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Dr. Joachim und Hanna Schmidt
Stiftung für Umwelt und Verkehr



“We are grateful for the financial support of the journal
from the Dr Joachim und Hanna Schmidt Stiftung fuer
Umwelt und Verkehr, Hamburg, Germany”

<http://www.dr-schmidt-stiftung.de/28-0-Aktuelle+Projekte.html>

This issue brings together two important strands of thinking in sustainable mobility and the bigger picture around how the world is changing and now faces a rather stark choice. We can either go down the route of high quality, people-centred, healthy, active, child-friendly cities or we can finish the job started by Henry Ford and shape a future dominated by vehicles and technology, exterminate walking, cycling and public transport and deeply entrench our total submission to a space greedy, dollar-greedy, unhealthy technological domination of the way we live. The latter is the world of electric vehicles and autonomous vehicles (AVs) and is now attracting large scale support and buy-in from politicians, corporations and environmental groups.

In this issue we are delighted that Jeff Kenworthy has set out a very clear case and argument for the sustainable ethical, child-friendly option that is available and is already working in many best practice cities around the world. He provides a wealth of evidence and case studies to show that we can design high quality cities with low level of car dependency and a very high quality of life. This is supported by Wiki, Kingham and Banwell who pick up the Donald Appleyard revelations around “liveable street” and how attractive social spaces and quality of life depend on low traffic volumes. We can have a high quality of life based on community activity and social interaction but only at low levels of traffic volumes.

The article on public transport planning and funding in Casablanca reminds us all that the issues around sustainable mobility are being tackled in different ways in Africa, China, India and South America and require a very sensitive and evidence-based approach to the development of solutions. The European and North American model of widespread car ownership and use and huge subsidies from tax dollars to road building, car parking and vehicle manufacturing is being exposed around the world and colleagues in the countries struggling with congestion and pollution need assistance to provide alternatives to even more

road building and motorised transport subsidies. Casablanca has made a great deal of progress on its public transport projects but as Asmaa Aitboubkr shows that we need to do a lot more thinking and prioritisation about equity and social justice and this means delivering traffic reductions and increases in walking and cycling and reductions in road traffic danger.

The forces that are re-shaping our world in ways that Henry Ford would have approved of so that we become even more dependent on sitting in cars and using vehicles for as many trips every day of any length to as many destinations as possible, are very strong. Electric vehicles (EVs) have successfully colonised the thinking of many transport planners and sustainability organisations for their ability (allegedly) to sort out climate change. Our view is that they do not represent a solution to climate change problems and the huge reductions in greenhouse gases that are required to deliver even a small chance of heading-off the worst consequences of climate change. This is a difficult subject for all of us working on sustainability issues. The EV has an excellent track record in shifting thinking, planning, spending and delivery into car world and contributing to the demise of walking, cycling and local public transport.

Support for EVs requires a very strong reminder of prioritisation of options in urban planning, transport and design. This has been put very well indeed by Michael Cramer of the European Parliament Committee on Transport:

“Electric mobility can be part of the solution – but only if we overcome a narrow vision focused almost exclusively on private cars. Let’s start by reducing transport demand and by shifting to modes that are already very environmentally-friendly, like walking, cycling, public transport and the railways. It is absurd that some people now want to build overhead contact lines on motorways, while only 53% of the EU’s rail network are electrified.

Electrifying transport can make sense provided that we choose a targeted ap-

proach. Let's first focus on highly-used vehicles such as taxis, shared cars, buses and trains. And e-bikes already offer a real alternative for longer-distance commuting or cycling in hilly areas. Moreover, even the EU transport ministers confirmed that e-cargobikes could carry out more than 50% of all freight operations in European cities.

E-mobility must be thought across all modes, and as such it is only a propulsion technology that can never replace good planning and clever policies."

Michael Cramer MEP,
Member of the Committee for Transport and Tourism, European Parliament
www.michael-cramer.eu

We are very pleased indeed that we have been given permission to publish the letter sent by 15 German transport professors to a major German newspaper on EVs and very grateful to Professor Helmut Holzapfel for arranging the translation. The letter makes some very important points that have been missed or misunderstood by many environmental organisations in the UK including Friends of the Earth and Greenpeace. EVs are not a solution to climate change problems.

The world of car-centric thinking has now moved heavily into autonomous vehicles (AVs) sometimes known as driverless cars (DCs). In this issue we have an article by John Mullins who works on AVs for a major UK based car manufacturer heavily involved in AV's. The views expressed are his own, in his private capacity. His main points are well made and will stimulate debate. I disagree with most of his points but this journal does not censor and wants to stimulate debate and will be delighted to publish any comments on AVs and their impact on re-shaping cities, societies and public health

In this issue we carry a book review of "Driverless cars: on a road to nowhere" by Christian Wolmar. The book and the review are very critical indeed of the hype around AVs and the ways it is intended to transform mobility and cities and (possibly) exterminate walking, cycling and public transport. We hope that readers will look

at Mullins and the book review and contact us with comments.

Christian Wolmar is very good indeed at identifying the hype around AVs and the very poor track record on delivery. In one of those wonderful serendipity moments that often crop up in the fertile world of sustainable mobility writing this editorial coincided with the receipt of a press release on AVs:

Driverless car will be able to turn water vapour to tea as they travel

NEWS COPY - WITH PICTURES AND VIDEO

Commuters could soon be taken to work in a driverless car which is so clean they could relax on the journey with a cup of tea - brewed using water from the tailpipe.

The state-of-the-art Hyundai Nexo is a crossover SUV vehicle which runs on electrical energy generated by hydrogen fuel cells.

Unlike traditional combustion engines, hydrogen cars don't emit carbon dioxide or nitrous oxide so its only by-product is water vapour.

The water produced by Nexo could even be stored and used later to pour on plants or even used to make a cup of tea or coffee.

Source: SWNS Digital, London

We do not know whether this is real or a "wind-up" and a joke but it fits very well indeed with Christian Wolmar's emphasis on hype. Assuming for the moment that it is real we note that there would appear to be nothing that driverless cars cannot deliver and help us all to improve our sad lives by making it possible to make tea from water dripping out of an exhaust pipe.

The articles in this issue bring into very sharp perspective two visions of the future. We can have tried and tested, ethical, sustainable, socially just policies and interventions that shape our cities in ways that are very child-friendly and like Freiburg are delightful places to walk and cycle and

prioritise non-car modes as the preferred solutions. Alternatively we can have a future dominated by vehicles, streets that are dripping in vehicles and are unpleasant environments for residents and cities that are decidedly not child-friendly but are totally given over to an auto-utopia and a future that would be welcomed by Henry Ford, road builders and global corporations. On current form the choice has been made and it is auto-utopia and several billion vehicles taking over every aspect of street life.

John Whitelegg
Editor

Planning as if Children Mattered: A Case for Transforming Automobile Dependent Cities and Some Examples of Best Practice

Jeff Kenworthy

Abstract:

The automobile with its accompanying urban sprawl, roads and parking has changed cities dramatically in the last century from places where walking, cycling and public transport were the dominant or even only modes of transport. While the automobile can be a good servant it is a very bad master and has led to a host of environmental, economic and social problems for cities. One of the casualties of automobile dependence is the independent mobility of children and other vulnerable populations in cities, such as the elderly and those with disabilities. This paper shows the extent of these problems and many of the fallacies that lie behind the idea that the car-based model of urban development has uniformly led to a better quality of life for everybody. It is presented in three parts. The first part provides a brief review of the problems of automobile dependence and the differences in this dependence between American, Australian, Canadian, European and wealthy Asian cities (Singapore and Hong Kong). The second part considers some of the primary ways in which the character and qualities of cities can impact on the ability of cities to meet the mobility and other needs of people, especially children. It particularly tackles the question of density. It shows how assumptions about the benefits of low density and the negatives of high density have been overstated and how children have become a key casualty in this planning and policy-driven fallacy, which has helped drive cities towards greater automobile dependence. The third part of the paper shows how unnecessary it is to continue along such paths by showing some best practice examples from around the world of cities that have ensured a better balance of transport modes and a much fairer and just system of land use and transport planning for children and other vulnerable populations, often making up about 50% of urban populations. Zurich, Vancouver, Freiburg im Breisgau, Portland, Munich, Stockholm and Seoul are examined, as well as the somewhat

unifying concept of traffic calming. Conclusions are drawn about the key things cities need to do to avoid the problems of automobile dependence and to begin to transform themselves into places that better meet everyone's needs and which contribute to environmental, social and economic improvement.

Keywords: Children, Urban Density, Sprawl, Cities, Automobile Dependence, Community, Independent Mobility, Public Realm, Walking, Cycling

Re-working Appleyard in a low density environment: An exploration of the impacts of motorised traffic volume on street livability in Christchurch, New Zealand.

Wiki J., Kingham S., and Banwell K.

Abstract

Street space was once an essential element of urban environments and provided a place for community interaction and engagement. This role however is increasingly being subverted by vehicular dominance. As a result street space no longer acts as a driver for social interaction in many places, which has significant impacts on the liveability of streets and the wellbeing of their residents. This study sought to assess the extent to which motorised traffic volumes impact street liveability and community severance in Christchurch, a relatively low density city in New Zealand. Based on Appleyard's work of the late 1970s, data was collected from six streets, in two areas, categorised into three motorised traffic volume classifications. Results showed that residents on light trafficked streets have more neighbourhood connections and community interactions and perceive their street to be more liveable. Furthermore, residents on heavy trafficked streets had a negative perception of their street environment, smaller local home areas and a decreased sense of belonging to their community. This affirms relationships found in previous research and raises questions about what and whom the residential street spaces of Christchurch are, and should be, designed for.

Keywords: traffic, low density, environment, community, liveability, Christchurch.

**Transportation Equity in Morocco:
A preliminary analysis of Casablanca's
Tram Line.**

Asmaa AIT BOUBKR

Abstract:

In Morocco, the city of Casablanca - The 5th largest city of the country, with five million inhabitants- is facing important transport challenges of current burgeoning cities: the social sustainability of transportation sector remains inadequate, notably for the poor and women.

In order to remedy to this situation, the Moroccan Government has designed a broad program of investments in Casablanca by implementing a network of four tramway lines. Improving Casablanca's transportation systems tends to achieve social equity objectives. However, transport equity analysis has not gained enough attention in tram line project studies as a concept of its own. This research is a preliminary analysis of mobility equity in the city of Casablanca undergoing the implementing of the first Tram Line.

Keywords: Vertical Equity, disadvantaged people, mobility equity.

Planning as if Children Mattered: A Case for Transforming Automobile Dependent Cities and Some Examples of Best Practice

Jeff Kenworthy

Introduction

The suburban home, and later the automobile, appeared to offer unprecedented freedom and amenity to the residents of cities, especially families with children. Separated from the noise, air pollution and perceived crowding of the old central and inner cities, and freed from the need to rely on public transport, it seemed that cities could become healthy, livable, enjoyable places to live, despite industrial development.

However, the unfettered use of the automobile and the design of modern cities around its movement and storage requirements, have brought a new era of environmental decay to cities. Many cities again have bad air pollution from car exhausts. Traffic noise affects nearly everyone. Traffic accidents kill and maim thousands of

people every year, particularly children. Natural areas and rural landscapes recede as suburbs advance (Figure 1). The sense of urban community has declined and social isolation has become a norm for many single parents, elderly people, young people of non-driving age, and those with disabilities. The city's public spaces, its streets, squares and parks, have become dominated by transport infrastructure and dangerous levels of traffic (Figure 2). For fear of traffic, many parents don't allow their young children independent mobility, not even in suburban neighbourhoods. In the USA, parents are being prosecuted for permitting children to walk on the streets without adult supervision (St. George and Schulte, 2015).

This paper examines the extent to which automobile dependence has become a feature of modern cities and provides a rationale for reducing this dependence. It also examines various ways in which cities today are reclaiming the space and amenity which the automobile has stolen and shows how cities might again become convenient, safe, attractive and clean envi-



Figure 1: Suburban sprawl in Western Australia: Loss of bushland, poor walkability, little community and nowhere for children except the family home.

ronments for people of all ages and needs and especially the most vulnerable members of society, children.

Such cities would become places in which it is again a pleasure to stroll around the public spaces and where it is possible to gain convenient, safe access to most needs on foot, bicycle or public transport - environments in which a car is no longer essential for every trip.

The paper considers the central city environment and how to bring people back through pedestrianisation, traffic calming and public activities, how to make sub-centres, more pleasant places, and how to traffic calm and beautify streets to make them safer and more attractive. It looks at case studies of cities that have designed public spaces for more vulnerable members of society, those which have brought nature and gardens back to the public realm, and developed easily accessible and safe public transport systems for everyone. It also looks at case studies around the world of appealing 'urban village' or transit-oriented development (TOD) alternatives to the suburbs.

The paper is divided into three parts. Part I provides an overview of a large body of international research that we have conducted over the last 40 years into how different cities vary in their degree of automobile dependence. It also briefly examines some of the problems stemming from that dependence. This helps to set the context for the discussion to follow by showing the wide range in automobile dependence and the extent of the problems that exist in cities across the globe.

A full account of all the data including detailed methodologies on each item can be found in Kenworthy and Laube et al (1999) and Kenworthy (2017) and further discussion of the data's policy implications are available in, for example, Newman and Kenworthy (1999, 2015) and Schiller and Kenworthy (2018).

Leading on from this quantitative overview, Part II considers some of the primary ways in which the character and qualities of cities can impact on the ability of cities to meet the needs of people. It addresses several key themes and arguments which provide the rationale for the positive in-



Figure 2: Designing cities around the needs of the car such as in Auckland, New Zealand, designs out the mobility needs of around 50% of the population.

ternational examples of city 're-shaping' described in Part III.

Part I – The Problem of Automobile Dependence: An International Overview

This section examines some key environmental, social and economic problems of automobile dependence through the lens of a large international comparison of cities in the USA, Canada, Australia, Western Europe and Asia that has been published in different forms over the last 35 years (Newman and Kenworthy, 1989; Kenworthy and Laube et al, 1999; Newman and Kenworthy, 1999; Newman and Kenworthy, 2015; Schiller and Kenworthy, 2018; Kenworthy, 2013a, b, 2014a, b; Priester et al, 2013). The data presented here are for 1995 and 2005 so that changes can be seen. Note that only Singapore and Hong Kong, as representatives of wealthier, more developed Asian cities are included.

Environmental Problems of Automobile Dependence

The problems for urban livability and sustainability which widespread use of the automobile in cities has created are well known and hardly need detailed elaboration. Some of the more significant environmental issues are listed in Table 1. We have become somewhat desensitized to and accepting of these problems because our perception of the urban environment in cities where automobile dependence is endemic and where its associated problems are rife, is largely shaped by the view through the windscreen of an automobile. The environmental impacts of the automobile are especially hard on children whose once rich street and community experiences have been replaced by anonymous and mind-numbing chauffeured trips in cars and the parents of these children spend

much of their spare time during the week engaged in "serve passenger" trips, to use the transport planning jargon. But again, after several generations of living with the automobile, such problems have become part of life and what has been lost is often not appreciated or understood (Figure 3). Part II discusses in more detail some of these problems for children and vulnerable populations generally and shows in part why it is so important to develop creative solutions to auto dependence.

Naturally these problems tend to become more visible and extreme in cities as automobile dependence escalates. Figure 4 from our detailed comparative work on cities over almost 40 years, shows how the key indicator of automobile dependence, the annual level of car use per person, varies dramatically around the world.

US cities have extreme levels of car use and experience some of the most potent, widespread and intransigent combinations of problems listed above. On the other hand, European and wealthy Asian cities have much less car use per capita and less dramatic manifestations of these problems, though no city is exempt from bad cases of all the problems in Table 1.

One sees particularly how local emissions per capita of the main transport air pollutants (CO, VHC/VOC, NO_x, SO₂) vary systematically with the level of auto dependence shown in Figure 4. Figure 5 illustrates that per capita transport emissions decline with declining car use. One sees that the American cities in 2005, had almost a five-and-a-half times higher per capita emissions than the Asian cities. The European cities are almost identical to the Asian cities despite significantly higher car use, due to their more stringent emissions standards.

Environmental Problems of Automobile Dependence
• High energy use
• High air pollution
• High traffic noise
• Severance of neighbourhoods
• Destruction of rural and natural landscapes
• Deterioration of the public realm

Table 1: Environmental problems in the automobile-based city



Figure 3: Low density, single-use suburbs designed around the automobile with little to walk to and long distances, leave little possibility for the independent mobility of children (Perth, Western Australia).

Some of the other factors in Table 1 are more difficult to quantify, though a discussion of energy use in transport is provided in the next section. As well, the consumption of land for sprawl, roads and parking is a major environmental as well as economic problem in many cities (Schiller and Kenworthy, 2018). This is indicated in Figures 6 and 7, the latter of which shows the urban densities characteristic of cities around the world (urban density includes all urbanised land for all purposes). The data clearly demonstrate how the auto cities of the US and Australia are exceptionally low density, consuming large quantities of land per person compared to cities in Europe and Asia. Even Canadian urban regions have about twice the density of US and Australian cities.

Traffic noise, neighbourhood severance and deterioration of the public realm are more difficult to specify and we have not collected systematic comparative data on these factors. However, from observation and from detailed discussions in other work, traffic noise pervades every aspect

of life from intrusion into dwellings and work places to the inability in some cases to converse in public places. Furthermore, since the automobile began to dominate urban transport systems, neighbourhoods have been carved in two by large freeways and roads have been widened making it impossible for neighbours to maintain contact across their own streets (Appleyard et al, 1981). The public realm has suffered immeasurably as streetscapes have become dominated by car parks, roads and the other paraphernalia of auto dependence (Whitelegg, 1993, 2016; Newman and Kenworthy, 1999).

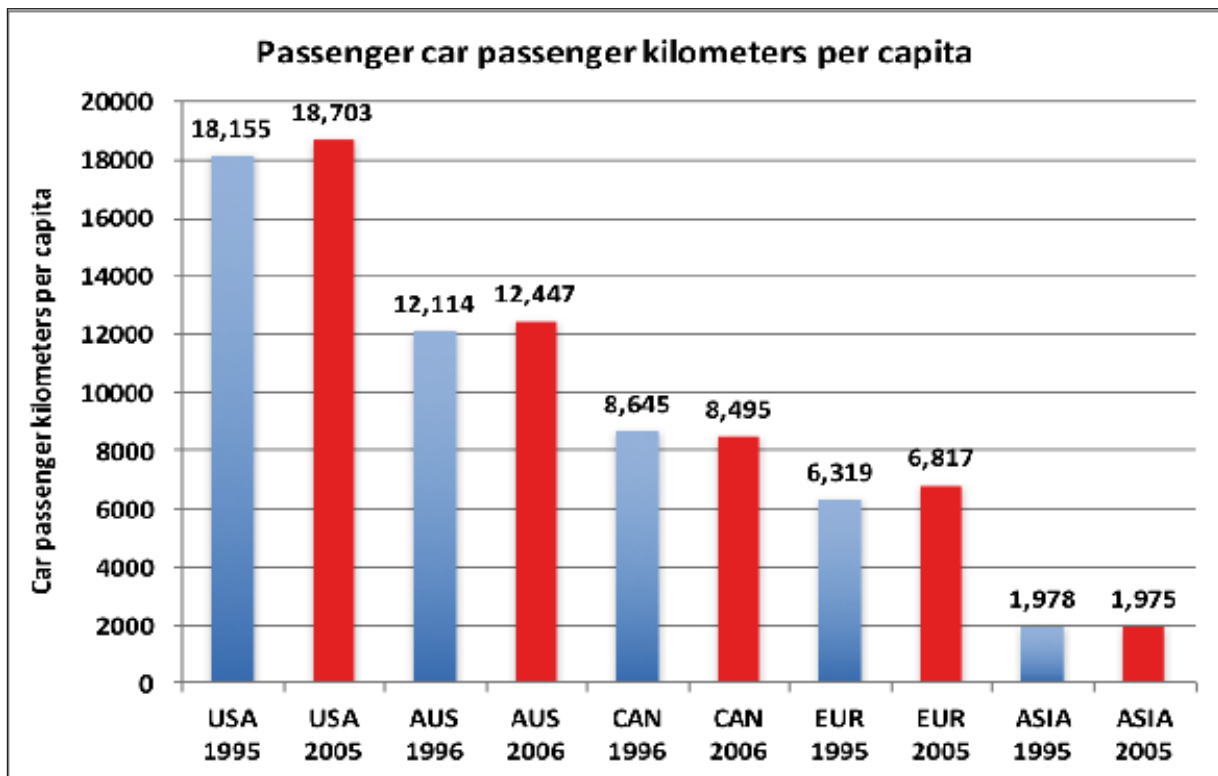


Figure 4: Trends in car use per capita in global cities, 1995-2005.

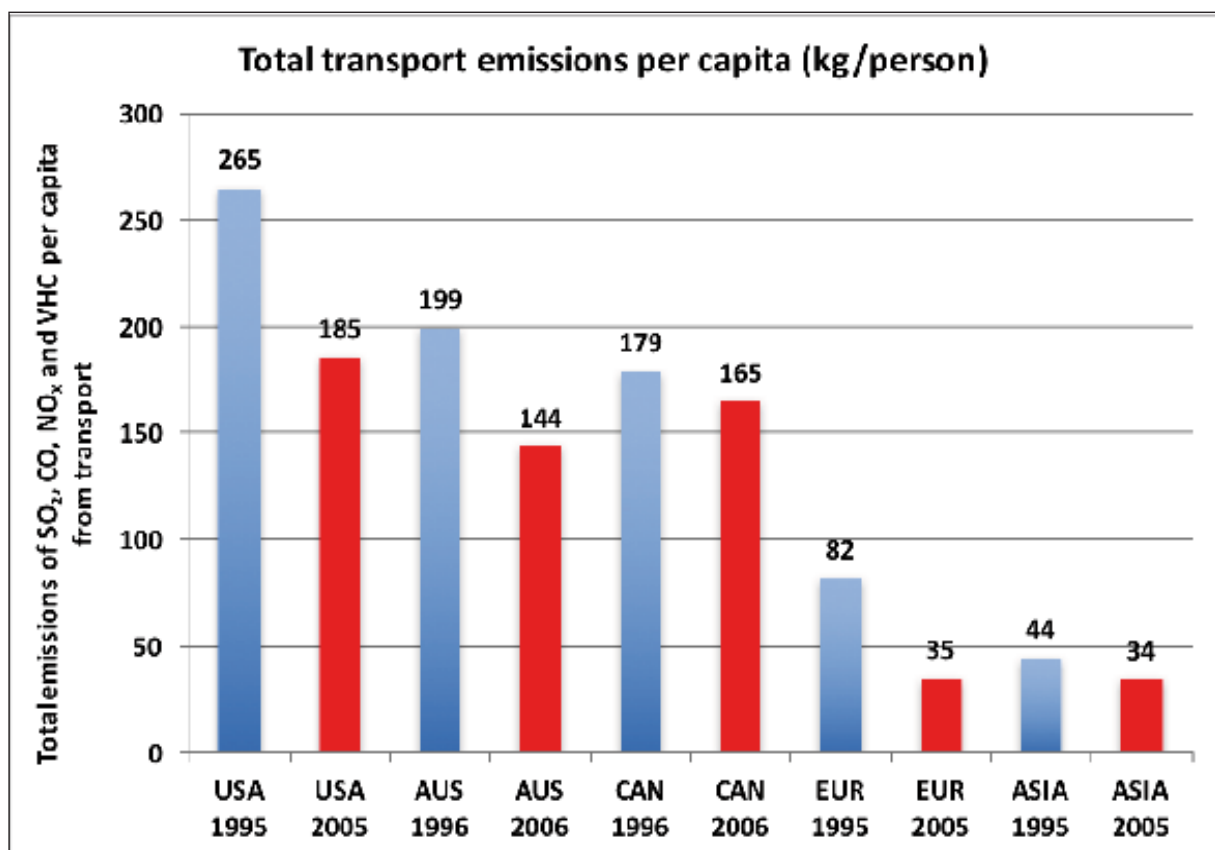


Figure 5: Per capita transport emissions in global cities, 1995-2005.



Figure 6: Perth, Western Australia - large land consumption for housing and roads.

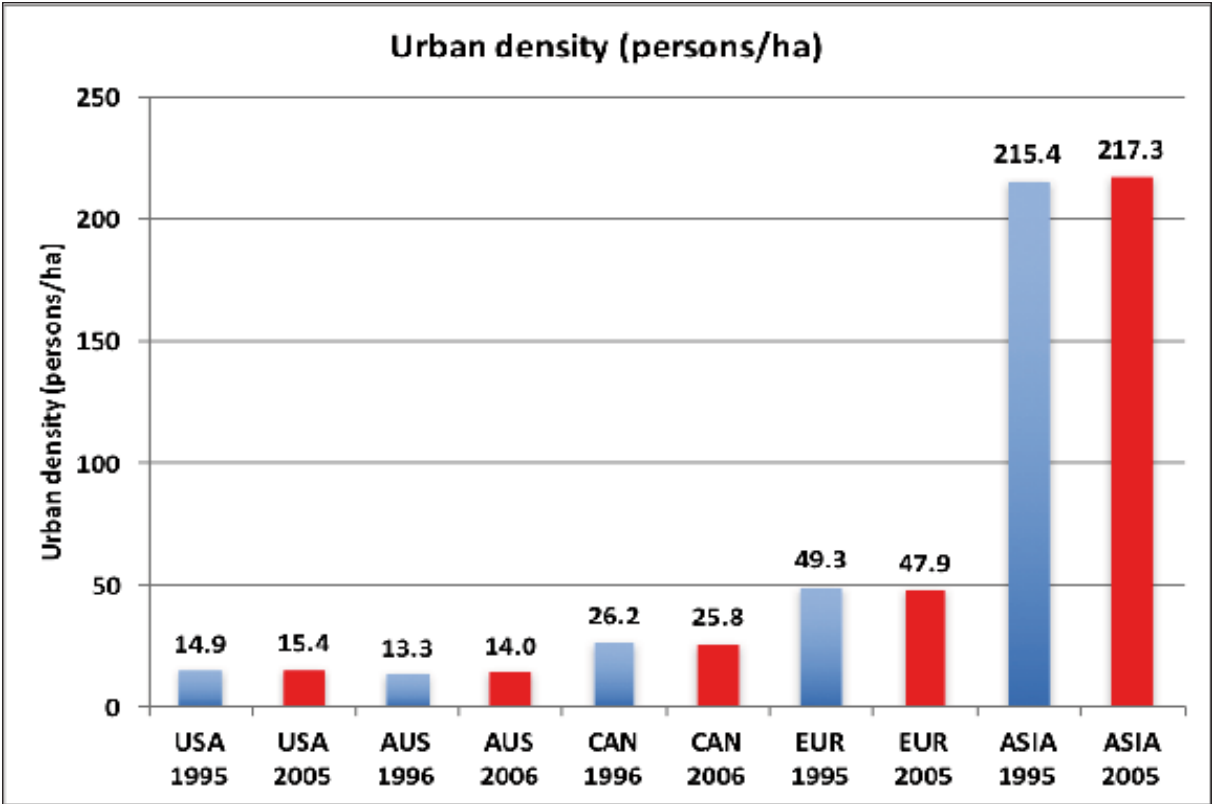


Figure 7: Urban density in global cities, 1995-2005.

Some Characteristics of Automobile Dependence

Cities vary quite systematically in many physical characteristics according to their degree of auto dependence. For example, one of the factors that facilitate high levels of auto dependence is the extent of the freeway system (Figure 8). Auto cities in the US and Australia clearly have much greater per capita freeway provision than those in Europe or Asia (Figure 9). Generous freeways and their grade-separated interchanges have a dramatic effect on the urban environment in terms of space consumption and community severance. Urban sprawl that is facilitated by high capacity extensions to the road system consumes vast quantities of rural and natural land.

Cities that have committed themselves to the automobile in an intense way also must devote vast areas to parking lots. This issue is drawn into sharp focus in the central city area. The number of parking spaces per 1000 CBD jobs shows a dramatic pattern of variation around the world with cities in the USA having more than one parking space for every two jobs in their CBDs, while the two Asian cities average

little more than 1 parking space for every 10 jobs in their CBDs (Figure 10). The negative effect of high parking availability is clearly seen in the vast, sterilised and fragmented public realm that has come to characterise many US and Australian cities (Figure 11).

One of the key resource outcomes of these patterns of automobile dependence is how much passenger transport energy the urban systems require. This naturally follows the level of car use and shows how utterly dependent the US cities are on cheap and readily available conventional oil and how comparatively little energy is expended on public transport (Figure 12). Other cities in Australia and Canada have an unhealthy dependence on oil too, while cities in Europe, but especially in Asia, seem much better positioned in a global context to weather any forthcoming oil shock or price hike.

It must be remembered that dependence on oil is potentially one of the most destabilising geo-political problems in the world and that the US particularly seems prepared to go to war to protect its regional oil interests (Campbell, 1991; Fleay, 1995; Campbell and Laherre, 1995).



Figure 8: Large land consumption of freeway right-of-way (Miami).

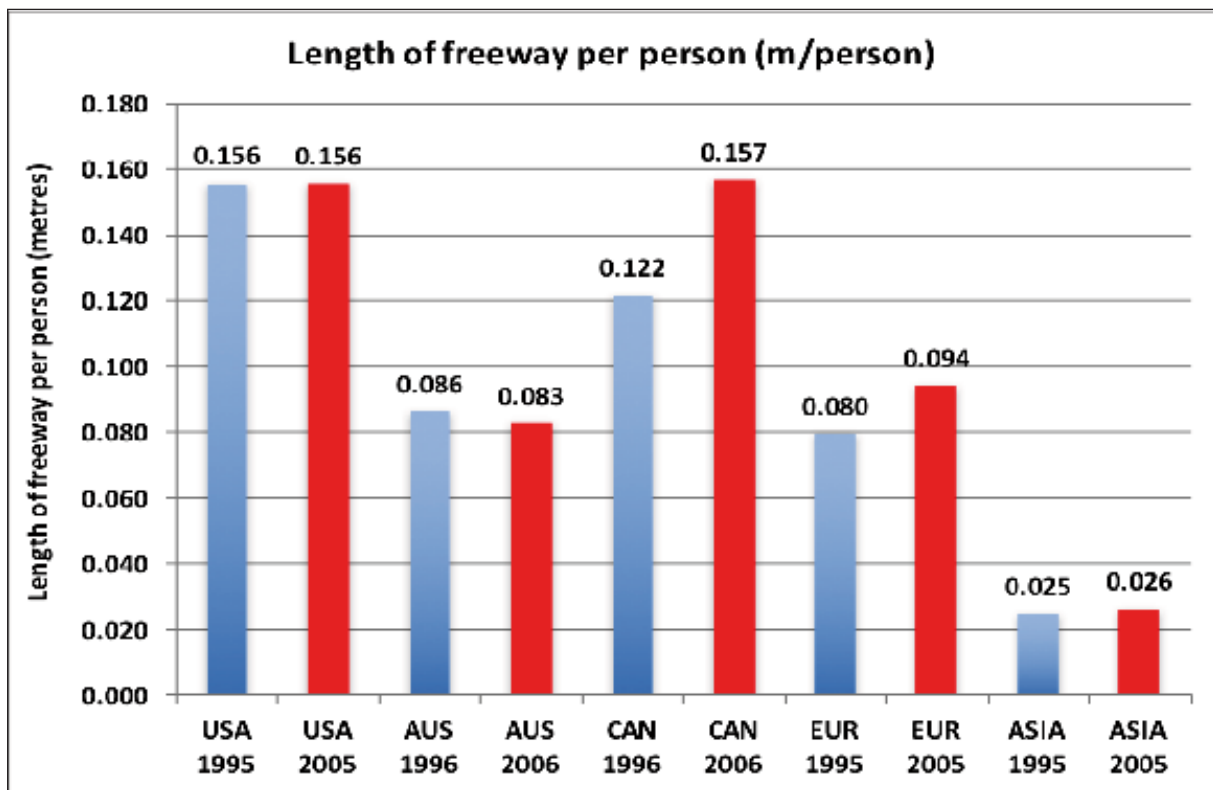


Figure 9: Length of freeway per person in global cities, 1995-2005.

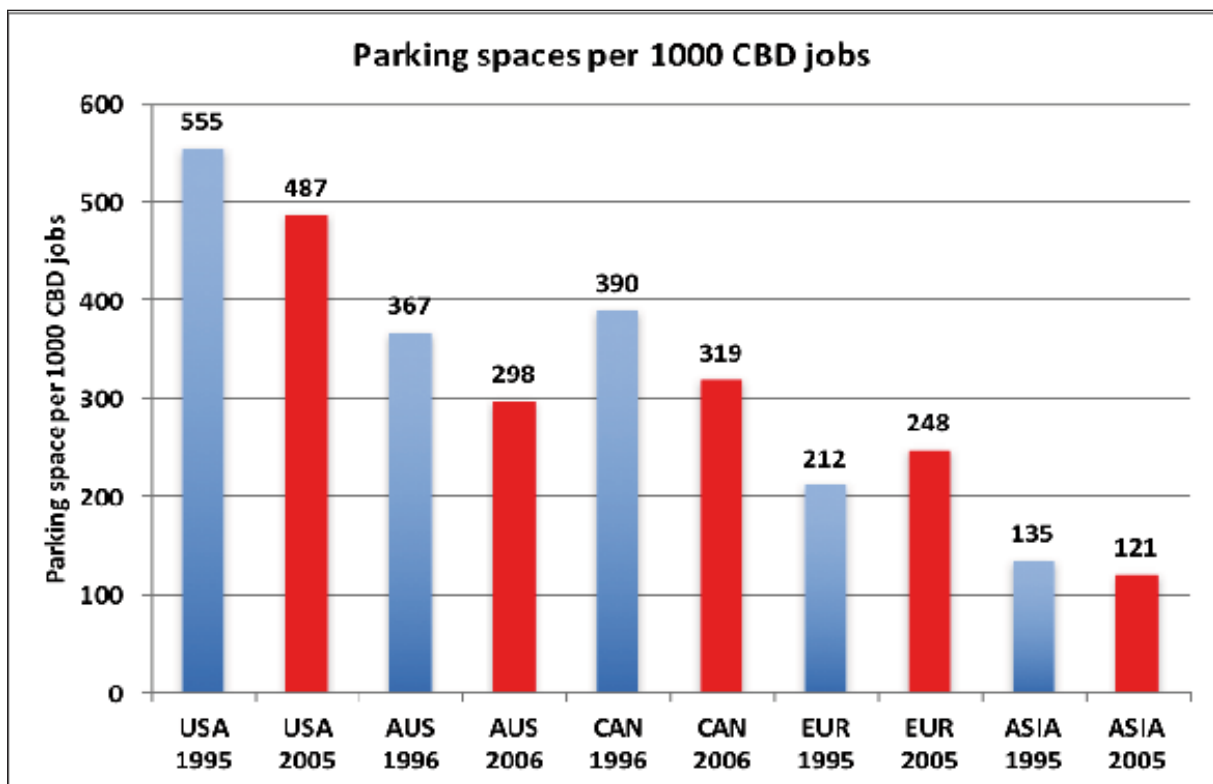


Figure 10: Central business district (CBD) parking spaces per 1000 jobs in global cities, 1995-2005.



Figure 11: Vast land consumption required for parking in cities such as Los Angeles.

Social and Economic Problems of Automobile Dependence

The livability and sustainability of cities are significantly undermined by a whole host of social and economic problems attributable to automobile dependence. Some of the key problems are summarised in Table 2.

The US cities have mostly reduced their public transport systems to a mere social safety net, while the Asian and European cities have public transport systems that are central to the life and character of those cities and are used extensively by everyone.

Social and Economic Problems of the Automobile-Based City
• Decimated public transport systems
• Little opportunity for walking and cycling
• Reduced mobility for those without cars
• Traffic accidents and deaths
• Loss of urban community - social isolation
• High costs of operating passenger transport

Table 2: Social and economic problems of the automobile-based city.

The first issue in Table 2 is clearly illustrated by existing patterns of public transport use around the world’s cities shown in Figure 13. Some 97% of all passenger movement in US cities is by private motorised modes (mainly cars), whereas in the two wealthy Asian cities the figure is 37%.

Likewise, in auto-based cities the role of walking and cycling has gradually been eroded and it is difficult for these modes to compete for many trips. This is not just because of distance (in fact large numbers of trips in auto cities are short and quite comfortably managed on foot and bicycle),

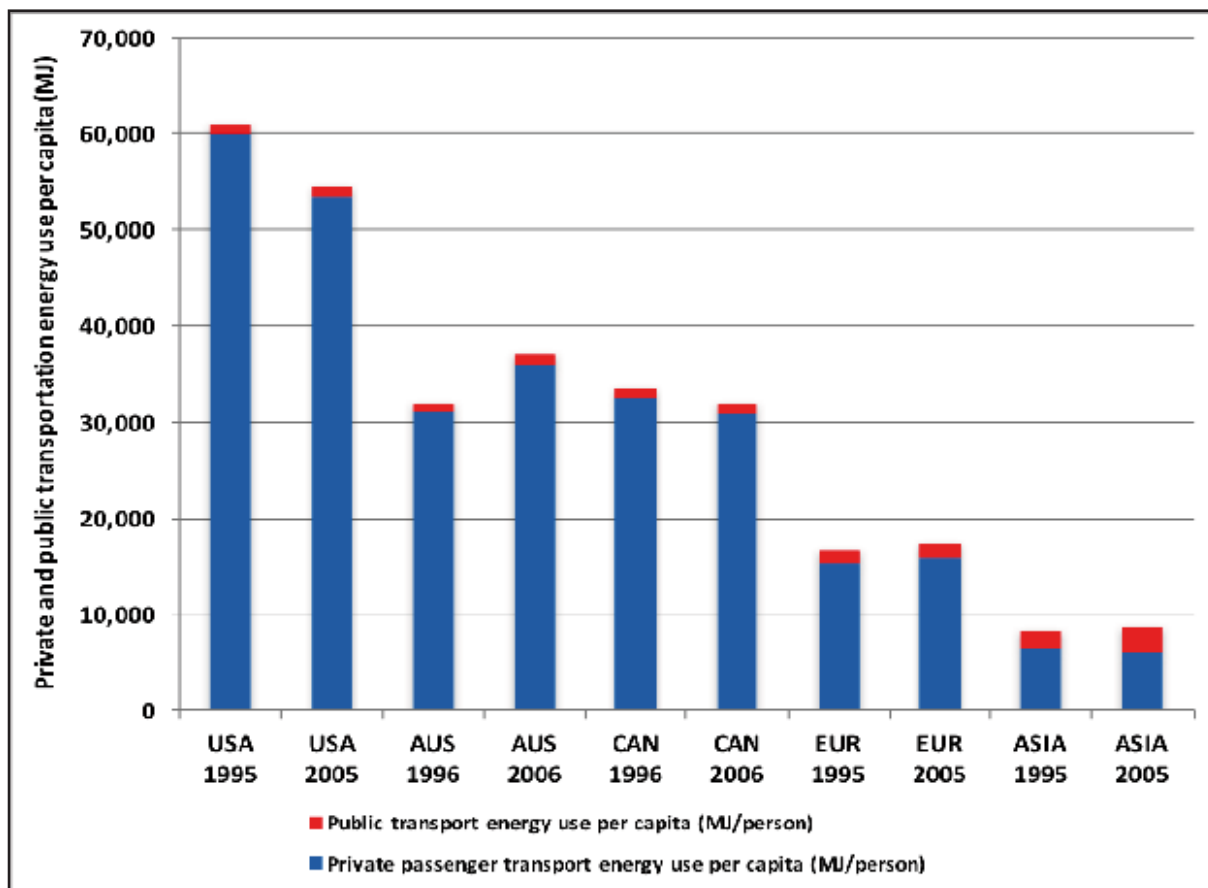


Figure 12: Private and public passenger transport energy consumption per capita in global cities, 1995-2005.

but because the public realm has been made so hostile to non-motorised transport that it is gradually being squeezed into oblivion.

However, in developed cities efforts have been and are being made to assist a return of these most sustainable modes, with varying degrees of success (e.g. Pharoah and Russell, 1989; Roberts, 1989a, b; Buehler and Pucher, 2011; Buehler et al, 2016).

Linked to the decimation of public transport, walking and cycling in auto environments is the escalating road trauma seen in the patterns of death from transport causes (Figure 14). These data follow the patterns of car use and show how exposure to the automobile by way of high levels of use is the key factor in determining transport deaths. Transport deaths in cities amount to billions of dollars in external costs every year, but this seems to be largely absorbed or accepted by society as natural or inevitable (Whitelegg, 2016). A war inflicting the same losses on a country with soldiers returning in body bags would

most likely result in a change of government. The data show that in every region, transport-related deaths declined significantly between 1995 and 2005. Some of this would be the result of improvements in vehicle technology (e.g. air bags), but some of it may be reduced exposure of vulnerable populations (children, the elderly) due to withdrawal from walking and cycling because of the perceived danger of these modes resulting from traffic and lack of facilities for pedestrians and cyclists.

Figure 15 shows the proportion of daily trips that are catered for by walking and cycling. Notwithstanding the above problems, there is some good news in these data. Non-motorised modes have slightly increased their share of trips over the decade, except in Australian cities where they declined marginally. The bad news is that with only between 9% and 14% of daily trips by these most sustainable modes in American, Australian and Canadian cities, it indicates the difficulty of choosing such modes in auto-dependent environments, especially for children, when this is combined with fears about "stranger danger".

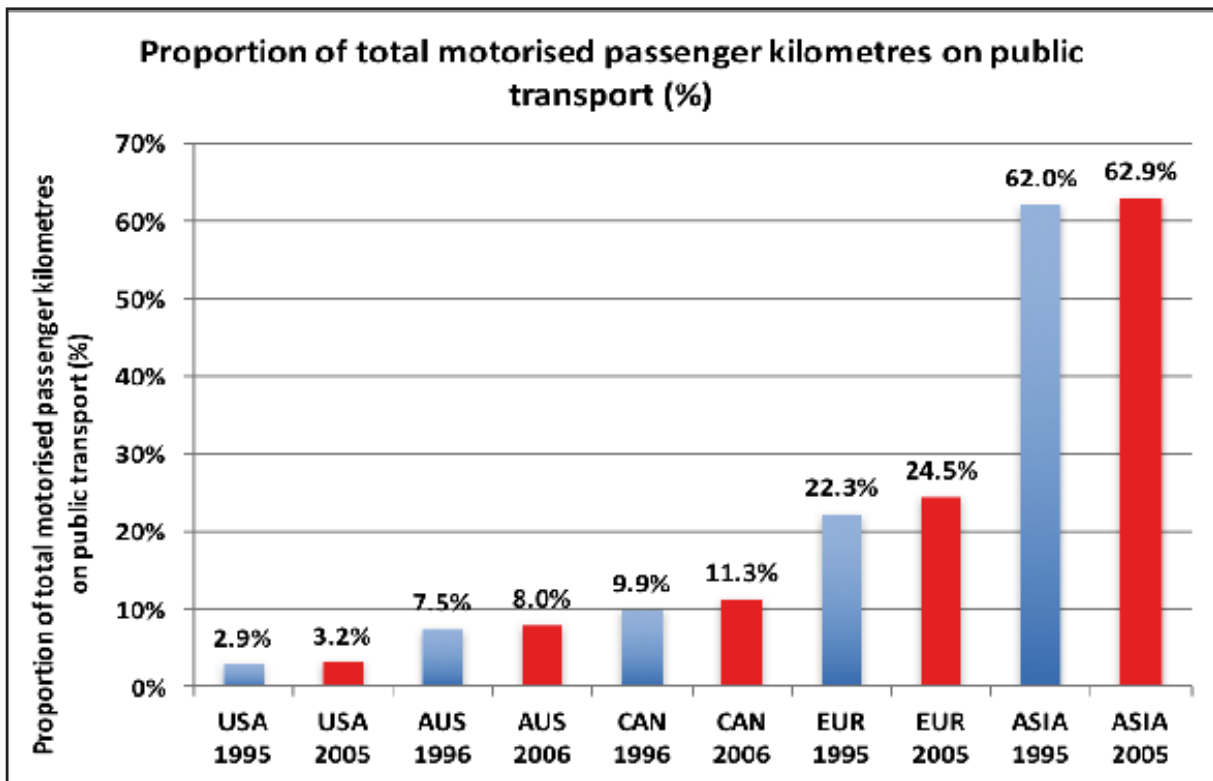


Figure 13: Public transport's share of total motorised passenger kilometres in global cities, 1995-2005.

A more difficult to quantify area that is negatively impacted by automobile dependence is the quality of neighbourhoods and community life. Traditionally in cities that were based around walking, cycling and public transport, housing was more densely developed. Frontages and en-

trances to dwellings and business were arranged in such a way along the street or in courtyards which allowed for the possibility of friendly interaction and "accidental" meetings which are the stuff of urban community (Engwicht, 1993). Businesses were mixed with housing and streets were

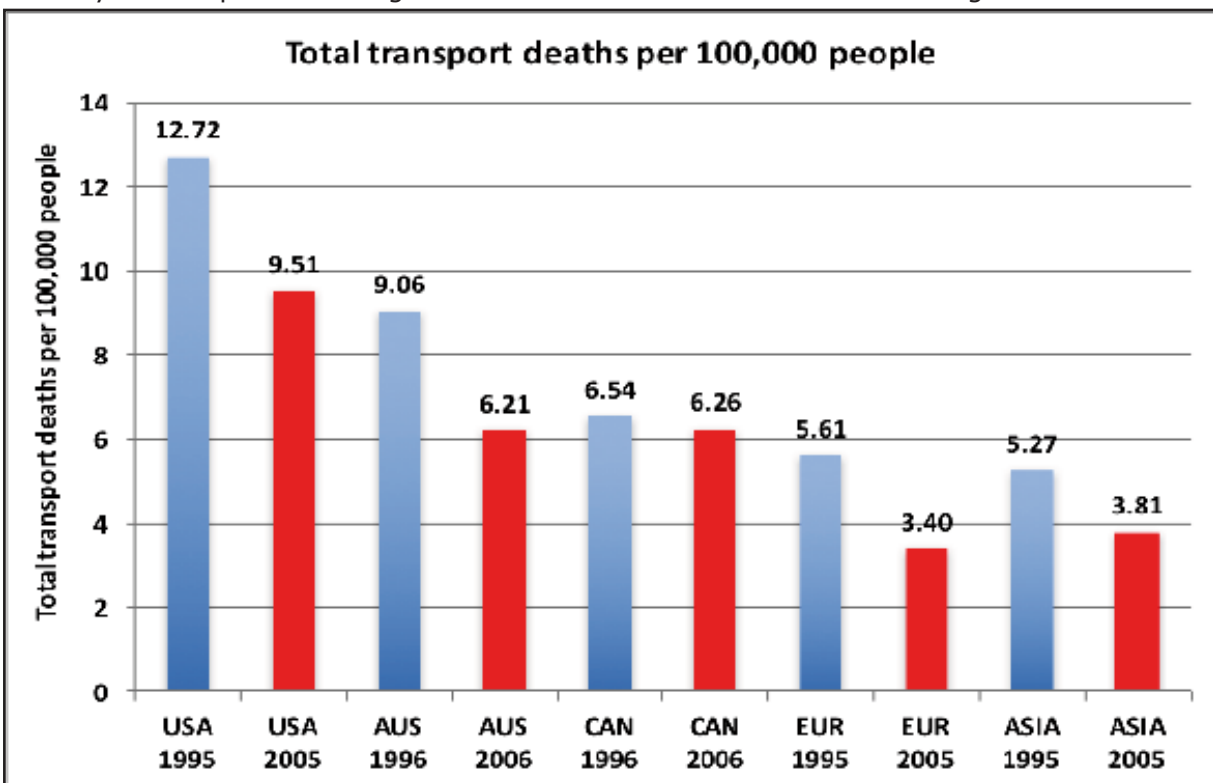


Figure 14: Transportation-related deaths in global cities, 1995-2005.

lively, human places. Streets were for social interaction and for children to play in, not just for movement.

This changed as the automobile took over. Streets became passages for motor traffic rather than places. Houses became separated, other activities were zoned out, people entered and left properties by car and streets became deserted and certainly not places where children were expected to play. Some cities such as Freiburg im Breisgau in Germany are bringing back these qualities (Figure 16).

The gradual or not so gradual switch in cities from urban living to suburban living parallels increased privatism and a weakening of the connections between people at a local level (e.g. Davis, 1990). The negative consequences of this trend are felt in many areas such as increased need for formal policing, vandalism, youth problems, increased crime, problems of social isolation for those without direct access to cars and so on.

A final area for which we have collected data is the costs of operating transport systems in cities. Our 1995 data show that the proportion of a city's gross regional product (GRP) that is spent operating both

private and public passenger transport is much higher in auto-dependent cities than in cities that rely on so-called expensive and heavily subsidised public transport systems or on the cheapest modes of all, walking and cycling (Kenworthy and Laube, 2001).

The result of this is that car-based cities will tend to have less money available for investment in productive or income-earning economic activity or on other societal uses such as good education and health care. This is because a disproportionate amount is invested in the infrastructure of sprawl which will also tend to make them less competitive in a global economy (Frost, 1991).

This concludes this brief overview of the problems of automobile dependence in modern cities. It suggests that the more auto-dependent cities are tending to lose, economically, environmentally and socially compared to cities with more balanced transport systems and more compact patterns of land use.

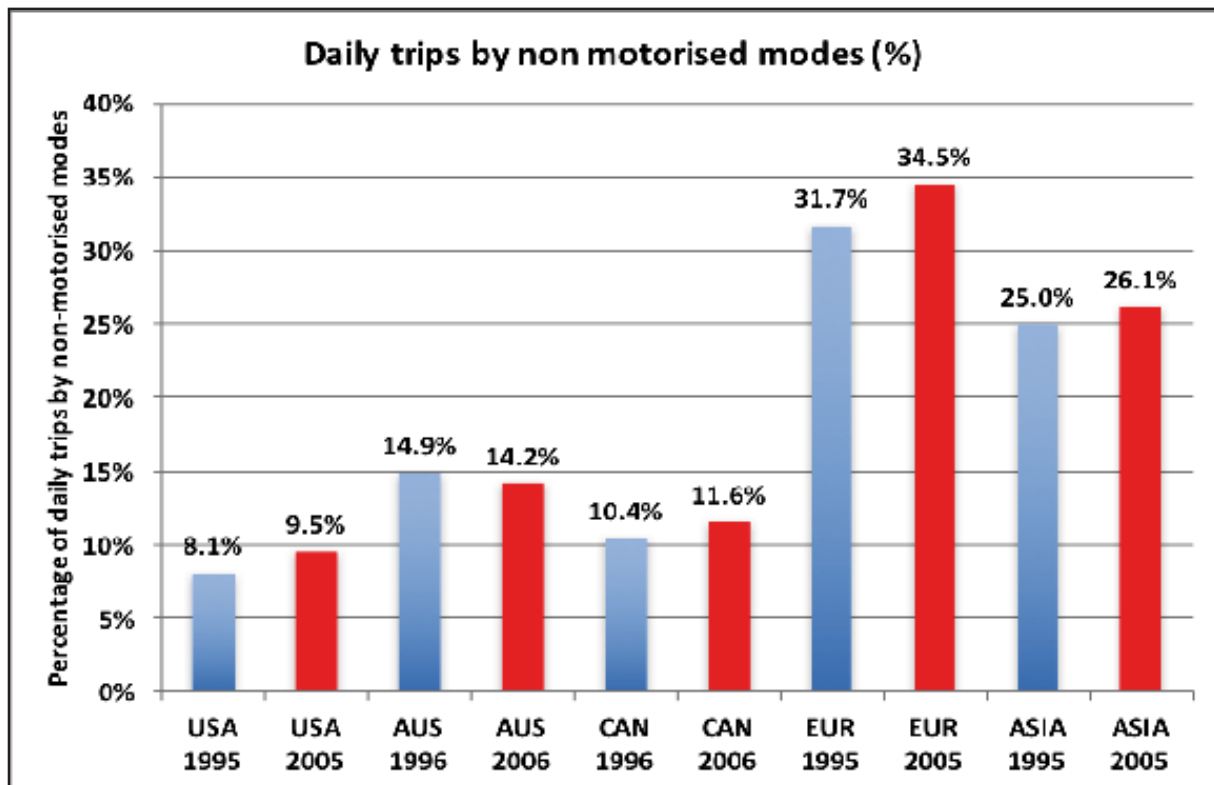


Figure 15: Modal split of all daily trips by walking and cycling in global cities, 1995-2005



Figure 16: Children have independent mobility in Vauban, a model ecological neighbourhood in Freiburg im Breisgau, Germany

Part II – More livable and sustainable cities - a rationale for revising the suburban, car-based model

Some Key Themes

Flowing on from this international overview of the patterns of automobile dependence, this section argues in more detail for a revision of the suburban, car-based model of urban development. Three key themes are argued:

- *The need for community* - The focus in automobile dependent cities on the sanctity of the suburban, detached house as the only acceptable living environment, has shaped a highly privatised view of the world in which 'isolation' rather than 'connectedness' has become a norm; the importance of 'community' for both adults and children has been severely downgraded. As this has happened our public spaces have been downgraded, not only streets and other interstitial spaces, but also public transport systems. There is an irony in this for the institution of the family, the one social institution deemed to gain most

from suburbia. The obsession with the privatised, suburban family can lead to enormous extra pressures on family life. This is because the burden of responsibility for most of the needs of everyday life (material, social and spiritual), falls heavily on individual households, whereas some of these needs are inherently a function or even responsibility of the larger community within which family life should be grounded.

- *The need for higher densities* - The previous section has shown the low density nature of automobile cities and has implied the need to address this factor in reshaping cities into more sustainable forms. However, the strong emotional attachment to low density suburbia leads many in auto-based cities to label most attempts at higher density development as necessarily bad. For example, Stretton (1989, 1994) and Troy (1992) in Australia provide arguments in favour of suburban environments and against density increases. There has been generally, though this is changing, a very low recognition and understanding in

automobile dependent cities that other attractive forms of housing exist which have the potential to shape a different, more people-friendly and supportive environment, while still meeting people's needs for open space and privacy. It is argued that higher density development in the form of urban villages or TOD can provide, for many households, both with and without children, an attractive and convenient way of life. For too long high density living has been labelled as negative in social terms, while suburbia has been largely accepted as providing a better quality of life for most people, especially families. Such views are being increasingly challenged because they overlook positive aspects of higher density settings and some of the negative features of suburbs.

- *The need to reduce automobile dependence* - Along with an obsession with the suburban home has come a love affair with the car, which is reflected in the data on car use in cities in the previous section. The car is marketed as an essential consumer good and as an object of desire - as the only way people can avail themselves of the resources of both city and country and maintain or enhance their social standing and enjoyment of life (Schiller and Kenworthy, 2018). Public transport, walking and cycling are rarely promoted as viable means of transport for all people and yet they clearly are in many societies (Figure 17). This is again reflected in the large differences in transit use between cities in the previous section.



Figure 17: In rapidly motorizing cities such as Bangkok, both regular and electric cars are aggressively marketed everywhere.

The low-density nature of suburbia, with its lack of interspersed other activities such as work places and corner stores, means that a large proportion of trips are difficult to serve by public transport, walking or cycling. Trying to provide for transport needs across generations and different activity patterns is hard without neighbourhood-based services and facilities or without good public transport and safe infrastructure for walking and cycling. Older people, children, those with disabilities, those who cannot afford a car, and people stuck at home without the household car, find it extremely difficult to maintain independent access to their everyday needs and needed social contact, unlike in many European cities (Figure 18). People with cars are placed in the role of chauffeurs and the burden of responsibility for providing expensive transport resources falls on the household unit. This can create both economic hardship and stress. What is more, the design of urban environments around the car means greater dangers especially for children and older people - this comes about both from traffic and a lack of people in the streets to help maintain security, especially at night (Jacobs, 1961).

It is argued here that for cities to become more livable they must have good public transport systems that cover most of the destinations people need and the vehicles themselves must be accessible to the least able members of society. It must become possible for people to meet a significant number of their needs on foot and bicycle in the local area through better infrastructure for these modes and better land use planning. It is also argued that to create more livable urban environments that better meet peoples' needs, streets must again become places for people, not just passages for motor vehicles. Cities have been in existence for many millennia, but streets have only since World War II, become the sole province of motorised vehicles.

On at least some of this, even the proponents of suburbia can agree. Stretton (1994) argues quite strongly against the private car and the destructive system it has created and says that "Australians would rather lose their cars than lose their cars and their houses." (p. 136).



Figure 18: People, especially children, need to again feel comfortable and safe in a city's public spaces, such as here in Budapest.

Cities, Density and Community

There has been an enormous amount of research and policy discussion within many different disciplines about the effects of population density on people and their quality of life. Much of this has focussed on the alleged negative effects of higher density in terms of stress, social breakdown and other disorders. There is also a well-documented literature on the anti-urban traditions of Anglo-Saxon culture - life in rural areas and the bush has been romanticised and viewed as uplifting and purifying, while the city is seen to corrupt moral virtues. The suburbs provide an escape from most of what was bad about city life, and achievable without leaving the city (Newman and Kenworthy, 1999).

Various authors have pointed out the fallacies in such views. Newman and Hogan (1981) reviewed an extensive range of literature and found that most of the research purporting to show the negative physical and social effects of higher densities has been overturned, or the results are explainable in terms of other factors which have little to do with density per se. Wohlwill and van Vliet (1985) provide a far-ranging discussion on the impact of density on children's habitats. Wohlwill (1985) points out that developmental psychologists have paid little attention to the density variable in their work - they have been primarily concerned with the quality of parent-child relationships and the effects of siblings and peers. They have not considered how few or how many interactions children have with people, yet some authors have suggested that such factors are 'far from negligible' (Wohlwill, 1985, p18; Jacobs, 1961).

Important here is that the first approach tends to focus on the development and welfare of individuals in isolation from the broader community setting in which they exist. By contrast, the latter begins to recognise broader environmental influences...the influence of 'others' on children's development (or, as put by Wohlwill - "the rate of encounter with other unspecified individuals"; p.17).

There is also a paradox here. Wohlwill sums it up saying:

"...the emphasis in past research and discussions of density has been almost entirely on one end of this [bipolar] dimension, i.e. the high density or crowding pole...Yet possible effects of low rates of social interaction have rarely been considered...Curiously, this situation is just the reverse of what has happened in the field of sensory stimulation, where virtually all of the work has been concentrated at the low-stimulation end (e.g. the effects of sensory deprivation)...what does low density mean, and to what extent is it equivalent to physical and social isolation?" (Wohlwill, 1985; p18/19).

It is not the intention here, nor is it possible, to review the plethora of research into such questions. The issue has rather been raised to introduce an important point. What value do we place on community in our thinking about city livability and sustainability, and how might more communitarian environments assist in creating more livable and sustainable cities?

Jacobs (1961) is unashamed in her support for big, dense, diverse cities and claims that places such as the North End of Boston and Greenwich Village in New York with their busy street life present more interesting and complex environments for human development (Figure 19). In a discussion of liberalism and civic virtue, Lasch (1991) takes Jacobs' work in such cities and shows the link between the communal life of cities and the stability of family life. After a discussion of the failure of the school system (or more generally, "formal systems of socialization") to replace the physical, mental and social training of the child that should occur in families, Lasch goes on to explain the importance of informal associations in developing social trust and human potential. These are the very associations that are to a strong degree dependent on the density at which people live and the quality of the public realm through which they must move and which have been grossly neglected in modern conceptions of what is good in city planning.



Figure 19: Jane Jacobs' beloved North End of Boston, today still a high walkable, compact, mixed use environment also catering for bikes.

"The informal associations that have been allowed to wither...include not only the family but the neighbourhood, which serves much more effectively than the school as an intermediary between the family and the larger world. Jane Jacobs speaks of the 'normal, casual manpower for child-rearing' that is wasted when city planners and other well-meaning reformers seek to get children off the streets into parks, playgrounds and schools where they can be professionally supervised." (Lasch, 1991; p64).

Lasch goes on to talk about the way in which city streets teach lessons available nowhere else. This can include, perhaps, the way in which a child scolded by a local shopkeeper for running onto a road, learns that adults unrelated to each other, except by propinquity, maintain certain civic standards by assuming responsibility for a neighbourhood. Jacobs again:

"The myth that playgrounds and grass and hired guards or supervisors are innately wholesome for children and that

city streets, filled with ordinary people, are innately evil for children, boils down to a deep contempt for ordinary people...people must take a modicum of public responsibility for each other even if they have no ties to each other" (quoted in Lasch, 1991; p. 64).

Los Angeles epitomises the breakdown of what Jacobs calls "casual public trust" with devastating results on many levels. There is a pervasive sense of fear in the city's public environments, despite most people living in the suburban homes that are the hallmarks of the Australian and American dream, though more recently even LA has been developing more people-oriented spaces (Figure 20). Davis (1990) in the City of Quartz talks of the "militarization of city life", the "ecology of fear" and of "Fortress LA" - a city of secured gated communities, of high-tech surveillance and para-military style action to repel intrusion.

Lasch explains that Los Angeles demonstrates the logical extreme of liberal philosophy, the most important pillar of which

is privacy - "the privatization of the good life" and relief from most civic obligations. But this has been with disastrous results because public order must be largely by self-policing and cannot be just 'handed over'.

To sum up, Lasch again refers to the important role Jacobs assigned to city streets:

"City streets, as Jacobs reminds us keep the peace and instruct the young in the principles of civic life. Neighbourhoods recreate many features of village life celebrated in American folklore...Neighbourhoods provide the informal substructure of social order, in the absence of which everyday maintenance of life must be turned over to professional bureaucrats. In Los Angeles, a city deliberately designed to maximize privacy, we see how this hyperextension of the organizational sector is the necessary consequence of the retreat from the neighbourhood." (Lasch, 1991; p.65).

It is instructive to remind ourselves that the world of Los Angeles can be seen in microcosm in many cities:

- the call for more and more police to patrol city streets; the retreat from public transport systems by women, especially after dark;
- fears for personal security in central areas after office hours;
- a retreat by families from the traditional centres and sub-centres which are the civic focal points of our urban communities;
- a trend towards more centralised electronic surveillance of public spaces such as rail stations, trains and city squares;
- the walls that go up around new suburban development, ostensibly for exclusivity and status, but at root to create a sense of enclosure and retreat from the rest of the city;
- the tendency towards higher levels of domestic security systems;
- the increasing lawlessness in suburban streets, epitomized oft-times in the public's mind by the increasing incidence of car theft and car chases.



Figure 20: Los Angeles too is gradually changing in small projects towards more human-scale, shared environments.

The list goes on. The Mayor of a large suburban municipality in Melbourne once said that "the only safe place left is my house and the cocoon of my car" (Kenworthy and Newman, 1991). In 1992, the Community and Family Commission found in a survey that a significant number of people in Perth, Western Australia wanted to see more local community resources and activities, more local involvement to break the anonymity of suburban living. Essentially, they expressed a desire for more village-like qualities in suburban environments.

Hugh Mackay, in an article about what life in Australia might be like in the next century, made some powerful points about the deterioration of community in Australian cities. A major thrust of his piece is the way we all help to change the nature of neighbourhoods through relatively simple choices such as saving a few cents at the regional supermarket versus buying from smaller local shops. But his major attack was on the car and its role in the deterioration of neighbourhoods.

"If you've decided to be a two or three-car household, you've already established some fundamental patterns for your own life in the 21st century. For a start, you've increased the probability that you will continue to be a stranger to neighbours you never meet on the footpath. We may complain about the loss of a sense of belonging to a local community but, by our perfectly understandable enthusiasm for the car, we've taken such giant strides away from a communal life that we can hardly expect the community to re-emerge all by itself...The fear of urban violence... has already gripped many older people and many parents of young children... But many of us have already decided to create a climate of fear, which is conducive to violence, by teaching our children to avoid eye contact with strangers and by staying away from public spaces, such as streets and parks, which if only we thronged them would remain safe." (Mackay, 1994).

He goes deeper into the phenomenon of community decline in Australian cities, referring to the idea of "caving", which he

used to characterise suburban life in Australia in the 1990s. He describes "caving" as an:

"...ultimately defensive form of escapism: a retreat to the comfort, privacy and, above all, security of home base... There is a growing emphasis on entertainment and recreation equipment being installed in the home, to minimise the need to go out...as the sense of neighbourhood community gradually broke down in the '70s and '80s, we developed a compensatory obsession with the notion of privacy which, in turn, further fuelled the fortress mentality." (Mackay, 1993).

The major point that I wish to make here is that it is extremely difficult to maintain any sense of community or togetherness in an urban environment if the very physical structure essentially builds out any possibility of casual interaction. In other words, it is difficult to have a livable and sustainable city if unplanned encounters which do not constitute an invasion of privacy, but which help maintain a sense of belonging and can lead to unexpected loose social connections and mutual support systems, are eliminated.

In discussing the merits of dense neighbourhood redevelopment, Allen (1980) suggests that many suburbs can be quite ethnically diverse but that:

"the failure of the suburbs as a physical arrangement lies in their low densities. The suburbs create the illusion of homogeneity because one seldom sees or has face-to-face contact with different kinds of people...The real ingredient that is missed in the suburbs is density." (Allen, 1980; p. 416).

Along similar lines van Vliet (1983a) has tackled the widely-held belief that families, and particularly children, living in apartments (a more extreme form of high density living) has inevitable detrimental effects. He provides evidence that supports the benefits of increased density, particularly the need for a critical mass of population to "support the desired type and quality of facilities and services within acceptable distance from the home." (p.

215). He also reports evidence which suggests that the wider urban context of the apartment is important, particularly access to community facilities, public transport and proximity of other children, which tends to eliminate any boredom of apartment living. He concludes that "...specific factors may also create situations in which apartments are an acceptable and satisfactory form of family housing." (p.228).

This conclusion regarding density, or at least the style of urban environment, is borne out in a different way by authors who have looked at issues to do with cognitive development of children, a feeling of belonging and the development of competent functioning in the urban environment. Lynch (1977) summarises the results of a cross-cultural examination of how adolescents (13-14 year olds) function in and perceive their urban environments. The study involved communities in six cities covering four nations - Salta in Argentina, Melbourne, Australia, Warszawa and Cracow in Poland, Toluca in Mexico and Ecatepec in Mexico City. Bearing in mind that the survey work was conducted in the early 1970s when all cities were significantly less dominated by cars and traffic, the study still has some interesting results. Results relevant to the present discussion are summarised below, focussing particularly on Melbourne as an example of an auto-dependent environment.

- Streets and courtyards, their own room and to a lesser degree, sports facilities, wastelands, natural open spaces and the central cities, are the places that adolescents talk about when asked what they do, their places of interest and how they spend their time (or would like to). An exception is one Mexican community where streets and narrow footpaths are so dangerous with speeding traffic and the solid walls lining the streets have no recesses, that children retreat to the parks and playgrounds.
- Major barriers to movement were not distance but fear, dangerous traffic, a lack of spatial knowledge, cost of public transport and parental control.
- Melbourne children had by far the biggest physical range but were exposed to a restricted variety of people, were less at ease in areas unlike their own and

were less familiar with their central city.

- Children in Melbourne spoke of their own room or the homes of friends as the best places to be, to meet friends or be alone. While other cities showed similar responses, their children added significant public places such as streets, the plaza, local street corners and woods.
- Melbourne children spoke constantly of boredom and the lack of new things to see or do. "The children seem to suffer from experiential starvation." (Lynch, 1977; p.24). Contrasting statements by Melbourne and Polish children highlight the point: Melbourne - "Nothing much. Just messing around; there's nothing else to do." Cracow - " I like to be in the Old Town. I look at historic monuments. I like window shopping"; "My street is the best to live in. It's in the center, you don't have to go anywhere by train."
- Places that were considered beautiful by Australian children were all somewhere else (gardens, parks, trees) and ugly places were "their own factories, old houses, impersonal public buildings, pollution and rubbish." (Lynch, 1977; p. 51). There were ugly places in the other cities but many spoke of local beauty - of plazas, flowery local streets, parks and monuments in the city centre, new stores, luminous signs and multi-storey apartments. Some even said they knew no ugly places.
- Asked to draw maps of their own area and the central city, most drawings were either rich with a sense of place and familiarity, or endowed with minute detail of the activities and places lining the streets. By contrast, Melbourne adolescents did not provide much detail, mainly streets and main roads.

"Every map is essentially a street map. The streets are drawn large; other locations are appended as small rectangles along them...They have difficulties in recording the neatly planned, basically rectangular, but frequently interrupted, layout of streets...they have no vivid image of that central district [CBD], while the Salta and Cracow children display a clear conception of their downtown plaza with its historic buildings. The Melbourne home region has no definite boundary, no center... The social facilities are the conven-

tional sports fields and schools. The playgrounds are featureless and empty. The asphalted, treeless streets are equally empty. The houses seem solid and comfortable, but the yards appeared unused, except for sheds. The Australian scene is almost perfectly unmanipulable by its children, except that they can move through it." (Lynch, 1977; p. 44/45/48).

The original survey work for this study reports that low density is an important variable in explaining some of the results and that raising densities could improve the situation, particularly in relation to children's access to more activities and lessening boredom (Lynch, 1977; p118). Peter Downton who conducted the survey, makes a particularly damning summary of Australian suburbia for adolescents:

"The effect of the physical environment on these children is primarily one of limiting their experiences severely... The chances for self-development, broadening of outlook, and contact with a variety of people and ideas are

all very poor...The resultant inhibited thinking of the children was extremely evident in the interview." (Lynch, 1977; p.117/18 - Figure 21).

This low-density structure which appears to have some rather negative implications in terms of children's perception of the environment and their development, also makes public transport, walking and cycling impossible for most trips. This means people are seldom on the streets without driving or being driven in a car. But what can be done? How, for example, can the benefits of denser cities that work better in a communal sense and provide a richer more diverse place to live, be balanced with the desire for open space, especially in auto-oriented cities in Australia and North America, where this is such a major issue? Examples are provided later of more compact developments that can provide some balance between the private needs of 'home' and the need for an engaging and cared for public realm.



Figure 21: Australian suburban houses and streets have become larger and more monocultural over time, leading to all the problems mentioned above over 40 years ago.

Cities, Community and Transport

Cities have evolved essentially through three stages: Walking Cities, Transit Cities and Automobile cities (Newman and Kenworthy, 1996, 1999; Newman, Kosonen and Kenworthy, 2016). The old walking cities which existed up until the latter half of the 19th century were small, compact places with activities strongly mixed together. Many activities took place in the city's public spaces and nearly everybody walked. Transit cities developed in the mid-to-late 19th century as trains and trams allowed the city to grow beyond the old walls. Cities were still very communal places with lots of activities in the streets and with compact communities built in nodes within walking distance of rail stations or as strips along the tram lines. The advent of the diesel bus and the car allowed the previously inaccessible spaces between the rail tracks to begin filling in. The automobile city with its footloose urban development was born (Newman, Kenworthy and Vintila, 1992; Newman and Kenworthy, 1996, 1999).

In urban North America and Australia, ever since the transition to automobile cities, the car has increased its role in urban transport every year and the other modes have withered, though since around 2004 there has been increasing evidence of "peak car use" in developed countries and their cities (Newman, Kenworthy and Glaesbrook, 2013; Newman and Kenworthy, 2011; Millard-Ball and Schipper, 2010). European cities still retain a significant amount of public transport use and walking and cycling, though they too struggle to maintain the role of these modes (Newman and Kenworthy, 1989; Kenworthy and Laube et al, 1999), especially today with electro-mobility and autonomous vehicles taking over the transport debate (Schiller and Kenworthy, 2018; Whitelegg, 2016). This process of growing automobile dependence has, on the one hand, provided an enlarged degree of travel freedom and choice for those with cars or access to car services, though not without costs. However, it has gradually eaten away the independence of others in the community, particularly children, the elderly, those with disabilities and the poor.

This slow process of attrition in the independent mobility of the most vulnerable members of society is being increasingly questioned. In some ways, the mobility problems of children can be used as a yardstick of this process and some literature has been reviewed here on this subject.

The general questioning of suburbia as an environment for children, has been well-documented by authors such as Cunningham and Jones (1993 and 1994 a, b), Tranter (1993) and Tranter and Doyle (1994). The degree to which children are given free range over their city environs has gradually been reducing because of several factors, but the growing use of cars and associated traffic dangers is high on this list. Nevertheless, independent mobility by children is still considerably higher in European cities today than it is, for example, in Australian cities such as Canberra, despite its reputation for excellence in suburban planning. For example,

- 9 to 11 year olds in German cities visited twice as many places alone than those in Canberra;
- 58% of German children were allowed to catch buses alone, compared to 25% in Canberra;
- only 13% of German children were driven by car to school, compared to 43% in Canberra (Tranter, 1993; p. 62).

While Tranter shows that in England children's independent mobility is also better than in Canberra, the traffic situation is generally worse than in countries such as Germany where there is better public transport and more traffic calming. For example, a study by Sully (1976) showed that while 80% of British children over 9 years old owned bikes, only 2.5% could ride them to school due to parents' fear of traffic, even on streets with sporadic vehicle numbers. In terms of changes over time in children's mobility, 88% of 9 year olds in England went to school unaccompanied in 1971, but by 1990 it was only 27%. Some traffic engineers attempt to show through statistics on reduced deaths per capita, that on the whole roads have become safer over the years. However, it can also be shown that people are simply reducing their exposure to increasing road

danger by restricting children's activities and taking more precautions themselves (Hillman et al, 1990).

As Tranter (1993) notes, such a dramatic reduction in independent mobility would not have been allowed to occur in a short space of time, but because it has occurred over a long period, it has been accepted as the norm. Adults join in an unconscious conspiracy against their children's opportunities for independent access to their city. They accept unwittingly that parks, playgrounds and play and social events organised by adults will somehow replace the freedoms that were once enjoyed in the street and other informal meeting places outside the home (Figure 22).

Children in different types of urban environment obviously enjoy different levels of independent mobility and this has implications for them and their parents, as well as the physical sustainability of the city.

In a study of city and suburban environments in Toronto, van Vliet (1983b) provides further evidence for differences in

children's independent mobility due primarily to the physical form of their environments. He reports the mean distance (metres) and mode of travel of after-school and weekend trips of 14 to 16 year olds in typical city and suburban sections of Toronto for eighteen different trip purposes. All eighteen trip purposes were longer in the suburbs, and for eleven out of the eighteen, they were longer by factors of between 1.5 and 4.5 times (average 2.3 times).

The data are summarised for all trips in Table 3. It shows that suburban adolescents had to travel a total of nearly twice as far as their city counterparts to reach the multitude of activities they require. They are considerably more dependent on chauffeurs and their level of walking is below the city dwellers, though bicycling is higher in the suburbs. Public transit is higher in the city than the suburbs. However, the difference is not as high as it would be in Australia or the US because Metropolitan Toronto has a relatively good, safe and cheap public transport system based on trams, buses and subway and is



Figure 22: Children in the city centre of Freiburg enjoy the freedom and interest of city spaces without the danger.

accessible to children in the suburbs and city alike.

Children in the suburbs nevertheless made "frequent complaints about poor accessibility and the lack of 'something to do' in their own neighbourhood..." (p. 63). The suburbs contained few or no land use activities other than residential, and as Table 3 shows, there were less than one-quarter as many children per square kilometre in the suburbs than in the city.

Summary

The need for higher densities, less car dependence and greater freedom, especially for children and those without cars is aptly summarised in an empirical way in a study which compares the qualities of two New Towns, one in England - Milton Keynes - and one in The Netherlands - Almere (Roberts, 1992). Both cities claim to be influenced by the Garden City movement, but only Almere comes close to having the

Factor	City Environment	Suburban Environment
Mean total distance (all trips)	25.57 km	48.23 km
% trips by public transit	30%	25%
% trips by walking	52%	42%
% trips by bike	3%	9%
% trips by car	14%	23%
Density of 15-17 year olds	520/squ.km	124/squ.km

Table 3: Travel characteristics of 14-16 year olds in Toronto (early 1980s).
Source: compiled from van Vliet (1983; p. 62)

One of the most important points made by van Vliet in the present context is the self-esteem and independence of children.

"There is no question...that spatial mobility plays a crucial role in children's physical, social and intellectual development. To mature, children need to explore opportunities in their environment. The specialization and separation of land uses has dispersed those opportunities and has increased children's need to travel." (van Vliet, 1983, p. 63).

Like Lynch (1977), children in studies by van Vliet were asked to draw mental maps of their neighbourhood. There was a striking difference between children with a small independent travel range and those with a large one based on public transport, walking and cycling. The former typically drew a grid of streets with nothing much more than street names, while the latter were rich with buildings and the names of individual shops and establishments. Such independent travel was shown as linked to greater independence and maturity, satisfaction with their neighbourhood and a greater number of friendly people known.

density of population typical of the original Garden City (see Newman et al, 1994). Milton Keynes is designed as a low density residential environment, heavily zoned, with a big emphasis on roads and car parks. People in public spaces are notable by their absence. Almere is more typical of the European compact planning tradition, designed on a human scale with lots of activity in the public spaces, and a great deal of walking and cycling (Figure 23). Table 4 summarises the differences in urban form, transport characteristics and the degree to which the environment encourages independence in the child population.

The table shows that Milton Keynes, with its lower density, zoned land use, greater car orientation and retreat from the public sphere, has over half of households with children under 12 years of age always being supervised outside home; only 8% are never supervised. In Almere, with its community atmosphere, lots of walking and cycling and mixed use environment, only 16% are always supervised outside home and 48% never supervised. The Dutch new town is also clearly better designed for people without cars.

Building more livable cities is clearly a com-



Figure 23: Like Almere in The Netherlands, Freiburg in Germany has generous, safe green spaces often inhabited by free-range children.

plex process tied up with physical planning approaches, the diversity of transport options, access to green space, the health of communities and social equity and justice. The degree to which these different qualities are played out in various cities is outlined in Part III below.

	Milton Keynes (UK)	Almere (Neth.)
Density (dwellings/ha)	20	35-40
Urban form	Scattered, separated	Organic, mixed use
% trips by car	59%	35%
% trips by public transport	17%	17%
% trips by walk and bicycle	24%	48%
% of trips < 3km	45%	85%
Households with children under 12 years who are always supervised outside home	52%	16%
Never supervised outside home	8%	48%

Table 4: Differences in land use and transport between Milton Keynes, UK and Almere, The Netherlands.

Part III – Building more livable and sustainable cities - some alternative approaches to housing, transport and public spaces.

This section describes some positive aspects of physical planning and transport development in other cities which are making them more functional, attractive and livable places. It is not exhaustive, but is representative of the efforts of many cities to try to bring back a public dimension to urban life based on more compact living, more use of public transport and non-motorised modes and active use of the city's public spaces. It has been argued in Part II that such opportunities in cities are supportive of urban community and particularly the needs of more vulnerable populations. The blind pursuit of privatised, car-based suburbia fails to recognise these benefits.

Zürich, Switzerland

The Zürich region of around 1 million people (or depending how it is defined, up to 3.8 million) is something of a model of the kinds of approaches that make a medium density city more livable. I was fortunate enough in 1993 to spend a month living in a small apartment in Zürich with my family without a car. Later, I lived for 7 months in Switzerland and visited Zurich many times. It taught me many lessons about the way suburbia, while often acclaimed as the ultimate living environment, can sometimes defraud people of the opportunities for an active, interesting and convenient life.

Public transport - Zürich's public transport is second to none in the western world, beaten only in usage by Eastern European cities such as Prague (Kenworthy and Laube, 2001). Through big improvements in availability as well as marketing, advertising and operations, use of public transport has risen in the Zürich region from 363 trips per person in 1980 (1 trip per person every day) to 505 trips per person in 1995, or 1.4 trips per person (Kenworthy and Laube et al, 1999) and 535 trips per person in 2005. By comparison, use of public transport in Australian cities in 1996 ranged from a low of 59 trips person in Perth to 136 in Sydney (average 90 trips per person; Kenworthy and Laube, 2001).

By 2006, the average had risen to 96 trips per person.

In Zürich, it is possible to access every part of the city on some form of public transport - light rail/tram, diesel bus, trolley bus, minibus, electric train (S-Bahn), funicular, ferry and cable car (Figure 24). The marketing of public transport is aggressive and high profile, and the product is excellent.

- Passenger information systems - there are network maps and easy-to-use rhythmic timetables at every stop. Signage and identification of the system is excellent. Every stop in Zürich, regardless of mode has a name (an identity - in common with most continental European cities), which means that people's mental maps of the region can be built around the public transport service. To assist this, the transit authority introduced in the 1990s four custom designed information brochures/system maps showing how to get to specialist destinations - Education and Hobbies; Sport and Recreation; Eating and Drinking; Culture and Entertainment. Of course, information systems for public transport have evolved like in most cities, towards on-line mobile information and guidance, but the physical presence and in-person information has been retained and enhanced through, for example, more electronic, real-time public transport information displays.
- Quality of transit environments - every effort is made to provide good quality shelters and waiting environments. Cleaning of stations and waiting areas is routine and reliable. Vehicles are kept clean and are refurbished on pre-determined rotations. Vandalised facilities and information systems are repaired or replaced. Facilities are provided at many stops, or the stops are located near shops, mail boxes, telephones, toilets etc.
- Connectivity - the different modes are strongly interconnected through timed transfer points across the region, so changing modes and directions is not an obstacle. In inner locations services are so frequent that interchanging can be reliably achieved without timetables. Zürich's public transport prides itself on being faithful to its published timetables

and this increases public acceptance of the system. Reliability is enhanced through a high level of reserved routes for all public transport modes (rights-of-way that are fully protected from all other modes).

- Fares - a great majority of all fares are pre-sold at big discounts (general abonnement) so that regular users are benefited and encouraged. Seasonal passes are transferable between family members, encouraging use of the system throughout the day by different age groups.

- Marketing - the advertising of public transport is well thought-out with social pressure being exploited as much as possible to discourage car use. The transit authority has been known to promote its services and commitment to the systems through things such as sponsored dances for younger riders to help raise the profile of public transport and make it more socially acceptable amongst maturing residents. Physically, the transit system is designed to be seen and recognised, with a coherent and highly visible set of signs and colors throughout the

city - the transit authority believes that one shouldn't be able to take a photo of a street scene in Zürich without public transport's presence being recognized in the form of their colour scheme or logos.

Public transport is used by all age groups at all hours of the day. People of all ages and socio-economic status pack the system on weekends getting to favourite destinations throughout the city or using it to connect with the national system for more distant day trips (the general abonnement covers all public transport in Switzerland apart from some smaller specialized systems, mainly in the mountains).

Public places - natural and man-made - Zürich is rich in attractive public environments and opportunities for contact with nature.

Forests and woods - The ridge tops and slopes surrounding Zürich are forested and are all accessible via the public transport system and a short walk. Most residential areas are only a relatively short walk from wooded areas. People have direct access



Figure 24: Zürich has an extensive, well-used tram/LRT system.

to natural areas in a way that is disappearing or has disappeared in Australia and North America because of the car and suburban home's appetite for land.

Gardens and farming - Community gardens and allotments proliferate the region and functioning agricultural areas can be found throughout the city - they can be observed from the public transport system as close as a few kilometres from the city centre. Compact planning and strict regulation of land use has ensured that Zürich is not covered by development. People living in apartments can take walks through forests and farming districts right next to their apartments.

Water - Like many cities, Zürich is well endowed with water environments - the Lake of Zürich is the central water body and there are numerous other smaller lakes. The lake is well-utilised for recreation and is very well serviced by ferries. There is an emphasis on non-car public access and people use the lakes edge and linear parklands intensely for prom-

enading, especially near the central city. Car ferries negate the need to build road bridges over the lake.

Walking networks - The Zürich region is totally interconnected with named, sign-posted and mapped walking trails that lead through forests, farmland and other public areas. It is possible to walk between any parts of Switzerland using this national system. A national cycling system, the Swiss Veloland Cycle Network also exists. *Pedestrianisation/traffic calming* - The old city is pedestrianised and the main street of the city is a transit mall with light rail and limited car access (Figure 25). The city has many small public spaces where people play life size chess games, children play on swings or where small fairs are set up with merry-go-rounds etc.

Housing areas - Zürich, like any city has a range of housing styles from quite high density apartments to separate houses, though the bulk of housing consists of compact, 'attached' dwellings and some is cooperative housing. Walking through the range of housing areas one is constantly



Figure 25: The old pedestrianized city centre of Zürich.

struck by the extent to which community life is visible. Public space - the streets, the playgrounds, the communal areas and gardens around multi-family dwellings - is well-utilised. There is a lot of contact at ground level between children and their parents and between neighbours.

Urban villages/TOD - There are numerous examples of new housing developments which have been consciously planned to provide an attractive living environment at medium to high density.

There is an emphasis on good quality dwellings set amidst generous, well-designed public space with traffic totally excluded - parking is underground (Figure 26). Some provide ecologically-based landscaping with natural or semi-natural wetlands and water courses running through the development. The developments are always set adjacent to public transport stops, especially rail stations. Some are integrated with seniors housing and on-site shopping and eating places. Play areas are focal points for families to enjoy the communal

environment and are usually designed for parental surveillance from inside dwellings.

Overall, Zürich is a city which acquits itself well in providing for both the private and public dimension of everyday life - civic responsibility, both for each other and the physical environment, is an essential part of the way the city functions. The private domain is not allowed to dominate the development of the city to the extent that it does in more auto-dominated environments. The city's public realm is first class (both transport and land use) and people can be seen using it together in a way that encourages community and minimises the possibility of individuals becoming inadvertent victims of isolation. The independent mobility of those without cars is strong because of the extremely good and safe public transport system.



Figure 26: Transit-oriented development on the S10 S-Bahn in Zürich, designed also for bikes and pedestrians.

Vancouver, British Columbia

Vancouver is a metropolitan area of over 2.3 million people. Its distinguishing feature in a North American context is that the City of Vancouver at the core of the region (close to 650,000) has no urban freeways and is preparing to tear down two short viaducts (Dunsmuir and Georgia Streets), reminders of the freeways that were never built. Compared to most American cities Vancouver enjoys quite high levels of transit use (134 trips per person in 2006, compared to the average for 10 large US metropolitan areas of 67 trips per person in 2005). The New York-New Jersey-Connecticut metropolitan region is by far the most transit-oriented US urban area and has 168 trips per person in 2005; Schiller and Kenworthy, 2018).

Vancouver is noteworthy for its attention to:

(a) intensification of housing in the inner area through medium to high density infill with special attention to the needs of families wishing to escape the

car dependent suburbs, though housing has become increasingly expensive and unaffordable (Figure 27). Specific design manuals are aimed at producing compact environments suitable for a whole range of household types. The City of Vancouver (inner Vancouver) population rose by 172,000 people between 1986 (431,147) and 2011 (603,502) due to intensification of dwelling construction (in the face of falling household sizes);

(b) development of large scale, compact developments with a strong focus on community development, public spaces and a mix of housing types and affordability e.g. False Creek South and North at the foot of Vancouver's CBD and Arbutus Lands in the close inner suburbs, and

(c) integration of new residential and mixed use development in strong nodes around stations on the Skytrain driverless metro to reduce car dependence, e.g. Metrotown, New Westminster and smaller developments at other stations such as Joyce-Collingwood and Edmonds.



Figure 27: South-East False Creek neighbourhood planned with non-motorised modes in mind.

The larger nodes on Skytrain have mixed commercial, office, residential, retail and markets within a short walk of the station. The new housing consists of high-rise towers, 3 to 4 storey condominium style developments and townhouses. Some of the housing consists of individual housing co-operatives. New Westminster is set along an attractive boardwalk that includes playgrounds for children and people are often seen talking to each other in the public areas (Figure 28). The family units have inner courtyards in which families and friends congregate. The farmers market where residents do some shopping is communally orientated with open eating areas and a more relaxed, less structured, less sterile atmosphere than a supermarket.

False Creek South (about 5,000 people), North (3,000 people) and now South East (11,000 people) are excellent examples of how to build high density, planned, green communities in a central location with extensive and beautifully designed open spaces, together with adjacent mixed land uses such as markets, hotels, cultural activities, shops and restaurants (e.g. Gran-

ville Island). The extensive open spaces and children’s play areas are traffic free as road access is from the rear of the development and parking is mostly under the buildings at the rear.

There is an enormous variety in housing forms and styles including townhouses, terraced units and medium rise apartments, many of the earlier ones of which were cooperative housing ventures. False Creek is linked together by a generous, meandering boulevard and series of open spaces for pedestrians and cyclists along which there are a variety of local shops, businesses and other facilities built into the housing areas.

A guiding principle in these developments is that the facilities and resources which people need already exist in inner locations and that it is advantageous to make these available to as many people as possible. Where large developments such as False Creek, New Westminster, Joyce-Collingwood or Main Street/Science World (Figure 29) occur on previously derelict industrial land, there is also a need to



Figure 28: New Westminster transit-oriented development on the Fraser River in the Vancouver region.



Figure 29: Main Street/Science World TOD on Vancouver's Skytrain.

provide community facilities on-site such as child-minding centres, libraries, meeting halls, community playgrounds, sports areas, theatres etc. The absence of free-ways in Vancouver is a contributing factor in improving the attractiveness of the inner city and areas around Skytrain stations for residential development. If free-ways had been built, not only would the land that presently houses these developments have been alienated, the quality of life would have also been reduced due to fumes, noise and severance.

Freiburg, Germany

Freiburg im Breisgau is a small southern German city of around 250,000 people set in a wider urban region of around 650,000 which has become renowned for its green

transport policies which discourage car use and encourage, bicycles, walking and public transport.

Pucher and Clorer (1992) outline how the city, while growing in auto ownership and wealth, remained static in car use over 15 years (a mere 1.2% increase). But total trip making by all modes, excluding walking, increased by 30%; public transport grew 53% and bicycle use by 100%. The relative shares changed as shown in Table 5.

By 1999, modal split for all trips, including walking had cars at only 32%, non-motorised modes at 50% and public transport at 18%. The aim is for even further reductions. For full modal split for Freiburg for 1982, 1999 and a projection for 2020,

MODE	1976	1991
Cars	60%	47%
Public Transport	22%	26%
Bicycles	18%	27%

Table 5: Relative share of non-pedestrian trips by mode in Freiburg, 1976-1991.
Source: Pucher and Clorer (1992)

please refer to:

www.freiburg.de/pb/site/Freiburg/get/311570/Modal-Split.jpg accessed November 24, 2017)

The three policies which Pucher and Clorer (1992) suggest were used by Freiburg (and still are) to “tame the auto”, are:

“First, it has sharply restricted auto use in the city. Second, it has provided affordable, convenient and safe alternatives to auto use. Finally, it has strictly regulated development to ensure a compact land use pattern that is conducive to public transport, bicycling and walking.” (Pucher and Clorer, 1992, p. 386).

In implementing the above three policies (which could be loosely translated as embodying the use of light rail, traffic calming and urban villages; see Newman, Kenworthy and Robinson, 1992), Freiburg has created a people-friendly, livable city:

- *Pedestrianisation* - The central area is almost entirely pedestrianised with many people of all ages enjoying the city’s spaces (Figure 30). This is complemented by

greening of the city and attention to urban design detail such as beautiful designs and colours for different parts of various size streets (footpaths, public transport right-of-way).

- *Water theme* - The city celebrates water in its public areas. In the days before waste disposal systems, Freiburg in common with other cities, had small open drains along all streets. Today this theme continues with fresh water running in small channels (Bächle) throughout the city and continuing into residential neighbourhoods and new developments. Children love the streets for this reason and can be seen playing with and paddling in the water. Small wooden boats can be purchased which children use to float down the Bächle. This melding of urban design and the needs of children, gives the central city a family and child-friendly atmosphere (Figure 31).

- *Extensive traffic calming* - Outside the central city, many streets have been made safer and friendlier for bicycles and pedestrians through traffic calming (Verkehrsberuhigung) treatments such as mid-block neck downs (room for only one vehicle at



Figure 30: Freiburg’s pedestrianised city centre.



Figure 31: Freiburg’s signature urban design feature – the Bächle - combined with pedestrianisation and quality public transport.



Figure 32: Extensive use of bikes throughout Freiburg.

a time), strong entry statements leading into residential areas, such as green arches, canyons of trees to reduce perceptible width etc. Spaces such as parking areas have been reclaimed for civic uses and children's play areas as the city has become less car-orientated.

- *Bicycles* - Many off-road facilities for cyclists (and pedestrians) have been developed as well as bike storage facilities around the city (Figure 32).

- *Light rail* - Light rail has become the backbone of Freiburg's public transport. In places, the light rail lines run along grassed track beds either on their own right-of-way through parkland settings, or in the centre of roads. Buses have become primarily feeders to the light rail system and mobility by public transport has improved greatly (Pucher and Clorer, 1992). The central city has benefited environmentally by having a clean, quiet mode of transport servicing it.

- *Urban villages* - There is a concerted effort to provide for Freiburg's population growth in planned urban communities linked to public transport, e.g. Der Seepark, Rieselfeld and Vauban. Der Seepark is

a large urban village consisting of a variety of different types of multi-family dwellings. It is set adjacent to several light rail stops and its central feature is the large integrated lake and parkland on city property (former State Garden Expo site). The environment is traffic free and internal circulation is all on foot and bicycle. Parking is underground or restricted to traffic calmed peripheral streets. The public spaces were designed for a short term and long term purpose - initially as the site of the State garden show and then as a multi-purpose public park which melds with the surrounding housing as a seamless whole (Figure 33). Vauban is a widely publicized urban redevelopment neighbourhood, renowned for its renewable energy and family friendly, green spaces (see extensive discussion in Schiller and Kenworthy, 2018).

The overall results are extremely attractive and convenient living environments in which people of all ages can be seen sharing the public spaces. Activities in Der Seepark include swimming in the central lake; cycling; strolling; eating in the on-site facilities; enjoying open air concerts; using adjacent formal sports facilities; sunning in the 'meadows'; resting in formal gardens and children's play activities.



Figure 33: Part of Der Seepark urban village development in Freiburg.

Portland, Oregon

Portland is a US metropolitan area of 2.4 million people with a density of 13 persons per ha (like most auto-orientated cities in the US and Australia, but much less than Canadian urban regions). Although car-orientated, it has done numerous things to improve its livability and diversity of housing environments, as well as its commitment to the public realm of the city.

- *Light rail* - Instead of building another freeway, Portland used freeway funds to open a light rail line (MAX) in 1986 which has played an integral part in revitalising a declining central city. For example, retail sales in the 'downtown' rose from just 5% of the region's total sales to 30% (Transactions, September 1993, p. 2).

- *Downtown market area* - One of the big draw cards for families with children in central Portland is the Saturday Market through which the light rail runs. It was previously a derelict, car-based area and now has a human scale vitality to which people flock (especially on the light rail line). An historic tram services the area on market days and is popular with locals and tourists (Figure 34).

- *Coordinated transport planning and urban design in the central city* - With the light rail line has come a total re-organisation of the street space in central Portland to give more room to public transport and people on foot. Trees have been planted throughout, flowers, civic art, fountains and pedestrian squares have been provided by converting car parks (Pioneer Courthouse Square – Figure 35). The business community has played a key part in the changes. Cars have been restricted to one lane along key public transport streets (both light rail and bus streets). Quality bus shelters, waiting areas and information systems have been developed. A ceiling has been in force since 1972 on parking supply, though very recently this has been relaxed. Some parking areas have been reclaimed for civic space. Jobs have grown from 56,000 in 1975 to 91,000 in 2005, but traffic congestion has not increased and air quality has markedly improved (Arrington, 1993).

- *Central city housing* - Mixed use developments such as River Place (built partly on a former parking area) have provided housing above shops set in pedestrian and bicycling environments. These new



Figure 34: Portland's MAX light rail transit operating through the Saturday Market area in downtown.



Figure 35: Pioneer Courthouse Square, Portland, built on a former car park and now a place for celebration.



Figure 36: Pearl District of inner Portland built around a new tram line.

public spaces are popular with people from across Portland. More recently, the Pearl District adjacent to downtown, has been revitalized and new residential and mixed use development integrated with a streetcar (tram – Figure 36). At the heart of the development is a large family-oriented park with computerized fountains for everyone to cool off in during summer. Other parks have also been provided (Figure 37).

- *Transit-Oriented Development* - The light rail line has been the site of significant new commercial, institutional, residential and mixed use developments. There is a conscious programme of Transit Station Area Planning to provide alternatives to suburban sprawl and less car-dependent development. The aim is a mutually reinforcing set of transport and land use policies to reshape Portland into a less car-dependent city. A strong urban growth boundary helps to support this, though it also pushes up land prices which helps reinforce the need for density (Arrington, 1993).

One aspect of Portland’s multi-faceted vision helps summarise the relevance of the above for city livability in the Portland of the future.

“The lifestyle is more urban than suburban. Despite considerable growth Portland has retained a ‘neighbourly’ feel to it. The city is bustling, but also provides citizens quiet time. In Portland, unlike most American cities, people spend their interludes of quiet in parks, in open spaces, along the rivers and in museums - rather than entombed in lonely cars stuck in traffic jams.” (Arrington, 1993, p. 12).



Figure 37: A park in the Pearl District, Portland.

Munich, Germany

Munich has notable good examples of urban villages/TODs that have been designed with livability strongly in mind and which provide greater independence for children.

- *Arabella Park (Bogenhausen District Centre)* - This is an excellent TOD, both in the intensity and mixture of the activities it contains, and in the extremely high quality of urban design and human scale, traffic-free and traffic calmed public spaces in which the development is set. There is a strong emphasis on landscaping and general greening of the environment. It is based around a rapid transit (U-Bahn) station located in the centre's market square. The development is approximately 5 km from Marienplatz in the heart of Munich's pedestrianised core. Arabella Park has excellent accessibility to other parts of the city on the U-Bahn line, which is an important selling point of the centre (Figure 38).

Arabella Park consists of homes for

10,000 residents in rental and owner/occupier apartments, employment for 18,000 workers and 2,000 hotel rooms. The result is a fine grained, lively mixture of land uses including offices, shops, restaurants, hospitals, movie theatres, night clubs, an adult evening school, a city library, post office, swimming pool, recreational centre and sports facilities as well as a multitude of peripheral facilities and service companies. There are undercover bicycle storage facilities and ramps incorporated into steps for people with bikes or prams.

In the public spaces of Arabella Park there is a lot of social interaction with people of all ages on foot and bike making use of the green boulevards and market areas to talk and relax. The number of parents and grandparents with children playing in the public areas and on their bikes, is particularly striking. Child-minding occurs around small areas of running water and public sculptures. There is also a steady stream of business people walking through the area (Newman and Kenworthy, 1991).



Figure 38: Arabella Park TOD on the U4 U-Bahn line, Munich.

- *Zamila Park* - Zamila Park is located on Munich's S-Bahn system and is a short walk from a station. It is a 19ha site which contains a mixture of 1300 dwellings of different types (ranging from 2 storey homes and units with private gardens, up to 6 storey quality apartments). There is also 50,000 square metres of office space, as well as a neighbourhood centre within walking or bicycling distance of all dwellings (it contains local facilities such as restaurants, food shops, newsagent, public laundry and other facilities). There is also a large lake on one side of the development and a complex of sporting facilities a short walk from all dwellings.

The emphasis in the design is on traffic-free or traffic-calmed public areas including quiet inner courtyards, pedestrian and bicycle spines and park-like green areas that link the development together into a contiguous whole. Dwellings of different styles and colours add a large amount of visual variety to the project and avoid any sense of a monolithic environment. There is minimal penetration of roads and traffic into the site. The public spaces within the area are characterised by children playing and parents and adolescents strolling or sitting on the seats provided. There is a noticeable amount of interaction between

parents on balconies and children in the public spaces. The number of families living in the development is clear from the amount of children's play equipment visible in the yards of many dwellings, the formal playgrounds built into the development and the number of small bikes parked in courtyards.

It appears from observation that a sense of privacy and ownership over private territory is maintained, but that this does not limit the opportunities for interaction where residents decide that is what they want. Play opportunities for children are many. By building in opportunities for sociability in well-designed, inviting public areas, it appears that the likelihood of isolation, and possibly crime, would be reduced in places such as Zamila Park (Newman and Kenworthy, 1991).

- *Messestadt Riem* - The old Munich airport has been transformed into a new compact community with a town centre built around an extension of the U-Bahn system with numerous feeder buses (Figure 39). The housing areas are diverse, the green space is extensive and roads are minimal. Within the development most circulation is by non-motorised means. Children can be seen arriving and leaving school on foot and bike accompanied or unaccompanied by par-



Figure 39: Messestadt Riem Town Centre, Munich.

ents and without having to deal with the dangers of traffic (Figure 40).

- *Central city revitalisation* - Munich has also been very successful in creating an extensive pedestrianised central city

area (Figure 41). Marienplatz, Karlsplatz and the Viktualienmarkt have become focal points for all age groups and most people arrive there on rail transport (U-Bahn or S-Bahn which share common rail stations in the central area).



Figure 40: Outside a Messestadt Riem school, showing the focus on non-motorised access.



Figure 41: Munich's pedestrianized city centre.

Stockholm, Sweden

It has long been policy in Stockholm to focus urban development around stations on the Tunnelbana (metro) system. One of the first and best known examples of this was the development of Vällingby in the 1950's. Since then numerous other satellite centres have been added such as Kista, Akalla, Tensta, Rinkeby, Skärholmen and so on. The centres are strung together like pearls on a bead along the railway system and are all high density, particularly around the station core, but taper off in density towards the periphery (Cervero, 1995, 1998). Some of these TODs are predominantly residential while others are highly mixed centres. The general physical planning principles in Stockholm on which these centres are based can be summarised as follows (Stockholms Stadsbyggnadskontor, 1972):

- Site workplaces close to houses;
- Minimise distance from houses to shops;
- Concentrate service functions in easily accessible areas and make premises

easily convertible to meet new service needs as times change;

- Create housing variety from low 2 storey dwellings with good ground contact; 4-6 storeys around courtyards; and 10-13 storeys near stations;
- Urban environment to have rich variations in form and colour;
- Multi-family housing no more than 500m walk to station;
- Single-family housing no more than 300m from a bus stop;
- A bus-rail interchange in all communities and;
- Centres to be linked and permeated by a coherent network of foot and bicycle facilities separated from roads with the convenience of people with disabilities in mind.

Stockholm's centres are compact and walking scale with a rich array of facilities clustered together within a relatively small area. In Kista, for example, the rail sys-



Figure 42: Kista pedestrian area outside the rail station, Stockholm.

tem delivers passengers directly into an enclosed large shopping mall which opens into a car-free town centre surrounded by community facilities, shops and housing. The excellent network of footpaths and cycleways feeding into it makes these modes the easiest and most convenient way to move around and the relatively short travel distances assist further. The shopping centre forms a bridge between the rail station and the predominantly residential development on one side of the railway and the commercial/office development on the other side (Figure 42).

The total segregation between motorised and non-motorised traffic in Stockholm's centres, together with traffic-free town squares and well integrated community spaces such as children play areas, help make the environment of a human scale, despite being high density (e.g. Vällingby – Figure 43 and 44). Stockholm's centres are also well endowed with open space networks weaved throughout the housing areas and a comprehensive network of natural open spaces (lakes, forests, fields etc) are in direct contact with each centre.

These areas are preserved and surround the housing areas due to compact planning principles.

While there is an emphasis on local self-sufficiency within Stockholm's sub-centres, the broader need for good public transport connections to the rest of the city is paramount. It is recognised that the smaller satellite centres cannot contain all the diversity of typical central city functions and people will always want to travel beyond their local centre for a range of needs. There is an assumption in Stockholm that feeder buses and the rail system, rather than cars, will be used as a major way of getting to Stockholm's core and other areas across the city in peak and off-peak periods.

The striking success of this strategy is described in detail by Cervero (1995, 1998) and runs directly counter to those who argue that dispersion is the best way to get people and activities closer together and to minimise travel (see Newman, Kenworthy and Vintila, 1993).



Figure 43: Vällingby town centre, Stockholm.



Figure 44: Vällingby town centre in Stockholm showing separation of traffic from pedestrians.

Seoul

Seoul undertook one of the boldest ever projects of 'trip de-generation' involving the tearing down of 5.86 km of the Cheonggye four-lane elevated freeway and the surface street below, which together carried more than 168,000 vehicles per day through the heart of the city, to exhume the culturally significant Cheonggyecheon River beneath (http://www.globalrestorationnetwork.org/uploads/files/LiteratureAttachments/270_restoring-cheonggyecheon-stream-in-the-downtown-seoul.pdf; <http://preservenet.com/freeways/FreewaysCheonggye.html> accessed November 28, 2017 - Figures 45 and 46).

The freeway alignment has been transformed into a linear, green heart for the city, a place to promenade, relax and enjoy, especially for children and families. This occurred without any significant traffic disruption and furthermore changed the direction of transportation planning in the city towards prioritizing transit and non-motorized modes. The project was a large-scale example of the idea of traffic

behaving more like a gas than a liquid and has been followed by further conversions of sections of freeway into pedestrian environments (e.g. Seoulo 7017 conversion of freeway infrastructure to a Highline-style pedestrian space, locally dubbed as the "sky arboretum" (<https://steemit.com/design/@mintvilla/seoulo-the-highline-of-seoul> accessed November 28, 2017).

Traffic engineers and transportation planners are trained to think of traffic as a liquid that holds its volume and will flow over everything if blocked or allowed to grow beyond its current 'container'. However, traffic tends to shrink when road capacity is removed, as has been proven time and again when pedestrian zones have been created (Kenworthy, 2012).

The full story of the Cheonggyecheon restoration project can be found in a 25-minute PBS documentary called Seoul: The Stream of Consciousness and more details at: <http://preservenet.com/freeways/FreewaysCheonggye.html>. accessed November 28, 2017.



Figure 45: Cheonggyecheon river restoration project in Seoul after tearing down the surface road and elevated freeway.



Figure 46: Cheonggyecheon freeway removal has provided a large pedestrian heart and green boulevard for Seoul.

Traffic calming

Many cities in Europe and increasingly in more auto-oriented cities are developing programmes to traffic calm residential areas, sections of main roads and urban centres where a balance is needed between cars and pedestrians (e.g. Ministerial Task Force on Traffic Calming, 1994). The aim is primarily to improve safety for people on foot and bicycle, though there are important benefits in terms of more attractive street environments, reduced noise and emissions and business is known to improve in environments where the car is brought under control (Hass-Klau, 1993). Newman and Kenworthy (1999) provide a literature review of traffic calming and its benefits for urban living which are the direct opposite of much of the planning that today characterizes places such as Dubai (Figure 47).

Area-wide schemes are known to be most effective in improving the urban environment so that it becomes more livable. Central and inner Frankfurt have some very

good examples of the way traffic calming has encouraged people to use the streets in high density districts (e.g. Leipzigerstrasse in the Bockenheim district – Figure 48). Cunningham and Jones (1994a) provide a list of the key things that planners need to do to make more child-friendly neighbourhoods. The second item on their list is that "...streets themselves should primarily be designed as playspaces - social space for children and adults. Motor traffic functions in residential areas should have lowest priority..." (p. 92).

Conclusions

The extent of automobile dependence varies dramatically in cities around the world with US and Australian cities, and to a lesser extent Canadian cities, having far greater auto dependence than cities in Europe and Asia. The trend in automobile-dependent cities in Australia and North America over many decades has been towards increasingly privatised, and to a significant extent, isolated forms of living. The roles of community, cared for public



Figure 47: Dubai: A reminder of the kind of city designed around the car that is anti-thetical to the needs of children and other vulnerable populations and which should be roundly rejected in today's urban and transport planning.



Figure 48: Traffic calmed Leipzigerstrasse in Frankfurt, Germany.

spaces, good quality public transport and walking and cycling infrastructure in supporting the livability and sustainability of urban areas have been neglected. Use of the private car has had increasingly destructive effects on the physical and social environments of the city. The physical sustainability of the city, the maintenance of civic virtues, the freedoms and development potential afforded to children, the elderly and others without access to cars, have been grossly eroded. Some of the worst urban environments in the world have been created through a single-minded pursuit of 'private splendour', resulting in almost universal 'public squalor', such as in parts of Los Angeles and other highly motorised cities.

Nevertheless, there are many cities around the world which demonstrate that other approaches are possible which attempt to provide for urban living through:

- more compact housing arrangements which have a greater variety of facilities closer at hand and which provide traffic free, shared open spaces, both natural and man made;

- revitalisation of the public realm in recognition that a good city must provide for useable, healthy public spaces in all areas, and not just pander to the desires for private space (see Newman, 1990);
- commitment to curbing use of the private car and to providing excellent public transport systems that are accessible to all people at most times of the day;
- providing more infrastructure for walking and cycling and the kind of land use planning that brings activities closer together so that they can be conveniently accessed by these modes.
- removal of large road infrastructure and its replacement with linear parkland and pedestrian environments.

Such strategies will assist in creating a more communitarian atmosphere in cities by providing the opportunities for people to come together in constructive ways. These changes will, however, require either or both a strong political vision and commitment from mayors and other decision makers (quality top-down lead-

ership), as well as powerful community pressure and civil society organisation and commitment.

"We have a rather unattractive tendency to hope for better things, without actually doing anything to make them come about. Our faith in the new century...or the new car, or the new school, or the new leader...is touching and understandable but, in the end, we are always left with ourselves and with the consequences of our decisions." (Mackay, 1994, p. 16).

More livable cities and sustainable cities can be achieved. But we must be prepared to work or even fight for them.

NOTE: This is a significantly revised, updated and illustrated version of a paper originally published as: Kenworthy, J.R. (2000) Building More Livable Cities by Overcoming Automobile Dependence: An International Comparative Review. In: Lawrence, R (ed.) Sustaining Human Settlement: A Challenge for the New Millennium Urban International Press, Newcastle-Upon-Tyne. (pp 271-314). Though originally published 18 years ago, its call has unfortunately been inadequately heard and cities need more than ever to heed its message.

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References:

Allen, I. (1980) The ideology of dense neighbourhood redevelopment: Cultural diversity and transcendent community experience. *Urban Affairs Quarterly* 15 (4), 409-428.

Appleyard, D., Gerson, M. and Lintell, M. (1981) *Livable Streets*. University of California Press, Berkeley, CA.

Arrington, G.B. (1993) Portland: Transportation and land use - A shared vision. *Pas-senger Transport*, 2 (3), 4-14.

Buehler, R. and Pucher, J. (2011) Sustainable transport in Freiburg: Lessons from Germany's environmental capital. *International Journal of Sustainable Transportation*. 5 (1): 43-70.

Buehler, R., Pucher, J., Gerike, R. and Götschi, T. (2016) Reducing car dependence in the heart of Europe: Lessons from Germany, Austria, and Switzerland. *Transport Reviews*, [dx.doi.org/10.1080/01441647.2016.1177799](https://doi.org/10.1080/01441647.2016.1177799), accessed 24 August 2016

Campbell, C. J. (1991) *The golden century of oil 1950-2050: The depletion of a resource*. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Campbell, C. J. and Laherre, J. H. (1995) *The world's oil supply 1930-2050*. 3 volumes, Petroconsultants, Geneva.

Cervero, R. (1995) Sustainable new towns: Stockholm's rail served satellites. *Cities*, 12 (1), 41-51.

Cervero, R. (1998) *The Transit Metropolis: A Global Inquiry*. Island Press, Washington DC.

Community and Family Commission (1992) *Speaking out, taking part*. Community and Family Commission, Office of the Family, Government of Western Australia.

Cunningham, C. and Jones, M. (1993) Child friendly neighbourhoods? A critique of the Australian suburb as an environment for growing up. Presented to the 12th World Conference of the International Association for the Child's Right to Play, Melbourne, Australia, 16 February.

- Cunningham, C. and Jones, M. (1994a) The child-friendly neighbourhood: Some questions and tentative answers from Australian research. *International Play Journal* 2, 79-95.
- Cunningham, C. and Jones, M. (1994b) The child in the suburb: Erosion of the play environment. Presented to the community seminar of the New South Wales Play Alliance, State Office Block theaterette, Sydney, NSW, 18 August.
- Davis, M. (1990) *City of quartz: Excavating the future in Los Angeles*. Vintage, London (462pp).
- Engwicht, D. (1993) *Towards an ecocity: Calming the traffic*. Envirobook, Sydney.
- Fleay, B. J. (1995) *The decline of the age of oil*. Pluto Press, Sydney.
- Frost, L. (1991) *The new urban frontier: Urbanisation and city building in Australasia and the American West*. University of N.S.W. Press, Sydney.
- Hass-Klau, C. (1993) Impact of pedestrianization and traffic calming on retailing: A review of the evidence from Germany and the UK. *Transport Policy* 1 (1) 21-31.
- Hillman, M., Adams, J. and Whitelegg, J. (1990) *One false move: A study of children's independent mobility*. Policy Studies Institute Press, London.
- Jacobs, J. (1961) *The death and life of great American cities*. Random House, New York.
- Kenworthy, J.R. (1997) Automobile Dependence in Bangkok: An International Comparison with Implications for Planning Policies and Air Pollution. In: Fletcher, T. and Michael, A.J. (editors) *Health at the Crossroads: Transport Policy and Urban Health*, John Wiley and Sons, Chichester, England (Chapter 19, pp 215-233).
- Kenworthy, J. (2013a) Decoupling urban car use and metropolitan GDP growth *World Transport Policy and Practice* 19 (4) 7-21
- Kenworthy, J. (2013b) Deteriorating or Improving? Transport Sustainability Trends in Global Metropolitan Areas In: Renne, J. and Fields, W.M. (eds.) *Transport Beyond Oil: Policy Choices for a Multi-Modal Future*. Chapter 14, pp. 244-264, Island Press, Washington DC.
- Kenworthy, J. (2014a) Trends in Transport and Urban Development in Thirty-Three International Cities, 1995-6 to 2005-6: Some Prospects for Lower Carbon Transport. In: Lehmann, S. (ed.) *Low Carbon Cities: Transforming Urban Systems*. Chapter 5, pp 113-130, Routledge, London.
- Kenworthy, J. (2014b) Total daily mobility patterns and their implications for forty-three global cities in 1995 and 2005. *World Transport Policy and Practice* 20 (1) 41-55.
- Kenworthy, J.R. (2017) The good, the bad and the ugly in urban transport: comparing global cities for dependence on the automobile. In: Hartz-Karp, J. and Marinova, D. (eds.) *Methods for Sustainability Research*. Chapter 3, 46-62 Edward Elgar Publishing, Cheltenham.
- Kenworthy, J. and Laube, F. (2001) *The Millennium Cities Database for Sustainable Transport*. (CDROM Database), International Union (Association) of Public Transport, (UITP), Brussels and Institute for Sustainability and Technology Policy (ISTP), Perth.
- Kenworthy, J., Laube, F. with Newman, P., Barter, P., Raad, T., Poboon, C. and Guia, B. (Jr) (1999) *An International Sourcebook of Automobile Dependence in Cities 1960-1990*. University Press of Colorado, Boulder (forthcoming).
- Kenworthy, J. and Newman, P. (1991) *Moving Melbourne: A public transport strategy for inner Melbourne*. Inner Metropolitan Regional Association, Victoria and Institute for Science and Technology Policy, Murdoch University, Perth, Western Australia, 6150, 64pp (Main Report).

- Kenworthy, J. and Newman, P. (1993) Automobile dependence: "The irresistible force"? Commissioned report for the University of Technology, Sydney, Faculty of Design, Architecture and Building, Institute for Science and Technology Policy, Murdoch University (49pp).
- Lasch, C. (1991) Liberalism and civic virtue. *Telos* 88, 57-68
- Lynch, K. (ed.) (1977) *Growing up in cities: Studies of the spatial environment of adolescence in Cracow, Melbourne, Mexico City, Salta, Toluca and Warszawa*. The MIT Press, Cambridge, Massachusetts (UNESCO, Paris).
- Mackay, H. (1993) *Reinventing Australia: The mind and mood of Australia in the '90s*. Angus and Robertson, Sydney.
- Mackay, H. (1994) The future stops here. *The Weekend Australian, The Weekend Review*, September 3-4, p. 16).
- Millard-Ball, A. and Schipper, L. (2010) Are we reaching peak travel? Trends in passenger transport in eight industrialized countries. *Transport Reviews*, 2010, 1-22. First published on 18 November 2010 (iFirst).
- Ministerial Task Force on Traffic Calming (1994) *Traffic calming in Western Australia: A discussion paper*. Minister for Transport, Government of Western Australia, August.
- Newman, P. (1990) The search for the good city. *Town and Country Planning*, 59 (10), 272-275.
- Newman, P. and Hogan, T. (1981) A review of urban density models: Towards a resolution of the conflict between populace and planner. *Human Ecology*, 9 (3), 269-303.
- Newman, P. and Kenworthy J. (1989) *Cities and automobile dependence: An international sourcebook*. Gower, England, September, (388pp).
- Newman, P. and Kenworthy, J. (1991) *Towards a more sustainable Canberra: An assessment of Canberra's transport, energy and land use*. Institute for Science and Technology Policy, Murdoch University.
- Newman, P.W.G. and Kenworthy, J.R. (1996) *The land use-transport connection: An overview*. *Land Use Policy* 13 (1) 1-22.
- Newman, P. and Kenworthy, J. (1999) *Sustainability and cities: Overcoming automobile dependence*. Island Press, Washington DC.
- Newman, P. and Kenworthy, J. (2011) 'Peak Car Use': Understanding the Demise of Automobile Dependence. *World Transport Policy and Practice* 17 (2) 31-42
- Newman, P. and Kenworthy, J. (2015) *The End of Automobile Dependence: How Cities are Moving Away from Car-Based Planning*. Island Press, Washington DC., 273 pp
- Newman, P., Kenworthy, J. and Robinson, L. (1992) *Winning back the cities*. Australian Consumers' Association and Pluto Press, Sydney.
- Newman, P., Kenworthy, J. and Vintila, P. (1992) *Housing, transport and urban form*. Background Paper 15 + Appendices for the National Housing Strategy, Commonwealth of Australia.
- Newman, P., Kenworthy, J. and Vintila, P. (1993) Can we build better cities: Physical planning in an age of urban cynicism. *Urban Futures* 3 (2) 17-24.
- Newman, P., Kosonen, L. and 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. and Burke, G. (1994) *Greening the city: Can the ecological and human dimensions of the city be part of Town Planning? Presented to: A Vision for a Greener City, National Greening Australia Conference, Fremantle WA, October*.
- Pharoah, T. and Russell, J. (1989) *Traffic calming: Policy evaluation in three European countries*. Occasional Paper 2/89, Department of Planning, Housing and Development, South Bank Polytechnic, London.

- Po boon, C. and Kenworthy, J. R. (1997) Bangkok's traffic disaster: An international comparative assessment of transportation and land use in Bangkok with its implications for air quality. Presented to Pathways to Sustainability Conference, Newcastle, NSW, Australia, June.
- Priester, R. Kenworthy, J and Wulfhorst, G. (2013) The Diversity of Megacities Worldwide – Challenges for The Future of Mobility In: Institute for Mobility Research (ed.), *Megacity Mobility Culture: How Cities Move on in a Diverse World* (Lecture Notes in Mobility) Chapter 2, pp. 23-54, Springer, Munich
- Pucher, J. and Clorer, S. (1992) Taming the automobile in Germany. *Transportation Quarterly* 46 (3): 383-395.
- Roberts, J. (1989a) User-friendly cities: What Britain can learn from mainland Europe, TEST, London.
- Roberts, J. (1989b) Quality streets: How traditional urban centres benefit from traffic calming. TEST, London.
- Roberts, J. (1992) Changed travel - Better world? A study of travel patterns in Milton Keynes and Almere. TEST, London.
- Schiller, P. and Kenworthy, J. R. (2018) *An Introduction to Sustainable Transportation: Policy, Planning and Implementation* Second Edition. Earthscan, London 420pp (published November 10, 2017)
- St. George, D. and Schulte, B. (2015) 'Free-range' parents plan to file lawsuit after police pick up children. *The Washington Post*, April 14, 2015. (https://www.washingtonpost.com/local/education/free-range-parents-plan-to-file-lawsuit-after-police-pick-up-children/2015/04/14/ed4f7658-e2b7-11e4-b510-962fcfab310_story.html?utm_term=.9d02029f7dc1) accessed November 19, 2017
- Stockholms Stadsbyggnadskontor (1972) *Stockholm urban environment*. Stockholm, (169pp).
- Stretton, H. (1989) *Ideas for Australian cities*. 3rd edition, Georgian House, Melbourne.
- Stretton, H. (1994) Transport and the structure of Australian cities. *Australian Planner* 31 (3), 131-136.
- Sully, J. M. (1976) Child cycling. *Town and Country Planning* (June), 323-25.
- Tranter, P. (1993) *Children's mobility in Canberra: Confinement or independence*. Monograph Series No.7, Department of Geography and Oceanography, University College, University of New South Wales, Australian Defence Force Academy, Canberra, ACT 2600.
- Tranter, P.J. and Doyle, J.W. (1994) Reclaiming the residential street as play space. Department of Geography and Oceanography, University College, University of New South Wales, Australian Defence Force Academy, Canberra, ACT 2600.
- Troy, P.N. (1992) The new feudalism. *Urban Futures* 2 (2), 36-44.
- van Vliet, W. (1983a) Families in apartment buildings: Sad storeys for children? *Environment and Behaviour* 15 (2), 211-234.
- van Vliet, W. (1983b) Children's travel behaviour. *Ekistics* 298, 61-65.
- Whitelegg, J. (1993) *Transport for a sustainable future: The case for Europe*. Belhaven Press, London.
- Whitelegg, J. (2016) *Mobility: A New Urban Design and Transport Planning Philosophy for a Sustainable Future*, Straw Barnes Press (Amazon Digital Services LLC), Church Stretton, UK.
- Wohlwill, J.F (1985) Residential density as a variable in child development research. In Wohlwill J.F. and van Vliet, W. (eds) (1985) *Habitats for children: The impacts of density*. Lawrence Erlbaum Associates, Publishers, Hillsdale, New Jersey.
- Wohlwill J.F. and van Vliet, W. (eds) (1985) *Habitats for children: The impacts of density*. Lawrence Erlbaum Associates, Publishers, Hillsdale, New Jersey.

Re-working Appleyard in a low density environment: An exploration of the impacts of motorised traffic volume on street livability in Christchurch, New Zealand.

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1. Introduction

The majority of the developed world's population live on streets, using them to transport and access the essential elements of life. The way in which such spaces are used is complex and constantly evolving to suit societal and environmental norms. As urban sprawl continues to intensify there are increasing numbers of people living away from diverse and pedestrian-orientated streets. In some areas the neighbourhood has become vehicle-orientated and considered no longer as a place of social connection and value. Such relationships have been recognised worldwide with research in San Francisco among the first to clearly demonstrate that motorised traffic volume can decrease street livability, have negative social consequences and impact significantly on community wellbeing (Appleyard, 1980).

Such relationships have also been recognised within New Zealand. Kingston et al (1982) sought to identify the extent to which awareness of motorised traffic, effects of motorised traffic on life and activities, and feelings about motorised traffic increase in proportion to volume, resident response to volume, and the thresholds at which these change. Results showed that vehicle speed and volume promote a predominantly negative social response, with the perceived health effect of heavy volumes as a dominant concern (Kingston et al, 1982). Despite the limited nature of this study they did arrive at significant conclusions, confirming that the negative social effects of motorised traffic volume found by Appleyard (1980) were also present in New Zealand. More recently, research by Tranter and Pawson (2001) found that motorised traffic volumes impact significantly on children's freedom in Christchurch. They noted that a place where there needs to be an emergence of values in Christchurch is in "[the] traditional role of the street as a place for social interaction and community integration" (Tranter and Pawson, 2001, p46). The need for a revitalisation of such values has been

noted since the 1980s yet vehicle use is still dominant and very evident throughout Christchurch. The lack of freedom and fear of endangered safety this generates for pedestrians, particularly children, has led to life becoming increasingly privatised with a significant proportion experienced inside the home. To assess street livability and community severance within Christchurch it is necessary to consider the role that motorised traffic plays and understand if the relationships between traffic volumes and social harm found in previous research are present in contemporary Christchurch.

This study utilised a similar approach to Appleyard's work of the 1970s and 80s, collecting data from streets of varying traffic volume and examining the impact of motorised traffic on community livability and wellbeing. It was conducted in Christchurch, New Zealand, a city of 350,000 people. Population density is low, car use high and many residential streets are wide. In many ways, it is similar to many medium sized towns and cities in more recently urbanised parts of the world such as North America and Australasia, and very different to San Francisco and European cities where similar studies have been conducted.

2. Literature Review

"We have taken the creative crucible of the city – its streets – and handed them over to a form of movement which destroys both the essential elements of creativity: diversity and spontaneity" (Engwicht 1999, p30).

Streets, holding the dual function of exchange and movement, were once, and in some cases still are, a significant part of the individual and community's urban environment. Motorised traffic has changed the traditional roles of streets however, a paradigm shift has occurred where what was once considered safe for social interaction and play are now often viewed as dangerous and impersonal. It is argued that this is largely due to increases in motorised traffic, and while vehicles have enabled improved access for many the quality of life in other areas has been eroded by their presence (Marsh and Watts, 2012). This is particularly true of the public space

outside the home, the street, where carrying vehicular traffic has become the accepted purpose. Engwicht (1999) argues that the introduction of the vehicle has converted streets into the single function of movement only, decreasing the opportunity and diversity of social and cultural human exchange and forcing society into polarized intimacy with significant losses in casual community contact.

This is also referred to as community severance where motorised traffic speed, volume or infrastructure acts as a psychological or physical barrier to community interaction by inhibiting access to goods, services and people (Boniface et al, 2015; Mindell and Karlsen, 2012). The health impacts of community severance have been discussed by Boniface et al (2015) with emphasis on the effect of transport on social interactions and the impact this has on individual and community health and quality of life. Additionally, Mindell and Karlsen (2012) found through a comprehensive literature review that community severance impacts significantly on street livability, travel and social networks and it is suggested that such impacts directly contribute to poorer health. Community severance has various understandings and interpretations however and Anciaes and colleagues (2015) acknowledge that there is a lack of consistent guidelines for the identification and solution to issues of community severance. Furthermore, there is a lack of consistency and use of quantification measures demonstrated by Anciaes and colleagues (2015) discussion surrounding techniques and the sensitivity of input variables on quantification.

A wealth of literature demonstrates the importance of recognising that the residential street should be viewed as a neighbourhood, a destination and social centre, rather than a channel for vehicles (Appleyard, 1980; Hart and Parkhurst, 2011). Appleyard (1980) found significant differences in the social nature and liveability of streets with varying traffic volumes. He found that motorised traffic does more than just take over physical space; it has a zone of influence that controls a space psychologically, and as vehicle speed and volume increase, the zone of influence and home territory shrinks. He further argued that street livability is enabled in protected neighbourhoods which require the right of way for pedestrians and enforce accepta-

ble traffic speeds, volumes, and noise levels. Bosselmann et al (1999) and Hart and Parkhurst (2011) replicated Appleyard's study, looking at residential streets in the USA and UK respectively, and showed similar results to Appleyard's (1980), demonstrating that motorised traffic acts as a barrier to street liveability and social interaction. This emphasizes that such research is still applicable to varying contexts today.

A number of studies have also demonstrated the impacts of motor vehicles on health and wellbeing (Dora and Phillips, 2000; Gee and Takeuchi, 2004; Marsh and Watts, 2012). Gee and Takeuchi (2004) examined relationships between traffic stress, vehicular burden, health and wellbeing in urban populations and found that people living in areas with high vehicular burden reported not only the most traffic stress, but also the lowest health status and increased depressive symptoms. A number of studies including Dora and Phillips (2000) have examined the effects of vehicle pollution on health and wellbeing and found that the consequences of motorised traffic volume and transportation systems go beyond the individual, having the ability to affect the health and wellbeing of communities. In addition, motor vehicles can lead to injuries from accidents and a reduction in physical activity which is associated negative health outcomes.

3. Methods

The research presented in this study adopts Appleyard's (1980) approach of street observations coupled with resident questionnaires and interviews, to examine the impacts of motorised traffic volume on street liveability and community severance within the context of Christchurch, New Zealand. To gather information on residents in the chosen streets, a survey was distributed to residents in seven study sites on six streets, with options of both paper and electronic completion. Respondents were also invited to participate in further, in-depth interviews. The six streets were broken into seven study sites as one street, Grants Road, had two study sites due to significantly differing traffic conditions on the length of this road. Observations of all study sites and their surrounding areas were used to construct figures reflecting the environmental layout and ambience of each study site. Such figures

were based on those used in comparative studies (Appleyard, 1980; Bosselmann et al, 1999; Hart and Parkhurst, 2011), and were used to demonstrate the extent to which traffic volumes affect where residents consider their local home area to be and to show their neighbourhood connections.

Motorised traffic volume levels were based on the New Zealand Transport Agency's (NZTA) Code of Practice for Temporary Traffic Management (CoPTTM, Fourth Edition, Second Amendment), which has been designed in line with the Road Controlling Authority guidelines for designating road levels and has been effective since July, 2013. The CoPTTM describes annual aver-

age daily traffic (AADT), with level 3 classification indicating the highest volumes. Level 3 roads are not included in this research project, but to indicate their measure they are associated with high volumes, high speed and multi-lane roads and motorways that are typically divided by a carriageway with average speeds exceeding 75kmh (NZTA, 2013). Each street for this study was selected because they had varying traffic volume counts accessed using CCC data available on level 2, level 1 and low volume classification roads (CCC, 2012/13) (Table 1). As noted, there were six streets with seven study sites in total, with Grants Road broken into two study sites (Table 1).

	Study Classification	NZTA Classification	Traffic Volume (VPD†)
Milton Street	heavy	level 2	13,720
Grants Road (a)	heavy	level 2	8,400
Grants Road (b)	moderate	level 1	2,500
Roker Street	moderate	level 1	1,400
Proctor Street	light	level 1	500
Taunton Green	light	low volume	150*
Stenness Avenue	light	low volume	100*

Table 1: Traffic Volume and Street Information

* CCC does not display accurate information for counts of less than 500 VPD, estimated numbers only.

† Vehicles per day, two way traffic volumes.

	Heavy	Moderate	Light	Total	
	<i>N</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>%</i>
Gender					
Female	10	11	10	31	59.6
Male	6	9	6	21	40.4
Age					
<30	0	0	0	0	0
30 - 39	3	2	0	5	9.6
40 - 49	2	3	2	7	13.5
50 - 59	3	10	7	20	38.5
60+	8	5	7	20	38.5
Ethnicity					
NZ European	12	15	15	42	80.8
Asian	1	2	0	3	5.8
MELAA	0	1	0	1	1.9
Other*	3	2	1	6	11.5

Table 2: Descriptive Information

*Included European, Canadian, English, Irish, Scottish

4. Results and Discussion

There were 52 respondents involved in this research, a fairly small response rate for the given areas; 16 from the heavy traffic streets, 20 from the moderate traffic streets, and 16 from the light traffic streets. Interviews were conducted with eleven residents; two from light trafficked streets, five from moderately trafficked

streets, and four from heavy trafficked streets. There were slightly more female respondents than male and the mean age of respondents was 50.6, with the majority of respondents aged above 50 and none below 30. The majority of respondents, 80.8%, were New Zealand European with only small percentages of Middle Eastern, Latin American and African (MELAA), Asian and other ethnicities (Table 2). Addition-

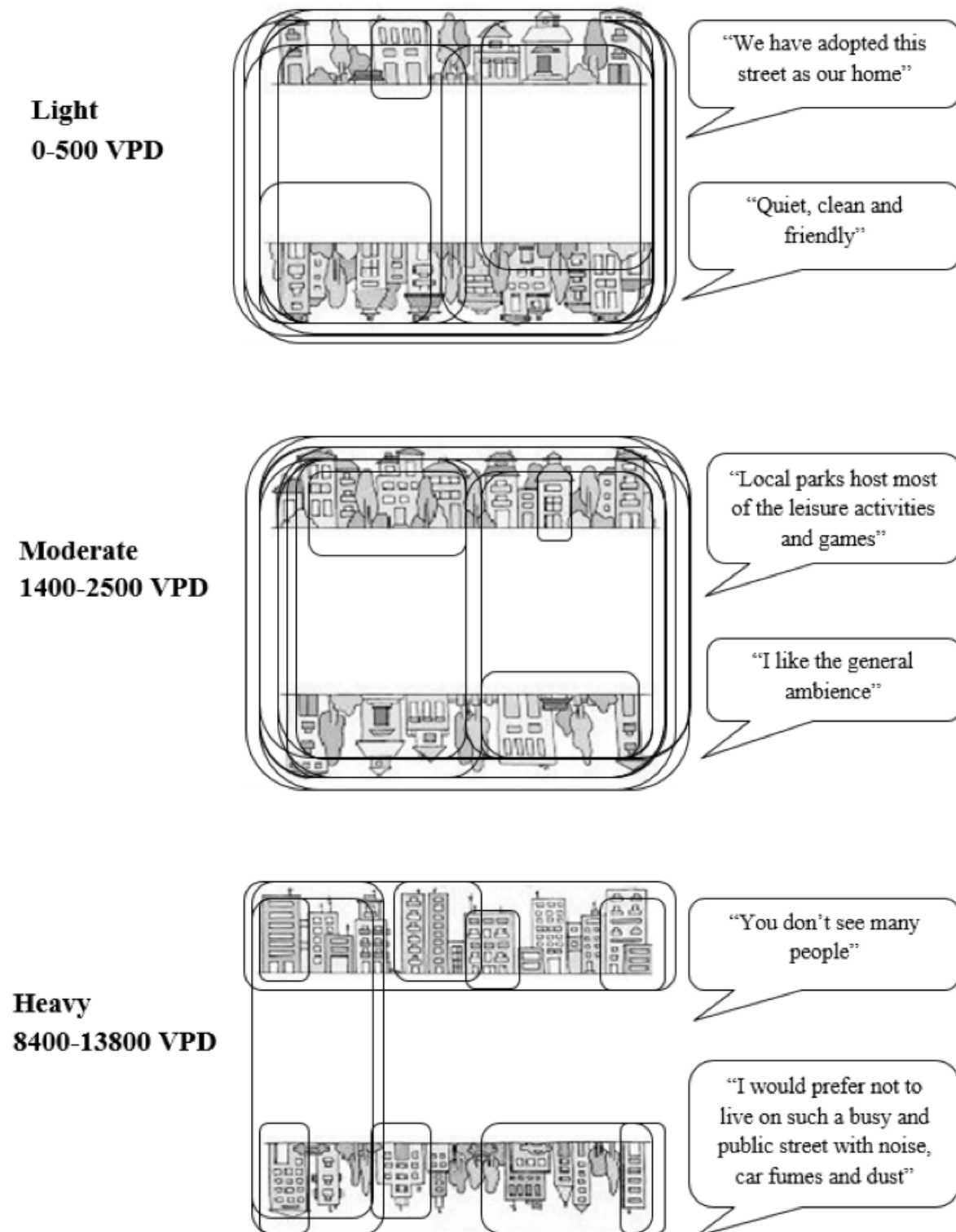


Figure 1: Local Home Areas

ally, there were no respondents of Māori or Pacific ethnicities which was surprising given that these two ethnic groups make up a significant proportion of New Zealand residents.

4.1 Home area

Light and moderately trafficked streets commonly had local home areas extending into the street or beyond, with many respondents noting local recreational areas and greenspaces as areas of particular importance (Figure 1). Additionally, heavy trafficked streets had significantly smaller local home areas with the majority only encompassing the respondent's house or part of their side of the street, emphasising the barrier effect motorised traffic can have in residential areas. Comments given during interviews describing the street image for light and moderately trafficked streets demonstrate that the most common feelings associated with these street environments were positive, indicating an appreciation of the quality and nature of the streets with low traffic volumes (Figure 1). Conversely, responses from heavy trafficked streets have predominantly nega-

tive connotations, indicating a dissatisfaction with the street environments in areas of heavy traffic volume (Figure 1). This is an important consideration when discussing street liveability as the perceived image and nature of the street contribute to the way it is viewed, and subsequently used, by both residents and visitors.

The perceived negative liveability impacts of motorised traffic volume can also alter the way in which the street is utilised. In this research, street utilisation was judged on a scaled index score based on responses to five variables; restricting children from playing and crossing the street, accompanying children to school, going out on the street less often, sitting outside less frequently, and having a fenced property. There was a significant relationship, indicating that as motorised traffic volumes rose residents were increasingly aware of the impact it was having on the liveability of their street ($R^2 = 0.18$, $p = 0.02$).

4.2 Community Severance

To understand the effect of motorised traffic volume on community severance, re-

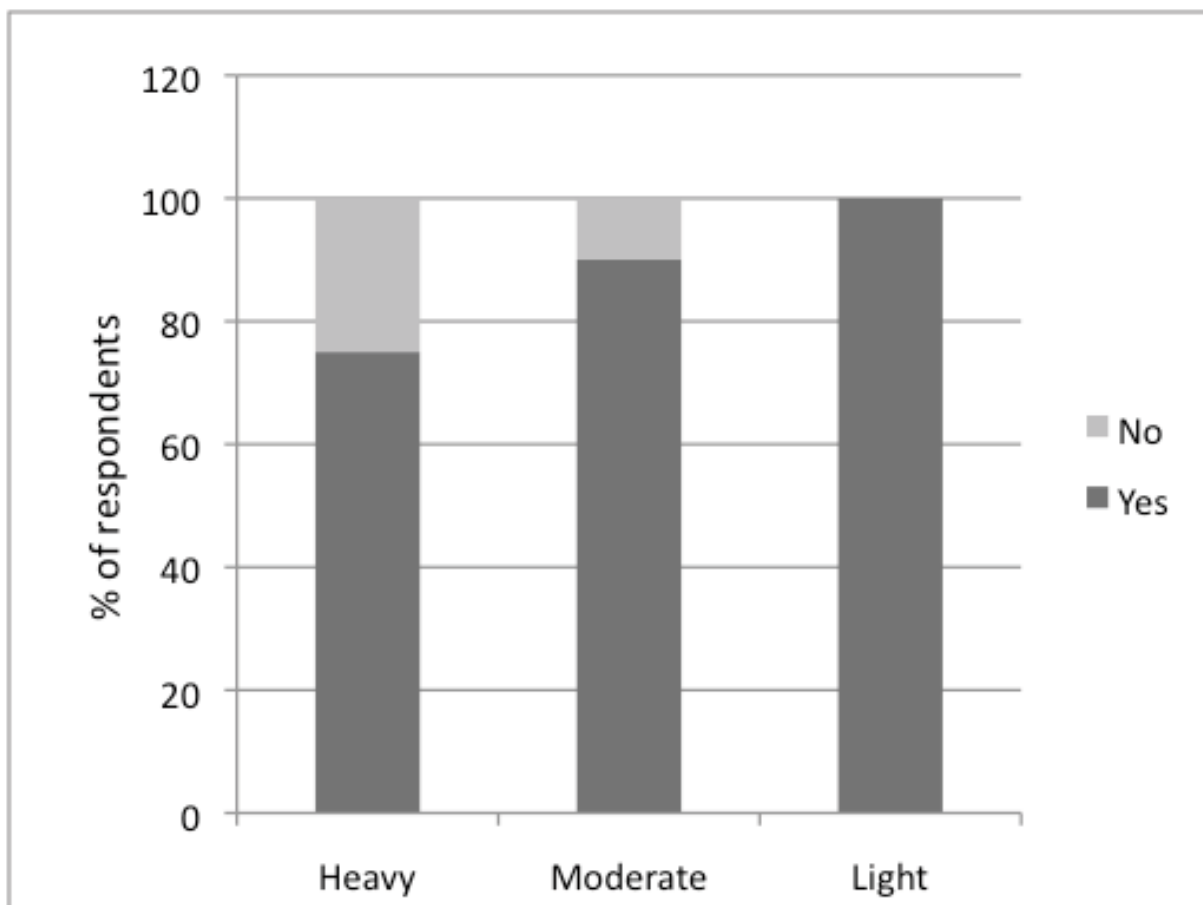


Figure 2: Sense of Belonging

spondents were asked to indicate if they felt a sense of belonging to their street and community or not (Figure 2).

This shows that as motorised traffic volume increases, the proportion of residents who feel a sense of belonging to their street and community reduces slightly. While other factors may have contributed to this relationship, motorised traffic volume can act as a barrier to social interaction by taking away the street space both physically and psychologically as discussed by

Engwicht (1999). While motorised traffic volumes seem to be impacting on the relationship with community belonging within this study further research is required to understand the extent of this and what other factors are involved. Respondents were also asked to indicate on a map of their street the number and location of neighbours they knew or had connections with. These maps were transformed into representative images to protect the confidentiality of respondents (Figure 3).

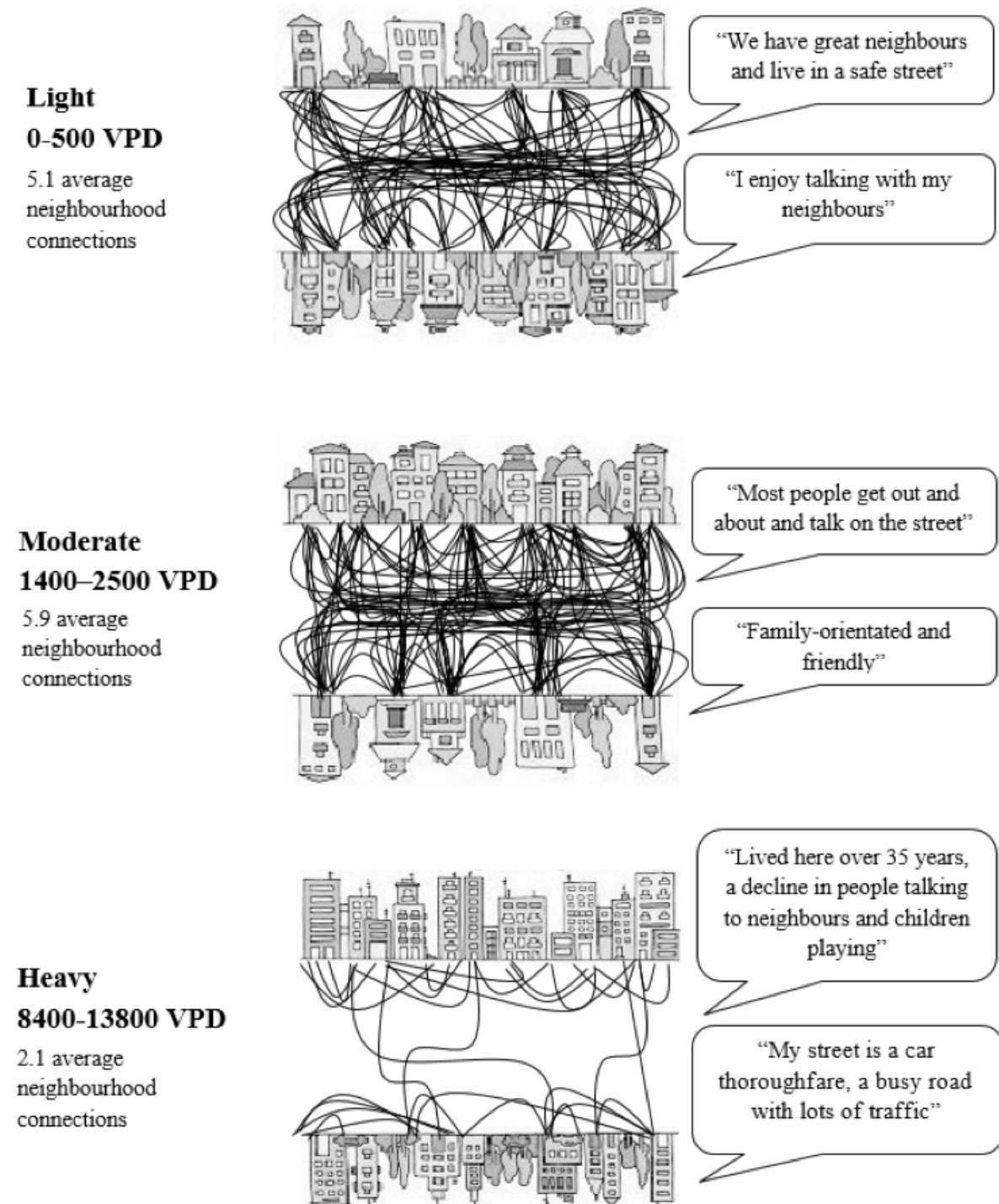


Figure 3: Neighbourhood Connections

Light and moderately trafficked streets had high numbers of neighbourhood connections, with an average of 5.1 and 5.9 respectively, extending to both sides and ends of the street (Figure 3). Heavy trafficked streets were shown to have an average of only 2.1 neighbourhood connections however, significantly less than those of the light and moderately trafficked streets. Additionally, neighbourhood connections on heavy streets are shown to centre on one side of the road only with only five connections extending to the other side of the street, once again demonstrating the barrier effect of motorised traffic volumes in residential areas (Figure 3). Comments from respondents on heavy trafficked streets demonstrate that motorised traffic volume acts as an inhibitor to community interaction with a decline in people talking and children playing, and the street being viewed predominantly as a place for vehicles. Comments from respondents on moderate and light trafficked streets are shown to have very different perceptions of the social interaction within their neighbourhood and community however, with the majority of respondents commenting on the regularity of social interactions. The distinct differences in community in-

teraction between the study streets demonstrates the impact and restrictions that motorised traffic volumes are having on this aspect of community severance within Christchurch.

While neighbourhood connections are an important aspect when discussing community severance, the level of neighbourhood interaction is also important to consider as it reflects not only how many residents know each other but how often they stop to interact. An indication of how often respondents involved in this research interact with others in their street and community can be seen (Figure 4).

Respondents from all streets had occasional community interactions, while respondents from light and moderate trafficked streets had significantly more frequent interactions, and respondents from heavy trafficked streets were more likely to never have interactions within their community (Figure 4). Motorised traffic volume may be a contributor to this relationship as it restricts residents from using the street space outside their home as an area for community interaction.

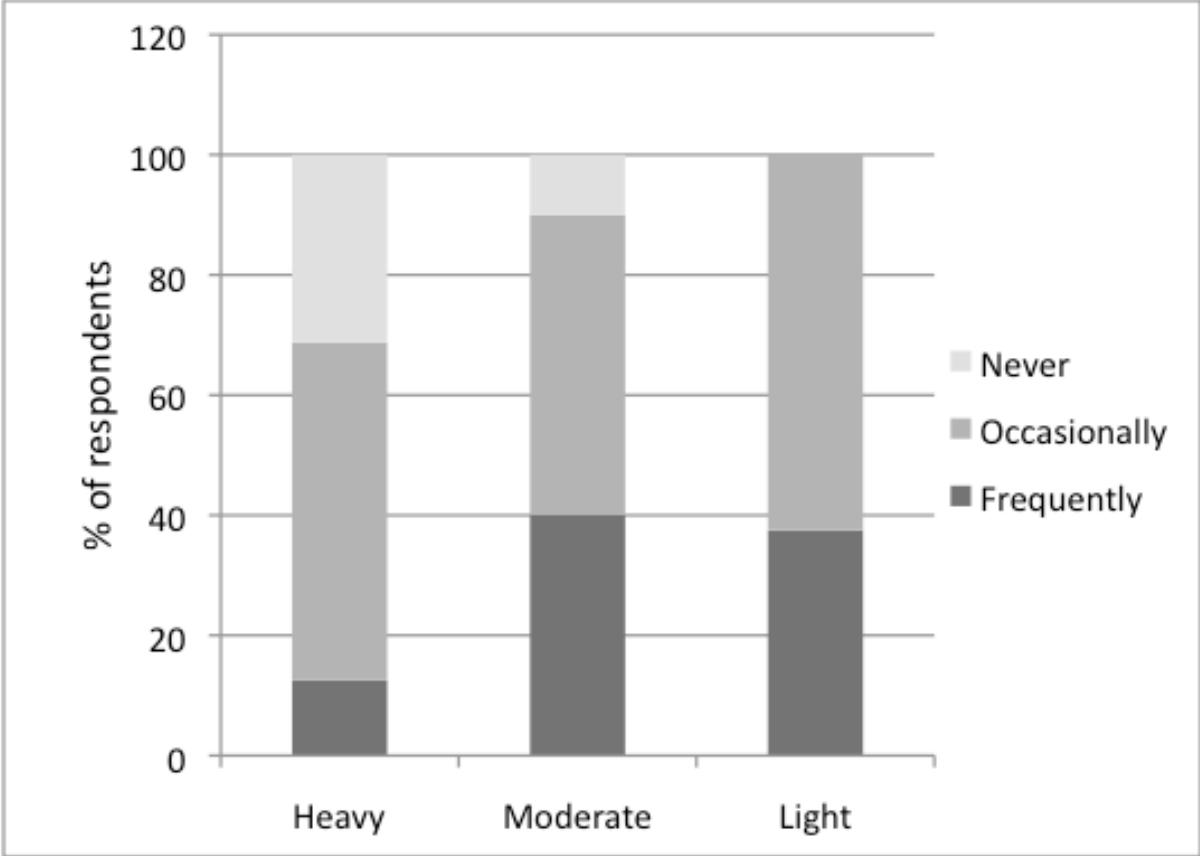


Figure 4: Community Interactions

The level of community annoyance within the research areas was also used as a measure to judge the community severance impacts of motorised traffic. Community annoyance was based on responses to the level of annoyance felt by the following factors around their home; dangers affecting children, motorised traffic noise and vibration, lack of greenspaces, lack of contact with others, and motorised traffic volumes. The only significant finding was regarding the traffic volume variable, indicating that as motorised traffic volumes rose residents were increasingly annoyed by its presence ($R^2=0.17$, $p=0.001$). Respondents were also given the opportunity to note other factors that contributed to annoyance including on-street parking and general neighbourhood noise, however the majority of respondents noted motorised traffic as their primary source of annoyance.

5. Limitations

There are various limitations implicit in this study, including that the research areas within Christchurch are limited in number, and data collected from this study is not fully representative of the population within either the research areas or greater Christchurch. The sample size of 52 is too small to confidently draw causal inferences from and the response rate was fairly small, indicating that findings would be more robust if gathered from a larger sample of residents within the study sites. Additionally, there were no respondents of either Māori or Pacific ethnicities or of younger age groups. While this may have reflected the demographic nature of the chosen study areas it is an important consideration for both this study and future research. Further research should also control for confounding variables to strengthen findings. The accuracy of data over time and space also needs to be taken into consideration, presenting a further limitation of this study as the data used for both motorised traffic volume and demographic information are from 2013 and may not accurately reflect the current situation within Christchurch. Motorised traffic volumes levels are based on classification by average annual daily traffic and reflect counts which do not take into consideration temporal and seasonal variations or

the substantial effects of changes in road closures and traffic diversions due to post-earthquake circumstances and road repairs. Additionally, while being broken into intersectional counts for heavily travelled or long streets, it does not take into account varying traffic volumes which can be present within segments of some streets, particularly those less travelled, something that was notable in observations of moderate streets involved in this research. Further research, wider research areas, and up to date data is needed to give a better indication of accurate motorised traffic volumes within Christchurch and their causal relationship with street liveability, community severance and health.

6. Conclusion

Streets and roads are where the majority of the world's population live, and are also how a large proportion of the world's inhabitants access the essential elements of life. How we use such spaces has evolved within varying contexts over time to suit societal and environmental norms, demonstrating the complex nature of the street space, its use, and the impact it can have on populations. This is particularly important when discussing residential spaces and communities where increasing motorised traffic volumes in the street space have been shown to impact significantly on livability and community severance worldwide since the 1970s and 80s, with many areas implementing urban designs and initiatives to minimise the negative impacts of vehicular dominance. While there are many other factors which impact on these relationships, research from varying contexts has identified the repressive and pervasive effect that motorised traffic can have in residential spaces.

This research sought to understand the extent to which motorised traffic volume was impacting on such relationships within contemporary Christchurch, examining the effects on street liveability and community severance. Results indicate that residents on light and moderate trafficked streets have more neighbourhood connections and community interactions in addition to perceiving their street to be more liveable. Furthermore, residents on heavy trafficked streets were shown to have a negative perception of their street environment, smaller local home areas and a

decreased sense of belonging to their community. This affirms relationships found in previous research, indicating that increasing motorised traffic volumes can have significant impacts on street liveability and community wellbeing. Ideally further research will be conducted to address the limitations of this study and specifically assess the impact of motorised traffic on community wellbeing in a more overt and substantive way.

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References:

Anciaes, P. R., Jones, P., and Mindell, J. S (2015). 'Community severance: Where is it found and at what cost?' *Transport Reviews*, doi:10.1080/01441647.2015.1077286

Appleyard, D (1980). 'Livable streets: Protected neighborhoods?' *Annals of the American Academy of Political and Social Science*, 451 (1), 106-117.

Boniface, S., Scantlebury, R., Watkins, S., and Mindell, J (2015). 'Health implications of transport: Evidence of effects of transport on social interactions'. *Journal of Transport and Health*, 2 (3), 441-446.

Bosselmann, P., Kronemeyer, T., and Macdonald, E (1999). 'Livable streets revisited'. *Journal of the American Planning Association*, 65 (2), 168-180.

Christchurch City Council (2012). Road Level Classification List. Regulations 2012. Retrieved from: resources.ccc.govt.nz/files/RoadLevelClassificationList.pdf

Christchurch City Council (2012). Volume Count Search. Retrieved from: www.ccc.govt.nz/CCC.Web.TrafficCount/cityleisure/projectstoimprovechristchurch/transport/trafficcount/volumecount.aspx

Dora, C., Phillips, M., Danzon, M., and Molterer, W (2000). 'Transport, environment and health'. World Health Organization Regional Publications - European Series, (89), 4-54.

Engwicht, D (1999). *Street reclaiming: Creating livable streets and vibrant communities*. Annandale, NSW, Australia: Pluto Press.

Gee, G. C., and Takeuchi, D. T. (2004). 'Traffic stress, vehicular burden and well-being: A multilevel analysis'. *Social Science and Medicine*, 59 (2), 405-414.

Hart, J. and Parkhurst, G (2011) 'Driven to excess: Impacts of motor vehicles on the quality of life of residents of three streets in Bristol, UK', *World Transport Policy and Practice*, 17 (2), 12-30.

Kingston, Reynolds, Thom and Allardice Limited (1982). *Traffic in residential streets: The social response*. Wellington: Road Research Unit, National Roads Board.

Marsh, K. and Watts, C (2012) 'Literature review on community severance and social connectedness: Definitions, pathways and measurement'. NZTA. Sourced from: www.nzta.govt.nz/assets/resources2012

Mindell, J. S., and Karlsen, S (2012). 'Community severance and health: What do we actually know?' *Journal of Urban Health*, 89 (2), 232-246.

New Zealand Transport Agency (2013). *Code of Practice for Temporary Traffic Management (4th Edition, Amendment 2)*. ISBN 987-0-478-40773-0. Retrieved from: www.nzta.govt.nz/resources/code-temp-traffic-management/docs

Tranter, P., and Pawson, E (2001). 'Children's access to local environments: A case-study of Christchurch, New Zealand'. *Local Environment*, 6 (1), 27-48.

Transportation Equity in Morocco: A preliminary analysis of Casablanca's Tram Line.

Asmâa AIT BOUBKR

Introduction

Transportation continues to be a civil rights issue. Transportation investments, enhancements, and financial resources can bring new life and revitalization to much needed urban areas and disadvantaged people. It provides access to opportunity and serves as a key component in addressing poverty, unemployment, and equal opportunity goals while ensuring access to education, health care, and other public services. Transportation policy tends to achieve equity objectives.

In the context of transportation the concept of equity refers to the fair distribution of benefits and costs that arise from transport between travelers. As explained by Holden (2013), mobility equity refers to an access to a certain minimum level of mobility for all people.

There are growing body of literature and studies addressing the concept of equity in transportation planning and investments all over the world. The USA (Pyrialakou & al. 2016), UK (Litman 2016), Germany (Shirmohammadli et al. 2015), Australia (Curie et al. 2015), Iran (Mortazavi and Akbarzadeh 2017), Israel (Nahmias-biran et al. 2013) Canada and a few Latin American countries (Lucas 2012) have actively attempted to revise their planning and policy perspective to account for the phenomenon of transport disadvantage.

In Morocco, the city of Casablanca - The 5th largest city of the country, with five million inhabitants- is facing important transport challenges of current burgeoning cities: the social sustainability of transportation sector remains inadequate, notably for the poor and women.

In order to remedy to this situation, the Moroccan Government has designed a broad program of investments in Casablanca by implementing a network of four tramway lines. Improving Casablanca's transportation systems tends to achieve social equity objectives. However, transport equity

analysis has not gained enough attention in tram line project studies as a concept of its own. This research is a preliminary analysis of mobility equity in the city of Casablanca undergoing the implementing of the first Tram Line.

Our focus is largely on:

- Measuring vertical equity, i.e the distribution of benefits and costs across socio-economic groups, with a particular focus on poor population;
- Examination of the impact of the First Tram-line on the disadvantaged people's quality of life and general satisfaction.

Due to lack of data, it was not possible to conduct a horizontal equity analysis.

This article is structured as follow: 1st section provides a literature review about equity aspects; section 2 provides some background about the case study metropolitan area and the transportation policy implemented there; section 3 describes the methodology of the research section 4 provides the results and finally the section 5 concludes and discusses the results.

1. Equity in transportation

1.1 Equity Definition

In transportation planning and investment, the subject of equity is becoming increasingly important and there is no consensus among scholars on how transportation equity should be defined (Litman 2017, Thomopoulos et al 2009).

The Oxford English Dictionary defines the term Equity as "*The quality of being equal or fair; fairness, impartiality; even-handed dealing*". In the economic literature, equity refers to the fairness in the distribution of impacts (goods and services or costs and benefits) and to the corresponding injustice caused by substantial uncompensated losses.

In the context of transportation, the concept of equity refers to the fair distribution of transportation effects between travelers (Litman 2002), especially for "*territorially excluded individuals*" whom are "*those from the poorest areas, which are suffering often from their peripheral lo-*

cation, limited accessibility, lack of basic infrastructure, socio-economic backwardness, low level of education development, deteriorating housing and life conditions, difficulties with access to public services and the huge number of people which belong to groups with risk of social exclusion" (Zakowska, Pulawska 2014).

However, transportation equity analysis is not a simple issue. As explained by Litman (2017) there are no recognized and acceptable methods for analyzing equity impacts of transport because there are various types, measurement units, and categories of people to consider. Two types of equity are identified: Horizontal Equity and vertical Equity.

Horizontal Equity implies to give the same treatment to people in an identical situation. Consumers should "get what they pay for and pay for what they get". This is concerned with the fairness of impact allocation between individuals and groups considered comparable in ability and need.

In transportation, horizontal equity refers to the distribution of costs and benefits which are results of external effect (environmental sustainability and climate change, access to basic and secondary services...).

Vertical Equity, is based on the idea that those who earn more money, or have more economic resources, should be taxed at higher rates than those earning less money. In transportation, this approach supports vulnerable individuals or social groups, who could be in a difficult situation (children, disabled people, older people...). The vertical equity can be stratified (Litman 2016) into:

- Vertical Equity With Regard to Income and Social Class: transport is most equitable if it provides the greatest benefit at the least cost to disadvantaged groups, therefore compensating for overall social inequity. This approach is often used to support transport subsidies and oppose price increases.
- Vertical Equity With Regard to Mobility Need and Ability

This is a measure of how well an individual's transportation needs are met com-

pared with others in their community. It focuses on two issues: access for people with disabilities, and support for transit and special mobility services.

1.2 Indicators of transportation equity

Transportation equity analysis is not a simple issue because of the diversity of types of equity, numerous impacts to consider and various ways of measuring these impacts (Litman 2002). However, there are two commonly used primary indicators of transportation system performance: mobility and accessibility.

Mobility reflects to the ease of moving throughout the transportation system. The primary measures of this are travel time savings and travel costs.

- Travel time savings can be significant benefit to the poor that typically face very long travel times due to a combination of poor location and limited access to high-speed modes.
- Travel costs or affordability is a key constraint to mobility among the urban poor. There is a need to be cognizant to the equity implications of fare policies (Deakin and Harvey).

Accessibility is perceived as the ease of reaching a number of key activities and opportunities (education, health care, employment...). Two types of accessibility measures can be distinguished (Florida Di Ciommo, yoram shiftan 2017):

- Isochrones measures used to determine the accessibility level each group has;
- Gravity-based indicators measure the value of destination the further it is located from the place of residence of population group.

Bills and Walker (2016) distinguished two high level approaches to transportation equity analysis. The first one called "modeling approach" refers to equity impacts using regional travel demand model. The second one, "non-modeling approach" is characterized by the use of spatial analysis tools to map the residential locations of poor communities in relation to location of the proposed transportation projects.

2. Background

According to a report¹, existing conditions of inequitable transportation accessibility among the city of Casablanca have resulted from transportation planning processes. The poor cannot use public transport services. Public transport coverage of poor neighborhoods is frequently insufficient because of their location in peripheral urban areas and the poor quality of roads.

2.1 Mobility characteristics in Casablanca

The Demand for urban mobility in Casablanca has sharply increased in the last decades. However, Walking remains the primary mode of transport of the poor, although the urban environment is largely unfavorable to pedestrians and the length of trips tends to increase. The table 1 presents the key characteristics of transport demand and modes in Casablanca².

- 11 million trips per day
- 2.9 trips (on average) per inhabitant per day
- 35 % of trips are related to commuting to centers of education
- 28 % of trips are from domiciles to work places
- 63 % of trips are obligatory (not elective)
- 140 vehicles per 1,000 inhabitants
- 53 % of inhabitants have to walk due to lack of transport
- Taxis: 15,000 units
- Bus system: 736 buses for 77 lines covering 1,350 kilometers; fare = 4 dirham
- Tramway (since 2012): 1 line of 31 kilometers, 48 stations, and 37 cars with 600 seats; Fare = 6 dirhams (0,09€)

Table 1: key characteristics of transport demand and modes in Casablanca

2.2 Insufficiencies of urban transport in Casablanca

Based on the analysis of available documentation (urban master plans, World Bank Reports and data from urban transport operators), the main insufficiencies of urban transport in Casablanca are:

- The commercial speed of public urban transport as reported by transport operators is particularly low and unpredictable. It may go down to around 5 kilometers per hour on average during peak hours.

¹ DOCUMENT OF THE WORLD BANK Report No. 101010-MA) November 2015

² Autorité Organisatrice des Déplacements Urbains. "Situation de la Mobilité à Casablanca," Casablanca, September 2014.

- Most users have to inefficiently combine different tickets, passes, and fares for the same journey because of deficiencies in intermodal interoperability.
- Accessibility to public transport is especially problematic for people with limited mobility (PLM), including the elderly and women that are pregnant or are carrying children.
- Traffic accidents disproportionately affect the poor as pedestrians, cyclists and motorcyclists are the most vulnerable road users and account for the majority of traffic-related deaths and injuries.

This situation hinders the citizens' access to jobs, education, and health services, which perpetuates the current deficit of social integration.

In order to remedy this situation, the Government has designed a broad program of

investments in Casablanca by implementing a network of four tramway lines that connects Casablanca's strategic hubs, two transversal (T1, T2) and two radial (T3, T4). These lines will interchange with the operational AlBidaoui suburban railways (Figure 1). By 2022, Casablanca will have a network totalling 76 route km costing 5.9 billion dirhams (Figure 1).

The first tramway line (T1) for the city has been launched on December 2012. At 31 km in length, the line connects the city's Eastern districts (Sidi Moumem and Moulay Rachid) with the Southwest (Hay Hassani and the university district) via the city centre.

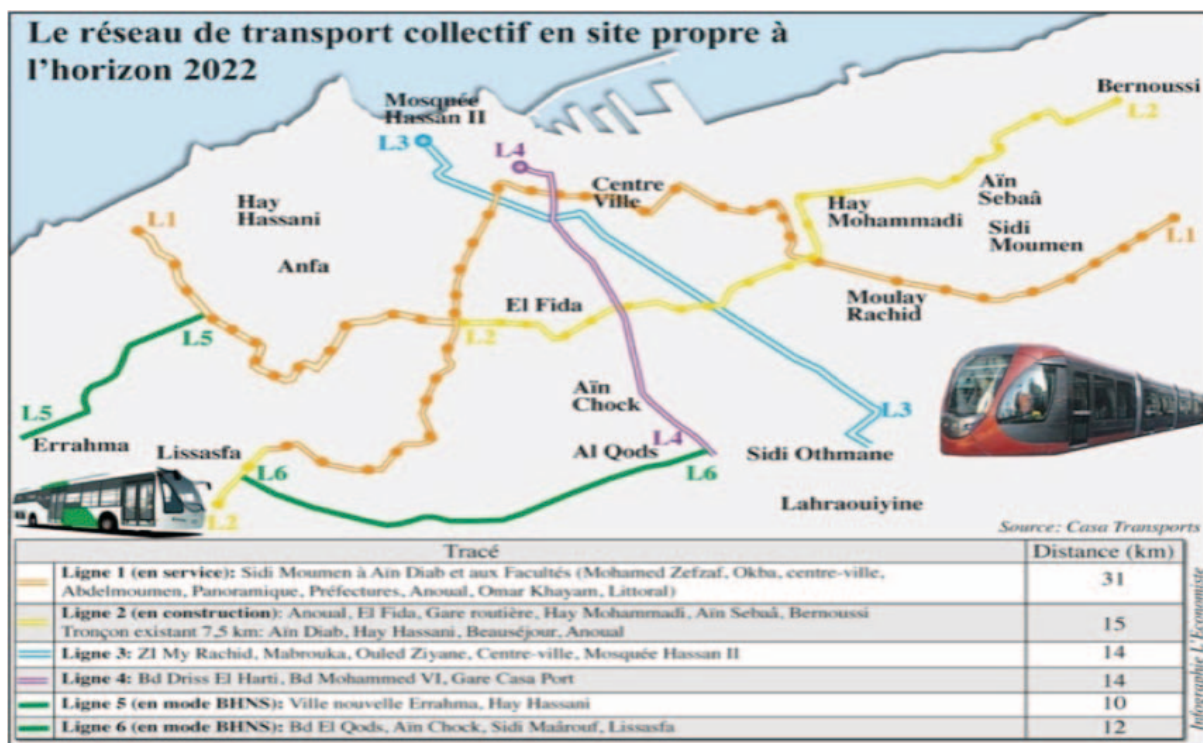


Figure 1: Casablanca’s Tram Line network by 2022

By 2013, the tramway had met its objectives by carrying over 100,000 passengers a day. However, only relatively few passengers or 1 percent of travel demand (100,000 passengers per day) are served by the tramway, which had cost as much as US\$800 million.

3. Methodology

Social meaning of public transportation service is not identical for all citizens. Public transportation is considered an essential good for captive users but only an option for choice users (whom own a car). It’s better to distribute public transportation services based on vertical equity (Mortazavi and Akbarzadeh 2017).

Vertical equity evaluation requires that people be categorized by demographic and geographic factors such as income, employment status, age, education level, gender, car ownership and the place of residence to identify those who are transport disadvantaged (Fan and Huang 2011; Hine and Mitchell 2001; Jiao and Dillivan 2013; Karner and Niemeier 2013).

Disadvantaged status evaluation should take into account the degree and number of these factors that apply to an individual. The greater their degree and the more

factors that apply, the more disadvantaged an individual or group can be considered. For example, a person who has a low income but is physically able, has no care giving responsibilities, and lives in an accessible community is not significantly transportation disadvantaged, but if that person develops a disability, must care for a young child, or moves to an automobile-dependent location, their degree of disadvantage increases.

Litman (2002) introduced some criteria to identify potentially vulnerable people such as having low-income, being car-less or living in a geographically disadvantaged area etc.

In this study the analysis of vertical equity focuses on evaluating the distributional impacts of the first line Tram among various groups of the population by using demographic and geographic factors:

Geographic factors: People living in peripheral urban areas with low income and served by the first tram line (T1) (figure 2 & 3). The income profile of the served areas is mixed, ranging from upper-middle income households to very low income people. (Figure 2).

Economical Status	Unemployed	1.7%
	Retired	3.0%
	Student	27.8%
	Employee	61.4%
Age	15-24yrs	36.0%
	25-34yrs	28.8%
	35-44yrs	15.7%
	45-54yrs	11.7%
	55yrs+	7.8%
Gender	Male	59.3%
	Female	40.7%
Income	<2000 Dh	7.0%
	2001-4000 Dh	31.7%
	4001-8000 Dh	33.8%
	8001-14000 Dh	15.7%
	14001-20000 Dh	8.4%
	20001-25000 Dh	3.5%

Table 2: Socio-economic characteristics of Tram Line passengers

designed to estimate the overall perception and satisfaction of passengers with the Tram services. The survey included passenger socio-economic characteristics, trip origin and destination as well as travel behavior which includes trip frequency, travel purpose, trip duration and portion of passenger income devoted to transport. The population of the survey is composed of 3000 passengers.

4.Results

4.1 Who use the Tramway?

The majority of tramway passengers are students, employees with an average age of 34 years. Before the tram line was launched, 90% of the passengers are cap

tive users; they used the bus for their travel before the implementing of the 1st tram line (table 2).

Gender issues in public urban transport are also particularly relevant in Casablanca as women are less reliant on public urban transport.

The students and the employee use the Tramway intensively (more than twice a day). During the week, the tramway is used mainly for the trip home work or home study, and the trip duration declared by the users is more than 30 minutes. Passengers were asked for their satisfaction with the using of the tramway compared to the bus system. 95% of the passengers are generally satisfied.

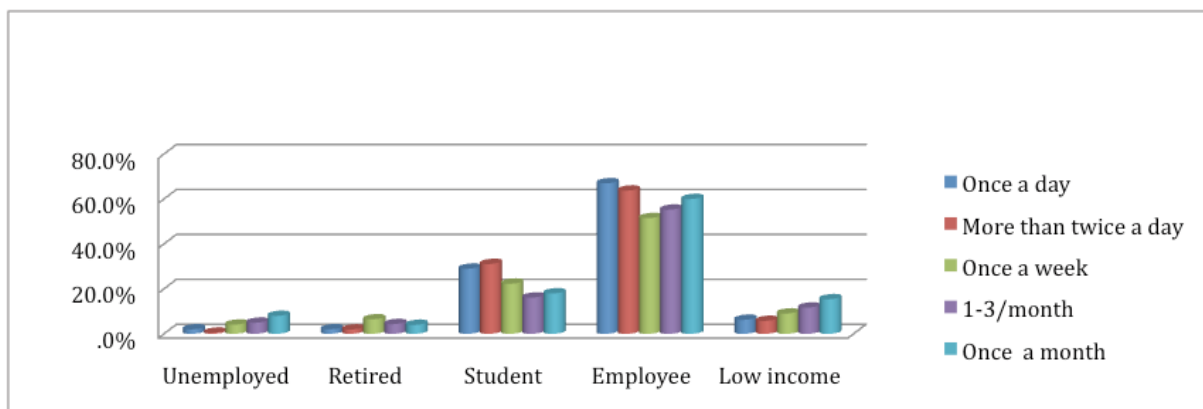


Figure 4: Trip frequency for different groups

4.2 Vertical equity analysis

Vertical equity was investigated between four groups: Students, seniors, unemployed and low-income people. The figure 4 shows that unemployed (1,7%), seniors (7,8%) and low-income people are the least mobile group. The low-income group frequently travels on foot or by bicycle.

Travel cost

Affordability is acknowledged as a key constraint to mobility among the urban poor. In this case, the tramway offers lower fares as reported by 85% of passengers.

Despite relatively low fares in Casablanca compared to other middle-income countries (World Bank, 2015), the poor are often priced out of urban transport due to the necessity to combine different modes. Spending on urban transport can represent as much as 20 percent of the poorest households' incomes in Casablanca.

However, the portion (per day) of poor people income (less than 4000 Dhs) devoted to tram line still important (10%) even if the tramway is perceived as affordable. This situation can be explained by the fact that most users have to inefficiently combine different tickets, passes, and fares for the same journey because of deficiencies in intermodal interoperability (figure 5).

As Casablanca residents' income rises they will tend to choose automobiles as their main mode of transport, which explain the low average of public transport budget for higher income (1% for people earning more than 8000 Dh/month).

5. Discussion and conclusions

The increasing rate of mobility-disadvantaged groups as well as the lack of adequate mobility equity studies in Morocco inspired this study as an introductory work for this issue.

This paper presents some results of the preliminary analysis on transport equity in Morocco. Examining the data and considering the results of vertical equity enables an evaluation of whether the new tram line promotes equity among four separate disadvantage groups -Students, seniors, unemployed and low-income people- in Casablanca. This analysis by socioeconomic variables showed that unemployed, seniors and low-income people are the least mobile group despite relatively low fares.

However, the tram line is students' first choice of transport mode thanks to the low-price tickets.

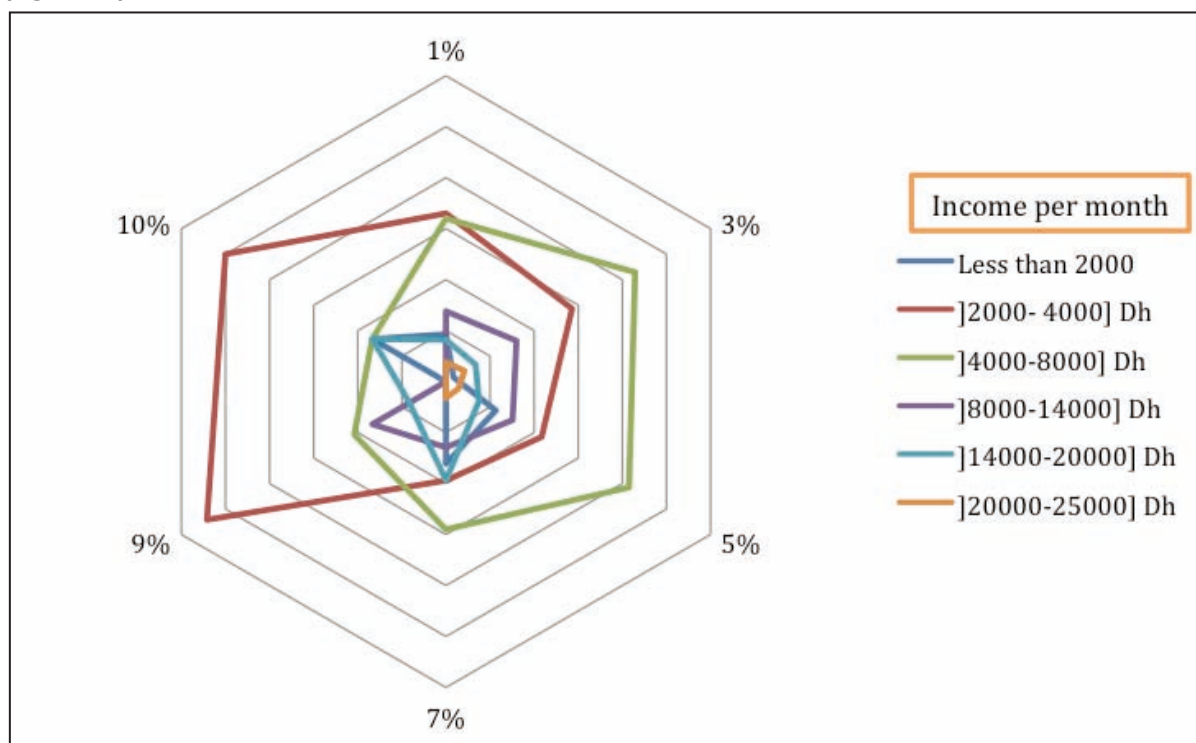


Figure 5: Proportion of income spent on public transport (per day)

A World Bank report (2015, page 3) confirms these results. It shows that "Social sustainability of the urban transport sector remains inadequate, thus worsening the deficit of social integration". Gender issues have become increasingly relevant as a rapidly growing number of women become more reliant on public urban transport. However, despite the implementation of the Tram Line, most women still experience inadequacies particularly in terms of safety, which obstruct their access to basic social services, limit their labor force participation, and potentially reduce their income. Accessibility is especially problematic for persons with limited mobility (PLM), including the elderly, which represent up to 18 percent of citizens in major cities.

Future studies should calculate the Gini index to measure the horizontal equity and should also investigate the incorporation of equity issues into the appraisal of transport projects; in order to define where and for whom transport plans are really made.

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References:

Bills, T.S., Walker, J. L., (2016). Looking beyond the mean for equity analysis: Examining distributional impacts of transportation improvements. *Transport Policy* 54(2017) 61-69.

Deakin, E., Harvey, G., Pozdena, R., Yarema, G., (1996). *Transportation Pricing Strategies for California: An Assessment of Congestion, Emissions, Energy, And Equity Impacts*. University of California Transportation Center.

Di Ciommo, F., Shifan, Y., (2017). Transport equity analysis. *Transport Reviews*, 37:2, 139-151

Fan, Y., Huang, A., (2011). *How Affordable is Transportation? An Accessibility-Based Evaluation*. CTS Report 11-12, Transitway Impacts Research Program, Center for Transportation Studies.

Hine, J., Mitchell, F. (2001). Better for everyone? Travel experiences and transport exclusion. *Urban Studies*, 38(2), 319-332

Holden E, Linnerud K, Banister D. (2013). Sustainable passenger transport: Back to Brundtland. *Transportation Research Part A*, 54, p. 67

Jiao, J. and D. Maxwell. (2013). Transit deserts: The gap between demand and supply. *Journal of Public Transportation* 16(3): 23-39

Karner, A., Niemeier, D. (2013). Civil rights guidance and equity analysis methods for regional transportation plans: a critical review of literature and practice. *Journal of Transport Geography*, 33(0), 126-134.

Litman, T., (2013). The New Transportation Planning Paradigm. *ITE Journal* Vol. 83, June, pp. 20-28

Litman, T., (2017) *Evaluating Transportation Equity Guidance For Incorporating Distributional Impacts in Transportation Planning*. Victoria Transport Policy Institute

Litman, T. (2002). *Evaluating Transportation Equity*. *World Transport Policy and Practice* 8: 50-65.

Lucas, K. (2012). *Transport and Social Exclusion: Where are We Now?* *Transport Policy* 20: 105-113.

Mortazavi, SAH., Akbarzadeh, M. (2017). A Framework for Measuring the Spatial Equity in the Distribution of Public Transportation Benefits. *Journal of Public Transportation* 20 (1), 44 - 62

Pyrialakou, V. Dimitra & Gkritza, Konstantina & Fricker, Jon. (2016). Accessibility, mobility, and realized travel behavior: Assessing transport disadvantage from a policy perspective. *Journal of Transport Geography*. 51. 252-269.

Ricciardi, A. M., J. Xia, and G. Currie.(2015). Exploring Public Transport Equity Between Separate Disadvantaged Cohorts: A Case Study in Perth, Australia. *Journal of Transport Geography* 43: 111–122.

Ruiz, M., J. M. S. Pons, J. M. Lladó, and M. R. M. Reynés. (2014). Improving equity of public transportation planning. The case of Palma de Mallorca (Spain). Paper presented at proceedings of the AGILE'2014 international conference on geographic information science, Castellón, Spain, June 3–6.

Shirmohammadli, A.Matin & Louen, Conny & Vallée, Dirk. (2016). Exploring mobility equity in a society undergoing changes in travel behavior: A case study of Aachen, Germany. *Transport Policy*. 46. 32-39.

Thomopoulos, N., Grant-Muller, S., & Tight, M.R. (2009). Incorporating equity considerations in transport infrastructure evaluation: Current practice and a proposed methodology. *Evaluation and Program Planning*, 32, 351-359.

World Bank, November (2015), PROGRAM-FOR-RESULTS URBAN TRANSPORT, Morocco, Report No. 101010-MA

Zakowska L., Pulawska S. (2014), Equity in Transportation: New Approach in Transport Planning – Preliminary Results of Case Study in Krakow, "Transport Problems", 9, 3, 67–74.

Electromobility: Will a changeover to electric-powered vehicles make transport systems environmentally friendly?

Working Group of German and Austrian Emeritus Transport Professors

Foreword

A group of emeritus professors in transport studies and retired directors of transport re-search institutes at German and Austrian universities meet annually in Fulda, Germany, to discuss evolving issues in the transport field. At these gatherings, much attention has been paid to developments surrounding the use of electric-powered vehicles in urban and regional transport systems. At their most recent meeting, the transport experts have called on all involved parties to use the emerging technical possibilities responsibly for the general welfare of persons, cities and the environment, and to make a realistic assessment of what these possibilities in fact are and what their effects will be (see accompanying text).

The transport experts see long-term opportunities to improve climate and environmental protection in urban and regional transport systems through the use of electromobility. However, they point out the necessity of introducing these new technical possibilities with an informed overview of the overall context of urban and regional transport systems and settlement patterns. They identify the many as yet unclarified technical questions associated with electromobility. In this connection they call for an augmentation of the strategic approach "Clean Energy in Transport" outlined by the Austrian Transport Ministry (bmvit). For an independent performance review of electromobility developments, a "national electromobility expert platform" should also be established in Austria as well as in Germany, which includes independent experts from the field of transport planning. The professors call for a comprehensive impact assessment and also for an informed consideration of possible negative effects that may occur in the development of electromobility.

Increased use of electrically powered road vehicles in personal and freight transport in the pursuit of climate protection goals

and new technological developments is foreseeable. To ensure a positive impact on solving future transport and environmental challenges in urban and regional areas it will be necessary for the involved political decision makers to establish the necessary framework and parameters without delay.

There are, however, many open questions that must be clarified in order to take these important steps. More intensive participation of the involved cities and regions, civil society, political actors and policymakers, administrative bodies and business leaders in this crucial process is therefore essential.

Electromobility: Will a changeover to electric-powered vehicles make transport systems environmentally friendly?

1. All forms of energy generation and use entail costs

In the current public discussion, the technology of the drive systems used for cars and trucks has been brought into close connection with desired changes in the global climate and environment. Limiting global warming is recognised as an important objective around the world. An effort to limit CO₂ emissions in accordance with the Paris Agreement is one focus of this effort. Another focal point concerns nitrogen oxide emissions coming from diesel-powered vehicles, an additional matter which demands effective countermeasures. Both of these goals give rise to demands for change in the transport and mobility concepts used in the field of vehicle propulsion systems – particularly in urban areas.

Road-based transport is responsible for a significant portion of ongoing CO₂ emissions. In the past, the principal effort to reduce CO₂ emissions has been made through the development of more efficient internal combustion motors. Another possible route to reduce such emissions could be the use of electrically powered vehicles in connection with modern battery technology and fuel cells or hydrogen combustion. More and more governmental support is available for such developments, which also have a growing positive

reception in the general public discourse. In consequence, they are being pursued more and more intensively by the involved industries. Nonetheless, it is necessary to pose the question to what degree e-mobility really serves environmentally friendly transport policy and what secondary effects are associated with it.

Against the background of ongoing discussions of exhaust emission values from diesel motors that have become almost incomprehensible, the public debate regarding future transport systems is concentrated mainly on various vehicle propulsion technologies, which should either be required or regulated one way or another. This is particularly the case for electric-powered vehicles. A possible mandatory introduction of such vehicles by a certain date (e.g. 2030) has been the subject of heated debate among politicians of various parties in Germany and Austria. In this situation, it is useful and necessary to undertake a comprehensive scientific assessment of the current efforts to develop more efficient and environmentally sound drive systems for vehicles. This should also include an identification of the deficiencies of the existing debate as one important step in finding the most promising way forward.

There exist only highly specific and not easily comparable¹ compilations of the advantages and disadvantages of various vehicle propulsion energy sources due to the complex chains of factors in the production and use of energy. Depending on the standpoint taken in the debate regarding future energy sources, only certain advantages of the one or the other type of energy are highlighted, depending on the interests of the involved parties. Often one gets the impression in this type of discussion that the laws of physics (which of course underlie the entire situation) are simply being ignored. It is a fact that in the production, storage and use of energy, energy consumption is necessary, which typically involves direct or indirect emission of pollutants and the use of limited resources.

1 Also of significance in the production chain of energy (including the storage of the produced energy) are pertinent social factors such as child labour, oil production in nature sanctuaries, etc. Although relevant, these factors will not be considered in more detail here.

Of course, it is advantageous if at least part of the energy used to power vehicles comes from renewable sources (wind, solar). In the current discussion, however, often the problems of alternative power sources (electric vehicles) are not adequately considered. In the following paper, the main alternative to the internal combustion motor currently under consideration – namely, battery-powered electric vehicles – will be analysed with regard to a number of disadvantages that to date have received little attention. Other electric-powered alternatives such as fuel-cell vehicles will not be considered here even though many of the factors that will be cited also are relevant for such systems. In the following examination, existing deficits in the current strategy will be identified which urgently need to be addressed.

2. Deficits in the comparison of electric-powered vehicles and other forms of propulsion

2.1 Disregard of the size and weight of vehicles

It is well known that all forms of technical progress can also trigger so-called “rebound effects” (see Santarius, Tilman, 2012). Thus, for example, the energy savings that are achieved by more efficient vehicle drive systems are at least partially dissipated through more intensive vehicle use as well as the purchase and use of larger and heavier vehicles with greater engine power while operating costs are kept more or less constant. Precisely this rebound effect was in evidence in recent years with the ever more excessive engine capacity in passenger cars – with increasing vehicle size and performance. In connection with the introduction of electric vehicles, however, this type of development has not yet received the attention that it should.

It is already foreseeable, however, that the automobile manufacturers are aiming to follow the example of the Tesla Model S and will bring large and heavy electric vehicles to the market while categorising such vehicles as “ecological”. The involved energy losses occurring through sheer size² and weight have not been addressed

2 Energy consumption increases disproportionately to the size of a vehicle’s frontal surface.

– either as a technical or a political topic³. This strategy is abetted by current law that on the one hand requires that specified fleet averages in fuel consumption or CO₂ emissions are met while calculating the emissions from electric-powered vehicles as zero and falsely undercalculating the values for hybrid-drive vehicles. Even without the electrification of vehicles and most certainly with it, there is an urgent need to limit the size and weight of passenger cars or at least to subject it to taxation.

2.2 Disregard of acceleration

Owing to the characteristic line of their motors, electric vehicles can accelerate very rapidly at all speeds. In all the relevant publications, this is judged nearly without exception to be a great benefit (a “delightful driving experience”, etc.). That the acceleration realised with these vehicles also consumes energy is only mentioned peripherally, if at all. That the increased acceleration in urban settings may be exceedingly dangerous because the vehicles approach at once swiftly and silently, thus denying pedestrians and bicyclists the necessary time to react and avoid accidents, is also hardly mentioned. Nor is it considered that the increased acceleration results in higher rates of wear to the roadway and to tyres with increased levels of particulate emissions. A limitation of acceleration capacity in electric vehicles (which presents no technical problems) is therefore urgently required⁴, also for safety reasons as the reflexes of drivers in an aging society are also declining.

2.3 Use of the description “emission-free” or “locally emission-free” for electric automobiles

It has often been stressed that electric vehicles generate no emissions – and thus are emission-free – in the locations where they are used (in urban centres, for example). However, in accordance with the laws of physics, emission-free movement

3 In addition, effects such as road wear should be considered. Calculated approximately (Cambridge Road Formula), road wear increases at a power of 4 relative to axle load; a vehicle with twice a given weight increases road wear by a factor of 16.

4 Outside of urban areas, the reflex of increasingly elderly drivers will in many cases also not be commensurate with the possible rates of acceleration.

of a larger mass is simply not possible. The fact that the electricity is produced at another removed location and that it may well be that “indirect emissions” are produced there is only acknowledged with the formulation “vehicles that are locally free of emissions”⁵.

However, even this description is not correct. The fact is that the particularly dangerous emissions, namely fine particulate matter, are also generated with the operation of electric vehicles. The street cross section at the Neckartor location in Stuttgart has been very thoroughly studied in connection with the current debate regarding diesel motors in Germany. The particulate matter there has been analysed in detail to determine its origin, and it has been shown that at least 85% of emitted particulate matter in the size of PM 10 does not come from the motors of the involved vehicles. This is a very complex situation⁶. Measurement results obtained by the State Institute for the Environment and Conservation in Baden Württemberg (LUBW) are regularly updated on the website of the Institute. A useful summary of the findings is provided in an article by Christof Vieweg⁷.

2.4 Disregard of energy consumption of electric vehicles or of the distances covered with electric power by plug-in hybrid vehicles

Axel Friedrich, the former head of the UBA researching for the German environmental organisation “Deutsche Umwelthilfe”, has rightly demanded that “efficiency standards must also be established for electric automobiles to prevent the waste of valuable ecologically generated electricity”⁸.

Ecologically generated electricity is not available in unlimited amounts at a given time or place. At night when the wind blows less strongly, every kilowatt hour is particularly valuable (more on this later).

5 A comparison of the emissions caused through the production of electricity with those resulting from motor combustion will not be undertaken here. The literature on this subject is as diverse as the various viewpoints regarding this topic.

6 Depending on the particle size, differences can occur which bring turbocharged petrol-fuel motors into focus as a causal agent.

7 Vieweg, Christof: Feinstaub – Die Motoren sind nicht das Problem, in ZEIT-online (2017).

8 See, Friedrich, Axel (2017).

To act as if the energy consumption levels in electric vehicles are irrelevant – as suggested by terms such as “zero emissions” or “zero energy” – has serious consequences. Because these figures have also been used for the official consumption levels, it benefits the manufacturers to replace large and heavy combustion vehicles with high CO₂ emissions through large and heavy (or even heavier) electric vehicles so that the “fleet consumption value” is effectively reduced for the brand as a whole.

This has a particularly unfortunate effect with the regulation for plug-in hybrid vehicles which in practical use only achieve low consumption values of combustion fuels when there is a sufficient amount of electric recharging. Even the specified petrol/diesel consumption values used for the fleet consumption figures are highly unrealistic due to the overestimation of distances covered with electrical power, which are included in the calculation with a “zero” value. In all of this, the question of the production, storage and distribution of electricity remains unclarified as well as the specific degrees of energy loss occurring in the course of these processes. The availability of sufficient capacities in the power grid to accommodate charging infrastructure is also not automatically available.

It is essential that a standardised value for total CO₂ emissions has to be introduced. An efficiency standard for electric vehicles could be the CO₂ equivalent value⁹ of consumed electrical energy in an RDE (real driving emission) test. It would also be an adequate orientation value for plug-in hybrid vehicles because it would generally reflect the disadvantageous additional petrol consumption resulting from the overall higher weight of such vehicles. The CO₂ values set in EU regulations must reflect these real conditions. They then will be more realistic and not set at an illusionary low range.

⁹ In accordance with the current energy mix so that in general an impetus is created for the development of eco-logical energy production.

3. Errors and misconceptions regarding energy provision

3.1 Providing energy for electric vehicles is no problem

It has already been mentioned above that ecologically generated electricity is particularly valuable. Making such power available in the desired quantities without time-based or location-based limits will not be possible in the directly foreseeable future. In addition, there will be other consumers of such energy, for example in the heating sector if the goal of completely eliminating CO₂ emissions for such purposes is to be met. The energy requirements for heating will compete particularly with the requirements for charging electric vehicles, especially on winter nights (despite reduced night-time heating needs). The scenario of a windless winter night in the year 2050 indicates that considerable investments in power storage facilities will be necessary if ecologically generated electricity is going to be continuously available – and that is the case even without considering requirements for electric motor vehicles. Besides the storage facilities, a comprehensive expansion of the power grid will be necessary to accommodate the production possibilities of green power at locations removed from the place of use. Many locations are currently only equipped with power supply connections of insufficient capacity. Currently we do not have integrated concepts for ecological electricity generation, its large-scale and decentralised distribution, its storage and the storage-orientated conversion (to-liquid / to-gas ...).

The generation of the total power necessary for electric vehicles is in itself a significant challenge¹⁰, if one supposes that all of the currently used fossil-based fuel is to be replaced by electric power. Nonetheless, with the appropriate level of effort – which however must commence immediately – this should be possible, particularly because the scenario “Everyone has an electric car” will not in fact be realised so quickly.

¹⁰ See the exposition of the physicist Vince Ebert (2017) in “Spektrum der Wissenschaft” which makes reference to the peak loads that can be expected. This presentation may be questionable regarding certain details but in its general thrust it is entirely correct.

3.2 Disregard of local and time-based peak requirements for energy with e-mobility

The current discussion regarding e-mobility and electric vehicles has mostly been conducted by economists and automobile technicians with little participation from transport engineers. For many years, these specialists have directed their attention to the connections between settlement patterns and transport needs arising in response to daily, weekly and annual occurrences and the particular problems of handling spatial and temporal peak loads. If these peak loads did not occur, we would require far fewer roadways and transport area in total. Managing the spatial and temporal peak loads in transport demand represents a special problem – quite without the planned decommissioning of all coal, gas and nuclear power plants. Feasible concepts to handle these challenges with comprehensive operation and development strategies are lacking at the current time.

The efforts to level out peak hours of transport use run up against very strict limits – as can be seen in everyday life. Measures such as time-of-day-based fees for the use of streets or charging of electric power inevitably have social consequences. More wealthy persons can drive or charge whenever they want, while less prosperous households do not have such options. Equal access to such infrastructure, however, is part of the public services that we aim to provide and a key element of social inclusion. Price-based measures are therefore only acceptable with careful consideration and balancing of their social impact.

Extreme peaks (both time and location-based) occur in transport volume – not only seasonally on certain days with holiday and leisure travel at certain weekends, but also at certain hours with daily commuting. This will not be simple to handle with the demand for electric energy to power electric vehicles in future. Ideas are in development that would tend particularly to reduce nightly charging (e.g. “charge at work”) and also would make use of well-supplied locations. However, substantial costs are to be expected for such measures and the required infrastructure development.

Because charging current does not simply flow out of the socket, all measures that impact transport behaviour and make it so that automobiles are used less intensively than presently will become even more important through the process of electrification of vehicular transport. The ongoing development in demand for motorised means of transport, which has not in the least reached its peak in Europe or internationally, can also not be ignored.

3.3 Electric cars do not require additional power storage in the grid because they themselves serve as power storage units and can be used as such

The argument is often made that the batteries of electric vehicles can themselves be used as a power storage facility as part of an intelligently managed “smart grid”. For this reason, large vehicles with large batteries will be one aspect of the solution rather than a problem. In making this argument, it is overlooked that the daily time-based need for power with electric vehicles will probably not allow this. In the morning, the electric car should be fully charged, therefore it cannot provide power at night for light and – particularly in winter – for heating and warm water. If the full battery capacity is not available in the morning, then it may be that the whole daily programme cannot be implemented.

Today, the peaks of electricity generation in certain areas, such as the surpluses of wind-generated power in Northern Germany, cannot be effectively transmitted through the grid to other areas such as Southern Germany. All the computers in a smart grid still cannot send the power of a full battery in a vehicle in Kiel to a household in Munich if the capacity constraints of the grid do not allow this. Therefore a comprehensive optimization concept taking time and distance factors into account to effectively handle the distribution of power generation, energy transport via networks and energy storage so as to cover energy demand for transport, heating, industry, etc. needs to be prepared, financed and ultimately implemented.

4. Consequences

Every form of vehicle propulsion creates problems, and this is no less true for electric power. Concerted efforts must be undertaken as soon as possible within each state, on an European level and internationally if electric power is to provide competitive as well as ecologically sound and socially acceptable mobility and the future of electric propulsion is to be ensured. For electric power, these problems on the one hand are caused in particular by the demands regarding weight, speed and acceleration in a new generation of vehicles. On the other hand they derive from the actual energy consumption and transport behaviour that may occur with such vehicles.

The expenditures necessary for the creation and maintenance of new infrastructure as well as the energy consumption in the production and disposal of vehicles and batteries represent further areas of concern.

A future without CO₂ emissions from motor vehicle use definitely cannot be achieved if we hold to the current level of motorisation and mileage found in developed western countries today, possibly with vehicles that are even heavier and have higher levels of acceleration than those in use today. If we transfer only 50 percent of the current level of motorisation found in Germany or similar western countries to the world as a whole, then the number of vehicles on the planet would increase from the recently reached figure of one billion to two billion. With the transfer of the full level of motorisation to the rest of the world, there would be four billion automobiles, a quantity that torpedoed any notion of environmental compatibility.

The goal of switching over to propulsion systems for motor vehicle transport without CO₂ emissions is necessary for the mid-term and long-term protection of the global climate and environment. In pursuing this switchover, the current misconceptions regarding electric propulsion need to be avoided. Without infrastructure planning for settlement and transport that reduces the overall transport activity, any conceivable form of automotive transport

– including electric propulsion¹¹ – will result in a global burden that is unsustainable and intolerable. A public debate that includes issues of alternative settlement and transport infrastructure planning, in particular with improved concepts for non-motorised transport and public transport as well as the problem of truly representing the overall economic costs of different transport options is essential for a comprehensive view of the challenge facing us, as is a debate regarding the propulsion systems for vehicles. But these infrastructure issues are not popular and thus amount to a sort of taboo subject in transport policy.

Viewed as a whole, it is urgently necessary to include the development of new propulsion technologies in an integrated approach to transport policy. This must not simply rest on questions of technical innovation but also include policies for managing changes in demand and behaviour in order to achieve defined goals (e.g. in CO₂ and NO_x reduction). In these efforts, the measures to reduce overall transport volume (sufficiency) must complement the strategies to improve efficiency and modal shifts (consistency). The electrification of bicycles, delivery vehicles/lorries as well as public transport that is currently powered with fossil fuels also needs to be integrated into a comprehensive approach.

¹¹ Several publications which make the elimination of combustion motors the central issue of discussion are therefore highly questionable. A close reading, for example of the study of the Wuppertal Institute for Greenpeace (Rudolph. F. et al, 2017) which calls for the elimination of combustion motors reveals that the prerequisite for this elimination for 2035 includes a level of motorisation at half the current level, lighter automobiles, a huge expansion of public transport and a general shortening of distances travelled in everyday life. But these are precisely the challenging points which are not sufficiently addressed in the study.

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References:

Ebert, Vince Was wäre, wenn wir alle elektrisch fahren würden? Spektrum der Wissenschaft, 19.03.2017, in the Internet: <http://www.spektrum.de/kolumne/was-waere-wenn-wir-alle-elektrisch-fahren-wuerden/1441400> accessed on 5 Sept. 2017 at 12:05.

Friedrich, Axel „Das ist nicht machbar“ Interview with Joachim Wille in the Frankfurter Rundschau 17 Aug. 2015, in the Internet: <http://www.fr.de/wirtschaft/dieselskandal-das-ist-nicht-machbar-a-1332659> accessed on 5 Sept. 2017 at 13:30.

Rudolph, Frederic et al. Verkehrswende für Deutschland - Der Weg zu CO₂-freier Mobilität bis 2035. Study of the Wuppertal Institute for Greenpeace, Wuppertal, 2017, in the Internet: <https://www.greenpeace.de/presse/publikationen/verkehrswende-fuer-deutschland> accessed on 7 Sept. at 13:13.

Santarius, Tilman Der Rebound-Effekt. Über die unerwünschten Folgen der erwünschten Energieeffizienz; Impulse (Hrsg. Wuppertal Institut für Klima, Umwelt, Energie GmbH) Nr. 5, Wuppertal, 2012, download from the Internet: <http://www.santarius.de/967/wachstum-energieeffizienz-rebound-effekt/> accessed on 5 Sept. 2017 at 14:05.

Vieweg, Christof Feinstaub - Die Motoren sind nicht das Problem, in ZEIT-online, 17.02.2017, in the Internet: <http://www.zeit.de/mobilitaet/2017-02/feinstaub-motoren-luftverschmutzung-reifen-abrieb-bremsen> accessed on 5 Sept. 2017 at 13:05.

Driverless Cars Technology. What next?

30 Million cars on roads now, projected growth rates 20/30/2040?

Upsides and downsides.

John Mullins

Transport, regarded in manufacturing/lean circles as one of the seven classic forms of "Waste", is about to undergo a huge upheaval in the coming decade, some of it predictable, some of it unpredictable. The only certainty is that it's a period of change, opportunity, with winners and losers, probably not seen since Henry Ford, positioned the Model T as the economic winner for his Age.

Cheap transport is all around us whether we like it or not; It brings global supply chains together to make everything from satellites to affordable coffee in your cup, and allows producers in one part of the world to sell to consumers in another part, be they phones from Korea or fresh-cut flowers from Kenya, all on sale here in the UK. Whole sections of our economy are based on transport, moving people and 'stuff' around, either directly or indirectly: Everything from truck and taxi-drivers, parcel delivery systems, cars and all the associated supporting industries: Not only assembly and physical component manufacture, but services, vehicle insurance, driver employment, traffic police, councils funding needed services through car-parks and parking fines, the list goes on: It all is based on the way our society has developed with the car over the last century.

The downside, is that all this movement takes energy and time and costs money to the end user: Hence its classification as a form of waste, something to be eliminated wherever possible in a Lean (read 'Efficient') system.

The change that is coming to the world of the car (And by extension, trucks/busses and all similar vehicles) has not been seen since they were invented, and is the result of the convergence of three different strands in society:

- The rise in computing power and machine learning/Sensing: With Moors law still holding sway after nearly 60 years,

computing power continues to double every ~2 years. We can now do more with our smartphones than we could dream of 11 years ago (The first iPhone was release only 10 years ago, in the days of Nokia...). Google can predict, in real time, what your typing into its search bar...this is huge computational power, coupled with new ways of teaching. 'Machine Learning', rather than programming, opens up the ability for an algorithm to cope with a complex world: And predict it. And we can provide the algorithm with information about its world through an increasingly sophisticated array of sensors.

- The rise in battery technology/energy efficiency. Driven by the need for smaller and more portable electronics, the detailed chemical wizardry which allows electrical power to be stored and retrieved from a battery is steadily improving: Challenges still remain: But we have come a long way from, for example, large chunky batteries in torches: Smaller batteries, with much more efficient use of that energy, is now the norm.

- Social environmental awareness. The pressure to address CO2 emissions has, like the emission rates, been climbing. While the US may be officially wavering in its belief in scientific fact, other countries and individuals are acting. Within the West, we have characters such as Elon Musk pointing to the rise in CO2 and saying "I'm going to make electric cars mainstream", and in the East, we have China making simple, clear rules which move the world. Unless you make an electric version of your car, down the same assembly line (that's the really, really clever part of the law), you can't sell your car in China from ~2020. The result is a stampede of auto-manufacturers designing and building and kick-starting the electric car industry on a global, industrial scale.

The convergence of these three strands has opened the way to the dawning reality that battery storage allows sufficient energy to be stored to viably propel a vehicle, the rising environmental pressures makes this a change necessary on an industrial scale, and the rise in computing power makes it possible to have a computer manage the calculations required

to be aware of its surroundings, make accurate predictions and control the car. If the 'waste' of moving stuff around can't be removed, then the cost of the driver could be removed...and this is where there is a huge pool of opportunity attracting investors around the globe.

An electric car is much, much simpler to design and build than a car with an internal combustion engine. Carrying a highly flammable liquid around, detonating it in the cylinders and having pistons and crank shafts whizzing around to turn chemical energy into rotary kinetic energy while making the car drive 'responsively', 'smoothly', and 'efficiently' is a huge, highly technical engineering challenge. It's one of the greatest barriers to new entrants into the automotive industry.

If you know where to get good electric motors from (Think Dyson with very clever motors in their vacuum cleaners etc), and you can get batteries (An electric car battery is just a big box containing hundreds of little batteries, each the size of a spice-pot, nearly all the big name electronics brands can make batteries, Tesla on its own is changing global battery supply with its GigaFactory(s)...the key consideration becomes "who has forward-bought the materials to make the batteries"), then a car can be put together comparatively easily. We then bring in the third technology strand: Computing power. If it's relatively easy to make an electric car, and there is huge opportunity in removing part of the transport cost, then those with the capability of bringing sophisticated computational solutions can, like Henry Ford, make a mark on history. New market entrants, such as the technology giants of today as well as well-funded Silicon Valley and Asian start-ups, are all looking to enter this space, and have money to spend (Think Apple, Microsoft...and their Chinese equivalents), meanwhile the existing car companies are hiring software engineers as fast as they can and may soon have more software engineers than 'vehicle' engineers.

The lure of opportunity for smaller scale experiments in autonomous driving is already real in the high-cost Australian mining world. 400-Tonne trucks costing mil-

ions each, with well-paid crews to drive them round the clock, are steadily giving way to autonomous trucks. These are operating in a controlled mining environment, with engineers overseeing operations from cities thousands of miles away. This is not Avatar: This is West Australia today, with significantly increased safety, higher productivity, lower costs clearly demonstrated. But this is in a booming employment environment and changed roles for ex-truck drivers are relatively easy to come by within the industry. The loss of a truck driving job means very different things in other parts of the world.

Making a fully autonomous car is not a 'big bang' change: There has been an evolution, which has been happening around us for years, which is recognised as having 6 defined steps:

Level 0: No automation. This would apply to most cars on the road today and to all the cars of the 20th Century.

Level 1: Driver assistance. Many newer cars today have systems on board which can do limited activities, such as self-parking, lane departure warning, adaptive cruise control etc. But the driver always has to remain vigilant and in control.

Level 2: Partial Assistance. Under certain, defined conditions, the car will take over throttle, steering, braking. Some cars, such as Tesla's Autopilot, allow an alert driver to watch as the car self-drives: But driver intervention at any time may be required, hands stay on the steering wheel.

Level 3: Conditional Assistance. Here the car, under certain conditions, will fully manage all driving actions. Audi have this on its new A8, active in certain conditions, for example up to 60km/h on a dual carriageway. Hands off the steering wheel, read a book in traffic. Coming from multiple manufacturers over the next few years.

Level 4: High Automation: Self driving under most conditions, with a driver in the vehicle, the car will still handle emergency situations if control is not taken over. Google's 'Waymo' Cars have been operating at this for several years now in the USA.

Level 5: Full automation: Self driving, but a human driver is not required. More fundamentally, the need for the ability for a human to take over is removed. This removes the need for all the driver equipment (Steering wheels, instrument clusters, pedals, forward facing front seats etc). The vehicle handles all situations, in any weather, on and off-road. Several concept cars from different manufacturers are now operating at this level, although under test conditions. Suddenly the campervan takes on a whole new dimension....

We as drivers essentially use our eyes to see the world in which we drive: As a result, we find fog a challenge to drive in. As for our other senses, we are largely insulated from the noise around us, all we feel is via the seat and the steering wheel, and the smells are best avoided. Car sensing technology today ranges from parking sensors, rain-sensors, cameras detecting speed-signs and lane markings, forward facing radar to gauge speed and distance to traffic in front, blind spot monitoring, infra-red cameras linked to head-up displays on the windscreen to see further in the dark....all these sensors are to help a human driver (or overwhelm them with beeps and warning lights) yet they provide a computer system able to process the data with a comprehensive view of the world, in all weathers and light conditions. Headlamps, for a level 4 car, are not required to be able to see in the dark, if all other cars are autonomous, you don't need the taillights... In fact, that big sheet of glass in front could be used as a movie screen....the car does not need it to see out.

The car algorithm needs to be taught to recognise objects: A whole, dedicated field of computer research, but one which has progressed from trying to tell a computer what a cat is (Very hard, and not very successful over many years), to working out how to teach a computer to learn: then showing it millions of pictures of cats, and letting it work out what a cat is. Times to teach a computer something new are now down to hours...not years.

The science of machine learning is progressing fast, with Google's Deepmind "AlphaGo Zero" project recently demonstrat-

ing its machine learning capabilities with the Chinese game "Go" by being given the rules and objective and then being left alone. Within days, it had self-taught the game, developed its own strategies (Regarded by human players as 'creative and intriguing') and was emphatically beating the previous software champion (Which had already beaten the worlds human champions). The importance is not the fact that it can beat a human at a board-game: The importance is that the algorithm can learn, and fast.

What information does the car receive to learn from? Cameras (Some cars have 10, binocular vision to give depth perception, LIDAR and RADAR systems (Using lasers and radio waves to sense the world around the vehicle), infra-red cameras, feedback from the wheels and motors, all of these generate huge amounts of data. So 'learning' is not just about knowing the rules of signal-brake-turn. It's about having a torrent of data, from all these systems, all being processed, analysed and assessed: And generating rules to make predictions on, and controlling the car accordingly.

With a car able to sense the world around it, predict it, respond to it reliably, the other key piece of the puzzle then drops into place: It's not just one autonomous car on the road. Its lots. And they connect and communicate with each other. Connected, autonomous cars could share data with eachother/the world around the car, giving advance warning of hazards, road conditions and whether the pub two miles ahead on the left has a rapid-charging point available now, and no other cars in the area plan on using it for the next 30 minutes. And it has your favourite beer and welcomes dogs...time for a stop.

With this step in machine learning, the ability to teach an algorithm to learn: and then give it literally millions of miles of driving experience (The system does not learn from the miles driven by the car in which it is in: It has all the data from the entire fleet: Waymo's fleet has just passed the four million miles driven mark) as 'learning experience' produces a system which is robust, capable, self-improving....but which can still make mistakes, the world is bigger than a games-board. A Volvo self-

driving car tested in Australia was most confused when it saw its first kangaroo... nothing moves like it, it was unpredictable and that's not a good experience for an autonomous car: Time to give back control to the human driver.

So what does this world look like?

The first challenge is regulatory: What are the rules? What happens when an unmanned car crashes into something/someone. Who is at fault? We have a litigious society where "accidents happen" is not an acceptable excuse, even for freak accidents. Where an autonomous system is proven to be safer than a human driver, will we as society allow it on the road if there could be 'no-one to blame'. The manufacturer will be reluctant to allow it on the road if they may be held legally liable with the punitive penalties as are seen in the US today. This is where the Chinese may be able to step ahead, with legislation seen as benefitting society as a whole, accelerating their adoption of such technology.

Trust. People are comfortable with what they have, even if it is harmful. Vested interests will always oppose each other where there is change and emotion will be used to sway opinion, in as fact-free a public debate as Brexit. Think of the opposition to smoking bans, and the resistance to mandatory car seat-belt usage. With autonomous cars, the challenges will be even greater, especially since the future is not certain, this is a loss of control, of employment, of a way of life. The statistical evidence of fewer (Think teenagers) deaths, greater efficiency, more free time, cheaper transport will be set against 'what we are used to', loss of control and today's job market.

Security. There is always and cat and mouse game between vehicle manufacturers and those who wish to steal/hack the vehicle systems either for gain or intellectual challenge. What happens when a connected system is hacked...and all cars are sent to park on the M1/M25 interchange? Or accelerate and turn left immediately? Assurance and thinking through the impossible / preparing for the inevitable is required.

What do roads look like? With Level 5 cars, the roads can start to look very different. The width of the road allows for our driving variation as humans: We try and keep inside wide lanes. Level 5 cars would not need lanes, and they would not need as much space between vehicles, either front / rear or side to side. Traffic density (driven by the space between cars) can go right up, without traffic slowing down: Since all the cars know what each other is experiencing, they could conceivably be centimetres apart: Gone are the days of traffic 'pulsing' down motorways, or roads being widened to squeeze an extra lane in: For a while at least, the traffic density can go up, average speed can go up, and the focus would shift to road maintenance rather than expansion.

Do connected, autonomous cars need speed signs? Traffic lights? Speed cameras? Traffic Police? Conceptually, with the new European Galileo GPS system, vehicle position will be known to centimetres, the vehicles know where each other are, and we could have multi-lane intersections with vehicles crossing, at speed, separated by whatever the laws of physics and human comfort allow, with no road-signs, lane markings or traffic lights. In such a world, a human would no longer be able to drive a traditional, less-enabled vehicle, not because of the risk of collision with an autonomous car...but the risk of meeting another human-driven car in that environment. We become more dependent on the system, even as it delivers us benefits.

What of the burgeoning car insurance industry and car accident repair/recovery industry? Accidents are wasteful to society, no one wants them: And accident rates should go down, significantly, with benefits both to road users and A&E departments. This is not just because autonomous cars are safer than a human (Even when compared to an experienced driver they are safer, with the majority of autonomous accidents so far being down to the other, human, party) but the influence they will have as a group on our roads. This does not require all cars to be autonomous: Just enough to act as a moderating force on overall traffic flow.

Lifestyle

I'm a commuter. I have an unfortunate Carbon Footprint, much of it on the M6, and it's a near total waste of my time which I have acclimatised to. On the M6, and going past schools and shops, there are an awful lot of people moving stuff around. What could the future look like?

- Driving the kids to school/acting as taxi on the weekends? Let the car take them (Unless I want to stand on the touchline on Saturday morning, in which case we all go)
- Dedicated driver at the Christmas Party.....why?
- Driving around the car-park looking for a space? Let the car find one...
- Now where did I park my car...well it knows where my phone is...and its coming to me.
- "Mum, we will come and pick you up bring you for Sunday lunch then drive you back".....or rather, the car will.
- Late drive home? Sleep, watch a movie on you way.....

For anyone living in/driving through a town, one has become used to seeing cars parked along the sides of the road. This is where they are kept when not being used, also in car-parks in towns, shopping centres, at work. Average price per car? Keep the numbers easy, £10k. That's only 100 second-hand cars to pass a million pounds of value, parked, doing nothing. The biggest cost of using a taxi is the driver, and his value is both the conversation, knowing the way and driving safely. Unless you need help getting in/out of the car, an autonomous taxi will become so cheap....why buy your own car? Uber and other similar companies are investing heavily in self-driving technology. If we loose all the parked cars on the side of the road, then we also loose all the effort of maintaining so many cars ageing: We dont need to buy so many cars: If you look at the auto-industry of the 1930s, the vast majority of the nameplates no longer exist: This will probably happen now if the marketplace for cars becomes smaller and the key purchase (Or rental) factors for a new car become the cost and quality of the software and its body. New entrants will have software, existing manufacturers know how to build traditional cars.....

not all will survive. On the plus side, all the money put into having a car parked at the side of the road can go into something else, and our streets suddenly open up with space. On the downside, if you were a parking attendant, you may need to get a new source of income.

One of the more interesting thought exercises with autonomous cars is how our current rules of the road work. We teach our children to be careful, even the dog has to sit before crossing. Why? Because human drivers are not safe, they react slowly, they get distracted: They may drive over you. What if an autonomous car was completely safe? Would all roads become pedestrian walkways? Would the chicken/hedgehog safely cross the road, since this car can drive, with millimetre precision, around/over it? The laws of physics still remain, a car cannot stop instantly: But they can be much, much safer to those around them: Which will drive changed behaviours in those around them? Children may be able to once again play in the street...just as screens drag them back to their bedrooms.

So when is this happening?

Level Three autonomy is already with us, Tesla and other companies start getting production Level three cars on the road this year, 2018, with the current mainstream manufacturers coming to market starting in 2020/2021 Given the lead time to produce a car, these are cars with full engineering teams working on them now, today. The real jump to Level 4 cars being on the road is dependant less on technology in ~2025 and more on society and the legal framework in which these cars will be operating.

Current global car sales are around ~90million units per year, with China being the single largest market at 24 million, then the US at 17 million, and Europe at 15 million. Electric vehicles currently only account for a tiny percentage of these, less than 500 thousand this year. However the growth rates are exponential, China has more brands, more electric vehicles sold than any other country and many of the brands on sale were not available a year ago. Forward predictions vary wildly, however 30% of the global market being

electric by 2030 (Meaning Europe will be near 100% electric in some form, with combustion engines banned by 2040) is a conservative expectation. Growth rates going from 500k/units per year to ~35million units in 12 years has not been seen since the birth of the auto industry. Increasing social awareness of CO2 impacts may drive faster legislative changes and accelerate the standardisation of charging points/plug/adaptors, while also requiring a fundamental shift in government tax systems as fuel sales begin to decline. The initial murmurings of a changed tax system are already present in the UK, "pay per mile driven", or similar: Anything to change the revenue stream options. While all new cars will be electric, the existing stock of fossil-fuelled vehicles will remain on the roads for up to 20 years+ (New cars replace only ~5% of the vehicle fleet per year), unless the cost of running them (Through taxation and the economics of supply) becomes prohibitive, accelerating their departure. The limits to the growth in electric cars is the accessibility of charging infrastructure on a global scale, so will remain a market for combustion engine vehicles in some parts of the world/market sectors. Applying the same growth projections to autonomous vehicles, where we are at the very start of the exponential curve, depends very much on legislation and social acceptance. The take-up of autonomous vehicles is not driven directly by the environmental debate, but a commercial one: Truck haulage and taxis rides and car ownership-on-demand becomes cheaper, those able to offer effective low-cost services will succeed: But this does have social consequences. Look at the way Uber has been received in cities around the world: It is simplifying the process of getting transport, and reducing prices. It has ordered a fleet of 24,000 Volvos to convert to autonomous vehicles during 2019-2021, where the technology will be in place to have "Driverless Ubers": And there will be a societal reaction, from those who gain by having cheaper deliveries, cheaper, more convenient transport and those who lose jobs as vehicle drivers.

Initially, fully autonomous cars will be expensive: The target market is not just the wealthy private owner, rather the fleet owner, taxi fleets with a single corporate

owner may well replace the current owner/driver arrangement of so many taxis today. Truck fleets already exist today, with distinctive livery on our motorways: The expansion of driverless truck fleets will again be initially driven by competition between companies able to fund change on a large scale. There may still be a role for a driven taxi: But it will be more expensive, and the driver's role will need to be much more than just driving the car.

If anything is easier or cheaper, then more people will tend to use it. Air travel was revolutionised by the emergence of the low cost airlines: Prices went down, passenger trips and total fuel-burn went up. Transport will get much easier with autonomous technology: So we may see more trips, more travel, because the time can also be used to do other things, the barriers to the young and the old are removed, and we make more, not less, use of the car, in a very different world.

John Mullins

Driverless Cars: On a road to nowhere

Christian Wolmar

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We very much needed this book. It is very obvious indeed to all observers of transport, sustainability, architecture, urban planning, public health and quality of life that we are all under extreme pressure to buy into a new utopia that will be delivered on the back of driverless vehicles (DVs) or as they sometimes described Autonomous Cars (ACs) or "connected and autonomous vehicles" (CAVs)

This pressure is a sustained ideological and corporate effort to change the world in which we all live and the change is far more dramatic, deeper and wider than almost any observer has noticed. Luckily Christian Wolmar (CW) has noticed and this book should be read and discussed by anyone with any involvement in shaping mobility or the way cities work or the way tax payer's hard-pressed cash is spent. If any of our readers are involved in delivering high quality walking and cycling facilities they should read this. If anyone is involved in arguing for high quality public transport to deliver safe, secure, accessible transport choices they should read this. If anyone is involved with fiscal issues and the way in which we effortlessly spend billions of dollars on servicing the wishes and desires of car owners and users they should read this. If anyone is even remotely interested in social justice, the plight of children, women and the disabled they should read this. If anyone is interested in fundamental change to improve road safety they should read this and note that the whole DC rhetoric and ideology very deliberately ignores the world of Vision Zero and the ways that streets can become safe, enjoyable, child friendly social spaces if we exclude cars.

We are now in the midst of rapid social change that is intended to reward the wealthy and ignore the poor and shunt even more tax dollars into the choices favoured by the relatively affluent as bus users or those that choose to walk and cy-

cle are marginalised even more than ever and in receipt of peanuts. In the UK we have had a decade of cuts in bus funding but I have not noticed any cuts in road building or car park closures because of budget pressures. We close libraries and terminate bus services because of budget pressures but cars inhabit a parallel universe where fiscal generosity rules and DCs bring the promise of yet more funding for motorised transport and more profit for the huge corporations that make cars.

None of this should be surprising. We know from the work of Wolfgang Sachs in his book "For the love of the Automobile" how deeply the ownership use and promotion of private motorised transport has penetrated every corner of thinking and spending in all countries and societies globally. Interestingly in the context of DCs and AVs we know from the writings of Sachs that people really enjoy driving and the feelings that go with the driving experience. The possibility that AVs and DCs might fail because people like to be in control and are pleased with their prowess as excellent drivers has not occurred to the AV optimists and might well be the key factor that kills the idea.

We know that any discussion in the UK with any group of politicians about non-road building options that deal with congestion, pollution, noise, greenhouse gases and road safety are doomed to go nowhere. UK politicians discussing a new bypass in Hereford or a new road in Shrewsbury or a tunnel under Stonehenge or the truly dreadful M4 relief road around Newport in South Wales (a snip at £1.6 billion for 14 miles) have already adopted an over-arching ideology shaped around the car and its promotion. It is the same in Melbourne, Sydney and many US cities and is an ideology that is energetically exported and adopted in India and China even though the c2.5 billion citizens in these two countries are still deprived of totally safe, secure, segregated pedestrians and cycling infrastructure. The shift to DCs and AVs for politicians and technology optimists is very attractive indeed and will be welcomed and embraced and will be incredibly difficult to challenge but CW does challenge that shift.

The author provides us with some splendid examples of hype around DCs and AVs e.g.

“Our vision for the future is free from petroleum, free from emissions, free from accidents, free from congestion, and at the same time fun and fashionable...it is a vision that will transform the lives [sic] around the world, bringing people and cultures closer together, a future in which people, motor vehicles and roads coexist in harmony and a future where motor vehicles no longer have a direct impact on the natural environment”

Kevin Wale, General Motors, page 14

It is a pity Kevin did not appear at the Public Inquiry into the M4 relief road in South Wales to listen to detailed scientific evidence around the damage caused to nature, biodiversity and important nature reserves by a new road justified by the increase in numbers of vehicles on the corridor from Bristol to Cardiff (Note 1). The destruction that is planned by the Labour controlled Welsh Government is not changed in any way at all by the presence or absence of a driver or by the use of fossil fuels or electricity from wind power.

The hype is oblivious to the kind of physics that I was taught as an 11 year old school boy in Manchester. Cars, no matter how they are powered and no matter what amount of clever kit they have on board by way of GPS, radar, cameras, software etc still take up space and are designed to go at speeds that are totally unacceptable in any urban area. Space and time still determine outcomes. The DC is not zero space and still moves at speeds that kill children. Even at 30mph 5 out of 10 children hit by a car will die and it can never equal the superb performance of a bike in terms of the amount of space it needs to deal with the mass of mobility and speeds that are socially responsible and nurture community life and public health. Ivan Illich got this right in 1972 when he made calculations about “social speed” and the time that has to be devoted to earn the income to pay for the vehicle and all motoring costs (Note 2). When all the time implications and demands of the vehicle

are taken into account the car is a very bad deal.

CW takes us through the hype around safety and benefits for the disabled claimed by supporters of DCs. This reviewer finds it amazing that motor vehicle manufacturers have suddenly discovered an ethical concern in their overall drive to make millions from making and selling cars regardless of the consequences. We have known since October 1997 when the Swedish Parliament adopted Vision Zero that there is a fundamental solution to death and injuries in the road traffic environment (Note 3). We can and must attach no significance whatsoever to the claim that DCs will improve road safety. We are still coming to terms with VWs treatment of ethics and social responsibility in “cheating” on the emissions performance of 11 million vehicles by using specific and deliberate “defeat” technology to fool European regulations on the emission characteristics of vehicles. This is well documented elsewhere and we will not go into it here but the deeply significant implication is that we cannot trust a motor vehicle manufacturer to tell the truth. Making and selling vehicles is the single top priority and if we are happy to bathe our children in health damaging polluting emissions in cities the absence of ethics and social responsibility does not stop there. AVs and DCs will pose threats to road safety and public health.

Currently on a global scale we kill 3,200 people every day on our roads. This is a scandal of enormous proportions and flourishes because of deeply unethical, ideological agreements between governments, motor vehicle manufacturers, global finance, politicians and apologists of all kinds. The mantra in all UK council chambers is very clear: motor vehicles are good and we must avoid even looking like we are “waging a war on the motorist”. This same ideological assertion underpins DCs and AVs.

The case for DCs is strengthened by the untested, evidence-free belief system that they will produce safer roads. The author gives examples of this untested belief system in a quote from Google on page 17 and once again we have a splendid example of the opposite strategy to that promoted by

former New York Mayor, Giuliani. Mayor Giuliani made a huge amount of progress with urban crime, nature and green space and public transport by putting into practice his mantra "always under promise and over deliver". DC/AV world is dripping with the exact opposite. The debate is characterised by exaggerated over promise of the many things it will do to make life wonderful and there is no delivery and no independent, robust examination of what can be delivered and not even a basic SWOT analysis (Strengths, Weaknesses, Opportunities and Threats).

On road safety CW draws our attention to the well documented links between "failsafe" automated systems in nuclear power, aviation and maritime transport (pp40-47). All the hype and wishful thinking require human intelligence and judgement in situations where DVs encounter children, cyclists or other vehicles and in situations where all the possibilities can be found in one street in one very short time interval.

CW's discussion of a fatality on page 39 involving a Tesla vehicle in Florida in 2016 is relevant. The Tesla driver had set the cruise control at 74 mph in a 65mph area. His vehicle collided with a truck and was killed. DC promoters frequently rely on the fallibility of human beings in the road traffic environment and the role of "human error" in death and injury on the roads. This is exactly the emphasis in Vision Zero except in Vision Zero the key measure is speed reduction and high quality infrastructure to deliver totally safe walking and cycling possibilities and this is on offer now and does not require billions of dollars to support motor vehicle manufacturing and IT, so why do we not have it now?

If we really wanted a world dominated by DCs with all its damaging consequences for social life, nature, urban space and extermination of walk, cycle and public transport we could design a system based on total speed limitation at 30kph/20mph on every road and street where there is a chance of any interaction at all with pedestrians, cyclists, buses or passengers getting on and off buses. This is not on offer because DCs and AVs are still cars and still plug into the ideology and mythology

of freedom, excitement and speed that is so lucidly revealed in "For the love of the automobile" and in Stephen Bailey's book "Sex, Drink and Fast Cars" (note 4).

DV promoters use the disabled in the same way they use road safety. After all who would argue against improving road safety and making absolutely sure that our transport systems deliver best possible conditions for the disabled? We now know we can have world beating road safety improvements through Vision Zero and do not need DCs to achieve superb outcomes and we can at the same time avoid the technological and ethical problems associated with vehicles making decisions about avoiding the chances of death and injury even those vehicles are designed to go at speeds that are associated with the certainty of death and injury in a collision. CW discusses in some details a number of other problems related to the technical performance of AVs under different circumstances e.g. snow, the visibility and clarity of signage, the possibility of hacking and the likelihood of "pranks". All of these technical issues are not yet solved but this lack of clarity does not make a dent in the strong ideological commitment to a major "refresh" in car manufacturing and the production of a few more million (billion?) cars on the world's roads.

On disability it is first of all important to note that we have had several decades of awareness of the need not to discriminate against the disabled and to make all our transport systems thoroughly disabled friendly and accessible and we have failed to do so. We do not care very much about the disabled when they have to use buses and trains. Why does my local train station in Church Stretton, Shropshire have steep steps and a pedestrian footbridge to get from platform to another platform or to get to the town centre? There are no passenger lifts. Why do the trains have a high step entrance so that it is very difficult indeed for a disabled person to get on or off the train? Why are all the pedestrian pavements in urban areas in the UK blighted with cars parked on pavements or just too narrow for a wheelchair user to use? We appear to have discovered a concern for the blind and partially sighted which was totally absent during the many years

that these groups had to navigate grossly inadequate pavements and obstacles. We do not care about the disabled but suddenly when we realise we can make and sell millions of extra cars and return large profits to high net wealth individuals and shareholders we do care?

On 8th February 2018 I received a letter from the UK Department for Transport replying to my question about facilities for the disabled at UK train stations. The official replying confirmed that 460 of our 2500 stations have "step free access" and there are no plans to make all our stations accessible to disabled groups.

CW gives us some very clear quotes from disabled groups in support of DCs (pages 17-20) and these views are very important indeed but they are not sufficient to justify a whole transport system transformation in the ways that car manufacturers have chosen for us. In addition there is no discussion of options and how we can transform the current system in a way that is genuinely attentive to the needs of disabled people. This conversation has not yet taken place and certainly not in the context of liveable streets, child-friendly streets, totally safe systems and car free streets. It cannot be assumed that the "disabled", however defined, are supportive of the total transformation of mobility and space as preferable to all the other things we can do to deliver on disability.

There are some very large elephants in the DV room that are not being explored by promoters of this technology. The first is the recognition that what is under discussion in this book and more generally in society as a whole is a total transformation of the ways we move around and spend huge amount of money and whether or not that is regressive. Does it reward the rich and neglect the poor? The second is what changes will have to be made in the way we organise, streets, roads and cities to make them DV friendly and stop people getting in the way and the third is the rather inconvenient truth identified by the World Health Organisation that sitting on bottoms and moving around by car is bad for health.

CW talks about the total transformation of the ways we move around. On page 20 he goes to the heart of the matter:

"The more one digs into the future envisaged by this new world of autonomy, the more it becomes clear that driverless cars are seen as a replacement for not just cars but other forms of transport too!"

This simple extension of Henry Ford's basic model will be the culmination of over 100 years of "love of the automobile". Henry Ford cracked the basic problem of producing, marketing and selling the dream of individual car ownership but in spite of several decades of successful trashing (certainly in the UK and USA) of buses, trolley buses, trams and urban rail these pesky things are still around and still attract support and take up valuable funds that could be allocated to new roads, new car parks and new kinds of vehicles. They deprive global corporations of future car sales. They also represent a kind of socialism or even worse, communism, so just as we got rid of the Soviet Union, the DDR and a number of other communist regimes we can now get rid of collectivised transport.

CW alerts us to one very clear example of the need to exterminate alternatives to the car when he talks about cyclists on page 79-80:

"Take cyclists, Carlos Ghosn, Nissan's CEO, is no fan of people on bikes. Indeed he hates them. In a speech in January 2017 to introduce a prototype DC he told CBNC that the arrival of the technology could be delayed by cyclists who he said, don't respect any rules usually."

Ghosn said:

"One of the biggest problems is people with bicycles. The car is confused by [cyclists] because from time to time they behave like pedestrians and from time to time they behave like cars"

CW comments (page 80):

"The implication was that he would like to see cyclists banned from roads where autonomous cars are traveling...there is a strong line of thought amongst promoters of autonomous technology that other road users will simply have to make way for their vehicles".

We cannot say with any certainty that the widespread adoption of AVs will produce a ban on pedestrians and/or cyclists but neither can the promoters of this social transformation say it won't. The history of how we deal with pedestrians and cyclists in cities help to identify this as a very serious risk (or threat in the SWOT framework). Historically we have peppered our streets and roads with metal railings, forced pedestrians and cyclists to go underground and experience urine-soaked, graffiti ridden subways and tunnels with an increased chance of being mugged and made them wait for very long periods of time at signalised junctions that are clearly rigged to prioritise the person in a car sitting in the warm, dry personal space and punish the pedestrian waiting in the rain with the additional experience of being soaked as the cars go through the many puddles. The system is already rigged to prioritise cars and if we now proceed and spend billions on the AV/DC technology are we really going to allow annoying pedestrians and cyclist to obstruct the march of progress? I think not!

The likelihood is that our streets and roads will be re-engineered to prevent pedestrians and cyclists getting in the way. This will be both a regulatory, legalistic process and a metal railing process and AV/DC world has not yet made a commitment to prioritise walking and cycling in the brave new world on offer. In AV/DC world does anyone realistically think we will get to the best practice level seen in Freiburg in Southern Germany where 28% of all trips every day are by bike and <30% by car?

AV/DC world has also ignored public health and the epidemic of Non-Communicable Diseases (NCDs) including obesity, cardio-vascular disease and diabetes type 2. The World Health Organisation has produced a strategy for increasing levels of

physical activity. This identifies an urgent need for higher levels of physical activity which means much more walking and cycling and this public health concern is very clearly undermined and contradicted by the ambitions of AV/DC world to get as many of us as possible sitting in cars as much as possible and so reducing levels of physical activity and increasing the number of deaths directly linked to sedentary lifestyles (Note 5). CW does not go into the public health dimension though he does draw attention (page 95) to the fact that the "fittest and healthiest older people are those who use public transport and walk...autonomous technology will merely encourage them to continue to use cars". Sadly the global epidemic of obesity applies to children and the extermination of walking and cycling for children has huge implications for health and the costs of dealing with the obesity epidemic.

Another problem with AVs and DCs is the enormous cost of the transformation. We know already that manufacturers are spending a great deal of money on the new technology. On page 56 CW states that the top 5 manufacturers in 2015 spent \$46 billion on R&D (which they can offset against tax liabilities and so reduce tax take). What we really need to know is how much public cash is going into supporting this technology both from national governments and from the European Union. At both national and EU levels there are multiple sources of cash ranging from grants and low interest loans to support regional development and job creation and these are in turn supported by cash-strapped councils who still find money to support business parks and industrial estates and in the UK "Local Enterprise Partnerships" (LEPS) that have no democratic control and find ways to spend hundreds of millions to support businesses. None of this cash goes to walking, cycling or public transport. This in turn is supported by research councils and universities that provide millions to academics and researchers to work on projects directly linked to AV/DC technology and control systems.

Even bigger sums of money will be required to deal with street re-design, signage and communication technologies that will be needed to feed the AV/DC transformation and all this will be required at the same

time as central government in the UK is cutting council budgets by hundreds of millions and councils are reacting by cutting staff, bus services, libraries, child protection and care for the elderly.

CW gives us a very useful summary of the exaggerated promises made for the benefits of DCs/AVs (pages 94-96). The new technology will not reduce congestion, improve road safety, make our streets greener, make the elderly more active, make property cheaper and it stands a very good chance of undermining public transport.

It is very clear indeed that the new technology on offer is a very simple extension of a very old technology and a deepening of a very old ideology. It is all about making us all even more car dependent, transforming cities so that they give top priority to cars and eliminate any obstacles to that prioritisation which will include making absolutely sure that pedestrians and cyclists are not allowed to get in the way. It is a rejection of several decades of intelligent and ethical thinking that has been going on to make our cities and regions safe, secure, clean, green, healthy, child-friendly places. It is a rejection of Copenhagen's success in getting 50% of all trips every day for work and education accomplished by bike, a rejection of Freiburg's achievements on modal split (<30% of all trips every day by car), a rejection of Oslo's car free strategy, a rejection of wide-area congestion charging. It is a very logical and clever next stage in creating hyper consumption of technology, grabbing billions of dollars of public money to achieve its objectives and even more deeply entrenching what Wolfgang Sachs called "the love of the automobile".

John Whitelegg

Notes:

Note 1: This evidence is presented in detail in volume 23.4 of this journal available on our web site

Note 2: Ivan Illich, Energy and Equity, 1974

http://debate.uvm.edu/asnider/Ivan_Illich/Ivan%20Illich_Energy%20and%20Equity.pdf

Note 3: John Whitelegg "Mobility. A new urban design and transport planning philosophy for a sustainable future", 2017

<http://www.lancaster.ac.uk/cemore/?publications=mobility-a-new-urban-design-and-transport-planning-philosophy-for-a-sustainable-future>

Note 4: Stephen Bailey "Sex, Drink and Fast Cars"

<https://www.amazon.com/Drink-Fast-Cars-Stephen-Bayley/dp/0394750462>

Note 5: WHO Global Strategy on Physical Activity

http://www.who.int/ncds/governance/gappa_version_4August2017.pdf