Sustainable Centres of Tomorrow: A Precinct Design Framework of Principles and Practices

A Literature Review

Authors: Savindi Caldera, Griffith University
Cheryl Desha, Griffith University
Sacha Reid, Griffith University
Peter Newman, Curtin University
Michael Mouritz, Curtin University

Research Project Number and Name: **1.62 Sustainable Centres of Tomorrow: People and Place**

Date: **19/09/19**

Citation: Caldera, S., Desha, C., Reid, S., Newman, P. and Mouritz, M. (2019) Sustainable centres of tomorrow: A Precinct Design Framework of Principles and Practices - Report for *Project 1.62 Sustainable centres of Tomorrow: People and Place,* Sustainable Built Environment National Research Centre.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The future of urbanism in Australia and around the globe to adapt and respond to the challenges of climate change, economic development and social inclusion, will depend on how well we create urban centres, not just suburbs. Creating Sustainable Centres of Tomorrow needs a new and transformative approach. The Sustainable Built Environment National Research Centre (SBEnrc) has been conducting research on how cities regenerate and create new centres by integrating new forms of transit along streets (using Trackless Trams) with urban regeneration around stations. Previous research has concluded that this could only be done by integrating a new approach to funding and financing with partnerships between land developers, the local community, state agencies and federal government goals for Australian cities. These findings align with the successes observed in initiatives such as the *City Deal* model that are now being adopted across Australia.

Building on previous SBEnrc studies, this paper presents a framework of core principles and practices that can be used to help create the best outcomes from the regenerating centres around transport nodes. This includes seven ***core principles*** and twenty-one associated ***core practices*** to ensure urban design and infrastructure development priorities are addressed:

Precinct Design Framework for Sustainable Centres of Tomorrow: Core Principles and Practices

Core Principles	Core Practices
1. Precinct safety and accessibility The development should be safe and healthy for people waiting to access transport nodes	▪ Human centred design ▪ Walkable urban design ▪ Place and movement design
2. Carbon neutral - positive approach The development should aim for carbon positive, being at least zero carbon, in both power and transport	▪ Solar passive design ▪ Solar active design ▪ Carbon neutral analysis
3. Local shared mobility The development should encourage diverse local modal services to access the transit service, with defined spaces	▪ Local mobility design ▪ Feeder transport design ▪ Mobility as a service
4. Property diversity The density and urban mix should contribute to urban regeneration	▪ Community engaged planning ▪ Agglomeration economy analysis ▪ Financial modelling
5. Property affordability The development should include diverse property options to provide affordable living as well as affordable housing	▪ Social housing analysis ▪ Life cycle assessment ▪ Sustainability operational analysis
6. Nature-loving and biodiverse spaces The development should include and connect biophilic and biodiverse greenspaces, supporting endemic species and habitat	▪ Biophilic design ▪ Water sensitive design ▪ Landscape oriented design
7. Inclusive, integrated place-based planning Planning, design and implementation (operation, maintenance) should involve diverse stakeholders and all tiers of government to provide an integrated place-based approach.	▪ Joined up governance analysis ▪ Partnership analysis ▪ Procurement option analysis

The paper uses the *Theory of Urban Fabrics* to explain why an integrated approach is essential to addressing the seven principles across the variety of urban fabric present with cities. This includes specifying *Corridors*, *Nodes* and *Places* to ensure:

- Quality transit corridors that reduce car dependence.
- Nodes at stations that emerge from redevelopment opportunities.
- Place-based design that uses amenity opportunities to create value along the whole corridor.

As well as the need to apply these core principles and practices, it is clear that there is need for renewed leadership and new governance models to guide these interactive processes. It is already evident through the case study process for this project that new forms of 'collaborative' arrangements, some formal and some less so, are emerging to drive better urban outcomes.

Given the national appetite (evidenced through SBEnrc consultation) for Trackless Trams, the paper focuses on this technology as a key lever to unlock urban development potential, as a city-shaping technology. Moving beyond traditional design or redesign, Trackless Trams can be inserted into centres as a fast corridor service as well as enabling walkable, dense centres at stations. The paper discusses road design that enables a 70km/h corridor and a 30 km/h centre, where:

1. the 70 km/h transit way ensures Trackless Trams can be faster than traditional buses, bus-rail transit (BRT) or light rail transit (LRT) and can compete with cars, and
2. the 30 km/h node or centre enables the centre to be sufficiently 'urban' in character and enables the core principles and practices listed in the above table.

The opportunity is made particularly attractive through connecting with innovations such as solar, smart systems and autonomous transport technologies. Through linking electric local and shared mobility to electric trackless trams, the solution embeds a reduction in energy demand, and reduced parking requirements, improving affordability of construction and operation. It enables the creation of land development value for investors and communities, and assists in financing the development itself.

How to provide the governance to deliver *Sustainable Centres of Tomorrow*, with centres of varying characters joined together along new transit corridors, remains a major challenge for local governments and state agencies and the communities which will benefit from the transition to a more urban lifestyle. Designers, planners and engineers need to work in far more 'co-creative' processes with politicians, developers, financiers and community leaders to help move in this direction.

The paper draws on the example of Trackless Tram technology as a potential city shaping opportunity to outline the ***Framework of Principles and Practices*** presented in the above table. It is intended that in the current SBEnrc project 1.62 *Sustainable Centres of Tomorrow,* this framework will be applied to four different urban fabrics, through case studies in Australia. The paper sets out how all seven principles can be applied and will use a case study process to test and refine their usefulness as part of a strong commitment to inclusive, integrated place-based planning processes. As the framework is tested, it will become clearer as to the range of new forms of leadership, governance and co-creations that are being tested by local communities.

The authors look forward to seeing how the framework informs, and adds value to, the consideration of future new urban regeneration development projects, towards urban environments where people can thrive in ways that are good for people and planet.

1. INTRODUCTION

The global agenda for cities has been set by the United Nations (UN) through the Sustainable Development Goals (United Nations, 2016) which include SDG 11 *'to make inclusive, safe resilient and sustainable cities'*. These broad goals are complemented by specific targets being set by nations to achieve the Paris Agreement on Climate Change and even more stringent needs as et out by the IPCC (IPCC, 2018). These matters highlight the need to shift mindsets with regard to urban development and renewal, showing the need for evaluating the performance of our built environments in the face of 21st Century challenges. For more than ten years researchers have been highlighting gaps in current practices and directing attention towards fostering more resilient and vibrant places for people and planet (see for example (Evans & Jones, 2008; United Nations, 2017). There is also coalescence of new technologies emerging in the transport space (i.e. information technology, electric vehicles, on-demand transport) that may be able to enable these global and local goals to be achieved in our cities (Glazebrook & Newman, 2018).

Project 1-62 of the Sustainable Built Environment National Research Centre (SBEnrc) provides an opportunity to reflect on global best practices in prioritising thriving, productive, sustainable, liveable centres, towards unlocking such potential in our Australian cities. It also is based on how technological innovation in local shared mobility technologies such as the Trackless Tram can help with these goals. This paper provides commentary to inform the project's investigations, summarising previous research and documenting emergent strategies that can deliver better connected and integrated *Sustainable Centres of Tomorrow*.

We begin by using the *Theory of Urban Fabrics* to enable a better understanding of key land development mechanisms and integrated transport technologies and what this means for creating urban revitalisation and regeneration. We then discuss approaches for enabling *Sustainable Centres of Tomorrow*, through creating Corridors, Nodes and Places. From this, and an assessment of literature, a ***Sustainable Centres Framework of Principles and Practices*** (the Framework) comprising seven principles and practices is developed, which will inform the subsequent case study investigations in Project 1.62, towards enabling public and private investment decisions for people and place friendly urban centres. The Framework is conceptually applied to four urban fabrics, showing how solutions can differ in emphasis but still have important shared approaches.

1.1 Context for Centres of Tomorrow - Urban fabric theory

Urban fabrics are *"products of transport-related lifestyles and functions that have needed certain physical elements and environments to enable them"* (Newman, Kosonen, & Kenworthy, 2016: Page 431). Each fabric consists of a particular set of spatial relationships, typology of buildings and specific land use patterns that are based on their transport infrastructure priorities (Newman, Kosonen, & Kenworthy, 2016; Thomson & Newman, 2018). Figure 1 presents the original typologies and the overlapping nature of these three fabrics are demonstrated in Figure 2.

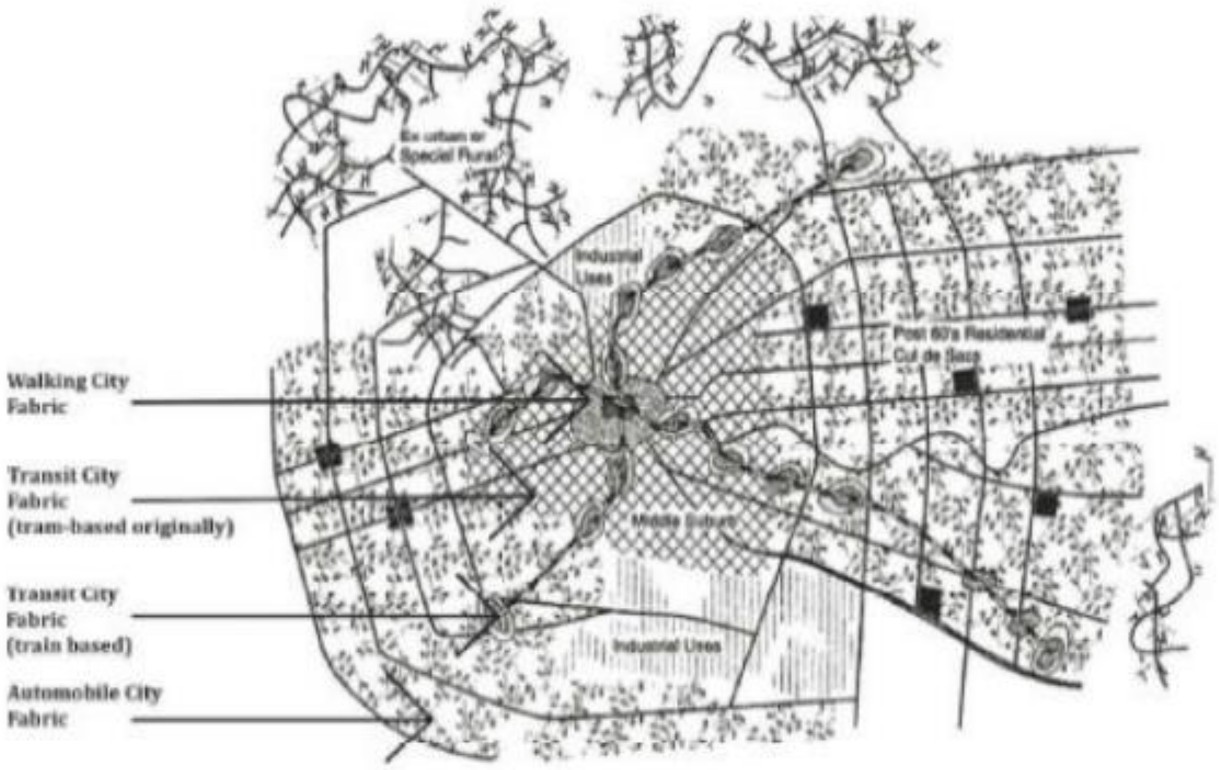

Figure 1: The urban fabric typologies
Source: (Kosonen, 2014)

Figure 2: Walking, transit and automobile city a combination of three overlapping systems
Source: (Kosonen, 2014)

The urban fabrics of any city can be visualised through maps based on historical development patterns. The fabrics can be defined and understood by the qualities of historical transport systems in the fabrics that have created the daily travel time budgets of the inhabitants as outlined below and the resulting properties of the three fabrics are presented below in Tables 1 and 2.

1.1.1 The walking urban fabric and walking cities

Walking cities have a long history as it was the only form of transport available in the majority of historical settlements to enable people to move from one place to another. This is at a walking speed of around 3-4 km/h. Walking cities were dense (usually over 100 people per hectare), with mixed-use areas with narrow streets. They were no more than 3-4 kilometres across, and roughly 2km in radius. Cities such as Kraców, Barcelona, Ho Chi Minh City, Mumbai, and Hong Kong, for example, hold the character of a walking city. In economically developed cities such as New York, London, Vancouver, and Sydney, the central areas are dominated by walking urban fabric, though they struggle to sustain this fabric due to the competing transit city and automobile city fabrics, which now overlap with it (Newman et al., 2016; Thomson & Newman, 2018).

1.1.2 The transit urban fabric and transit cities

Most global cities attempt to retrieve the intense urban activity and fine-grained street patterns associated with walkability in their city centres but have realised that they have to adhere to the urban fabric of the walking city areas. These patterns still exist today and are generally being reclaimed, often through pedestrianisation and traffic calming (Gehl, 2013). The building of new walking urban fabric in other parts of polycentric cities is now also firmly on the planning agenda due to its economic attractions (Florida, 2010; J. Kenworthy & Newman, 2015; Newman & Kenworthy, 2011).

The transit urban fabric since 1850 was originally based on trains and then trams. The steam train began to link cities in early 1890s which were followed by the later transit cities of trams (from the 1890s) that extended the urban fabric of the old walking cities (Hall & Tewdwr-Jones, 2010). Both trams and trains could travel faster than walking; trams with average speeds of around 10-20 km/h and trains at around 20 – 40 km/h. This created opportunities for cities to spread out in two ways with trams forming the urban fabric of the inner transit city 10-20 kilometres across, based very often on a regular grid street structure. The transit urban fabric that formed around such modes can be distinguished based on either trams that created linear development, or trains that created dense nodal centres with mixed land uses along corridors (Newman et al., 2016; Thomson & Newman, 2018).

1.1.3 The auto urban fabric and automobile cities

With the emergence of roads and parking for automobiles, trams of the transit urban fabric were often replaced by buses. Buses were used as a supplementary service to the car, which led to higher loss of the transit urban fabric though the basic building structure and layout remained. As urban development was no longer attached to fixed-track systems, it could be extended to wherever roads could be built. Therefore, the opportunity to continue creating transit city corridors was substituted by large continuous suburbs first in cities of America, Australia and Canada and then in other cities. Buses became merely supplementary to cars in the new automobile-based urban fabric. Automobile Cities from the 1950s onward could spread beyond the 20 km radius to some 80 km diameter (up to 40 km radius) in all directions, and at low density because automobiles could average 50-80 km/h while traffic levels

remained low. Cities which became automobile cities thus provided limited public transit to support their urban sprawling, mostly through infrequent and slow regular bus services without bus lanes. Ultimately such areas became the basis of automobile dependence (Newman & Kenworthy, 1989) and automobility (Urry, 2004).

1.1.4 Combinations and overlaps of three urban fabrics

Figure 3 shows the common overlap of the three urban fabrics (i.e.: walking, transit and automobile). The transit urban fabric overlaps and covers parts of the area of the walking urban fabric. It brings residents of the transit fabric to the services and other functions of the centre and the walking urban fabric but can have negative impacts on its inherent capacity to assist pedestrians and cyclists.

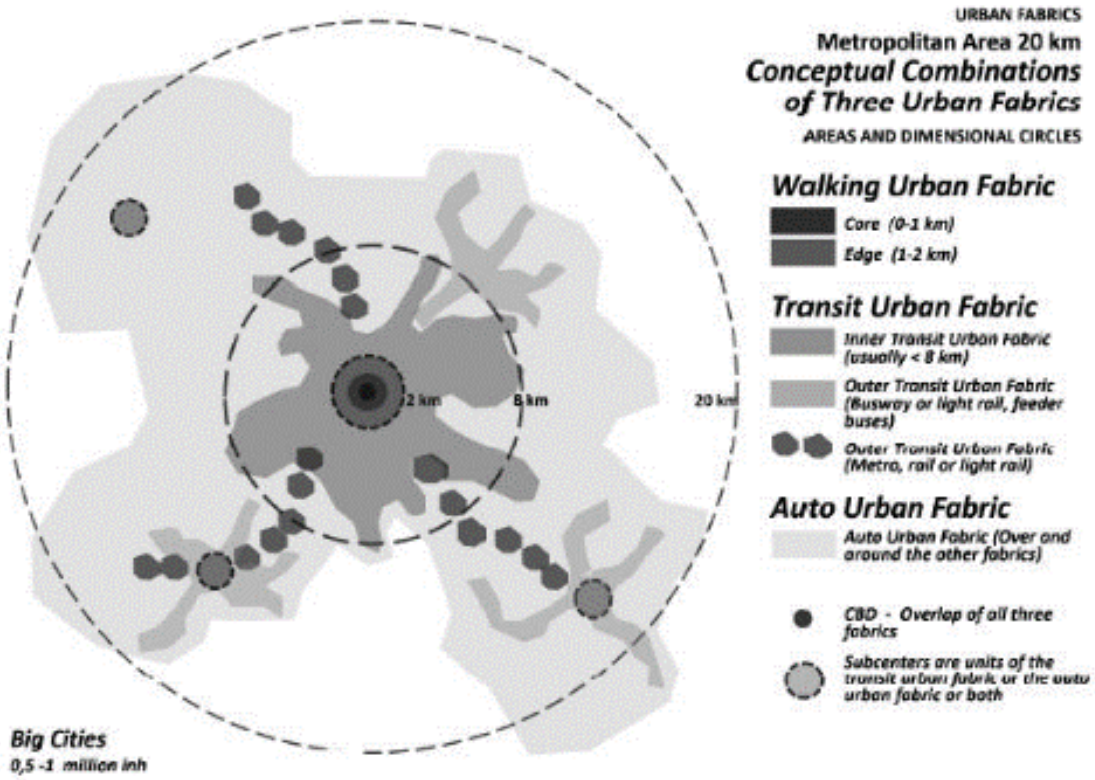

Figure 3: Conceptual combination of three fabrics (Kosonen, 2014)

The automobile urban fabric, which overlaps and covers all the walking urban fabric and all the transit urban fabric, in many cases can obliterate them (e.g. in American cities such as Detroit). In numerous situations it has disrupted underlying transit and walking urban fabrics due to its dominating nature. However, there have been cases where it has demonstrated symbiotic relationships with the transit and walking urban fabrics, e.g. visitors from the automobile urban fabric often come by car to these other fabrics and if parking and other automobile city elements are not unduly disturbing the transit and walking qualities of these areas, then the extra people add to the value of the walking or transit urban fabric and functions. The central business district (CBD) of all cities has usually become a combination of walking, transit and automobile urban fabric elements as it tries to attract all kinds of economic and social activity

to its focus. Despite these overlaps the fundamental forms of the three urban fabrics are usually very evident in any city. Table 1 set out how urban fabrics can be recognised in relation to nine 'elements'.

Table 1: Urban Fabric elements within a city (walking/ transit/ automotive) (Source: Newman et al., (2016))

Urban Fabric Element	Walking City	Transit City	Automotive City
1. Street Widths	Narrow	Wide enough for transit	Wide enough for cars/trucks
2. **Squares and Public spaces**	Frequent as very little private open space	Less frequent as more private open space	Infrequent as much greater private open space
3. Street furniture	High level for pedestrian activity	High level for transit activity (bus stops, shelters)	High level for car activity (signs, traffic lights)
4. Street networks	Permeable for easy access; enables good level of service for pedestrians	Permeable for pedestrians, networks to reach transit stops, corridors enable good levels of transit service	Permeability less important, enables high levels of service for cars on freeways, arterials and local roads. Bus circulation often restricted by cul-de-sac road structure.
5. Block scale	Short blocks	Medium blocks	Large blocks
6. Building Typologies	High density minimum 100/ha usually	Medium density minimum 35/ha usually	Low density <35/ha, often much less than 20/ha.
7. Building set backs	Zero set backs	Setbacks minimal, for transit noise protection and more space	Setbacks large for car noise protectionand extra space
8. Building Parking	Minimal for cars, seats for pedestrians, bike racks	Minimal for cars, seats for pedestrians, often good bicycle parking	Full parking in each building type
9. Level of service for transport mode	Pedestrian services allow large flows of pedestrians	Transit services allow large flows of transit users	Car capacity allows large flows of cars

Table 2 highlights how they can be regenerated and how old walking and transit fabrics can be built into new areas now that some fundamental problems are being found with building a city-region just with automobile urban fabric (Newman et al., 2016).

Table 2: Fabric qualities across the urban fabric elements (Source: Newman et al., (2016))

Urban Fabric Element	Walking City	Transit City	Automotive City
1. Urban form qualities			
▪ Density	High	Medium	Low
▪ Mix	High	Medium	Low
2. Transport qualities			
▪ Car ownership	Low	Medium	High
▪ Level of service	High l.o.s for pedestrians	High l.o.s. for transit users	High l.o.s. for car users
▪ Transport activity	High ped activity	High transit activity	High car activity
3. Economic qualities			
▪ Infrastructure costs per capita	Low - Medium	Medium - Low	High
▪ Gross domestic product per capita	High	Medium	Low
▪ Labour intensity	High	Medium	Low
4. Social qualities			
▪ Difference between rich and poor	Low	Medium	High
▪ Ability to help car-less	High	Medium	Low
▪ Health due to walking	High	Medium	Low
▪ Social capital	High	Medium	Low
▪ Personal security	Variable	Variable	Variable
▪ Traffic fatalities	Low	Low	Medium to High
5. Environmental qualities			
▪ Greenhouse gases and oil per capita	Low	Medium	High
▪ Waste per capita (buildings, households)	Low	Medium	High
▪ Footprint per capita	Low	Medium	High

1.2 Corridors, nodes and places

Having recognised the value of walking urban fabric and transit urban fabric, many cities are now attempting to regenerate old walking and transit fabric and many are also seeking to build new transit urban fabric into traditional automobile urban fabric as it is not working anymore (Newman and Kenworthy, 2016). For this research project, the core ideas of urban fabric theory are translated into the next phase of urban development through considering how a Trackless Tram technology can enable transit urban fabric towards local urban regeneration through an emphasis on *corridors, nodes and places*, as discussed in the following paragraphs. See Attachment 1 for a short history of Trackless Tram technology.

1.2.1 Corridors

Corridors provide the large-scale overview, showing where transit technologies are best located to provide good transport solutions and where good urban regeneration potential exists. A high level assessment has been done of the new technology of a Trackless Tram (Newman et al., 2019), which concluded it is best used as a corridor connector. The current SBEnrc project 1.62 is examining five

different corridors in Townsville (CBD to University/Health Campus), Inner West in Sydney (Parramatta Road), Liverpool in Sydney (CBD to new airport), Wyndham in Melbourne (several options connecting Point Cook to Tarneit Station), and Canning to Stirling in Perth (connecting the city from two sides not yet with a rail line). Most of these have a walking city centre urban fabric at one end of the corridor. All apart from two have inner city fabric based on old tram routes, all have middle suburb areas that are or could be redeveloped for urban regeneration, and most have new automobile urban fabric at the end of the corridors.

The SBEnrc workshops within the case studies (and other studies) by the local governments and state agencies, are examining the corridors from a range of perspectives to help generate information on the feasibility and acceptability of the routes. The corridors for Townsville, Inner West, Liverpool and Perth are already decided based on previous work by consultants and the councils involved. Wyndham Council has created a Route Assessment Framework to assess five different potential routes and given a points system to help clarify the benefits of each one. This led to one route being potentially better. The results of this analysis were presented at the Wyndham workshop as was the basis of the result for Perth, Liverpool, Inner West and Townsville in their workshops and previous work.

The key question being asked by the research is what are the city shaping opportunities and challenges provided by the introduction of Trackless Tram technology, within the existing or new urban context. In particular, how does this type of transit system shape or productively influence the existing urban fabric – (in walking, transit, automobile dominated parts of the city) (Newman et al., 2019; Newman, Mouritz, et al., 2018). This will need a combination of traffic engineering and urban design skills and tools to inform any workshop process designed to assess options and thus the Framework outlined below has been developed to assist with this process. Once a broad consensus of the route options is obtained then the next step is to see what can make these routes work due to the nodes that can be developed along them and how they can be designed to create amenity and value.

1.2.2 Nodes

Nodes are where the most obvious urban regeneration exists and hence should likely be where a station is placed. As a corridor transit solution the workshops are showing where the main function of the corridor will be to enable the Trackless Tram to proceed as fast as possible along a right-of-way, and where it will be integrated into a nodal area where the primary function is to enable urban regeneration (or in greenfield locations how better transit activated development can be shaped). Nodes are where density can be focussed. There are significantly different road and alignment design implications in the node areas as distinct from the fast corridor function associated with different land development opportunities. New road specifications are being developed in each Australian state to reflect the need for these different planning functions and different desired outcomes. In Perth, Green Routes are being planned which are primary roads that become high transit priority associated with density development. In Melbourne, Place and Movement Guidelines are being developed for similar corridors and in Sydney a similar process is well underway. Presentations on these guidelines are being given at workshops.

The 2018 research concluded that the significance of planning nodes into the design of a transit system (from the start) is that this provides a new approach to funding and financing transit with partnerships between land developers, the local community, state agencies and Federal government. This seemed to fit the City Deal model goals for Australian cities now adopted across Australia so we are continuing to

pursue how this model can drive the transit planning process. Part of this exercise will therefore be to examine the best value capture opportunities for each node.

The ability to attract high quality development and funding/financing capacity, all depends on what quality of urban regeneration is created in the centres that are facilitated around each Trackless Tram station, i.e. what kind of places we create. These places then enable the amenity to be provided that increases the land value along the whole corridor and enables an integrated transit urban fabric to be created.

1.2.3 Places

Places are where detailed design will optimise the integration of the trackless tram system to achieve a range of accessibility and sustainability outcomes. A Places Framework of core principles and practices has been researched from literature and from professional practice to help create the best outcomes from the regenerating centres around Trackless Trams. Place concepts need to be integrated into each precinct that is developed along new transit corridor and its nodal centres.

In the following section we outline the *Precinct Design Framework for Sustainable Centres of Tomorrow based on Core Principles and Practices*, working through the emergent seven principles and associated 21 practices designed to deal with a range of urban design and infrastructure development issues.

2. EMERGENT PRINCIPLES FOR A PRECINCT DESIGN FRAMEWORK

The following sub-sections distil seven emergent principles for successfully dealing with a range of urban design and infrastructure development issues in centres as places for thriving. These comprise:

1. **Precinct safety and accessibility:** The development should be safe and healthy for people waiting to access transport nodes
2. **Carbon neutral–positive approach:** The development should aim for carbon positive, being at least zero carbon, in both power and transport
3. **Local shared mobility:** The development should encourage diverse local modal services to access the transit service, with defined spaces
4. **Property diversity:** The density and urban mix should contribute to urban regeneration
5. **Property affordability:** The development should include diverse property options to provide affordable living as well as affordable housing
6. **Nature-oriented space:** The development should include and connect biophilic and biodiverse greenspaces, supporting endemic species and habitat
7. **Inclusive, integrated place-based planning:** Planning, design and implementation (operation, maintenance) should involve diverse stakeholders and all tiers of government to provide an integrated place-based approach to planning and design.

Principle 1: Precinct safety and accessibility

The development should be safe and healthy for people waiting to access transport nodes

Walkable urban design needs to provide safe, healthy and attractive spaces linking the transport nodes and right through the development (Gehl, 2013). Walkability has become the basis of the knowledge economy with its need for professional people to have face-to-face contact (Matan & Newman, 2016;

Matan, Newman, & Practice, 2012; Newman et al., 2016). It is critical to assess therefore how the transport nodes could be optimised, along with the demand for management practice to improve the functionality of centres for human interaction and knowledge economy, adopting the principles of Human Centred Design (Maguire, 2001). While creating this healthy, attractive, human-centred spaces, a place-making approach (Glazebrook & Newman, 2018) has emerged as a targeted method to examine the core elements of these processes, in particular the role of community-led processes and the role of the creative sector (Suleman, 2013).

This walkability aspiration will not be possible unless the centre is part of a high-quality transit corridor which provides access across the city. This access is needed for people living in the centre catchment and also for those who live elsewhere and want to use the centre for work and services (Newman et al., 2016). The importance of corridor access by transit as well as walkable access within a centre is a fundamental question for this research project. Rail stations in the past have been where walkable centres have emerged as they have been traditional places where walkability was possible. Similarly tram lines in the past had walkable areas around tram stops. However, the world of car-based planning has meant that tram lines have been either removed or filled with competing cars and increasingly heavy rail stations are being built with parking close to stations and hence walkability is lost. This project is now considering the potential for a Trackless Tram route down a street to reclaim walkability around stations as well as reclaiming speed along a corridor.

The resolution developed so far – through the SBEnrc project work with traffic engineers and urban designers – is to enable a transit urban fabric to develop where there is both corridor speed and nodal walkability. The two together can create a place of accessibility which is not car dependent. This requires corridor speeds of around 70 km/h with transit-way space that can enable such speeds, in addition to nodal speeds of around 30 km/h where traffic and space for cars is at a minimum and nodal walkability is maximised. This is not unlike how cities now function where they have quality transit along streets – with fast and slow sections – but it is not what is currently in traffic manuals, even those attempting to resolve issues of ‘place and movement’ (Newman et al., 2016).

Principle 2: Carbon neutral–positive approach

The development should aim for carbon positive, being at least zero carbon, in both power and transport

To adopt a carbon neutral or carbon positive approach to achieve close to zero carbon as possible in both power and transport it is important to evaluate how innovations can be utilised as a part of centres (Chen, Wiedmann, Wang, & Hadjikakou, 2016; Kennedy & Sgouridis, 2011). This includes for example on-demand transportation ODT), Information and Communication Technologies (ICT), Autonomous Vehicles (AVs), Electric vehicles (EVs), in addition to smart buildings, building design/building diversity and building types and associated smart cities concepts. To optimise their value, provisioning for flexibility is needed to accommodate these changes. This includes changes in renewable energy mix and solar passive, which are critical to provide sufficient solar power for the buildings, transit technologies and for local shared EVs. Various modelling techniques to optimise urban energy consumption have been developed using energy supply data and post-code information (Brownsword, Fleming, Powell, & Pearsall, 2005).

A three step process is required to integrate carbon neutral approaches for urban development (Newman & Asia, 2010), comprising: 1) reducing energy wherever possible (i.e.: building and transport sector), 2)

using renewable energy, and 3) offsetting greenhouse gas emissions. For example, in Sydney, the State of New South Wales (through its Building and Sustainability Index (BASIX) programme), has mandated that new homes must now be designed to produce 40 per cent fewer greenhouse gas emissions, compared with an existing house. The programme targeted reducing carbon dioxide (CO_2) emissions by 8 million tonnes and water use by 287 billion litres in ten years (Farrelly, 2005). Malmo (Sweden) claims that it has already become a carbon-neutral city and Newcastle in the United Kingdom and Adelaide also aspire to be carbon-neutral taking important steps in the direction of renewable energy. Carbon-neutral strategies are beginning in Singapore this city has demonstrated their interest in international forums that its CO_2 per dollar of gross national product (GNP) is going down steadily.

The implementation of solar energy in Barcelona was possible with a broad range of small actions and renewable energy projects spanning political commitment, capacity building and participation of the people. An innovative solar law, called "Barcelona Ordinance on Application of Solar Thermal Energy Systems into the Buildings" or "Barcelona Solar Ordinance, supported action*".* This requires all new buildings in Barcelona to have solar thermal water systems to cover 60 per cent of sanitary water heating needs. This highlights the criticality of government commitment and community participation for changing the way energy is generated and used.

At the scale of country, Bhutan has formulated a *Low Emission Development Strategy* to reduce the emissions of their transport sector over a 25-year period. As an augmented strategy for sustainable urban design and reduce air pollution, a Green Tax was imposed on imported vehicles where electric vehicles, do not incur a tax and the tax imposed on hybrid vehicles is much less than the tax imposed on diesel and petrol motors (Royal Government of Bhutan ,2012). In addition to working to increase a greater public transport share (up to 30 per cent), Vietnam is increasing energy efficiency and its share of biofuels through significantly reduced taxes for electric and hybrid vehicles (Sehlleier, 2018). These are clear examples of support through governance and policy formulation to promote a positive approach.

Principle 3: Local shared mobility

The development should encourage diverse local modal services to access the transit service, with defined spaces

To ensure that a precinct will not be dominated by parking and by vehicles trying to access the transit service options for local access via walking, biking and local shared mobility shuttle vehicles need to be facilitated (Kenworthy & Laube, 1996). Within this context, new city shaping technologies can be used to promote local connectivity, shared mobility and modal diversity. Integration of transport modes which includes walking and cycling, seeking to minimise the amount of travel and value-creation should be a key focus. Enhanced value-creation can be achieved through connecting the clusters, through well-defined corridors, serviced by a quality high priority transit system and recognising that value-creation varies along the corridor as related to proximity to stations (Newman, Mouritz, et al., 2018; Rawnsley, 2017; Scheurer, 2019; Wamsler, Brink, & Rivera, 2013). The local accessibility within centres aims to decreases the incentive for car ownership and use and encourages walking and cycling. The mixed land use within station precincts along rail corridors also makes the rail corridor and infrastructure itself more economically efficient, by creating destinations around stations that attract transit riders at all times of day and from all directions, rather than just transporting commuters to and from work (Cervero, Ferrell, & Murphy, 2002).

The public perception of shared goods has shifted placing high importance on sharing bikes, cars or rides on on-demand basis (Cohen & Kietzmann, 2014). This shared economy has gained popularity among many cities that are struggling with increased congestion and inner city traffic. Cohen and Kietzmann (2014) proposed a shared mobility business model to demonstrate the optimal relationship between service providers and local government. European cities are classic examples of laboratories for sustainable mobility through walking (Barcelona) (Roca, Aquilué, & Gomes, 2015), cycling (Amsterdam, Groningen, Copenhagen, Odense, Berlin, and Muenster) (Pucher & Buehler, 2008) and shared mobility services (Berlin and Paris) (Hildermeier & Villareal, 2014). Within the shared mobility services examples, the use of clean energy technologies received special attention. For example, two public electric car services in Berlin (BeMobility) and Paris (Autolib') demonstrated how each initiative enables shaping the future vision of sustainable mobility and transform regional transport systems in specific ways through their performative impact as local transport policy tools. BeMobility integrates electric cars as one element in Berlin's intermodal transport system, and focuses on 'intermodality' as the central vision of sustainable transport (Hildermeier & Villareal, 2014).

Principle 4: Property diversity

The density and urban mix should contribute to urban regeneration

Density and urban mix should be part of a local community engagement process to enable urban regeneration while fulfilling local needs and aspirations. For developers to evaluate how affordable higher density housing can be a key part of the 'people and place' transformation, a deep appreciation of creating centres through liveable, community-oriented design will be required. Community engaged planning process, diversity of property densification, evidenced based financial modelling have been identified as key practices to promote urban mix to enable developers to create viable and integrated corridors (Ball, Lizieri, & MacGregor, 2012; Brownsword et al., 2005; Robinson et al., 2003). It is also key to understanding the value uplift that captures the land value and positive externalities to ensure establishment of context-based solution to creating a centre.

Density in activity centres has a clear link to urban productivity and it is established through 'The Triumph of the City' by Harvard Professor Ed Glaeser (2011) where it has been measured in a number of cities including Melbourne, Australia. This phenomenon of agglomeration economies occurs as a result of clustering of urban activities and jobs that require face-to-face interactions for the creativity and innovation related to urban productivity gains, particularly in the knowledge economy sector. Within this context, agglomeration benefits such as economies that can be gained by the new density and mix of land uses that are facilitated by the project can be achieved. Such elasticities are assessed in many cities such as those developed by Trubka (2012) on Australian cities (Newman, Davies-Slate, & Jones, 2018).

Principle 5: Property Affordability

The development should include diverse property options to provide affordable living as well as affordable housing

There should be a clear goal of providing affordable and social housing along the corridor with particular goals for each station precinct. To achieve those goals, it is critical to assess how affordable higher density housing can be a key part of the 'people and place' transformation of centres through liveable,

community-oriented design. Inclusion of diverse housing products, inclusion of social housing and diversity of property product are therefore critical aspects to promote property affordability. Within this milieu, it is imperative to strike the right balance between appropriate quality, sustainability and safety standards and responsiveness to housing supply and affordability.

For example, the Chinese government at the national level has responded by developing new policies to support affordable and social housing; and at local level various new housing provision schemes have been tested, but their scale and impact have been limited because of the priority given by the local state to economic growth and securing local land related revenues (Wang & Murie, 2011).

The Australian Housing and Urban Research Institute provides a report evaluating the diminishing supply of affordable housing options for lower income (LI) workers near job-rich central city (CC) locations is having an impact on CC businesses and on the overall productivity of CC economies. There is evidence of increasing recognition by major-city governments, both in Australia and overseas, of high housing costs. High housing costs is recognised as a social welfare and equity problem in a policy context. However, there are emerging conversations in a number of strategic planning policies that specifically address the direct impacts of housing costs on urban economic growth. For example, In both Sydney and Melbourne, housing and economic development strategies note that housing costs can limit access to central city locations, which can in turn thin lower income labour markets, reduce productivity (Van Den Nouwelant et al., 2016).Principle 6: Nature-loving and biodiverse spaces

Principle 6: Nature-loving and biodiverse spaces

The development should include and connect biophilic and biodiverse greenspaces, supporting endemic species and habit

Sustainable design embraces societal, economic and environmental principles, although conventionally landscape designers are brought into project works late, and with minimal scope or budget to effect design solutions that could be considered 'nature-loving' (biophilic) or biodiverse. Participation in the design process especially in landscape architecture and design is critical (El Baghdadi et al, 2018), to ensure solutions are community-oriented and sympathetic to local environmental attributes.

Within this context, biophilic design and water sensitive design principles should be required to be part of all buildings and across the precinct. Creating a nature-oriented space to promote diverse, resilient and healthy ecosystem that contributes to local bio diversity will also have impact on the health and wellbeing of our community. This was elaborated in the Urban Ecology and Biodiversity Strategy in the City of Melbourne (Ives et al., 2013). To create better people friendly and place-based urban spaces that are not affected by excessive traffic nature-oriented spaces have emerged as a targeted practice adopted by many cities over the world. With the emergence of sustainable urban planning, the ideal of the sustainable cities can be characterized by high density, mixed land use and attractive green infrastructure. This has become a desirable urban form at global scale (Tappert, Klöti, & Drilling, 2018).

Urban greening, including urban gardening, has a great contribution in creating nature orientated places while offering benefits such as shade and urban cooling (Desha, Reeve, Newman, & Beatley, 2016; Hargroves, Spajic, Gallina, & Newman, 2018). For example, Singapore demonstrates nature-oriented urban planning efforts weaving nature throughout—which includes plant life, in the form gardens, green

roofs, cascading vertical gardens, and verdant walls. The policies and capacities both requires and enables this form of global cities and centres to be rapidly and constantly reworked while embedding nature-oriented spaces (Olds & Yeung, 2004).

Principle 7: Inclusive, integrated, place-based planning

Planning, design and implementation (operation, maintenance) should involve diverse stakeholders and all tiers of government to provide an integrated place-based approach.

The need for an inclusive and integrative design process that focuses on a place-based outcome is the final principle that needs to guide all planning and design. There are a range of processes that have been used over time but in recent periods, there has been an emphasis on City Deals that integrate the physical planning processes, the human-oriented planning processes and the financial planning processes. The guidelines of a partnership like a City Deal should be established with core functions involving planning strategy, planning controls, partnership development and investment mechanisms. The need for a single state agency to provide the integrative process within the guidelines of a City Deal should be established but with core functions involving design, density/mix, and financing. To examine partnership models for delivering transformation of centres, particularly the provision of private funding based on value creation/ capture approaches are critical for integrated partnerships. The governance process should identify the most appropriate procurement and delivery models, as well as statutory requirements, including a review of what powers local governments do have and recommend what extra powers might be useful. Key practices such as upfront and Integrative whole of agency approaches, regular and iterative consultation and harnessing existing incentive/schemes are key success factors for effective integrated planning processes (Atkinson, 2001; Goldman & Gorham, 2006). By overcoming institutional barriers related to cross-agency collaboration, governments must integrate transport and land use planning to realize integrated developments to enable people to walk or use transit between mixed-use complexes to satisfy daily needs (Hargroves et al., 2018). As outlined in this and other SBE reports (Newman et al. 2018) the role of private investment in enabling integration is also crucial.

To support each of these principles it is important to establish the most appropriate Transit Corridor governance arrangement that harness the best outcomes through urban re-shaping opportunities. A critical starting point is who is presently responsible for the preferred alignment and if there is a need for any shift in the governance of the alignment and the associated urban development opportunities presented by the introduction of trackless tram stations. Therefore, it is critical to identify what structure is best able to deliver such a project. Is it a local government, a series of local governments, a new integrated state agency with capability in both land management and transit with capacity to attract the funding and financing or a facilitated unsolicited bid process? Further details of models are described in Section 3.2.

3. ENABLING *CENTRES OF TOMORROW* – CORE PRACTICES

This section considers how the seven core principles can be enabled through professional practices. Each principle is a necessary component that can support the integration of transit technology – specifically trackless tram technology – within cities and how they can assist the creation of new centres through urban regeneration. The coalescence of advancements of technologies in transport, communications and energy now presents a unique opportunity to achieve city shaping transformational change. Thus, the

combination of practices brings together some new elements not usually considered as a necessary part of the tool kit used by urban designers, planners and transport engineers.

Core practices are listed below in Table 3, along with some key references and links to manuals that help with these practices.

Table 3: Practices informing the Precinct Design Framework for designing and implementing Centres of Tomorrow

Practices informing the principles	Key literature references	References and resources for good practice
1. Precinct safety and accessibility		
• Human centred design	(Gudowsky, Sotoudeh et al., 2017; Russo, Lanzilotti et al., 2018)	Design Kit (IDEO.org)
• Walkable urban design	(Forsyth, 2015; Badland, Mavoa et al., 2017; Litman, 2017)	Pedestrians First (ITDP.org)
• Place and movement design	(Carmona, 2014; Wunderlich, 2017)	Movement and Place Framework (Transport Victoria)
2. Carbon neutral - positive approach		
• Solar passive design	(Horvat and Dubois, 2012; Futcher, Mills et al., 2017)	A focus on Greening our Precincts (Aurecon)
• Solar active design	(Kanters, Wall et al., 2014; Mohajeri, Gudmundsson et al., 2019)	Solar Energy (International Energy Agency)
• Carbon neutral analysis	(Liu, Zhou et al., 2014; Tozer, Klenk et al., 2018)	Carbon Value Analysis Tool (World Resources Institute)
3. Local shared mobility		
• Local mobility design	(Hüging, Glensor et al., 2014; Lyons and Practice., 2018)	Pedestrian Access and Mobility Plan (NSW RTA)
• Feeder transport design	(Cole, Burke et al., 2010; Venter, Jennings et al., 2018)	Principles of Network Planning (Griffith University)
• Mobility as a service	(Hietanen 2014; Jittrapirom, Caiati et al., 2017)	Rise of Mobility as a Service (Deloittes)
4. Property diversity	Internal - In Progress DRAFT	
• Community engaged planning	(Bose, Horrigan et al., 2014; Konsti-Laakso and Rantala, 2018)	Resources (Internat. Assoc. for Public Participation)
• Agglomeration economy analysis	(Duranton and Kerr 2015; Jin; Gong et al., 2018; Thisse, 2019)	Spatiotemporal Analysis Framework (Jin et al 2018)
• Financial modelling	(Evans, Foord et al., 2007; Mulley, Ma et al., 2016)	Toolkit for rapid economic assessment of cities (ADB)
5. Property affordability		
• Social housing analysis	(Kraatz, Mitchell et al., 2015; Flanagan, Martin et al., 2019)	Conceptual Analysis (AHURI)
• Life cycle assessment	(Lee, Ellingwood et al., 2017; Petit-Boix, Llorach-Massana et al., 2017; Trigaux, Wijnants et al., 2017; Mirabella and Allacker, 2018)	Applied to Urban Fabric Planning (Gabbarell et al, 2015)
• Sustainability operational analysis	(Gunasekaran and Irani, 2014; Yigitcanlar and Kamruzzaman, 2015; Nesticò, Sica et al., 2017; Nijkamp and Perrels, 2018)	Sustainable affordable housing (Wiesel et al, 2012)
6. Nature-loving and biodiverse spaces		
• Biophilic design	(Cabanek, Newman et al., 2017; el-Baghdadi, Desha et al., 2017)	Biophilic Design Initiative (Living-Future.org)
• Water sensitive design	(Seminal: Wong, 2006; Furlong, Dobbie et al., 2019)	Scenario Tool (CRC Water Sensitive Cities)
• Landscape oriented design	(Choi and Seo, 2018; Dennis, Barlow et al., 2018)	Foreground Forum (Inst. of Landscape Architects)
7. Inclusive, integrated, place-based planning		
• Joined up governance analysis	(Keast, 2011; van der Jagt, Elands et al., 2017; Rode, 2019)	A Joined Up Policy Guide (South Aust. Government)
• Partnership analysis	(McAllister, Taylor et al., 2015; Farhat, 2018)	Partnerships Analysis Tool (Vic Health)
• Procurement option analysis	(Grimsey and Lewis, 2017; Hueskes, Verhoest et al., 2017)	National Guideline (Australian Government)

3.1 Governance models enabling good practice for integrated public transit

Most cities seek public transport aiming for thriving, productive and sustainable centres. Most cities want to integrate this transit and land-use. However, it is unclear how to integrate transit and land use for many cities in the world and this research project identified that integration occurs best through bringing in private development opportunities at an early stage in any transit project. Table 4 below outlines four different proportions of public-private funding to generate finance needed to build integrated transit systems. There are four models including 1) full Public Sector Capital: The Land-based Levy Model, 2) some Private and Substantial Public Capital: The Tax Increment Finance Model, 3) some Public and Substantial Private Capital: The Special Improvement District Model and 4) full Private Capital: The Entrepreneur Rail Model. The following table outlines the key mechanisms described under each model (Newman et al., 2018).

Table 4: Four models of public-private funding enabling centres of tomorrow

#	Model	Description of the mechanism	Key limitations & strengths	Examples
1.	Full Public Sector Capital: The Land-based Levy Model	▪ This will consist of full public capita investment.	▪ Often insufficient public investment available ▪ Many cities then seek additional private funding	Most cities in: Australia, Latin America, the Middle East, Asia
2.	Some Private and Substantial Public Capital: The Tax Increment Finance Model	▪ This takes the land tax revenue from various levels of government, which increases due to land value uplift	▪ Requires estimation of potential land value increases ▪ Revenue is only collected well after the project is completed	Several rail projects: America, Canada
3.	Some Public and Substantial Private Capital: The Special Improvement District Model	▪ Based on the concept of tapping into private investments in business ▪ Land development opportunities are created in partnership with owners and developers along the corridor	▪ Partnered in a consortium set up by local government along the corridor ▪ Substantial increase of private funding for land development	Hyderabad Metro, Tokyo (Tsukuba Express)
4.	Full Private Capital: The Entrepreneur Rail Model	▪ This is how historically tram and train lines were built as a real estate development ▪ This has been applied in a number of places including a new train and urban regeneration system	▪ Guarantees integration of transit and land use as without this financial success of the rail and land.	Florida, Hong Kong, Japan

3.1.1 Land-based Levy Model

This model is most largely used in cities in Australia, Latin America, the Middle East, Asia, Europe and North America leveraging the full capital investment for public transport. However, with the emergence of transit integrated with TODs private funding has transpired as a targeted opportunity for urban development. Within this context, it is common to try to attract private funding through rail line or other infrastructure however, it could have a risk of causing resistance of the developers (Newman et al., 2018).

3.1.2 Tax Increment Finance Model

This mechanism requires some private and substantial public capital and used in several rail projects: America, Canada. This takes the land tax revenue from various levels of government, which increases due to land value uplift from the new railway. However, its considerable capability in evaluating potential land value increase and the revenue being collected only after the post project completion stage have been highlighted as risks (Newman et al., 2018).

3.1.3 Special Improvement District Model

The Special Improvement District Model involved some public and substantial private capital investments encouraging more land development-based funding and financing than the Land-based Levy Model and Tax Increment Finance Model. This can be seen in some cities of North America, India and Japan to enable new rail line-based land development. Usually there is partnership between owners and local government along the corridor and this unique procurement approach is named as special improvement district or SID. This idea is based on leveraging the private investments in business improvement districts for urban regeneration projects (Newman et al., 2018).

3.1.4 Entrepreneur Rail Model

The Entrepreneur Rail Model is relying on full private capital, which is how historically tram, and train lines were built as a real estate development from 1840s to the 1940s in Western Australia. This model has been implemented in several places including ta new train and urban regeneration system in Florida, Hong Kong and Japan. This model ensures integration of transit and land use, as without this the financial success of the initiative e will not occur (Newman et al., 2018).

3.2 The economic, environmental and social benefits of urban design

The Ministry of Environment in New Zealand have published the "*The Value of Urban Design"* aiming to establish whether there is a persuasive case for urban design – the design of the buildings, places, spaces and networks (both public and private) that make up our towns and cities, and the ways people use them. The Value of Urban Design examined evidence relating to eight core elements of urban design. These elements – and the key economic, social and environmental findings for each – are summarised in Table 5 (Ministry for the Environment, New Zealand, 2005).

Table 5: Four models of public-private funding enabling centres of tomorrow (Adapted from The Ministry for the Environment, New Zealand, 2005)

Elements	Economic value	Social Value	Environmental Value
Local Character	▪ Attracts skilled workers, new economy enterprises ▪ Assists promotion and 'branding' of cities and regions ▪ Contributes a competitive edge by providing a 'point of difference ▪ Potentially adds a premium to the value of housing	▪ Reinforces a sense of identity among the residents of a neighbourhood ▪ Encourages people to become actively involved in managing their neighbourhood ▪ Offers choice among a wide range of distinct places and experiences	▪ Supports conservation of non-renewable resources
Connectivity	▪ Increases viability of local service shops and facilities ▪ Increases a site or area's accessibility, thereby enhancing land value	▪ Enhances natural surveillance and security ▪ Encourages walking and cycling, mainly for non-work trips, leading to health benefits ▪ Shortens walking distances, encouraging people to walk	▪ Vehicle emissions are reduced through fewer non-work trips
Density	▪ Provides land savings ▪ Provides infrastructure and energy savings ▪ Reduces economic cost of time allocated to mobility ▪ Is associated with concentration of knowledge and innovative activity in urban cores	▪ Is difficult to disentangle from the benefits of mixed use and other factors ▪ Can contribute to social cohesion ▪ Tends to promote health through encouraging greater physical activity ▪ Enhances vitality	▪ Reinforces green space preservation if linked into clustered form ▪ Reduces run-off from vehicles to water ▪ Reduces emissions to air and atmosphere ▪ May conflict with local green space needs
Mixed Use	▪ Enhances value for those preferring a mixed-use neighbourhood ▪ Utilises parking and transport infrastructure more efficiently ▪ Increases viability of local service shops and facilities ▪ Significantly lowers household expenditure on transportation	▪ Improves access to essential facilities, activities ▪ Provides convenience ▪ Encourages walking and cycling, health benefits ▪ Reduces need to own a car ▪ Increases personal safety ▪ Can enhance social equity	▪ Reduces car use for local trips (but minor impact on commuting) and hence emissions
Adaptability	▪ Contributes to economic success over time ▪ Extends useful economic life by delaying the loss of vitality and functionality	▪ Increases diversity and duration of use for public space ▪ Gives ability to resist functional obsolescence	▪ Supports conservation of non-renewable resources
High Quality Public Realm	▪ Attracts people and activity, leading to enhanced economic performance ▪ Public art contributes to enhanced economic activity	▪ Higher participation in activities & public space ▪ Gives greater sense of personal safety ▪ Attracts social engagement, pride and commitment to further achievements ▪ Public art contributes to greater community engagement with public space	▪ (not noted)
Integrated Decision-making	▪ Coordinates physical design and policy in related areas to ensure the benefits of good urban design are realised or enhanced	▪ Encourages people to take advantage of opportunities in good urban design ▪ Provides equity of opportunity for a range of people to benefit from good urban design	▪ (not noted)
User Participation	▪ Makes more effective use of resources ▪ Offers process cost savings by encouraging user support for positive change	▪ Improves fit between design and user needs ▪ Develops user ownership of positive change ▪ Enhances community, wellbeing, democracy	▪ (not noted)

4. THE PRECINCT DESIGN FRAMEWORK AND APPLICATIONS TO DIFFERENT URBAN FABRICS

Building on the discussion in the above sections, Table 6 presents the **Precinct Design Framework for Sustainable Centres of Tomorrow: Core Principles and Practices**, comprising seven core principles and 21 practices that can be used to help create the best outcomes from the regenerating centres around transport nodes.

Table 6: Precinct Design Framework for Sustainable Centres of Tomorrow: Core Principles and Practices

Core Principles	Core Practices
1. Precinct safety and accessibility The development should be safe and healthy for people waiting to access transport nodes	▪ Human centred design ▪ Walkable urban design ▪ Place and movement design
2. Carbon neutral - positive approach The development should aim for carbon positive, being at least zero carbon, in both power and transport	▪ Solar passive design ▪ Solar active design ▪ Carbon neutral analysis
3. Local shared mobility The development should encourage diverse local modal services to access the transit service, with defined spaces	▪ Local mobility design ▪ Feeder transport design ▪ Mobility as a service
4. Property diversity The density and urban mix should contribute to urban regeneration	▪ Community engaged planning ▪ Agglomeration economy analysis ▪ Financial modelling
5. Property affordability The development should include diverse property options to provide affordable living as well as affordable housing	▪ Social housing analysis ▪ Life cycle assessment ▪ Sustainability operational analysis
6. Nature-loving and biodiverse spaces The development should include and connect biophilic and biodiverse greenspaces, supporting endemic species and habitat	▪ Biophilic design ▪ Water sensitive design ▪ Landscape oriented design
7. Inclusive, integrated, place-based planning Planning, design and implementation (operation, maintenance) should involve diverse stakeholders and all tiers of government to provide an integrated place-based approach.	▪ Joined up governance analysis ▪ Partnership analysis ▪ Procurement option analysis

1.

In Table 7 below, the seven core principles are applied to four kinds of urban fabrics that are relevant to the case studies in this research. All but two of the case studies go through a central city walking city, all but two go through an inner city transit fabric that has been defined by a previous tramway, all have a middle suburb with potential for transit fabric as the only redevelopment is backyard infill that is failing to provide a centre with transit (Giles et al, 2017), and all have an outer suburb automobile fabric area with the need for a centre and transit. Table 7 sets out the findings.

Table 7: The Precinct Design Framework applied to four different urban fabrics.

Core Principles/ Urban Fabric Examples	Central City Walking Fabric (current rail-based centre)	Inner City Transit Fabric (old tram line area)	Middle Suburb Transit Fabric (infill failing)	Outer Suburb Automobile Fabric (new area needing a centre)
1. Precinct safety and accessibility	Walkability the critical value	Walkability in centre and corridor access both critical	Walkability in centre and corridor access both critical	Walkability in centre and corridor access both critical
2. Carbon neutral – positive approach	Strong transport carbon reductions but harder to do solar on buildings	Easier to do solar on buildings and harder on transport carbon reductions	Easy to do solar on buildings and hard on transport carbon reductions	Very easy to do solar on buildings and much harder on transport carbon reductions
3. Local shared mobility	Essential character	Essential character	Essential character	Essential character
4. Property diversity	Essential character	Essential character	Essential character but markets harder on mixed use	Essential character but markets hard on mixed use
5. Property affordability	Important but more difficult	Important but still difficult	Important and easier to achieve	Important and easier to achieve
6. Nature oriented space	Critical with emphasis on biophilic buildings and small pocket parks	Critical with emphasis on biophilic buildings, small pocket parks and green corridor	Critical with emphasis on biophilic buildings, small pocket parks and green corridor	Critical with emphasis on small pocket parks, green corridor and landscape-oriented development
7. Inclusive, integrated, place-based planning	Essential for delivery	Essential for delivery	Essential for delivery	Essential for delivery

The main conclusions from this analysis are:

1. Walkability for safety and accessibility is the critical value in all four fabrics with the need for a high quality corridor transit the extra critical accessibility component in the fabrics outside of the central city (Newman and Kenworthy, 2016).
2. Carbon neutral or carbon positive is easier the closer to the city centre as there is much less car dependence but the extra space associated with lower density fabrics is easier for solar on buildings; this trade-off can be managed to achieve carbon neutral in all fabrics but needs different kinds of technologies and investments (Newton and Newman, 2015).
3. Local shared mobility is essential in all four fabrics to manage the need for parking, for equity reasons and for transit support (Glazebrook and Newman, 2018); managing how to enable this along with walkability is a new design challenge.
4. Property diversity is also an essential character in each fabric though achieving mixed land use becomes harder with distance from the central city area due to the density levels required to achieve market viability (Konsti-Laakso and Rantala, 2018).

5. Property affordability is important to seek in all urban development not just low density areas on the urban fringe but this becomes easier to achieve the further away from the city centre (Kraatz, Mitchell et al., 2015).
6. Nature-oriented space is also a critical element of all fabrics as it is an essential part of human health and planetary health, but varies in its spatial definition from intensively building-oriented biophilics in the walking city supplemented with small pocket parks, to an emphasis on how the transit corridor is greened, then more and more landscape-oriented design as the fabric has less spatial intensity (Newman, Beatley and Boyer, 2017).
7. The integration of each of the other six core principles into a final design, procurement and delivery process that has place as its core focus is essential for each urban fabric.

5. CONCLUSION

Creating Sustainable Centres of Tomorrow needs a new approach. This paper has shown that there is a need for an approach that specifies Corridors, Nodes and Places and is based on the Theory of Urban Fabrics which shows there is a difference in the type of precinct needed whether its history and future is to be more walkable or transit-oriented or whether it is more car-oriented. The work in this project has focussed on those areas which already have walkable and transit-oriented fabric or are wanting more of this in formerly car-oriented areas. Within this context a *Precinct Design Framework of Principles and Practices* has been applied to four different urban fabric types, based on the fabrics in the five case studies being studied as part of the SBEnrc project. In each case, the Centres of Tomorrow will not emerge unless they have a quality transit corridor that can reduce car dependence, nodes at stations, which emerge from redevelopment opportunities, and place-based design that can make the most of the amenity needed to create value along the whole corridor. This shift to more urban places and spaces will also require renewed leadership and governance approaches built around new forms of co-creation, ideally involving enhanced levels of civil society involvement.

The future of urbanism in Australia and around the globe to adapt and respond to the big challenges of climate change, economic development and social inclusion, will depend on how well we create the centres of tomorrow. How to deliver these different centre qualities along a new transit corridor in a main street remains a major challenge for designers, planners and engineers to work out with politicians, developers, financiers and community leaders. Achieving integrated design responses will require new collaborative processes and co-creation processes. The governance systems related to integrated transit systems are outlined have a range of private investment involved but all require significant levels of partnership.

This literature review provides an important foundation for the case studies to use the Precinct Design Framework to achieve *Centres of Tomorrow* in a range of different street corridors and a range of different cities. It is intended that the Framework will be refined with the insights from these studies, towards enabling transformative changes to mainstreaming *Centres of Tomorrow* outcomes.

ATTACHMENT 1: Trackless Tram Historical Journey

To create better people-friendly and place-based urban spaces that are not affected by excessive traffic, several key technologies have emerged over the last two decades, spanning trackless tram systems (TTSs), through to autonomous vehicles (AV), electric vehicles (EV) and on-demand transit methods. Amongst the technology shifts, it is critical to identify viability and practicality for the local urban context, in order that authorities can make informed choices about budgets for capital works and operational requirements.

Among these available technologies, trackless trams have emerged with varying levels of success over the past two decades. TTS technology offers considerable advantages such as lower cost and minimal disruption to implement (Bodhi Alliance Pty Ltd, 2018). It has been recognised as an attractive alternative to light rail due to it being more affordability and ease of implementation. TTS also provides quality transit where ridership would not justify the higher investment in light rail or where construction is difficult due to cost or terrain.

Reflecting on the evolution of trackless trams technology, **Table 1** summarises a review of such technologies in chronological order.

Table A1: Examples of the evolution of trackless trams

Year	Type and link	Manufacturer	Countries of operations	Key features commentary	Indicative Image
2001	Guided light rail tram	Bombardier Transportation	France	▪ Rail guided by a single central rail ▪ System costs, reliability and maintenance issues. ▪ Too fewer vehicles to serve the demand.	
2007	Tramways on tyres	Translohr	France, Columbia, China, Italy	▪ Modular design with between 2 and 7 carriages. ▪ Narrow vehicle permanently fixed to guide rails ▪ Cannot divert, similar to traditional steel-wheeled rail vehicles. ▪ Lack of interoperability, and expensive to build and maintain.	
2011	Bus Rapid Transit	Van Hool	Italy, Switzerland, Germany, UK, Spain, France, Luxemburg, Sweden, Norway, French Antilles and Austria	▪ Similar to light rail regarding comfort, smoothness, and stylishness. ▪ A range of propulsion systems: fully electric trolley, on-board systems, hybrid gas electric, gas and hydrogen fuel cell technology.	
2017	ie Tram	Irizar	Spain	▪ More glass for the carriages ▪ Chrome edge around the body for a stylised appearance. ▪ 200km range on a single charge	
2018	Autonomous Rail Rapid Transit (ART)	CRRC Zhuzhou Institute Co Ltd	China	▪ Resembles a rubber-tyred tram, but with flexibility to move around like a normal articulated bus. ▪ Autonomous rapid rail transit vehicle fully autonomous and bi-directional. ▪ Composed of individual, fixed sections joined together by articulated gangways	

In 2001, the Guided Light Tram (GLT) rubber tyred vehicle was manufactured by Bombardier which is guided by a single central rail. But due to the system costs, limited reliability and maintenance issues this GLT became unsuccessful. In 2007, Translohr was built within a modular design which addressed the conditions of coming off the guide rail and pavement rutting. However, it's weakness was lack of interoperability and high costs. Then in 2011 Van Hool developed the ExquiCity which was suitable for corridor transit. It has the ability to travel up to 100km on a full charge. This tram was operating across Italy, Switzerland, Germany, UK, Spain, France and also entered the Australian market through a relationship with the Transit Australia Group TAG. Later in 2017, Iriza was launched with a stylish appearance featuring more glass and chrome edge around the body and was able to run 200km range on a charge. Last year, 2018 the ART Autonomous rapid rail transit vehicle started its operations in China and fully autonomous taking commands from both control centre and guidance from on board sensors as well as GPS and Lidar systems and cameras (Newman, Mouritz, et al., 2018).

In advancing the trackless tram journey it is critical to meet the interoperability requirements so ensuring that implementation would not be limited to any one supplier thus helping to mainstream this sustainable solution. With increasing attention on local shared mobility systems and broadening catchment areas, and limited parking spaces TTS can be considered as a game changer for its integrated transit, finance and land development. This is further established through the following table (**Table 2**) on comparative benefits of TTS (Newman, Davies-Slate, et al., 2018; Newman, Mouritz, et al., 2018).

Table 8: A summary of the comparative benefits of having a Trackless Tram (TT) (Adapted from (Newman et al, 2018)

Characteristic	BRT	LRT	ART or TTS
Speed and capacity	√	√√	√√
Ride quality	×	√√	√√
Land developer's potential	×	√√	√
Cost	√	×	√√
Disruption in construction	√	×	√
Implementation time	√	√√	√√

It is well proven that the proximate location of activities in an urban environment can provide significant benefits: mostly explained through agglomeration economics; and a broader suite of benefits arises through it being a counter to the problems of urban sprawl (low-density housing) and consequent high private car use - exacerbated by population growth (Trubka, 2011). The contemporary urban planning seeks to derive such benefits by, integration of land-use through promoting clusters of compatible activities such as residential, commercial (professional services), retail, educational, medical, cultural, social, recreational and so on referred to variously as Activity Centres, Development Nodes, Precincts, Hubs and the like integration of land-use and transport emphasising public transport and discouraging private car use.

REFERENCES

Atkinson, A. (2001). International cooperation in pursuit of sustainable cities. *Development in Practice, 11*(2-3), 273-291.

Badland, H., Mavoa, S., Boulangé, C., Eagleson, S., Gunn, L., Stewart, J., Giles-Corti, B. (2017). Identifying, creating, and testing urban planning measures for transport walking: findings from the Australian national liveability study. *Journal of Transport & Health, 5*, 151-162.

Ball, M., Lizieri, C., & MacGregor, B. (2012). *The economics of commercial property markets*. London: Routledge.

Beer, A., Kearins, B., & Pieters, H. (2007). Housing affordability and planning in Australia: the challenge of policy under neo-liberalism. *Housing studies, 22*(1), 11-24.

Bodhi Alliance, (2018). *Trackless Trams in Perth: From Concept to Reality*, Bodhi Alliance, Perth.

Bose, M., Horrigan, P., Doble, C., & Shipp, S. C. (2014). *Community matters: Service-learning in engaged design and planning*. London: Routledge.

Brownsword, R., Fleming, P., Powell, J., & Pearsall, N. (2005). Sustainable cities–modelling urban energy supply and demand. *Applied Energy, 82*(2), 167-180.

Cabanek, A., & Newman, P. (2017). Biophilic urban regeneration: can biophilics be a land value capture mechanism? In *WIT Transactions on Ecology the Environment* (Vol. 210, pp. 65-74). Southampton: WIT Press.

Caffyn, A., & Dahlström, M. (2005). Urban–rural interdependencies: joining up policy in practice. *Regional Studies, 39*(3), 283-296.

Carmona, M. (2014). The place-shaping continuum: A theory of urban design process. *Journal of Urban Design, 19*(1), 2-36.

Cervero, R., Ferrell, C., & Murphy, S. (2002). Transit-oriented development and joint development in the United States: A literature review. *TCRP research results digest*(52).

Chen, G., Wiedmann, T., Wang, Y., & Hadjikakou, M. (2016). Transnational city carbon footprint networks–Exploring carbon links between Australian and Chinese cities. *Applied Energy, 184*, 1082-1092.

Choi, H., & Seo, Y.-A. (2018). Design strategies and processes through the concept of resilience. *Journal of the Korean Institute of Landscape Architecture, 46*(5), 44-58.

Cohen, B., & Kietzmann, J. (2014). Ride On! Mobility Business Models for the Sharing Economy. *Organization & Environment, 27*(3), 279-296.

Cole, R., Burke, M., Leslie, E., Donald, M., & Owen, N. (2010). Perceptions of representatives of public, private, and community sector institutions of the barriers and enablers for physically active transport. *Transport policy, 17*(6), 496-504.

de Cea Ch, J., Malbran, R. H., & Practice. (2008). Demand responsive urban public transport system design: Methodology and application. *Transportation Research Part A: Policy and Practice, 42*(7), 951-972.

Dennis, M., Barlow, D., Cavan, G., Cook, P., Gilchrist, A., Handley, J., .Wheater, C. P. (2018). Mapping urban green infrastructure: A novel landscape-based approach to incorporating land use and land cover in the mapping of human-dominated systems. *Land, 7*(1), 17.

Desha, C., Reeve, A. C., Newman, P. W., & Beatley, T. (2016). Urban nature for resilient and liveable cities. *Smart and Sustainable Built Environment, 5*(1), null. doi:doi:10.1108/SASBE-02-2016-0003

Duranton, G., & Kerr, W. R. (2015). *The logic of agglomeration*. Retrieved from

el-Baghdadi, O., & Desha, C. (2017). Conceptualising a biophilic services model for urban areas. *Urban Forestry & Urban Greening, 27*, 399-408.

Evans, G., Foord, J., Porta, S., Thwaites, K., Romice, O., & Greaves, M. (2007). The generation of diversity: mixed-use and urban sustainability. *Urban Sustainability Through Environmental Design: Approaches to time-people-place responsive urban spaces* 95-101.

Evans, J., & Jones, P. (2008). Rethinking sustainable urban regeneration: ambiguity, creativity, and the shared territory. *Environment and Planning A, 40*(6), 1416-1434.

Farhat, R. (2018). Accountability in urban regeneration partnerships: A role for design centers. *Cities, 72*, 8-16.

Farrelly, E. (2005). Attack of common sense hits planners. *Sydney Morning Herald, 26*.

Flanagan, K., Martin, C., Jacobs, K., & Lawson, J. (2019). *A conceptual analysis of social housing as infrastructure*. Retrieved from https://www.ahuri.edu.au/research/final-reports/309

Florida, R. (2010). *The great reset: How new ways of living and working drive post-crash prosperity*. Toronto: Random House Canada.

Forsyth, A. (2015). What is a walkable place? The walkability debate in urban design. *Urban design international, 20*(4), 274-292.

Forsyth, A., & Southworth, M. (2008). Cities afoot—Pedestrians, walkability and urban design. *Journal of Urban Design*. 13(1), 1-3.

Furlong, C., Dobbie, M., Morison, P., Dodson, J., & Pendergast, M. (2019). Infrastructure and Urban Planning Context for Achieving the Visions of Integrated Urban Water Management and Water Sensitive Urban Design: The Case of Melbourne. *Approaches to Water Sensitive Urban Design*, 329-350.

Futcher, J., Mills, G., Emmanuel, R., & Korolija, I. (2017). Creating sustainable cities one building at a time: Towards an integrated urban design framework. *Cities, 66*, 63-71.

Gabarrell, X., Rieradevall, J., Josa, A., Oliver-Solà, J., Mendoza, J. M. F., Sanjuan-Delmás, D., Sanyé-Mengual, E. (2015). Life Cycle Management Applied to Urban Fabric Planning. In G. Sonnemann & M. Margni (Eds.), *Life Cycle Management* (pp. 307-317). Dordrecht: Springer Netherlands.

Gehl, J. (2013). *Cities for people*. Washington: Island Press.

Glazebrook, G., & Newman, P. (2018). The city of the future. *Urban Planning, 3*(2), 1-20.

Goldman, T., & Gorham, R. (2006). Sustainable urban transport: Four innovative directions. *Technology in Society, 28*(1-2), 261-273.

Gössling, S. (2009). Carbon neutral destinations: A conceptual analysis. *Journal of Sustainable Tourism, 17*(1), 17-37.

Grimsey, D., & Lewis, M. K. (2017). Choosing amongst infrastructure procurement approaches: Evaluating Public–Private Partnerships and Other Procurement Options. In *Global Developments in Public Infrastructure Procurement*: Edward Elgar Publishing.

Gudowsky, N., Sotoudeh, M., Capari, L., & Wilfing, H. (2017). Transdisciplinary forward-looking agenda setting for age-friendly, human centered cities. *Futures, 90*, 16-30.

Gunasekaran, A., & Irani, Z. (2014). Sustainable Operations Management: design, modelling and analysis. *Journal of the Operational Research Society*(65), 801-805.

Hall, P., & Tewdwr-Jones, M. (2010). *Urban and regional planning*. London: Routledge.

Hensher, D. A. (2017). Future bus transport contracts under a mobility as a service (MaaS) regime in the digital age: Are they likely to change? *Transportation Research Part A: Policy and Practice, 98*, 86-96.

Hietanen, S. (2014). Mobility as a Service. In *The new transport model* (pp. 2-4).

Hildermeier, J., & Villareal, A. (2014). Two ways of defining sustainable mobility: Autolib' and BeMobility. *Journal of Environmental Policy & Planning, 16*(3), 321-336.

Horvat, M., & Dubois, M.-C. (2012). Tools and methods for solar design–an overview of IEA SHC Task 41, Subtask B. *Energy Procedia, 30*, 1120-1130.

Hueskes, M., Verhoest, K., & Block, T. (2017). Governing public–private partnerships for sustainability: An analysis of procurement and governance practices of PPP infrastructure projects. *International Journal of Project Management, 35*(6), 1184-1195.

Hüging, H., Glensor, K., & Lah, O. (2014). Need for a holistic assessment of urban mobility measures–Review of existing methods and design of a simplified approach. *Transportation Research Procedia, 4*, 3-13.

Ives, C. D., Beilin, R., Gordon, A., Kendal, D., Hahs, A. K., & McDonnell, M. J. (2013). Local assessment of Melbourne: the biodiversity and social-ecological dynamics of Melbourne, Australia. In *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities* (pp. 385-407): Springer, Dordrecht.

Jin, R., Gong, J., Deng, M., Wan, Y., & Yang, X. (2018). A framework for spatiotemporal analysis of regional economic agglomeration patterns. *Sustainability, 10*(8), 2800.

Jittrapirom, P., Caiati, V., Feneri, A.-M., Ebrahimigharehbaghi, S., Alonso González, M. J., & Narayan, J. (2017). Mobility as a service: A critical review of definitions, assessments of schemes, and key challenges. *Urban Planning, 2*, 13.

Kanters, J., & Horvat, M. (2012). Solar energy as a design parameter in urban planning. *Energy Procedia, 30*, 1143-1152.

Kanters, J., Wall, M., & Dubois, M.-C. (2014). Typical values for active solar energy in urban planning. *Energy Procedia, 48*, 1607-1616.

Karlson'Charlie'Hargroves, D. C., Spajic, L., Gallina, L., & Newman, P. (2018). *Sustainable urban design co-benefits: role of EST in reducing air pollution and climate change mitigation*. Retrieved from https://apo.org.au/node/215216

Keast, R. (2011). Joined-up governance in Australia: how the past can inform the future. *International Journal of Public Administration, 34*(4), 221-231.

Kennedy, S., & Sgouridis, S. (2011). Rigorous classification and carbon accounting principles for low and Zero Carbon Cities. *Energy Policy, 39*(9), 5259-5268.

Kenworthy, J., & Newman, P. (2015). The End of Automobile Dependence: How Cities are Moving Beyond Car-Based Planning. In *The End of Automobile Dependence: How Cities Are Moving Beyond Car-Based Planning* (pp. 201-226). Washington, DC.: Island Press.

Kenworthy, J. R., & Laube, F. B. (1996). Automobile dependence in cities: An international comparison of urban transport and land use patterns with implications for sustainability. *Environmental Impact Assessment Review, 16*(4), 279-308.

Konsti-Laakso, S., & Rantala, T. (2018). Managing community engagement: A process model for urban planning. *European Journal of Operational Research, 268*(3), 1040-1049.

Kosonen, L. (2014). Model of three urban fabrics: adapted for Finnish intermediate cities. In: The Finnish Environment Institute.

Kraatz, J. A., Mitchell, J., Matan, A., & Newman, P. (2015). Rethinking social housing: Efficient, effective and equitable. *Sustainable Built Environment National Research Centre Research Report, 75*.

Lee, J. Y., & Ellingwood, B. (2017). A decision model for intergenerational life-cycle risk assessment of civil infrastructure exposed to hurricanes under climate change. *Reliability Engineering & System Safety, 159*, 100-107.

Litman, T. A. (2003). Economic value of walkability. *Transportation Research Record*.

Liu, H., Zhou, G., Wennersten, R., & Frostell, B. (2014). Analysis of sustainable urban development approaches in China. *Habitat International, 41*, 24-32.

Lyons, G. (2018). Getting smart about urban mobility–aligning the paradigms of smart and sustainable. *Transportation Research Part A: Policy and Practice, 115*, 4-14.

Maguire, M. (2001). Methods to support human-centred design. *International journal of human-computer studies, 55*(4), 587-634.

Matan, A., & Newman, P. (2012). Jan Gehl and new visions for walkable Australian cities. *World Transport Policy & Practice, 17*(4), 30-41.

Matan, A., & Newman, P. (2016). *People cities: The life and legacy of Jan Gehl*. Washington: Island Press.

McAllister, R. R., Taylor, B. M., & Harman, B. P. (2015). Partnership networks for urban development: how structure is shaped by risk. *Policy Studies Journal, 43*(3), 379-398.

McDonald, S., Malys, N., & Maliene, V. (2009). Urban regeneration for sustainable communities: A case study. *Technological Economic Development of Economy, 15*(1), 49-59.

Mirabella, N., & Allacker, K. (2018). The Assessment of Urban Environmental Impacts through the City Environmental Footprint: Methodological Framework and First Approach to the Built Environment. *Procedia CIRP, 69*, 83-88.

Mohajeri, N., Gudmundsson, A., Kunckler, T., Upadhyay, G., Assouline, D., Kämpf, J., & Scartezzini, J. (2019). A solar-based sustainable urban design: The effects of city-scale street-canyon geometry on solar access in Geneva, Switzerland. *Applied Energy, 240*, 173-190.

Mulley, C., Ma, L., Clifton, G., Yen, B., & Burke, M. (2016). Residential property value impacts of proximity to transport infrastructure: An investigation of bus rapid transit and heavy rail networks in Brisbane, Australia. *Journal of Transport Geography, 54*, 41-52.

Mulliner, E., & Maliene, V. (2015). An analysis of professional perceptions of criteria contributing to sustainable housing affordability. *Sustainability, 7*(1), 248-270.

Nesticò, A., & Sica, F. (2017). The sustainability of urban renewal projects: A model for economic multi-criteria analysis. *Journal of Property Investment & Finance, 35*(4), 397-409.

Newman, P. (2010). Green urbanism and its application to Singapore. *Environment urbanization Asia, 1*(2), 149-170.

Newman, P., Davies-Slate, S., & Jones, E. (2018). The Entrepreneur Rail Model: Funding urban rail through majority private investment in urban regeneration. *Research in Transportation Economics, 67*, 19-28.

Newman, P., Hargroves, K., Davies-Slate, S., Conley, D., Verschuer, M., Mouritz, M., & Yangka, D. (2019). The trackless tram: is it the transit and city shaping catalyst we have been waiting for? *Journal of Transportation Technologies, 9*(1).

Newman, P., & Kenworthy, J. (2011). 'Peak car use': understanding the demise of automobile dependence. *World Transport Policy & Practice, 17*(2), 31-42.

Newman, P., Kosonen, L., & Kenworthy, J. (2016). Theory of urban fabrics: Planning the walking, transit/public transport and automobile/motor car cities for reduced car dependency. *Town Planning Review, 87*(4), 429-458.

Newman, P., Mouritz, M., Davies-Slate, S., Jones, E., Hargroves, K., Sharma, R., & Adams, D. (2018). Delivering Integrated Transit, Land Development and Finance A Guide and Manual with Application to Trackless Trams. *The Sustainable Built Environment National Research Centre (SBEnrc), Australia*.

Newman, P. G., & Kenworthy, J. R. (1989). *Cities and automobile dependence: An international sourcebook*. Aldershot Gower Technical.

Nijkamp, P., & Perrels, A. (2018). *Sustainable cities in Europe*. London: Routledge.

Olds, K., & Yeung, H. (2004). Pathways to global city formation: a view from the developmental city-state of Singapore. *Review of International Political Economy, 11*(3), 489-521.

Petit-Boix, A., Llorach-Massana, P., Sanjuan-Delmás, D., Sierra-Pérez, J., Vinyes, E., Gabarrell, X., Sanyé-Mengual, E. (2017). Application of life cycle thinking towards sustainable cities: A review. *Journal of Cleaner Production, 166*, 939-951.

Pucher, J., & Buehler, R. (2008). Cycling for everyone: lessons from Europe. *Transportation Research Record, 2074*(1), 58-65.

Rawnsley, T. (2017). Economic performance of Australia's cities and regions 2016–2017. *SGS Economics and Planning, Canberra/Hobart/Melbourne/Sydney*.

Robinson, D., Stankovic, S., Morel, N., Deque, F., Rylatt, M., Kabele, K., Nieminen, J. (2003). *Integrated resource flow modelling of urban neighbourhoods: Project SUNtool.* Paper presented at the Proc. Building Simulation.

Royal Government of Bhutan (2012). Levy of Green Tax. Retrieved from https://www.mof.gov.bt/wp-content/uploads/2014/08/lgt31082012.pdf

Roca, E., Aquilué, I., & Gomes, R. (2015). *Walking the city. Barcelona as an urban experience*: Edicions Universitat Barcelona.

Rode, P. (2019). Urban planning and transport policy integration: The role of governance hierarchies and networks in London and Berlin. *Journal of Urban Affairs, 41*(1), 39-63.

Russo, P., Lanzilotti, R., Costabile, M. F., & Pettit, C. (2018). Towards satisfying practitioners in using Planning Support Systems. *Computers, Environment & Urban Systems, 67*, 9-20.

Scheurer, J. a. W. I. (2019). *Navigating the ethical challenges of Trackless Tram promotion*. Paper presented at the Ethics and Transport Planning Symposium, Centre for Urban Research (RMIT University) and Melbourne Sustainable Society Institute (University of Melbourne).

Sehlleier, F. (2018). Moving fuel economy policy forward in Thailand. Preparation workshop for nationally determined contribution action plan in transport sector. *Transport and Climate Change*.

Strømann-Andersen, J., & Sattrup, P. A. (2011). The urban canyon and building energy use: Urban density versus daylight and passive solar gains. *Energy Buildings, 43*(8).

Suleman, M. (2013). *The role of urban design in promoting cycle friendly environments in Johannesburg: the educational corridor.* (Doctoral dissertation, University of the Witwatersrand Johannesburg).

Tappert, S., Klöti, T., & Drilling, M. (2018). Contested urban green spaces in the compact city: The re-negotiation of urban gardening in Swiss cities. *Landscape and Urban Planning, 170*, 69-78.

Thisse, J.-F. (2019). Economics of agglomeration. In *Oxford Research Encyclopedia of Economics and Finance*.

Thomson, G., & Newman, P. (2018). Urban fabrics and urban metabolism–from sustainable to regenerative cities. *Resources, Conservation and Recycling, 132*, 218-229.

Tozer, L., & Klenk, N. (2018). Discourses of carbon neutrality and imaginaries of urban futures. *Energy research & social science, 35*, 174-181.

Trigaux, D., Wijnants, L., De Troyer, F., & Allacker, K. (2017). Life cycle assessment and life cycle costing of road infrastructure in residential neighbourhoods. *The International Journal of Life Cycle Assessment, 22*(6), 938-951.

Trubka, R. L. (2011). *Agglomeration economies in Australian cities: productivity benefits of increasing urban density and accessibility.* (Doctoral dissertation, Curtin University).

United Nations (2017). *New Urban Agenda*. Retrieved from https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_71_256.pdf

Urry, J. (2004). The 'system'of automobility. *Theory, Culture & Society, 21*(4-5), 25-39.

van der Jagt, A. P., Elands, B. H., Ambrose-Oji, B., Gerőházi, É., Møller, M. S., & Buizer, M. (2017). Participatory governance of urban green spaces: trends and practices in the EU. *Nordic Journal of Architectural Research, 28*(3).

Venter, C., Jennings, G., Hidalgo, D., & Valderrama Pineda, A. F. (2018). The equity impacts of bus rapid transit: A review of the evidence and implications for sustainable transport. *International Journal of Sustainable Transportation, 12*(2), 140-152.

Wamsler, C., Brink, E., & Rivera, C. (2013). Planning for climate change in urban areas: from theory to practice. *Journal of Cleaner Production, 50*, 68-81.

Wang, Y. P., & Murie, A. (2011). The new affordable and social housing provision system in China: implications for comparative housing studies. *International Journal of Housing Policy, 11*(3), 237-254.

Wong, T. H. (2006). An overview of water sensitive urban design practices in Australia. *Water Practice & Technology 1*(1).

Wunderlich, F. (2017). Place-temporality and rhythmicity: a new aesthetic and methodological foundation for urban design theory and practice. In *Explorations in Urban Design* (pp. 85-100): Routledge.

Yigitcanlar, T., & Kamruzzaman, M. (2015). Planning, development and management of sustainable cities: A commentary from the guest editors. In: Multidisciplinary Digital Publishing Institute.

Zhang, T., & Dong, H. (2009). Human-centred design: an emergent conceptual model.