or renewed that are connected by a transit corridor. Not only are the private sector developers incentivised to supply the transit service, they are also inherently incentivised to maximise the outcomes of the land development process they undertake in proximity to the transit, meaning that the sustainability and efficiency of the station precinct are also increased. Both the public and private sector are able to share risks accordingly, and the private sector are able to bring know-how and innovation to the projects to enhance the outcomes.

This report will outline how Public-Private Partnerships can be used to in Asian cities to attract private sector funding for the transition to shared high density transit infrastructure and associated station precincts. Such projects will also take advantage of innovative technologies to improve efficiency and reduce costs. Such corridors are integral to creating Smart Cities and Communities that can handle urban population growth in a sustainable manner, by attracting investment in sustainable forms of transit, and inherently contributing to economic, social and environmental outcomes for the communities they serve.

2. Overview of Urban Transport Infrastructure Gaps in Smart and Resilient Cities relevant to Asian cities

Urban transportation infrastructure shapes cities, and therefore infrastructure decisions directly impact the resilience and sustainability of cities. This section outlines key elements of sustainable transport for a smart and resilient city, and discusses urban infrastructure gaps facing Asian cities in relation to the types of infrastructure preferable to create sustainable outcomes using the TAC-smart city approach.

When infrastructure gaps are generally discussed for transport, the infrastructure elements considered for Asian cities include roads, railways, airports and ports. Specifically, this section focuses on key components of an urban transport system that can be strategically implemented with private investment (such as railways, BRT or trackless trams) and supporting land use and policy measures. It is clear that continued automobile dependence will not lead to improved conditions in Asia's growing cities. Therefore, the solutions presented in this report are ones that have significant potential to accelerate cities towards sustainability and resilience, based on the choice of 'smarter' urban growth using TAC-smart city opportunities.

Sustainable transport for a smart and resilient city

As highlighted in the Background section, cities and their transport systems are constrained by the space available and as urban density increases such space is growing more and more scarce. Most cities, especially the dense cities in Asia simply have too many people wanting to achieve their mobility objectives for everyone to drive their own private vehicle each day and higher density shared options are needed. Figure 5 below illustrates the passenger capacities of different modes of transport (NACTO, 2016). As can be seen public transport and active travel modes produce the most spatially-efficient transport outcomes however given such infrastructure typically needs to be now retrofitted into existing urban forms rather than by original design it must be integrated with land developments in order to access required capital.

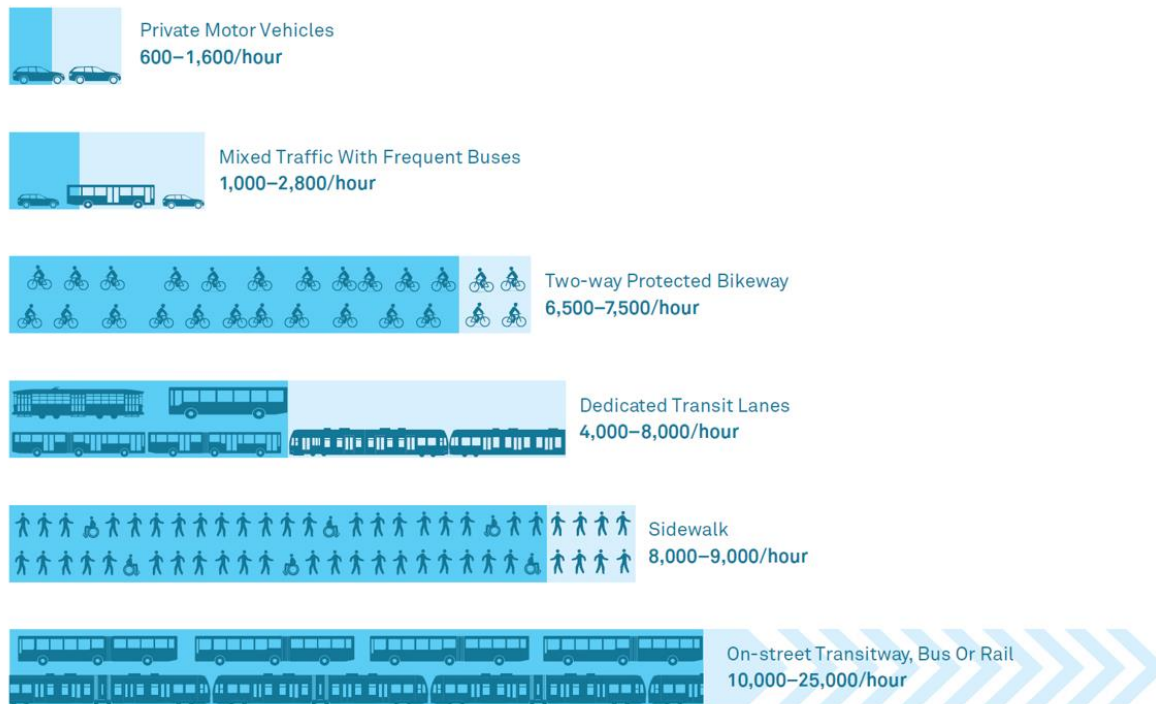


Figure 5: Passenger capacities of different modes (NACTO, Global Street Design Guide 2016)

Hence the only smart response to congestion and other traffic related issues that are set to be exacerbated by rapid growth in cities is to reorient transport systems to be shared transit dependent rather than automobile dependent. This means shifting from a focus on providing infrastructure for mixed traffic with in-traffic bus systems to dedicated on-street transit-ways, in conjunction with smart city technologies that can enhance benefits. This approach will be expanded throughout the report after outlining the different components of a smart and sustainable transport system, namely:

1. Separated Transit Corridors (Railways and subways on tracks).
2. On-Road Transit Corridors (Light rail, bus rapid transit and trackless trams).
3. Feeder and Distributer Services (Buses, shuttles, bikes and scooters).
4. Integrated Measures (integrating land use and transport planning).

Separated Transit Corridors

Railways and subways that operate separate to the road network can be a major element of the transport infrastructure for a Smart Transit City, and can provide rapid high density transit services that have significant economic and city-shaping benefits. These lines can not only connect cities but can form the backbone of a cities transport network where the land is available or metro construction is feasible. From a transport perspective, connector routes (such as buses or light rail) can be used to feed commuters into major railway hubs where they can travel longer distance on trains given the high capacities. As seen in Figure 6 below, global expansion of rail is increasing on average each year, with the majority of this growth occurring in Asia (with China making up a significant portion of this), although still mostly publicly funded (ADB, 2018).

Cities in Asia such as Hong Kong and Japan have leveraged private finance to fund extensive railway networks. The cornerstone of the finance for Hong Kong and Japanese systems has been land development around station precincts, the approach that is recommended in this paper. More detail will be provided in subsequent sections.

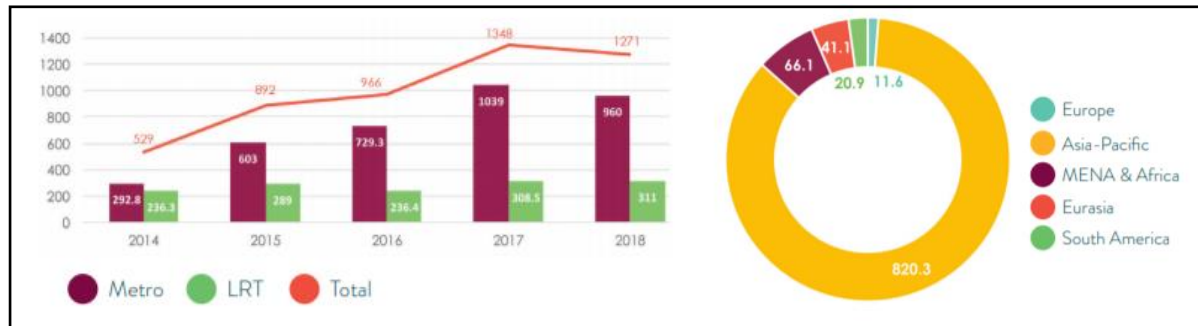


Figure 6: Left - Annual growth of urban rail globally (km); Right – Source of new rail in 2018 by region. Source: UITP, 2019. Statistics Brief, New Urban Rail Infrastructure in 2018.

Key considerations for Public-Private Partnerships:

- Asian cities are leading the world in the expansion of urban rail, however the majority is still publicly funded and there is only a small proportion of LRT as the connector technology used on urban streets.
- Due to the large capital investment required for train lines, once constructed there is significant ‘permanence’ to the lines that provides confidence to land developers.

On-Road Transit Corridors – Light Rail

Where land is available for a railway, or subway construction is viable, the first option for a smart transit city should be fast rail capable of efficiently moving large quantities of people between cities and along major commuter routes. The second stage is then to create on-road transit corridors as connector lines using light rail, bus rapid transit and/or trackless trams to connect railway stations to key activity hubs across the city. The length of such lines can typically be expected to be around 12-20km, and should travel along major urban streets creating boulevards that are walkable and filled with activity.

The graphs below in Figure 7 below show that globally there is a steady increase in new light rail lines around the world, with Asia-Pacific countries leading Europe in new lines in recent years. Europe has traditionally been a leader in the construction of light rail systems however the graph to the left indicates a ‘decline’ in the rate of new tram lines being added in Europe, this is likely due to a significant amount of existing lines needing to be re-laid, thus using up budgets without adding ‘new’ lines (UITP, 2019) a cost that can be avoided by leapfrogging light rail to trackless trams as will be discussed below.

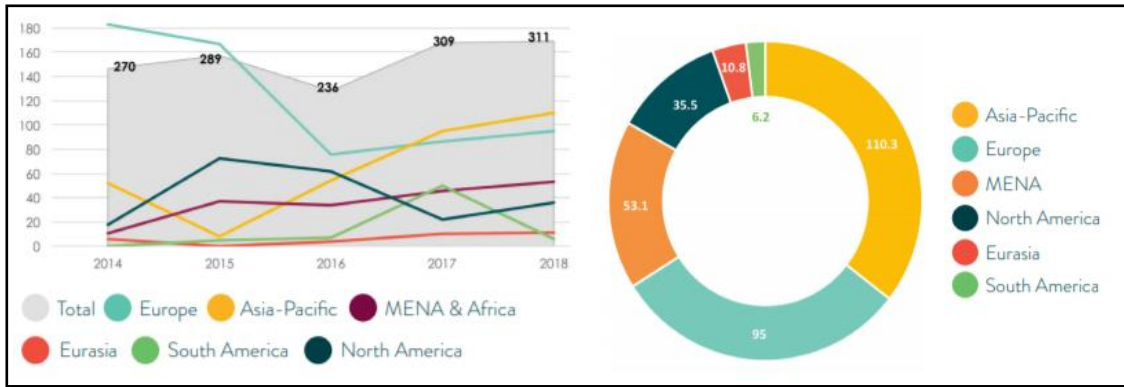


Figure 7: Left – Annual growth of light rail in global regions; Source of new light rail in 2018 by region. Source: UITP, 2019. Statistics Brief, New Urban Rail Infrastructure in 2018.

Key considerations for Public-Private Partnerships:

- Light rail provides an attractive mass transit option for cities, and are suitable for main street amenity and a smooth ride that can get people out of cars. Effective at turning 'main roads' into 'urban boulevards'.
- Have historically been seen as real estate/economic projects (street cars) and thus have great potential to be integrated with land development along corridor.
- Some cities in Europe are now capitally constrained by needing to replace old tram lines that they cannot afford to expand new lines at the same rate as previously achieved.
- Construction process can be costly and disruptive in comparison to new technologies such as Trackless Trams (discussed below).

On-Road Transit Corridors - Bus Rapid Transit

Bus Rapid Transit, or BRT, systems have been used to varying success in a number of cities (Stokenberga, 2014). Such systems seek to create priority bus corridors to allow conventional buses to gain faster access to key destinations and avoid traffic congestion. A transport benefit of BRT systems compared to a light rail system is that buses are able to depart the corridor and provide coverage services (lower ridership services that may circulate through less dense suburban areas to provide 'coverage' across all parts of the city, rather than just key corridors) and then enter the corridor.

In recent decades BRT systems have been considered a lower-cost option compared to light rail by budget constrained transit agencies facing growing populations and increasing transit demand. Thus many of these systems have been funded by transit agencies or local government rather than the private sector. A study undertaken that looked at various BRT systems and their influence on land value found that:

- In many cases, Bus Rapid Transit systems do raise rental prices in close proximity to the stations, however the results vary significantly.
- The transit system alone is likely not the only factor that contributes to development outcomes and increased land values, and must be enhanced by features such as:
 - Giving buses dedicated lanes.
 - Urban streetscape/landscape improvements.

- Supportive policies to support development.

Most buses around the world are still diesel powered, and these buses do not perform as well for trams in creating the main street amenity that light rail/trams create. This means that generally bus rapid transit have not been as successful as trams as creating urban boulevards that generate the places that people want to live and work, leading to greater commercial opportunities along these corridors.

Key considerations for Public-Private Partnerships:

- Bus rapid transit systems are able to act as effective on-road transit corridors to/from activity centres, and thus do enable higher densities of car-free development to occur around nodes.
- Bus rapid transit systems have been able to increase development and land values in proximity to stations, with varied results across different countries.
- Buses generally are not as amenable for main street boulevards as light rail.
- BRT systems typically don't have the capacity of trams or light rail and often have slow passenger loading due to limited doors.

On-Road Transit Corridors - Trackless Trams

The 'Trackless Tram' is a new transit technology emerging in Asia that harnesses the best aspects of rail, bus and cars to create a breakthrough urban transit vehicle developed by the Chinese Railway Rolling Stock Company (CRRC) – the world's largest rolling stock manufacturer, shown in Figure 8. The fact that this technology has been developed by a company whose history is in manufacturing rail vehicles, rather than buses, has contributed to the trackless tram being much more than a bi-articulated bus as it may first appear.



Figure 8: Images of the trackless tram in operation in ZhuZhou, China (Source: CRRC)

The Trackless Tram represents an exciting new smart city technology that combines the best elements of various transport modes with new innovations and technologies to new mode that out performs light rail and bus rapid transit systems without the cost. The new technologies incorporated into the Trackless Tram are (Newman et al, 2018):

- *Rail type bogies:* Installed in conjunction with low set axles to provide added stabilisation and distribute weight to approximately 9,000kg per axle (compared to around 15,000kg per axle for trucks which is often the pavement design vehicle).

- *Optical guidance:* The vehicle follows virtual rails using radar and lidar, meaning that it can automatically follow the corridor and steer accurately into stations, with the lines on the road intended to alert motorists of the path taken by the tram. Fixed markers can also be positioned along the path of the vehicle to provide additional calibration of positioning with an accuracy of 10-15cm.
- *Inertia Management Unit:* Drawn from high speed rail technology the inertia management unit minimises ‘tilt and sway’ as the tram travels along the road. As a result the Trackless Tram feels more like riding a light rail than a bus with children able to walk freely without risk of sudden braking or sway as in a bus.
- *On-board batteries:* On-board batteries that are capable of recharging at stations mean that the vehicle is quiet and suitable for main street amenity, and has a much better environmental performance than diesel buses (even better if the recharge points are powered by renewable energy). The batteries also eliminate the need for overhead gantries and cables to provide electricity to the tram.
- *Solid core rubber tyres:* Rather than rails, the Trackless Tram travels on rubber tyres suitable for pavement use meaning there is no digging up of underground services or major infrastructure works required to install a new line. The weight of a tram carriage applied at the axel is equivalent to a bus and less than a truck and hence will fall within the design parameters of most well designed roadways without further reinforcement.
- *Bi-articulation:* The Trackless Tram matches the capacity of light rail vehicles using bi-articulation to increase capacity, also making the passenger-to-driver ratio more productive, reducing operational costs.
- *LIDAR sensing:* Lidar is used to detect obstructions in the path of the Trackless Tram, adding safety to the line and means that in the future the vehicles will be capable of being self-driving. Given the tram is not on a fixed line this will allow it to join the traffic to avoid obstructions rather than being stopped.

By using all of the technologies described above, the Trackless Tram is able to achieve many of the best outcomes of BRT and light rail systems, and also overcome some of the key challenges. The table below summarises the performance of the trackless tram across various important public transport measures, in comparison with trams and buses (Newman et al., 2018).

Table 2.1: Indicative comparison of characteristics of corridor based transit systems

Characteristic	Bus Rapid Transit	Light Rail Transit	Trackless Tram System
Speed and Capacity	✓	✓✓	✓✓
Ride Quality	✗	✓✓	✓✓
Activation of boulevard land development	✗	✓✓	✓✓
Cost	✓	✗	✓

Disruption during construction period	✓	✗	✓✓
Implementation Time	✓	✗	✓
Overall	✓	✓✓	✓✓✓

A key benefit to enable private investment, and one that is discussed throughout this report, is the attraction of land development from fixed-route transit. Given its tram-like stations and fixed-route nature, trackless tram routes can be planned in conjunction with land development and attract private finance for station infrastructure and minor infrastructure works. Acting as connector services to railway stations that provide access to longer distance transit in Asian cities, Trackless Trams are a modern and cost effective way to deliver transit services while activating boulevards and main streets, which can attract significant commercial activity and residential demand.

One of the key differences between a Light Rail and the Trackless Tram, given that they both perform the same functions, is that the Trackless Tram requires significantly less capital investment and thus the implementation of new routes in conjunction with new land development projects is much more viable. This approach is outlined in detail in Section 3 of this paper.

Key considerations for Public-Private Partnerships:

- Trackless Trams can likely achieve many of the transit, amenity, sustainability and development outcomes that light rail can, with a lower cost and disruption comparable to BRT.
- Financially, the reduced cost of trackless trams makes developer contributions much more feasible, particularly in urban areas where property markets are less lucrative.
- Trackless Trams provide an opportunity to bring smart city technology into urban developments and this can be paid for by land developers and facilitate efficient shuttles for last mile connectivity as set out in Background.

Feeder and Distributer Services – The Last Mile

High capacity railways and supporting transit corridors are integral to a sustainable city. To support this in the outer suburban areas and in areas surrounding boulevards and transit precincts, last mile mobility solutions can play a role in extending transit catchments. Buses can play this role, however often buses are often underutilised along railway station feeder routes and instead mid-capacity shuttles can provide this service.

Emerging rideshare platforms such as Uber, Grab, Didi and others are positioning themselves to provide last mile transit for cities. This is an opportunity, particularly because the private sector is willing to provide these services and can likely do so more efficiently than local authorities. The key consideration for local authorities is that transit must be at the core of these services. Rideshare companies should not be taking customers on long haul journeys in every instance. Instead, they should be integrating with a broader transit network where they can provide last mile services and feed people into transit journeys.

Micro-transit such as scooters and share bikes are another way to expand the catchment of transit nodes with active travel options. These options will likely be provided by the private sector, and thus transit authorities should be sure to ensure they set the ‘rules of the game’ for private operators to behave within.

Key considerations for Public-Private Partnerships:

- It is important that transit agencies collaborate with private last mile mobility providers to ensure that their networks are aligned, and that on-demand services can prioritise transit ridership rather than long haul travel causing congestion.
- Transit agencies can think about beginning to streamline digital ticketing systems, as this will be required to efficiently integrate these systems with other modal systems (such as on-demand last mile bookings on mobile phones, or hire-bikes).
- The type of city that planners choose first, will be the type of city that technology amplifies. If the city is TAC-linked sustainable one, then these technologies stand to make the system even better. If an automobile dependent city is chosen, the negative impacts risk becoming worse.

Integrated Measures

Provision of sustainable transport infrastructure is important. However without a broader integrated approach to surrounding land use and policy, the infrastructure will not be maximised for the greatest outcomes. These integrated measures do not just create more sustainable outcomes, but also enhance the success of private sector participation. The two outcomes are intricately linked, and when governments seek to attract private investment for sustainable transport infrastructure, focusing on sustainability can lead to better outcomes for private sector participants. The table below explains four key integrated measures.

Table 2.2: Integrated measures to enhance both sustainability and private sector outcomes

Integrated measure	Benefit for sustainability	Benefit for private sector
<i>Urban design that supports walkability and active travel, complemented by open space</i>	Transit precincts and main street boulevards that can be created by trains and trams should prioritise walking as the primary means of moving among the precinct. This removes vehicles from the roads and allows inviting, vibrant streets to be buzzing with activity. This reduces air pollution (which can have negative health impacts especially in such dense hubs) and creates healthier citizens.	Walkability and active boulevards and precincts generate more commercial activity and lead to higher rent and sale prices of retail real estate. The face to face interaction that takes place between people in these areas stimulates innovation and innovative, knowledge economy workers want to work in these places.
<i>Commercial activity intensification at interchanges, such</i>	Commercial activity should be encouraged at interchanges. The ‘trip chaining’ benefits of	Maximising commercial activity at transit nodes creates the biggest opportunity for revenue sources

<i>as retail outlets, office complexes, and other mixed-use amenities at transit stations.</i>	co-locating commercial destinations with transit hubs allows people to reduce their car travel, and can reduce total number of private vehicle trips by up to 7 times (Newman and Kenworthy, 2015). This significantly reduces the need for private vehicle trips.	for private sector investors. These new sources of revenues (such as through rents) were not possible without the shared-transit, and therefore investors see a value in the transit provision. Businesses located in these areas achieve higher productivity due to agglomeration (Newman and Kenworthy, 2015).
<i>Densification around transit nodes that facilitates walkability and safety</i>	More population in greater proximity to transit nodes means more public transit riders. It means more people can walk and ride transit to where they need to go, and substantially reduce car use. They are healthier, more social, and consume far less energy in their daily lives for commuting (Matan et al, 2015). The need for greater urban sprawl is also avoided, which maintains natural landscapes around cities.	By facilitating higher density growth in close proximity to transit nodes, private land developers are able to generate more real estate activity and potential revenues. The walkability and safety of neighbourhoods adds to the attractiveness of particular areas, and hence these outcomes are 'better for business'.
<i>Parking management, including the removal of minimum parking requirements, which take up valuable transit oriented space and facilitate more car dependency.</i>	Parking takes up significant space and encourages greater automobile dependency. If more parking space is provided, often more people will drive (Newman and Kenworthy, 2015). By reducing the need for parking, cities can allocate large amounts of space that is currently used for cars that sit idle 95% of the time, into higher value uses. Less parking means less urban sprawl and less automobile energy consumption.	Minimum parking requirements mean that land developers need to attribute more developable land to car parking. Less apartments or office space in a development, means less returns (or at least higher individual sale/rent prices). Therefore, by allowing the market to decide if parks are necessary, developers can maximise the output of their transit-oriented development how they see fit, and potential generate more revenues from higher value uses of space.

Summary of key gaps in transit infrastructure in Asian cities

As this section has shown the key gap in transport infrastructure in Asian cities is the provision of alternatives to automobile dependence. While cities are dependent on automobiles for mobility they face inevitable issues related to the space required to service this model as populations grow, and the efficiency gains from 'smart' technologies deliver diminishing returns until they have little to no effect at all. Hence a 'Smart-Transit City' focused on providing an integrated system of high density transit to carry the majority of commuters and private travellers, reducing the pressure on roads and freeways and making reduced car use feasible longer term. This underlying architecture is then enhanced with 'smart' technologies both in vehicle design for trams and busses, in optimisation technologies like machine learning, and in advanced database technologies like Blockchain.

However the third ingredient after an effective public transit system and the application of smart technology is an effective way for government to partner with the private sector to deliver transport infrastructure. This is where the Transit Activated Corridor (TAC) approach to cities provides new insights as the approach places sustainable transport and urban design principles at the core and uses this to attract private investment. The activation of land use potential that is achieved, the same activation that creates the opportunity for the private sector, is a result of high quality shared transit that links dense, mixed-use precincts. The sustainability and the private investment are integral to one another, and using this approach they will not be maximised without one another.

Table 2.3 considers the priority of each of the areas discussed above as they relate to infrastructure investment.

Table 2.3: Prioritisation of components of sustainable transport systems for investment

Key component of sustainable transport system	Considerations in context of infrastructure gaps for sustainable transport	Impact on public investment budget – prioritisation as 'public infrastructure gap'
1. Separated Transit Corridors - Backbone of railway and subways.	Significant gap in public investment. Heavy rail is expensive and is requires as the backbone of an efficient transit system.	High – Cities need new, innovative approaches to attract investment for heavy rail systems that can move large quantities of people long distances.
2. On-Road Transit Corridors: Light rail, bus rapid transit and trackless trams.	Significant gap in public investment. Conventional technologies (such as light rail) have been expensive for cities and present a finance gap.	High – Cities need connector services that can link people to heavy rail transit backbones. Need innovative finance and technologies.
3. Feeder and distributor services: Shuttles, on-demand mobility and micro-transit.	Private interests have been providing these services quite effectively (on-demand ride share and micro-transit). Real need is	Low – Priority here is for government to collaborate and coordinate preferred outcomes. Private sector likely to provide services

	for government to coordinate properly, not fund.	(incl. funding, innovation, operation).
4. Integrated measures: Supporting land use and policy.	These are key in attractive private investment in infrastructure. Rather than treated as individual category, should be integrated with all of the above three options.	Integrated – Not directly a major ‘infrastructure gap’ (as these are more policy), but need to be integrated with 1, 2 and 3 above to ensure investment is maximised.

Components 1 and 2 will be of key focus of the rest of this paper, with the integrated measures outlined above assumed to be necessary to achieve the best outcomes. These are the priority measures to create TAC’s, and can be done through public-private partnerships. Once this transit foundation is created for any city, the right policy approach will ensure that privately provided last mile, on-demand services and smart city technologies will increase the efficiency, sustainability and resilience of the network.

3. Public and Private Finance & Public Private Partnerships

This section will outline the following:

1. Why private investment in Transit Activated Corridors creates economic value
2. How land value increases due to urban rail
3. Land value capture tools
4. Land value capture tools and value creation

Why private investment in Transit Activated Corridors creates economic value.

Transport infrastructure significantly influences urban economic value creation as it shapes the urban fabric around which the economy is created (Glaeser & Kahn, 2004; Newman, Kosonen & Kenworthy, 2016). The following three urban fabrics each have their roles in urban economic value creation:

1. **Walking city urban fabric:** Where major government and financial services are provided as well as many tourist and recreational services;
2. **Transit city urban fabric (TOD's):** Around which increasingly the knowledge economy services of education and health and many business services are created; and
3. **Automobile city urban fabric:** around which manufacturing and consumer services and space-hungry freight services are created and where increasing need is now seen for transit fabric.

The overlap of these city fabrics and the trend towards knowledge economy jobs in cities means that there is an increasing demand to create TODs where car use is minimized, allowing for space efficient dense urbanism (Newman, Matan & McIntosh, 2015). However, each of these urban fabrics require significant private investment, which underpins the need for a Transit Activated Corridor (TAC) approach.

There are several ways of understanding how private sector investment creates economic value in cities. Wealth creation is essentially a process that is based on a combination of the hard infrastructure that services buildings and their needs as well as the soft infrastructure that enables opportunities for innovation and job creation (Newman, Davies-Slate & Jones, 2017; Glaeser, 2011; Porter, 1990). The private sector do the vast majority of this city building within a framework of governance providing equity and sustainability, and a wider framework of community values. The three sectors of private, government and community, need to work in partnership to enable urban economic value creation (Newman & Kenworthy, 1999, 2015). Such economic value in cities is the major element of economic growth around the world. See Figure .

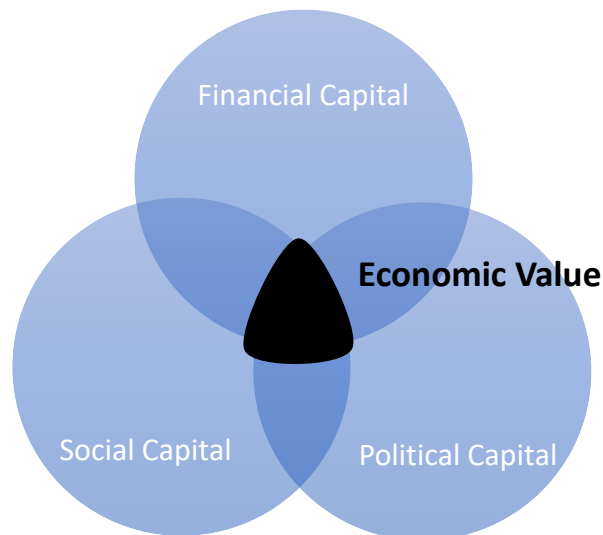


Figure 3.1: Economic value creation through integration of financial, social and political capital

Economic value is created in a city through integrating different forms of capital that are all involved in city building. There is financial capital that is necessary to build anything in a city; this depends on a range of technical assessments of how well the infrastructure will be used and what kind of demand there is for the urban development. This financial capital depends on risk assessment and demand evaluation which are also associated with social capital.

Social capital comes from communities that develop trust in an urban development because they see the demand and they recognize the risk if they don't have the new infrastructure and urban development. Social capital provides the ethical value and third party political validation necessary for the difficult process of urban regeneration.

The third kind of capital is about the system of government which provides the settings and processes that either encourage or discourage the infrastructure and urban development; it could be called political capital. The political capital is a combination of the transport and town planning regulations and the way it enables the links to the other kinds of capital.

When the three kinds of capital – financial, social and political – are integrated into a partnership then the best and highest value is created. This is what we are calling economic value and can be measured in terms of flows of activity and agglomeration benefits but it depends on the three other kinds of value being integrated.

Underlying the need for investment in TAC is the need for risk management that can enable both rail investment and urban development investment. In both investment situations there is a need for the three sectors of private, government and community to be in partnership if the full value of a TAC project is to be enabled.

Governments need to encourage an optimal land use mix through zoning, planning and operation of transit that integrates with the rest of the system and with local interchanges, planning for long-term project life cycle risks, and all the land assembly and statutory planning requirements of local amenity. Community is needed to ensure the TAC provides the extra

services and opportunities as well as the specific demands of local amenity as part of the bigger goals for access and new services in the TOD. Private sector involvement can address these elements by bringing innovation, technology, design stage efficiency, market driven land development skills, improved operational efficiency and long-term value for money through risk sharing. These latter skills are not readily available within government.

Figure 3.2 is a qualitative explanation of sharing risk for private participation in an urban rail project life cycle. The risk appetite of the private sector is higher when it is involved from the concept/ development (design) stage of the project and it decreases when the participation happens during the following stages of the life cycle. This is due to the fact that the private sector would be able to decide on technology, infrastructure, cost optimization, revenue streams and others for the project life cycle during the concept and planning stage. Private participation in urban rail projects has shown efficient exploitation of non-transport revenues such as advertisement, station area development and kiosks/ shops at stations along with bringing efficiency in construction and operations when involved from the design stage. Bigger projects which depend on even more land development for private investment opportunities, require even more obvious ways of incorporating private bids on how best to do it.

Involvement of the private sector at design stages can also enhance budget predictability for government. Private sector taking the life cycle risk can secure economies of scale (GIZ, 2013; Sakamoto, Delka & Metschies, 2010; Sharma, Newman & Matan, 2015). After the design stage, optimization of cost and revenue streams becomes limited in the construction stage and even further limits opportunities in the operational stage of urban rail if private sector involvement is delayed.

In sectors like mining and energy private participation has been engaged from the concept stage which has proven to show positive results (Cheah & Garvin, 2009). Transport has been mixed in its involvement with the private sector. Airports and seaports have become primarily private investment-based incorporating much closer integration with land development as a result. In the Modernist period of planning after the 1940's both road and rail have been primarily public within a strongly siloed regime of governance. Urban road provision remains heavily government based with some toll roads but few links to urban land development. Urban rail has been seen as a completely public responsibility in most developed and emerging cities with a few exceptions in Asia. However as shown below a range of mechanism are now developing to enable the same partnership approach to be applied for a TAC development.

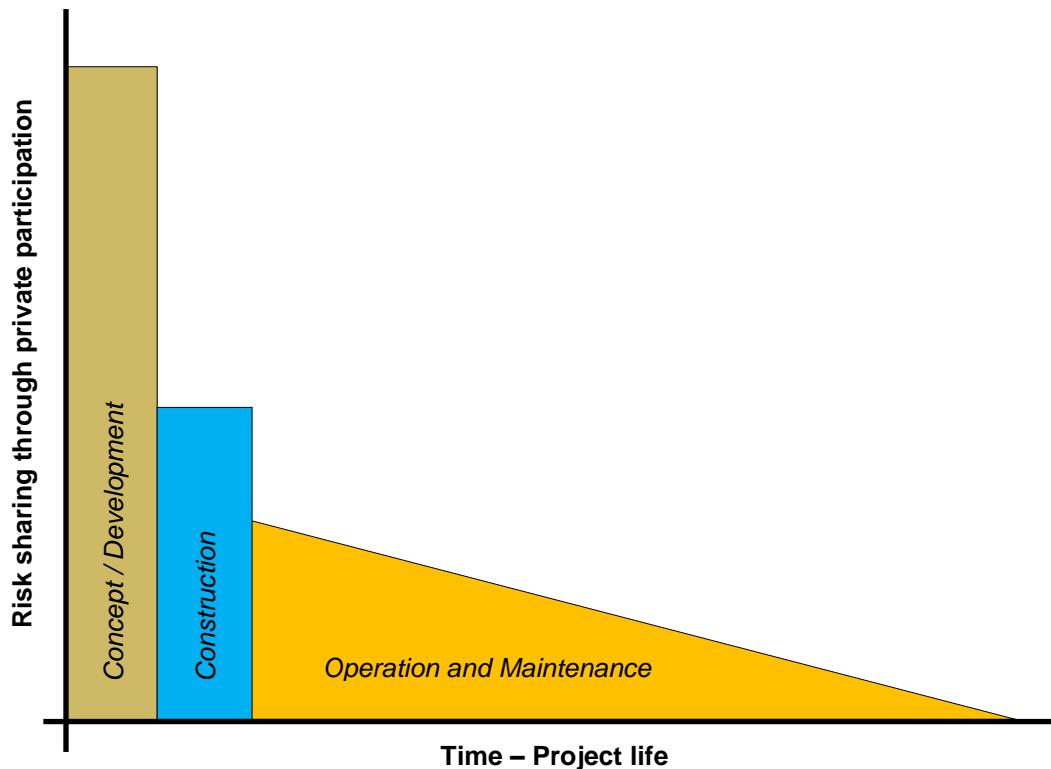


Figure 3.2: Urban rail project risks – sharing through private participation.

In order to optimize private participation Land Value Capture tools need to be aligned with two core needs:

1. How much cities are looking for help with financing TAC development to avoid conventional sources of finance, and
2. The extent to which cities are looking for economic outcomes in the associated TODs.

In the next section we discuss land value capture tools' potential for TAC development with private participation by discussing how land value increases happen.

How land value increases due to urban rail

The impact of urban rail on land value is well documented (see Anantsuksomsri & Tontisirin, 2015; Armstrong & Rodriguez, 2006; Cervero, 2003; Du & Mulley, 2007; Garrett, 2004; Laakso, 1992; Medda & Modelewska, 2009; Mulley, 2014; Sharma & Newman, 2017; Yankaya, 2004). There is a large variation in how much land value increases; this is expected as the factors that cause land value to increase include: the extent to which a station precinct is now connected to an improved transport system that can save time; how much local amenity is improved around the station; and probably most of all whether other economic opportunities are created through the TOD with its access to the train line.

Land value gain is generally estimated through quantitative price modelling (Freeman, 1979; Rosen, 1974). Hedonic price models have revealed the land value increase with respect to distance from stations at about 16% of the land value up to 1 km from the urban rail station in Izmir, Turkey (Yankaya, 2004); 11% increase in land values from 500 m to 750 m in Helsinki, Finland (Laakso, 1992); 17% increase in land values within 800 m in San Diego, USA (Cervero,

2003); 10% increase in land values within 800 m in Massachusetts, USA (Armstrong & Rodriguez, 2006); 7% increase in land values within 1 km in Warsaw, Poland (Medda & Modelewska, 2009).

In the case of Perth, the Southern Railway increased land values in the 500m around stations by 42% over 5 years after the announcement of the rail service (McIntosh, Trubka, & Newman, 2014). In Bangalore the value around Metro stations increased by 25% in the area going out between 500m and 1km and more significantly a 'before' and 'after' from the commencement of the metro rail operations shows a price uplift of 4.5% across the whole city; this indicates a major agglomeration economic event resulting in substantial economic value increase of USD 306 million from the metro rail's accessibility (Sharma & Newman, 2017).

The traditional approach to building urban rail based on top down supply of funding without much orientation to land development options will provide an increase in land value due to urban rail that benefits the landowners (both government institutions and private) without the owners making any direct investment in the rail. The increased desirability of that urban rail-accessible land, stimulates changes in land use, zoning and development intensification resulting in economic improvement which can be of significance across the city (Bowes & Ihlanfeldt, 2001; Cervero & Murakami, 2009; Chapman, 2017; Mathur & Smith, 2013; Medda, 2012; Pagliara & Papa, 2011; Salon, Wu, & Shewmake, 2014; Smolka, 2013). However, the full value creation is mostly lost to the land owners who did very little to deserve such a windfall gain but happen to be in the right place to receive the gain. It is not hard to see why attempts are therefore made to try and capture some of that value to help pay for the rail infrastructure.

Land value capture tools

LVC tools have long been applied to recover the windfall of land value uplift to fund public infrastructure (Chapman, 2017; Gihring, 2009; Ingram & Hong, 2012; Smith & Gihring, 2006; Zhao et al., 2012). The earliest implementation dates back to the days of the Roman Empire when the citizens to be benefited by the infrastructure were charged with the construction and maintenance of public roads and aqueducts, this practice was also followed by other civilizations the world over (Smolka, 2013). The literature on land value capture tools is large, some of the recent contributions on LVC tools includes Chapman, 2017; Connolly & Wall, 2016; Iacono et al., 2009; Levinson & Istrate 2011; Mathur & Smith 2012; Mathur, 2014; McIntosh et al., 2015; Suzuki et al., 2015; Vadali, 2014; Zhao, Das & Larson, 2012; Zhao et al., 2012.

As discussed in the sections above there is an important role for the private sector in enabling the best partnerships that create the most value in TFUL. If projects are fully planned and delivered by governments without involving private land development in investment partnerships then they will leak value and the opportunity to capture it will be minimal. It is not enough just to see value capture simply as a way of taxing windfall gain after it has happened. The full financial, social and political capital is not achieved in such projects.

The LVC tools are therefore set out under four groups that move from Fully Public through to Fully Private with two groups in between that are Partially Private or Partially Public. The four groups are shown in Figure 3 to illustrate the extent to which they create economic value.

Fully Public: Land Based Levies

Governments set up land based levies to immediately begin recouping value increases due to infrastructure construction. Such tools can be Business Levies, Developer Levies, Special Area Levies and Parking Levies.

- a) *A Business Levy is used in various countries such as France ('Le Versement Transport tax), Austria (Dienstgeberabgabe tax), the USA (employer/ employment tax) and the UK (Business Rate Supplement tax) to fund transit.*

The Le Versement Transport tax is paid by public or private companies in France when the company has nine or more workers located within a 10,000 inhabitant urban transport zone to fund public transport services (Pascal, 2003, as cited in Milan, 2015).

In the United Kingdom the Business Rate Supplement (BRS) tax is used by local authorities to impose a levy on business taxpayers to help finance local projects that can promote economic development like urban rail. BRS is a temporary tax imposed for a period to cover full cost of the infrastructure. The development of Crossrail in the Greater London Area is financed partially by business rate supplement (BRS). The BRS is expected to fund GBP 4.1 billion of the GBP 14.8 billion project by 2038. The tax is proposed to be increased by 15% in revaluations to take place every five years. In the first financial year 2010-11, collection surpassed the projected amount (Roukouni & Medda, 2012; Medda & Cocconcelli, 2013).

- b) *A Developer Levy is imposed on land developers to fund public infrastructure gap created due to the new development.*

In the US, the Impact Fee is a charge to land developers as a form of developer levy. The Impact Fee is a one-time charge levied on development projects during the issue of building permits to fund new public infrastructure and services associated with new development (Vadali, 2014).

In Latin American countries developers are either asked to mitigate any shortage in supply of public services caused by their private project (Colombia, Guatemala and Argentina), referred to as an 'in kind payment', or are simply offered additional development rights against a 'cash payment' (in Colombia and Brazil) (Smolka, 2013).

- c) *The Special Area Levy is used by governments to charge all land owners in a specific area to fund local transport services. These are imposed by governments rather than being partnerships as explained in the Partially Public: Special Investment Districts LVC tools section below.*

Two examples of Special Area Levies and rail projects are in Milan and the Gold Coast in Australia. In Milan, such a levy was imposed on properties located up to 500 meters from local transit stations. The levy was proportional to the windfall gains on the land value to

help fund the construction of the subway system (Ridley & Fawcner, 1987). In Australia, a Transport Improvement Levy of AUD 111 per year for every rateable property (245,687) in the Gold Coast City was introduced to fund the Gold Coast Light Rail (SGS Economics and Planning, 2015). In both cases most of the funding was coming from other government sources and in the case of the Gold Coast with its very wide area the imposed levy did not help with TOD's.

Betterment Contribution charges are a form of special area levy that has been widely documented in statutory documents in the UK, Latin America, India and Australia. The overall application of Betterment Contribution has however been poor except in a few Latin American countries. The Indian city, Nagpur, has not been able to implement Betterment Contribution charge since 1936 due to lack of an implementation strategy and framework (Nagpur Improvement Trust, 2013). Smolka (2013) notes that most successful cases of Betterment Contribution seem to rely on rather arbitrary technical shortcuts to keep it manageable.

- d) *The use of Parking Levies as a government charge on parking spaces in a designated area have been used to fund transit. The levy is based on the notion of discouraging the use of cars as well as providing an alternative transit mode. These parking levies can be just imposed but if done with the involvement of community and businesses then they enable more effective economic value to be created.*

The City of Perth, Australia uses the Perth Parking Levy to fund the local transit, pedestrian and cycling infrastructure system and has significant community and business support as it minimises car dependence. Perth is funding 'free' local transit through this levy (Parliament of Western Australia, 2014).

Land based levies are completely governmental tools through which specific public infrastructure services are funded without private participation. If the levies are imposed they will obviously have some effect on development being driven away; at the same time the infrastructure to be built through the levy makes the site more attractive for developers to invest in an area close to the infrastructure. The result will be less economic value in the TOD but it is still better than doing nothing and continuing with car dependence. This first set of LVC tools can be considered to have the lowest economic value creation potential as it does not align partnerships and incentives around integrated land development with new transit.

However, such levies are also probably the simplest set of tools to implement as it does not mean much change to transport and town planning agencies; the levy generates the funds for the rail and the governance remains un-integrated and does not need partnership development. For the TOD to be more integrated in planning and delivery the governance systems require another kind of process that can include private finance and expertise from the beginning rather than just putting a levy on them. It also requires community and business partnerships. Fully public LVC tools that impose an LBL are not therefore really integrated transit, finance and urban land development as the finance is not providing the integration and need for partnerships.

Partially Private: Tax Increment Financing

Tax increment financing (TIF) is a tool used to fund redevelopment projects (infrastructure and community projects) based on forward hypothecation of property tax due to prospective land value increase. It simply requires governments to set up a Treasury Fund that hypothecates funding from a specific area where government rail investment is improving the area resulting in land-based rates and taxes going up (McIntosh, Trubka & Newman, 2015).

US cities use TIF extensively for redevelopment and infrastructure provision in urban 'blight' areas. Blighted areas are usually characterized by dilapidated infrastructure, low income, unsanitary conditions, and a high rate of tax delinquency (Mathur & Smith, 2012). TIF has also been used to fund rail extensions and station area projects in several American cities such as Chicago and Portland. TIF is considered a 'self-financing' tool as local governments do not need to put up additional fees or increase existing tax rates. In terms of private sector involvement, TIF is less likely to drive away private investment as the normal taxes are used to collect the increased value and they are simply hypothecated in later years. The Land Based Levies begin immediately in order to pay back government loans but TIF waits until the developments are completed and value has seeped through the land-based taxes into Treasury. It is therefore likely to create more economic value as market forces are not impeded but are tapped in the same way they are in any other part of the city.

TIF has enabled cities to issue project-specific TIF bonds to raise capital costs of the project. A USD 2 billion subway extension project (to Hudson Yards) in New York City is being financed by raising funds through municipal TIF bond sales (Demaue, 2015). The city of San Francisco uses a tax increment financing approach to fund transit and local development (Clark & Mountford, 2007; Schlickman et al., 2015).

TIF is a fully government-controlled LVC tool where no extra private investment is required directly into the infrastructure. It also does not need to involve partnerships with community and businesses to enable it to happen. However, TIF does eventually flow into the infrastructure pool controlled by Treasury and can be re-used for other projects. Because the infrastructure is targeted to enable urban regeneration it is better at value creation as it is attempting to invite more private investment into the precinct being targeted and thus there is an integrative force linking transit building to urban regeneration. TIF tools thus are targeting broader economic gains from specific areas though they are somewhat remote from the process of TOD building and could indeed be marginalized in the focus on building the rail system as has happened in many cities.

One other flaw in TIF is that revenue streams are not always stable and predictable due to fluctuations in real estate values. It is possible for governments to suspend or cancel TIF districts due to budget deficits or according to local and political circumstances like in the case of California and Chicago. TIF also requires significant institutional capacity to implement due to assessment, planning and compliance processes at local levels however this is a necessary part of any attempt to create urban economic value through TFUL.

Partially Public: Special Improvement District Levies

Special Improvement District (SID) levies come historically from a local amenity based levy set up where an area needs improving and private interests initiate or are willing to contribute a levy to improve the amenity of an area. Businesses are encouraged to tax themselves for the good of the infrastructure or amenity that they create together. Local governments simply collect the funds and manage the procurement of the disbursement to enable the improvements. This can be for security, for heritage conservation or simply providing better spaces that attract people to stay and hence create value in the area (Matan & Newman, 2016). SID levies are now being extended into whole corridors to create urban rail and urban regeneration in TOD's.

SID levies are called various things in various parts of the world. In America, Special Assessment District (SAD) fees have begun to be used in Los Angeles and Seattle to fund new rail lines. The SAD is also known as BAD or Benefit Assessment Districts in Los Angeles and LID or Local Improvement District in Washington DC and even a BID or Business Improvement District as they have become known in Australia. To implement a SID, SAD, BAD, LID or BID fee, governments identify specific special districts which can benefit from the planned public infrastructure in terms of land value uplift. The identified area usually comes out of a partnership from the bottom up where businesses, local governments and communities recognize the need for a new urban rail line and a new set of TOD's that could be unlocked by this. Through negotiations a partnership is established where a SID levy is agreed that can enable the whole process of urban rail and urban regeneration to proceed (Mathur & Smith, 2012). This is different to the Land-Based Levies as they are worked out in partnership based on the redevelopment potential that is assessed to be unlocked by the private investment enabling the infrastructure. They are not imposed from a remote agency and hence they create good will about urban development among the private and community partners which can contribute significantly to value creation. SID can also include special area levies and parking levies as set out in the Fully Government LVC tool but only if they worked out in partnership with business and community to enable more significant economic value possibilities.

In the case of the South Lake Union Streetcar project in Seattle, a SID fee from 760 land parcels was estimated to provide 52 percent of the total project cost. The City of Seattle issued government bonds to raise capital and linked them with a SID fund. The city assessed a SID fee in 2004 and land owners of the SID area approved it in 2005, the street car project became operational in 2007. The assessed SID fee was based on estimated land value uplift for various land uses. The land owners were provided an option to pay a SID fee up front or in 18 years at a 4.4% interest rate. In this case the use of SID was considered as low-risk as it was applied in an established urban area with a strong real estate market (Mathur & Smith, 2012).

In San Francisco a SID began with the establishment of a local committee by the district's residents, business owners, tenants, schools and developers. The committee prepared a local development proposal including financial plan and sought approval from local government authorities. The district residents were charged with elevated property taxes to fund the infrastructure. The involvement of developers in the committee from early stages was notable as they were perceived as a catalyst for the investment (Clark & Mountford, 2007).

Business Improvement Districts (BID) are common in the US and Australian cities for small area improvements. A BID is a non-profit organization for a designated commercial area involving the local land owners and is used to enhance infrastructure and services of the commercial area to help improve local business. BID services are funded through an additional charge on land owners. There are about 72 BID's in New York City serving 84,000 business (City of New York, 2016). The potential to turn a BID into a larger SID with urban rail and TOD outcomes remains as a real option in many cities as the BID processes are well understood and trusted.

Most of the SID based tools are structured as public private partnerships involving community participation, sometimes called PPPC's. In this partnership property owners and businesses self-impose a fee, in partnership with the government and community, for perceived land value gains due to the improved benefits in access or multiple non-transport services in TOD's. Thus the financial risk is primarily borne by the beneficiaries of the project.

No BID or SID tool has ever been used to create an urban rail project in Australia but could be used in the new City Deal process outlined below.

Fully Private: Entrepreneur Rail Development

The Entrepreneur Rail Model was developed out of the need to truly integrate transit and land use through finance to create the highest value outcomes (Newman, Davies-Slate & Jones, 2017). However, this is not an entirely new approach as historically this is how tram and train lines were developed. 'Joint development' has also been used for building urban rail since the 1980's wherever a major TOD was considered as a joint outcome (Newman & Kenworthy, 1999). These joint developments were set up to supplement government money through land development but they can also be used to go further and create a fully private approach.

The Entrepreneur Rail model emphasizes the important role of involving private sector expertise and approaches to redevelopment in the early stages of any new urban rail project otherwise it is not going to be possible to generate private investment or to create the economic value that is sought from developing urban regeneration-based TOD's.

Thus the tools in this section are based on formal public-private partnership arrangements designed to implement infrastructure projects through risk-sharing but all the finance is coming from private investment. These PPP arrangements where the private sector pay for the infrastructure and make money out of the value created, are common in mining, energy, ports and airports but are not yet very common in many parts of the world like Europe, America and Australia for transit projects. They are however common in Japan and Hong Kong. In our view, this LVC tool is likely to create the most economic value.

Historically private entrepreneurs have initiated public transport in cities. The US's first omnibus started in New York City in the 1820s by private operators who then laid down rails (in 1860's) to replace horse drawn carriages (Glaeser, 2012). The first private rail projects began in the 1840's in the UK and the earliest in the US dates back to the Pacific Railroad Act of 1862, under which government provided land grants, 400-foot rights of way plus ten square miles for every mile of track built, for the construction of the transcontinental railroad. Other

private projects in history, especially in Perth, are outlined in Newman, Davies-Slate & Jones (2017). These projects are similar to what is now known as 'unsolicited bids' from the private sector. The Entrepreneur Rail Model enables partnership proposals that involve fully private investment but are still best developed with community and government involved as well.

Fully private capital and operational funding with minimal government in-kind support can be illustrated from case studies where this approach has been used including the Brightline project in Florida, Rapid Rail in Gurgaon and Tokyu Den-en-toshi Line in Tokyo.

Brightline is a privately owned inter-city rail service and TOD project linking Miami to Fort Lauderdale and West Palm Beach using a relatively fast train (160 kph). The phase 1 of the Brightline project will be opened in late 2017. The project utilizes an existing freight rail line of 312 kms and plans to add 64 kms to Orlando after the first stage has been established. Project finance was raised through a mixture of debt, bonds and equity. Private developers have not had to seek public subsidies or grants other than federal low-interest private activity bonds which provide a risk guarantee. Such private sector financing structure has been made feasible through the establishment of TOD's at each of the four rail stations (Renne, 2017). Brightline's economic study (The Washington Economics Group, 2014) notes that in the timeframe from 2014 to 2021 the project will result in an economic impact of approximately \$6.4 billion comprised of \$3.4 billion from Rail-Line Construction, \$887 million from Rail-Line Operations, \$1.8 billion from TOD Construction, and \$284 million from TOD Operations, in the same timeframe the project will add USD 653 million to Federal, State & Local Tax revenue, \$945 million from rail and \$235 million from TODs. Therefore, Brightline is showing significant value creation through private investment and expertise in land development.

Japan has historically used Entrepreneur Rail Model development in order to fund and build urban railways. They amalgamate irregularly formed properties that result in smaller but fully serviced urban neighbourhoods and involves sale of 'extra' land to fund the associated railways. The government, as in-kind support, enables land consolidation and acquisition. This approach is known as land assembly or land adjustment. In case of Tokyu Den-en-toshi Line in Tokyo, in addition to land adjustment, the private company purchased land before announcing their plan to build the rail line and on some land parcels they co-developed the land with landowners. A private developer promoted the area development by selling land, constructing housing, and attracting shopping centres and schools. This project was mainly implemented on a greenfield area (Bernick & Cervero, 1997; Sanders, 2015). The economic downturn in Japan in the last few decades has resulted in additional strategies for value capture such as strategic infill urban development around train stations. Private companies have been able to raise equity from the stock market for rail projects in Japan to avoid interest on loans (Metrolinx, 2013).

The Entrepreneur Rail development cases show a larger value creation potential through such extensive private participation enabling comprehensive and integrated development of TODs. The cases show that urban rail projects require private involvement to enable any active and entrepreneurial approaches for creating innovative ways for higher value and revenue.

Land Value Capture Tools and Value Creation

Considering different value capture tools the joint PPP development is the best one to create new economic value through bringing innovations in the planning and administration of public infrastructure, new technology, and most of all in creating the best market-oriented development potential in the land areas around stations. In other words, the Fully Private model enables a high value creation TAC.

The fully government land value capture tools are rigid in terms of their application to fund a specific infrastructure element and will make some development around stations less attractive for investment. Value capture occurs in land based levy, tax increment financing, and special investment district levy tools to help government fund urban rail. But this capture may not lead to enough further private investment and wider value creation to enable the full economic potential of the infrastructure and its agglomeration opportunities.

As shown in Figure 1 if government agencies continue to plan and fund urban rail they will have fewer and fewer opportunities to create sustainable transport and high value TODs. If governments seek greater involvement of the private sector from the start of projects, then by competitive transparent bidding it is possible to achieve greater and wider public and private economic goals through economic value creation.

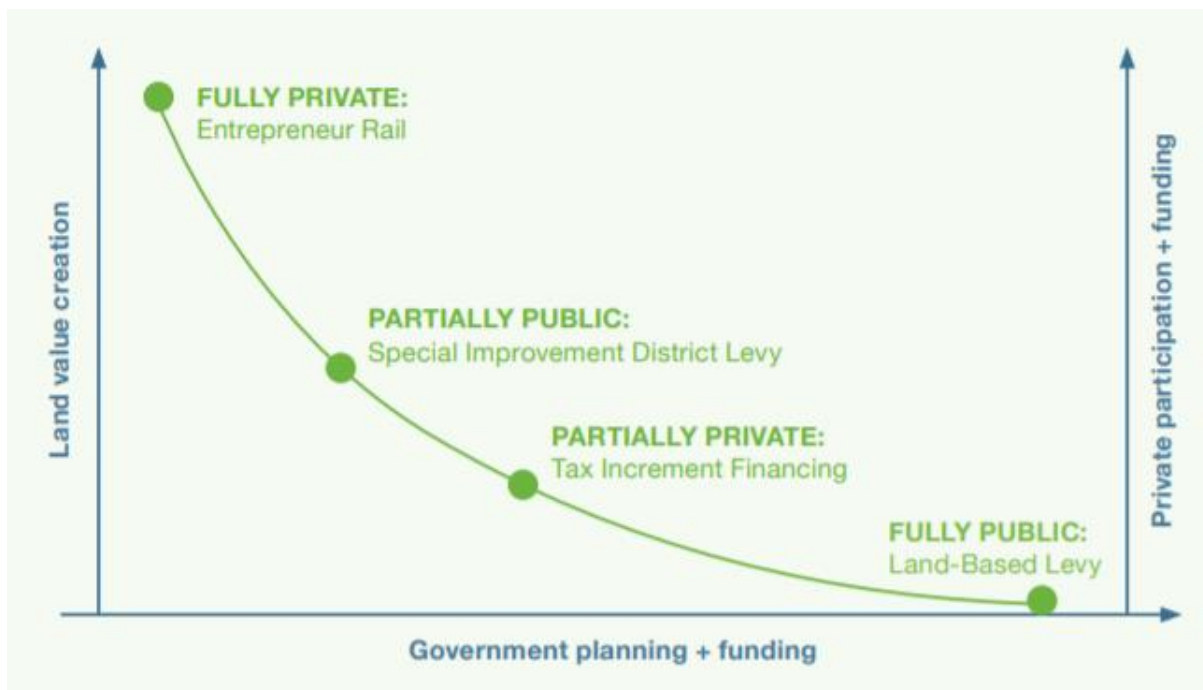


Figure 1.3: How land value creation varies with the extent of private involvement in TAC partnerships. (Source: Newman et al. 2018)

In the case of Entrepreneur Rail development, the full private participation can create additional value and capture opportunities as entrepreneurial opportunities are created, such as in the case of Brightline and Japan. Therefore, for the TAC development approach the optimal tool seems to be the Entrepreneur Rail Development model due to the private sector participation and comprehensive development for wider economic gains.

However, the next best is the Special Improvement District Levy model where private and community partnerships that help drive the rail and TOD planning and delivery, are developed

in specified corridors. The other tools are able to deliver urban rail but may not achieve much in the way of value creation in the associated TOD's.

The Australian Federal Government have begun a new approach to funding urban rail called City Deals – they only provide financial risk guarantees. Many governments reacted by saying they would prefer the traditional approach of being given cash for projects. However, this misses the point that with financial risk guarantees significant numbers of new projects can be built but they require a new approach with various levels of LVC tools and partnerships with community and private expertise and investment.

City Deals mean that cities must create partnerships between the three levels of government and be based around partnerships with private investors who provide the capital that they can return through TOD and urban rail activity. City Deals also require multiple urban outcomes for inclusive, smart and sustainable cities, as well as being clear about community goals. The LVC tools can all provide some help but the Fully Private and the Partially Public tools are likely to be the only ones that can create a City Deal. Such approaches are increasingly occurring around the world (Clark & Clark, 2014).

Conclusion

The LVC tools vary from traditional wholly government controlled processes that enable value to be captured but sacrifice value creation, through to entrepreneurial development where greater value creation happens with lower levels of government control but extensive partnerships. We have discussed these through various global examples in this paper. Obviously each city and each project will have different needs and requirements that will determine the appropriate mix of public and private investment in a PPP for integrated land use and transit. The main conclusion from this paper is that the more the private sector is involved in the investment and the process of developing a project, the more value creation is likely.

Private sector involvement for joint PPP development of a TAC project from the concept stage could increase the redevelopment potential commitment from the private sector and lead the public sector to focus on their core role of governance including community engagement and partnership development. This will lead to wider agglomeration benefits and economic gains as well as many local amenity gains.

The implementation process for TAC is not straightforward; it will require significant dialogue between community, private and public sectors. The public sector will have to create regulations to enable such processes and frame contracting documents for TAC that will address equity, sustainability and livability concerns of the community. Community engagement should be seen as an essential component not an optional extra as this can enable political validation as well as improving local amenity through their detailed knowledge of needs and options and hence provide the basis for partnerships with government and business.

Further research on such partnerships for a major project like urban rail and TODs can show the efficiencies and challenges in the life cycle of the project. The Australian City Deals for urban rail projects could show such partnerships required for infrastructure provision and

sustainable urban growth in a city. Delivery mechanisms and procurement processes for TAC will need detailed consideration as the structures of most town planning and transport planning do not easily lend themselves to such outcomes.

4. Case Studies

This section will look at cities in China, India and Bhutan to compare different approaches to transport and urban planning and particularly how they are doing in managing the automobile. China and India have both had dramatic economic growth based on their cities which has led to substantial automobile usage growth whilst in the other case study city of Thimphu in Bhutan, this small city in a relatively poorer nation is also growing rapidly in cars creating significant congestion issues. Data on the countries are provided in Table 4.1. Thimphu will be compared to Perth, Australia, to see how Transit Activated Development could work in both cities although they are very different in many ways.

Table 4.1: Relevant National Characteristics for People's Republic of China, India and the Kingdom of Bhutan. (Data Sources: UN, 2018; WB, 2019; IEA, 2007; IEA, 2017; Bhutan energy data directory, 2007; Yangka, 2019)

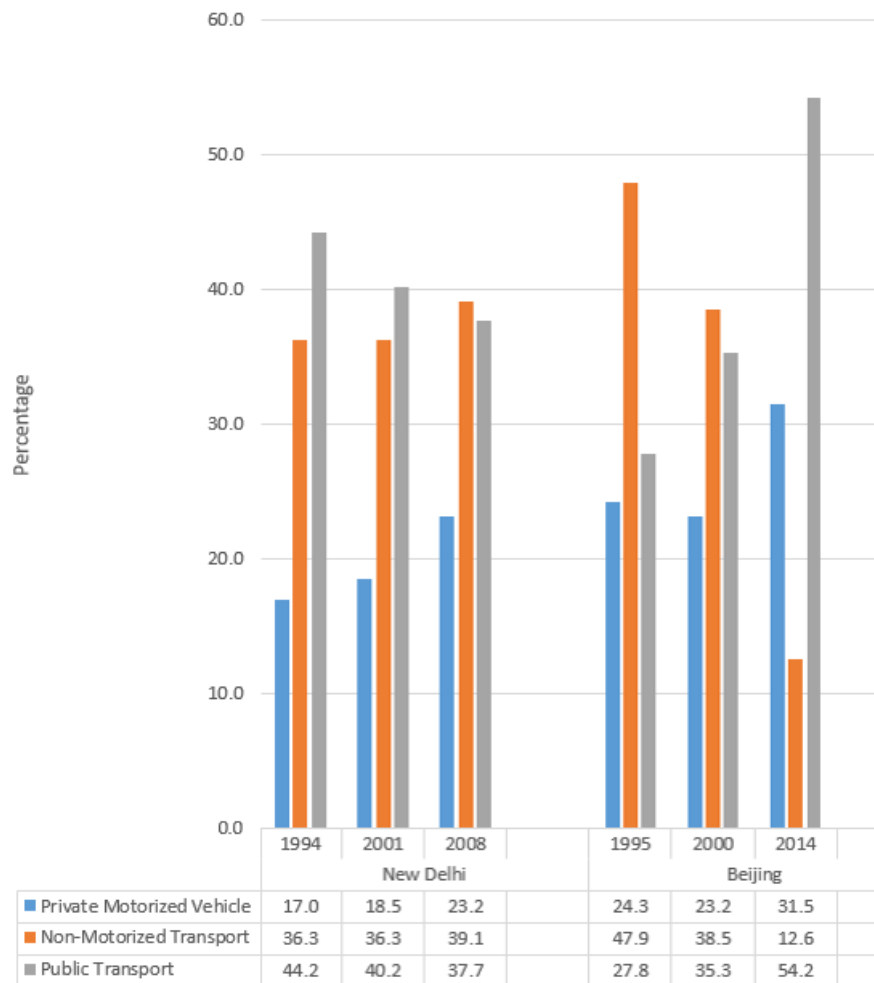
Indicator	People's Republic of China	India	Kingdom of Bhutan
Population in 2000 (Millions)	1,270	1,053	0.573
Population in 2015 (Millions)	1,397	1,309	0.787
% Compound Annual Growth Rate (CAGR) for Population 2000-2015	0.6%	1.5%	2.14%
Share of Urban Population (2015)	55.5%	32.8%	38.68%
GDP per capita PPP 2015 (constant international 2011 \$)	13,319	5,748	8,380
Transport Energy Consumption 2000 (Mtoe)	90	32	0.035
Transport Energy Consumption 2015 (Mtoe)	300	85	0.126
% CAGR Transport Energy 2000-15	8.4%	6.8%	8.91%
Transport CO2 Emissions 2015 (Million tCO2)	968	265	0.382
Per Capita Energy Intensity transport 2015 (ktoe/person)	215	65	160
Per Capita CO2 Emissions transport 2015 (kgCO2/person)	693	202	485

The three case studies will focus on Delhi, Beijing and Thimphu. The table and graph show trends in mobility drivers and mode share in New Delhi and Beijing (Thimphu data has not been collected at such scale over these timeframes).

Table 4.2: Trends in Mobility Drivers across New Delhi and Beijing
(Data Sources: Kenworthy, 2017, MRSP, 2012, Pojani and Stead, 2017, MRSP, 2012)

Cities	Year	Population (x 1000)	Per Capita GDP (USD 1995 rates)	Density (Persons/Hectare)
New Delhi	1995	11,635	1,264 ^b	63.5 ^a
	2017	15,906	6,646	112.9
	CAGR	1.4%	10.9%	2.2%
Beijing	1995	8,355	1,829	123.1
	2017	19,228	11,463 ^d	109.0
	CAGR	3.9%	18.2%	0.5%

Where a=1991, b=2001, c=2011, d=2015



Transport mode share in New Delhi and Beijing over time:

Source Dhar et al., In Press.

Case Study 1: How China's capital Beijing is coping with automobile dependence

China's urbanisation has led to dramatic increases in economic growth. Between 1978 and 2013, the disposable per capita income in China increased 50 times. Beijing, the capital city, has increased from 8.1 million in 2012 to 13.5 million (Kenworthy, 2017). However, the density has decreased from 123 in 1995 Persons/hectare to 109 Person/hectare in 2015,

which is mainly due to development in the outer metropolitan area of the city though inner and central areas continued to increase in density (Gao and Newman, 2018). The decrease in density because of city expansion into outer areas and increased per capita income has increased the reliance on car travel in Beijing. The number of cars per 1000 persons in Beijing increased more than five times from 42.9 in 1995 to 230.9 in 2012. The mode share in the total trips has also changed dramatically, the share of non-motorized trips drastically reduced from 42.6% in 1995 to 13.9% in 2012, whereas the share of both public and motorised private modes increased from 30.7% to 44.0% and from 26.7% to 42.1% respectively.

More recent trends for Beijing are set out below which suggest that motorization-based mobility in emerging cities can be curbed but will require a range of infrastructure and policy changes that increase the relative speed and cost of transit and NMT. The decline in car use per capita across most developed cities in the past decade has been attributed to a range of factors (Newman and Kenworthy, 2015) but has been generally seen as not applicable to emerging economies as their disposable incomes across the average citizen are still much lower. However, Beijing has achieved peak car in 2010 (Figure B1) at per capita income level of around 11,000 USD.

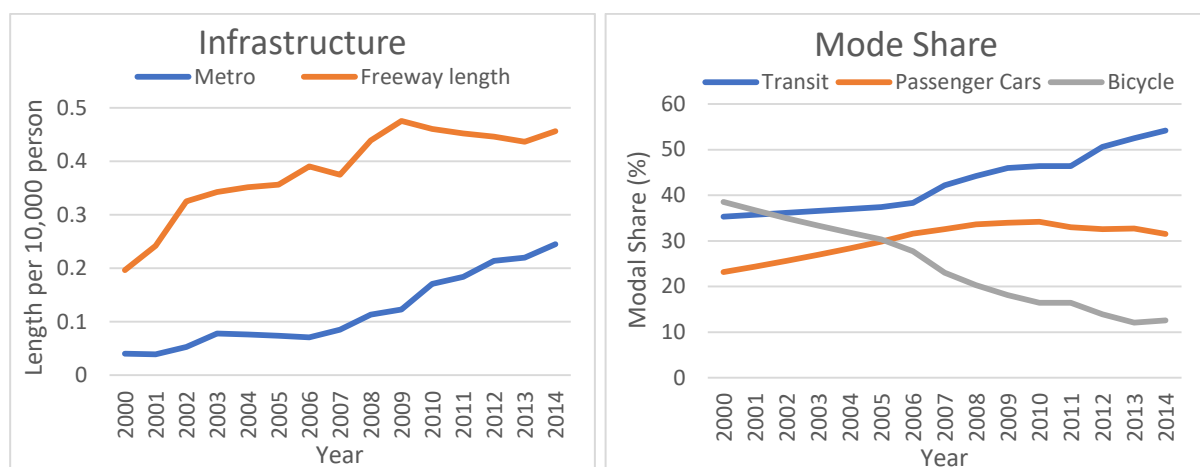


Figure 1: Transitions in Modal Shares, Metro length and Freeways in Beijing

The achievement of peak car in Beijing is the consequence of deliberate policy and infrastructure choices. The peaking of car use coincides with a change in priorities for spending on infrastructure with a switch from Freeway spending to transit systems (Metros). Similar trends are also witnessed for Shanghai (Gao and Newman, 2018).

The peaking of car use in Chinese cities besides policies on the supply side that augment transit capacity is also the result of demand-side measures that reduce the availability, convenience and flexibility of cars e.g., there are restrictions on the purchase of cars and you are not allowed to drive fossil-fuelled cars inside the city (Gao and Newman, 2018). It is now possible to build smart city technologies into the whole transport system as it has a core of transit and NMT opportunities. It is therefore taking on some of the new smart transit systems such as Trackless Trams (Newman et al. 2018).

The Chinese government does do value-capture related transit as it builds shopping centres and offices into stations to help pay for the Metro lines. The government owned Hong Kong

Mass Transit Railway (MTR) Corporation has to run as a private corporation undertaking significant land development with private sector partnership to turn a net loss in the 1980s into profit worth USD 2 billion in 2015. The key to MTR financial success is starting the land development-based finances before the actual rail line operation (Cervero & Murakami, 2009; Mass Transit Railway, 2016; Zhao, Das & Larson, 2012). Such an entrepreneurial approach is required in urban rail projects which necessitates private involvement.

Case Study 2: Transit Activated Development in India is an opportunity for New Delhi

India has adopted a policy of slow urbanisation (until recently) while encouraging economic growth. Despite comparatively low urbanisation (32.8%), India has the second-largest urban population in the world (377 million). The per capita income (in PPP terms) has grown rapidly since 2000 from US \$2130 to US \$5,748 in 2015 (World Bank, 2019). However, the income levels are still below China. In Indian cities significant share of travel is with non-motorized modes, that is walking, and bicycling (around 40%), about 15% use public transport, and 36% use private transport of which, 20% is by motorcycle. The land use in cities in India has been characterised as having high density, low rise and with mixed land use.

In Delhi, the number of Vehicles/1000 persons increased from 125 vehicles/1000 persons in 2001, 441 vehicles/1000 person in 2011. In 2008, 39% of total trips in Delhi were made using NMT modes (35% by walking), 38% by public transport (31% by Metro/bus and the rest by auto-rickshaw and cycle-rickshaw) and 13% trips were made using private motorized modes of transport (9% by car). Delhi's metro has grown rapidly since this period (Sharma & Newman, 2018; Sharma & Newman, 2016). The population density in Delhi is 93 persons/hectare which increased to 112 persons/hectare in 2011.

Delhi has been trying a range of partnership approaches to try and help build new transit systems like Metro. Other Indian cities have been doing likewise. In the case of Gurgaon, the urban rail project is fully privatised under a Design Build Finance Operate Transfer (DBFOT) agreement with a 99-year concession period. The private developer financed the project through private loans and equity raising. The government provided an existing right of way for the rail line, however access to the station and transport interchange facilities as well as land acquisition for stations was undertaken by the private developer. Project revenue sources include fare-box collection, advertisement and leasing of shops within the station area, however no land development was involved. The private developer conducted an aggressive advertising campaign which resulted in 61% of the total revenue in 2014-16 through the auctioning of the naming rights for the stations (even before the stations were opened) and advertisement space on the inside and exterior of the train coaches (Deloitte Haskins & Sells, 2015). The private developer operates 'free' feeder bus service to adjacent industrial hubs from stations in order to increase fare-box revenue. The feeder service benefits the commuters by providing comfortable last mile connectivity. This case shows that full private participation results in innovative revenue strategies and greater public benefit however it is very unusual not to have used land development opportunities and it remains to be seen whether the project can survive without this.

In other Indian cities there are clearly lessons that can be learned for Delhi. In Mumbai a new rail line was built based entirely on the private owner paying for it from the fare box but this

was never enough, even in Mumbai where rail is so important. In Bangalore the value around Metro stations increased by 25% in the area going out between 500m and 1km and more significantly a 'before' and 'after' from the commencement of the metro rail operations shows a price uplift of 4.5% across the whole city; this indicates a major agglomeration economic event resulting in substantial economic value increase of USD 306 million from the metro rail's accessibility (Sharma & Newman, 2017a). Thus a PPP approach involving land development can work in India.

Hyderabad Metro involves significant land development. It is built on a DBFOT agreement wherein a private developer was provided about 10% of the capital cost as grant (equity) from the federal government of India and the state/ provisional government granted air-rights for commercial development of about 12.5 million sq. ft. over the three depots and 6 million sq. ft. at the 25 select stations. The private developer has raised capital through loans and equity. The private developer's concession period is for 35 years. The project was operational in mid-2017. The private developer started renting the spaces before the rail is operational. This case shows the private sector's active approach towards enhancing revenue streams.

Case Study 3: The potential for Transit Activated Corridors to shape both developed and developing car-dependent cities: The case of Thimphu, Bhutan and Perth, Australia.

Trackless trams can provide both developed and emerging cities facing different urban challenges an opportunity to break out of automobile dependence and avoid more urban sprawl and congestion. Let us consider two cities:

1. *Thimphu, a developing city which is the capital city of The Kingdom of Bhutan with a population of 100,000 and aspirations to grow to 400,000 in a valley with very limited development space.*

- Automobile dependence: Thimphu's automobile dependence has seen a rapid rise in recent times and has been forecast by the Asian Development Bank to increase from 75,000 vehicles in 2015 to over 350,000 in 2040. Over 50% of the total vehicles in the country are located in the Thimphu region (Road Safety and Transport Authority of Bhutan, 2018).
- Forecast urban growth: The city is only 26km² in land area, and plans to accommodate an additional 300,000 people by 2050 in addition to its existing 150,000. This would mean the city would quadruple in size. The steep topography of the valley surrounding the city means that the city cannot spread much beyond its initial footprint.
- Corridor transit opportunity: Hargroves and Gaudremeau proposed a new 8.5 Km transit corridor with 12 stations for Thimphu that has the potential reduce the need for 75km² of land on the fringes to 37.5 km² of dense, urban re-development. The results are seen in table 4.3.

2. *Perth, a developed city which is the capital city of Western Australia with a population of 2 million that is sprawled 150km along the coast of Australia.*

- Automobile dependence: Perth has a strong history of automobile dependence since the 1950s like many developed cities that once had tramways but removed them to prioritise cars. This has led to significant urban sprawl along the Indian Ocean coastline.

- Forecast urban growth: The city is looking to grow its metropolitan population by an additional 1,200,000 people by 2050. The strategic plans of the city state that over half of this population growth is intended to occur within inner to middle urban areas (rather than more sprawl).
- Corridor transit opportunity: A proposal has been put forward for Perth to provide a new 25km transit corridor with 12 stations that stands to reduce the need for 100km² of urban fringe development and instead focus on facilitating 65.7 km² of urban re-development – see Table 4.3.

Table 4.3 below shows the space saving possible for both Perth and Thimphu if the next decades of urban growth are steered towards inner to middle metropolitan urban regeneration rather than fringe sprawl. This type of infill must happen around transit nodes.

Table 4.3. Estimates of land space savings from adoption of corridor transit systems in Perth, Australia and Thimphu, Bhutan (Newman et al, 2018)

Parameter	Perth	Thimphu	Units
Predicted Additional Population	120,000	300,000	People (Ppl)
Population Density (Fringe)	12	40	Ppl/Hectare
Population Density (Corridor Stations)	35	80	Ppl/Hectare
Additional Area Required (Fringe)	100	75	km ²
Additional Area Required (Corridor Stations)	34.3	37.5	km ²
Area saved by corridor transit approach	65.7	37.5	km²

Similarly, for each of the cities, the space saving from reduced parking is significant, as more of the population can instead ride transit. This also opens up the opportunity for re-development of greater intensity due to less parking requirements. These estimates can be seen in table 4.4 below.

Table 4.4: Estimates of parking space savings from adoption of corridor transit systems in Perth, Australia and Thimphu, Bhutan (Newman et al, 2018)

Parameter	Perth	Thimphu	Units
Predicted Additional Population	120,000	300,000	People
Car Park Supply (Urban Fringe)	10	4	Ppl/Hectare
Car Park Supply (Corridor Transit)	4	2	Bays/Hectare
Additional Parking Area Required (Fringe)	15.6	15.4	km ²
Additional Parking Area Required (Corridor)	6.2	7.7	km ²
Area saved in a corridor transit approach	9.3	7.7	km²

These two cities highlight the type of decision making that is needed in growing cities around the world over the coming decades. Thimphu and Perth are cities in very different parts of the world, however have some commonalities that they share with many cities around the world:

- Both are going to experience significant population growth over the coming decades, meaning they will need to make pivotal decisions about what type of urban growth they facilitate – supporting by transport infrastructure provision.
- Both are seeking to break out of the constraints of automobile dependence that has gripped them and most cities around the world in recent decades, and led to much sprawl, pollution, low density growth and pollution.
- Both need Transit Activated Corridors to enable the growth of their cities to happen in a sustainable and resilient way, that does not sprawl further and instead creates liveable, higher density centres around highly efficient transit.
- Both cities need private investment in fixed route transit to accelerate this transition. This is where the private sector and government incentives can be aligned to both play a role in shaping the future of their city in a sustainable way through transit provision and dense urban redevelopment. It is clear there is a demand for both.

5. Conclusions and Recommendations

The final section of this paper sets out 8 key conclusions and recommendations based on the discussion outlined in the paper.

1. Making the right choices about the type of city we create with our infrastructure decisions depends on the priority given to transit or to cars.

It is clear that there are a number of public-private partnership mechanisms and 'Smart' technologies that have the potential to empower Asian governments to create more smart, sustainable and resilient cities. However, the partnership mechanisms are influenced by the transport infrastructure that is prioritised by a city – and the type of transit it facilitates. Similarly, Smart technologies are not an 'add on' that will make any city smart and sustainable regardless of its transport choices.

The key differentiator that underpins the success of both of these opportunities are the strategic, policy and infrastructure decisions that are made by city governments that determine what type of city is created for its people. The two opposing futures are:

- **Automobile dependent cities** that prioritise car ridership, focus on building more lanes for cars which cause congestion, facilitate urban sprawl rather than density, and result in a number of negative environmental and social impacts.
- **Transit cities** that prioritise transit such as high speed rail, trams and buses, and aim to get people out of cars and move people much more efficiently using active and transit modes. Such cities can facilitate greater density, mixed use areas around transit and create economic value.

2. Adding 'Smart' technology to either of these cities will amplify their characteristics.

'Smart' car cities will have more cars on the road than car cities. 'Smart' transit cities will have more people on transit than transit cities. A comparison of these two cities is provided in Table 5.1 below. Both cities have the same level of smart technology applied to them but the outcomes are very different depending on whether it is marking the city a Smart Transit City or a Smart Car City.

Table 5.1: Performance attributes of Smart-Car Cities and Smart-Transit Cities

<i>Attributes of City Transport Network</i>	<i>Smart-Car City</i>	<i>Smart-Transit City</i>
Spatial efficiency for moving people	Low	High
Ability to cope with increasing urban density	Low	High
Ability to cope with increasing congestion	Low	High
Ability to cope with interruptions to the network	Medium	Medium
Ability to create people focused walkable spaces	Low	High
Energy efficiency per passenger	Low	High
Level of dependence on oil	Low	High
Level of Safety	Low	High
Level of Liveability	Low	High
Level of Climate Transformative Development	Low	High

Level of Resilience to climate change impacts	Medium	High
Level of achievement of SDG's	Low	High
Level of 'Smart Technology' applied	Medium	Medium

3. Create new transport capacity in-line with a trajectory towards transit-based cities of the future using an integrated approach.

This will need a strategic transport plan to:

- Prioritise mass transit (both heavy rail and on-road trams and buses) as outlined in Section 2, rather than focusing on expanding highways to prioritise more car use and congestion.
- Prioritise last mile mobility solutions around stations that can act as feeders into key transit nodes, rather than having no broader system coordination with long-distance transit lines. These can be a variety of traditional auto rickshaws or bikes and modern shared taxis like Uber and Lyft.
- Create opportunities for active travel for local and medium-term trips, through urban design for walkability and cycling infrastructure. Integrate these with transit.

4. Create new integrated land use and policy that align to sustainability and attractive private investment.

This will require a Strategic Land Use Plan that will:

- Steer new urban growth over coming decades to within existing metropolitan boundaries ('infill'), particularly within close proximity to mass transit stations. Allow for greater densities in these key areas.
- Encourage mixed use development (where commercial, retail, and residential land uses are co-located) to occur rather than single-use development, so that people can reach nearby useful locations without a car.
- Encourage all station precincts and surrounding catchment areas to incorporate walkable and cycling-friendly urban design as to remove the need for private vehicles in these areas.
- Reduce requirements for car parking in dense urban areas, allowing more commercial, retail and residential land use and more open space.

5. Determine the key transport infrastructure investment gaps in Asian cities and prioritize them.

This paper argues that transit cities are the only type of city that can effectively address the challenges of rapidly growing cities in Asia. The primary infrastructure finance gaps that exist for this type of urban future are:

- **Separated heavy rail infrastructure:** This includes potential subways and above ground rail lines where efficient metro systems can move large amounts of people. Such systems are expensive and are increasing in demand all over the world, with significant shortages in government funds to supply them.

- **On-road transit corridors:** These services include trams, trackless trams, bus rapid transit systems and the associated infrastructure. Transit cities need such corridor transit to support a primary heavy rail transit backbone, and should be complemented by attractive urban design and station precincts.

These two areas of critical funding shortages for Asian cities have been the focus of public private partnerships throughout this paper. The following sub-section provides key recommendations for attracting private finance to this area.

6. Funding can be created through leveraging the value created by transit through Public Private Partnerships (PPPs)

Transit creates many economic benefits for a city. Governments can work with the private sector to close the transit infrastructure finance gap in their cities, leveraging the economic value that is created that offers commercial gain for private participants. The most integrated (most input provided from land use considerations) and collaborative (private sector involved from earliest in the process) this process can be, the better the outcomes.

7. The fundamental step in making a viable PPP to fund transit infrastructure is to create a Transit Activated Corridor.

The main steps to making a Transit Activated Corridor will follow the Entrepreneur Rail Model:

a. Identify land use uplift potential of a corridor:

- Rather than focus solely on transport, instead begin the corridor planning process by considering land use opportunities within the corridor (which are also the key to meeting sustainable urban/population growth objectives).
- Identify potential corridor that contains the necessary land parcels for development opportunities that can be enhanced by transit service provision.
- This stage requires collaboration between Government agencies, private land developers/real estate parties, and the community.

b. Investigate financing options for new Transit Activated Corridor:

- Estimate land value uplift potential by comparing current values and projected future values that could be achieved if transit provided.
- Explore financing options from private sources willing to invest in long-term projects.
- This stage requires collaboration between Government agencies (mostly land and economics), private land developers/real estate parties, and private finance sources (banks, investment funds, etc.).

c. Design transit configuration that can 'Activate' the corridor (unlock the economic value):

- Undertake transit planning process that provides optimum mass transit infrastructure to serve the key land parcels identified in the opportunity and finance phases.
- Ensure that new transit line integrates with existing transport system.

- This process incorporates Government transit planning agencies and land/economics input.

d. Align governance mechanisms to project objectives

- Ensure that government policies allow for new technologies and partnership models to be implemented. Also consider new government entity within land development/urban growth that could be responsible for linking land development to transit projects.
- Ensure that station precincts and wider urban impacts are managed and appropriate community outcomes are achieved.
- Like the City Deals approach used in Australia, governments can provide financial risk mitigation for private investors in projects.

8. Governance to enable this Transit Activated Corridor-PPP approach will establish partnerships early and extensively.

The main ways to do this consist of establishing partnerships that:

- Engage private sector and land developers as early in the process as possible. Rather than government doing all of the planning and then bringing a project to the private sector and asking for funds, land developers should be engaged from the beginning to identify opportunities that work for them. This also encourages them to bear more of the risk.
- Align government, community and private sector incentives. Some of the value capture mechanisms rely on the costs of publicly funded transit being regained from land taxes after the infrastructure has been built. However, this does not result in as strong an incentive for development around stations as there is no upfront contribution and land taxes have now increased in these areas.
- Engage communities throughout the process. This reduces risk by ensuring that community expectations for services, opportunity and amenity are embedded in the project and thus greater demand for such precincts and services will be generated post-project. This is akin to 'incorporating customer feedback'.
- Allow some flexibility in the planning process. Conventional approaches rely on government to come up with the answers and want to control the outcomes. Allow for private bids to arise for new transit projects, and incorporate community and private ideation along the way. This is key in attracting private funding and creating integrated outcomes.

The Way Forward

[The Way Forward to be finalised following the UNCRD EST Forum in Hanoi during October 2019, based on discussions that occur during the Forum]

Member countries of the Environmentally Sustainable Transport Forum in Asia and their cities have the opportunity to adopt the recommendations provided in this report to move towards a more safe, smart, sustainable and resilient future.

Partnerships are at the core of the Sustainable Development Goals (being Goal number 17 specifically) and are a key tenet of the 2030 Agenda for Sustainable Development. Not only must countries work together by participating in Forums such as the EST Forum, to share knowledge and best practices, but they must also work within their own boundaries with stakeholders including the private sector and the community.

Planning for Transit Activated Corridors in partnership with the private sector allows for co-benefits to be achieved, where transit, land use and finance are inherently linked and all participants are incentivised to achieve sustainable outcomes.

The approach to achieving these results are outlined in the report. The next wave of transit provision must be in partnership with the private sector if the required level of transit is to be funded and financed. The 2020-2030 period is key to achieving this. Therefore, the successor of the Bangkok 2020 Declaration (2010-2020) which will provide guidance to 2030, should focus on partnerships for meeting infrastructure needs.

Cities can seek to provide opportunities for private sector participants to invest in new transit infrastructure projects. This requires innovative thinking from city planners and decision makers. It is also important that social and community benefits are paramount.

Together, Governments, private sector and communities can partner to shape the next decade of urban growth. This pivot from automobile dependency is only possible through these partnerships, and if achieved will set Asian cities on a course that is 'truly smart'; fostering sustainable growth, increased economic competitiveness and urban resilience.

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