

# IMPACT OF A TRANSPORT SYSTEM AND URBAN FORM ON THE POPULATION OF A CITY

**G HITGE and A GQAJI\***

Transportation Engineer, P O Box 2072, Durbanville, 7551\*Project Manager –  
SA National Roads Agency Ltd, P O Box 100410, Scottsville, 3209

## ABSTRACT

Transportation systems play a definitive role in shaping the societal characteristics of a city's inhabitants. In contexts where car-based transport modes predominate and their supporting road-based networks define the transportation system, society becomes heavily dependent on owning and utilising private travel modes in order to access resources and opportunities.

As a result of this dependency, a pattern develops whereby people may become excluded from gaining access to basic opportunities, facilities, amenities, and in particular, employment. Social challenges commonly found within developing countries, such as poverty and unemployment, exacerbate this problem even further due to the expensive and exclusive nature of car-based travel.

Within cities containing well developed and integrated public transport systems, land use typically exhibits a greater mix of high densities. Within high density land use areas, the reduced distance required to access a variety of facilities results in larger proportions of society gaining access to basic opportunities and services with greater ease.

This paper explores the relationship between city transportation systems and urban form, and their impact on city populations. Theory discussed is located within the South African context, and utilises the example of the City of Cape Town to elucidate how City transportation systems impact on the characteristics, mobility and accessibility of resources and opportunities of the society.

## 1 INTRODUCTION

The South African apartheid population segregation policy has resulted in the provision of a limited commuter transport service which almost exclusively caters for those with employment. This situation provides an extreme example of how land use and transport can disempower and marginalise communities within an urban population. Given this historical context and its' current implications, it is also important to recognise that the relationship between transport planning, the associated urban form and the supporting transport system have a broad range of impacts on individuals, communities and the greater population of a city.

These impacts are seldom explicitly qualified in transport planning documentation and processes, rarely quantified, and are seldom the subject of debate amongst transportation professionals. Yet, the impact of the relationship can have profound implications for the

well-being of urban populations, or even a nation. This issue warrants a shift in focus amongst transport and land use planners to begin to address these negative impacts.

This paper will not report on empirical research of these relationships, but will rather attempt to raise awareness of the importance of the matter with the intention of stimulating further investigation.

## **2 TRANSPORTATION SYSTEMS AND URBAN FORM**

The debate concerning the need for the densification of sprawling cities versus allowance for continued sprawl is raging strong worldwide. No agreement has been reached as to what the ideal city looks like in terms of size, form or transportation system. However, various authors (Vuchic, 1999; Wickham, 2006, Newman & Kenworthy, 1999) indicate that compact cities with well-developed public transportation / transit systems perform more efficiently than car-dependant transport systems within sprawling cities.

Cities that have developed around the necessity of accommodating the private car as the main mode of transport either have low population densities or extreme congestion. Simply put, the road system, including parking space needed at both ends of a trip, take up a large proportion of the space relative to the land uses they serve. Transit systems move dramatically more people in much less space and without the need for parking, which is then available for more productive uses. In cases where higher densities exist without functioning transit systems, very high levels of congestion result in delay and pollution that detracts from the overall competitiveness of the city, but more importantly, also the liveability of a city.

Newman and Kenworthy (1999) show that higher density cities with good transit systems have a higher per capita income than both low density cities and high density cities with poor transit.

The growth of the development of more cores with a sea of low-rise residential suburbs (suburbia) between is what is referred to as a sprawling city (Glaeser and Khan, 2003). This sprawling model appears to be an elegant transport solution where all persons experience freedom of choice that the private car became famous for. However, apart from the reduction in availability of arable land, high energy consumption and the associated impact on climate change, it also does not consider that the majority of urban dwellers do not have, or are likely to have in the foreseeable future, access to private transport.

The car-dependant city can therefore be seen as exclusive in that it marginalises the poor as well as others. To address the “problem” of access to the urban poor, who often get left behind in decaying cores or pushed to the periphery of cities where land is cheap, is to provide public transport systems that rely on high levels of subsidy.

Table 1 illustrates the simplified range of combinations between these two characteristics, describing key attributes for each combination.

**Table 1: Combination of density and dominant transport system**

Urban Form Transport System	Low Density / Sprawl	Higher Density / Compact
<b>Predominant Car based</b>	<ul style="list-style-type: none"> <li>- Dispersed land use activities</li> <li>- Longer travel distances</li> <li>- High cost of infrastructure</li> <li>- Poorly integrated transit</li> <li>- High operations cost</li> <li>- Car dependence</li> <li>- E.g. Pretoria, Los Angelis</li> </ul>	<ul style="list-style-type: none"> <li>- Mixed land use activities</li> <li>- Very high congestion levels</li> <li>- High levels of pollution</li> <li>- Lower car dependence</li> <li>- E.g. Athens, Bangkok</li> </ul>
<b>Predominant Transit based</b>	<ul style="list-style-type: none"> <li>- Integrated land use activities</li> <li>- Integrated transit system</li> <li>- High cost of infrastructure</li> <li>- Low utilisation of infrastructure</li> <li>- Very high transit subsidy</li> <li>- E.g. Helsinki</li> </ul>	<ul style="list-style-type: none"> <li>- Integrated, mixed land use activities</li> <li>- Shorter travel distance and time</li> <li>- High utilisation of infrastructure</li> <li>- High efficiency of investment</li> <li>- Independence from car</li> <li>- Also “walking cities”</li> <li>- E.g. Tokyo, Munich</li> </ul>

A study to rank the world’s top cities in terms of Quality of Living includes transport as a key factor to consider (Mercer, 2010). Findings indicate that cities dominating the top 10 places in the list are generally European, and are well recognised for their efficient transit systems. No African cities are located in the top 50 positions.

The total cost of transport includes the infrastructure, land taken by this, vehicles or rolling stock, operational elements including fuel, as well as the management systems which includes policing and traffic control. In a car-oriented city the bulk of the infrastructure and management system is provided by the local authority, while the vehicles and operational costs are carried by the public.

In a transit oriented city, the authority has a much bigger role in providing infrastructure, management systems, as well as the operational components of the system. If planned efficiently, it has the ability to influence the sustainable functioning and development of the city.

The land required for roads and parking has an opportunity cost to the society as a whole since it is no longer available for other economic or social uses. The land consumed to transit systems is dramatically less than for cars, which allows for significantly more productive land uses to occupy the space otherwise lost to roadway and parking.

### **3 SOCIAL IMPACT OF TRANSPORT AND URBAN FORM**

#### **a. Travel time to opportunities**

Car-based cities requiring a high number of parking result in sprawl leading to spatially separated land use placements which are relatively long distances apart. For instance, to

drop children at school, go to work, return to school and run some errands becomes impractical by any means other than the private car.

Low density sprawling cities entrench the need for the car by locating different land uses too far apart to access by NMT or to make PT viable. Low density, segregated land use developed for the convenience of car-based communities, and became virtually only accessible by car. In a higher density, mixed use corridor or city, the spacing of a variety of land uses are typically in closer proximity, and are often all served by some form of trunk or feeder transit service. Many more opportunities can therefore be accessed without the need for a private car.

b. Health

International examples show a correlation between obesity and the level of dependence on the private car to make trips. While walking and cycling for most trips have obvious health benefits, the amount of walking required when using public transport far exceeds the average exercise obtained from only car use.

Noxious gases are produced by internal combustion engines when cars or buses operate in city streets. In contrast, the air is cleaner with the use of light rail, as gases produced for electricity are far removed from transport users and pedestrians.

c. Safety

With all its advantages, the speed at which automobiles travel impose a safety risk to which the human body has not had time to evolve an adaptation for. While the same applies to other modes like rail, the conflict points between humans and trains are much less. Trams and light rail technology are relatively pedestrian friendly.

A compact city is a low speed city, with features such as narrow streets with typically low speed geometry. Such cities call for the design of movement links to respond to the context of the transport zone, and not the other way round (Salingaros, 2006).

About 50% of all transport accident deaths involve pedestrians or cyclists. Growing concerns regarding the safety of cycling to school has resulted in the significant decline of utilising this mode for school trips. Ironically, the more children get dropped off at school by car, the more unsafe roads become for the remaining cyclists.

As for pedestrians, children of poorer communities do not have the option of being dropped at school and are therefore much more exposed to the risks in the transport system. In higher density, low-rise settlements, the roadway provides important social space, which is not compatible with cars driving at high speeds.

d. Identity and social cohesion

In many Western cultures the car is seen as a right by most adults, through which access is gained through (simply) obtaining a driver's licence and purchasing a car. In many car-based societies, owning a car is seen as a significant aspect of the transition to "young adulthood". The inability to afford a car in some communities contributes to the feeling of being excluded, and could contribute to the attractiveness of sub-cultures such as gangs.

The private car also serves as an extension of the private space of the home where interaction with the general public, and specifically other cultural groupings, are avoided. The resultant segregation reduces social understanding and contributes to social conflict between communities.

Conversely, societies that share more public spaces acquire higher levels of tolerance for cultural differences and a stronger cohesion to address issues of common concern. These societies are often hailed for their higher levels of evolution and humanitarian skills.

#### **4 TRANSPORT USER PROFILE**

In order to distinguish the impact of city form and transport system on individuals, it is important to illustrate the different market segment for transport. While able adults are eligible to obtain driver's licences, there is a range of factors that affect the ability of people to have access to, and use a car. As will be shown, children under the legal driving age as well as elderly are treated separately.

##### **a. Gender**

Across the world, significantly more women than men use public transport, which can be attributed to factors such as education, as well as economic and social marginalisation. This suggests that a car dependant society contributes to the legacy of discriminating against women, while a transit oriented city enables women to develop on a more equal footing.

Women typically bear more responsibility for child rearing, including providing for the basic needs at home, as well as health and education trips. In a patriarchal society these issues are far more pervasive and concentrated than in a more gender equal society. The practical difficulties of performing these tasks, within the context of low levels of access to opportunities, place additional burden on women. These access barriers make it challenging to change the conditions, which perpetuate the gender divide.

##### **b. Children**

For the purpose of this discussion children are classified as all persons under the age of 18 who are not eligible to obtain a driver's licence. In addition to not being economically active, children are able walk, cycle and use public transport to move about from a fairly young age.

Access to bicycles and safety concerns for pedestrians and cyclists are higher in a car-dominated city, while a transit oriented city includes the attention to dedicated pedestrian and cycle facilities. A well-managed public transport system would be accessible to children and would negate the need for special learner transport services. As with most dedicated services, learner transport has inherent inefficiencies as the vehicles used often stand idle between school trips.

##### **c. The Elderly**

The elderly refers to persons, economically active or not, who are eligible to have a driver's licence yet experience increasing difficulty in performing driving tasks.

The elderly lose the ability to drive as eyesight decreases and motor-neuron abilities slow down. This degeneration gradually constrains, and eventually prevents, elderly persons from accessing many basic opportunities. This factor contributes towards feelings of neglect and isolation amongst the elderly. In many cases one spouse may still be able to drive, but will leave the remaining partner stranded immediately when he or she passes away.

Elderly people who are also economically marginalised are stranded in the absence of a public transport system. South Africa's past, public transport was developed as a commuter service, and did not provide access for other trip purposes such as recreational, social or even institutional purposes.

d. Urban poor

Amidst other complexities, being poor results in households not having access to a private car. As the poor are often located on the fringe of a city, this results in greater distances having to be traversed to reach opportunities. In addition, long distances between land uses in an "opportunity zone", such as a central business district (CBD), require private transport to access effectively. In a car-dominated city this precludes such households to partake in normal urban life. As Wickham (2006) puts it, "From this perspective, to be poor is to be unable to afford to be normal".

Wickham (2006) illustrates how this phenomenon is even true in higher income societies such as Dublin, Ireland during a period of economic boom. Members of the Jobstown community living in social housing would be within easy reach of major employment zones by car, but using public transport would involve taking a slow bus into the city centre and then another radial link out to about the same concentric distance from the centre. As the two zones are severed by an urban freeway pedestrian access is restricted, resulting in about a 10 minute trip by car being extended to bus trip of more than an hour.

Results from the National Household Travel Survey (DoT, 2003) indicate that households typically acquired cars when their incomes exceeded a mere R3 000. This low threshold shows that households would deprive themselves of meeting other basic needs in the hope of acquiring better opportunities with a car.

e. Disabilities

On average, 5% of South Africans live with disabilities, which include sight, hearing, communication, physical, intellectual, emotional, or multiple disabilities. Disabilities range from permanent to temporary, and impact an individual's ability to access the transport system to a variety of ways.

To accommodate these passengers, the transit system should not only be wheelchair friendly, but needs appropriate information systems, audible "signage", level boarding and adequate comfort levels.

While some disabilities allow individuals to use cars, the cost of adapting the car to a suitable standard is often significant and prohibitive to most.

f. Tourists

Many tourists are not prone to driving a car in a foreign country. This is due to, among other things, having to drive on the opposite side of the road, not owning a legal driving permit, not being able to afford a rental car (including insurance) or for being unfamiliar with local conditions. A city with a poorly developed transit system is therefore not very accessible to tourists.

By their very ability to afford to travel, tourists typically find themselves in the company of communities with access to cars, who are often poorly informed, or exhibit negative perceptions about the use of public transport.

g. Other

According to the NHTS (DoT, 2005), only 20% of adults in South Africa have driver's licences. While one can only speculate as to the reasons for this unexpectedly low proportion, the following factors are most probably among them:

- No access to a car, hence no need for or opportunity to obtain a licence;
- Preference not to use a car, for instance, many foreign visitors who reside in South Africa when retiring consider the reliance on a private car as a major disadvantage.

## 5 SOUTH AFRICAN CONTEXT

The authors support the proposal that transport planning should focus on creating access to opportunities for all members of society, and therefore assess the population in terms of factors that are correlated with different travel choice characteristics, and not race. While the discrepancies between race and factors such as income and life expectancy are acknowledged, it is considered that planning to improve the fundamentals will contribute to the development of an equal society. Reference to race in the population data described here was therefore specifically excluded.

a. National trends

The information discussed here is based on results from the National Household Travel Survey completed in 2003 (DoT, 2005) as well as reports generated by Stats SA's "Mid-year population estimates" (2010). While this data is not confined to urban areas, it provides an overview of typical trends experienced by South African citizens.

*Travel to work:*

According to the NHTS, the average travel time to work for all modes is 43 minutes, and 59 minutes if public transport is considered on its own. An estimated 1.3 million public transport commuters travel for longer than one hour to work. 87% of metropolitan or urban households walk more than 15 minutes to trains. 52% of urban and metropolitan households live more than a 15 minute walk to buses, however only 18% live more than a 15 minute walk to access a minibus taxi.

The public transport share of all motorised trips is only 52%, which is well short of the national target set to be achieved in 2010, of 80:20. It is difficult to maintain the market share of public transport due to stable or shrinking capacity, and a steady rise in car ownership levels.

### *Affordability:*

30% of households in the RSA spend more than 10% of their income on public transport (DoT, 2005). As one could predict, virtually none of these households fall in the higher income bracket.

However, the lack of efficient public transport systems has resulted in the rapid increase of private car ownership to the extent that households prioritise the purchase of a car above many other needs. It could not be ascertained what percentage of household income is spent on private transport, yet for lower income households this is likely to be even more burdensome than the cost of public transport. It is concluded that this is a sacrifice made to improve access to opportunities. An international trend has developed in the last few decades whereby car ownership has become a status symbol within society, especially amongst the urban youth.

Within the setting of a compact city, households would be able to postpone the purchase of a car for much longer in order to obtain more valuable commodities, such as better education, health care, etc. Authorities would also have greater ability to target subsidies to communities in need.

### *Accidents:*

About 10% of all deaths in South Africa result from non-natural causes, with about 10% of these directly related to transport. South Africa's traffic accident fatality rate is in the order of 6 per 100 million vehicle kilometre (VKmT) travelled, while internationally rates typically vary from 6 to 12 deaths per 1 billion VKmT – a tenfold increase.

In 2002 to 2006, for every 100 females who died in traffic accidents there were 266 male deaths. This ratio was fairly consistent for all age groups and all provinces in the country. It should be noted that death rates were typically higher in the rural provinces without major metropolitan areas, like Limpopo and the Eastern Cape.

#### b. Cape Town

The population characteristics for Cape Town were taken from the "2007 Community Survey Analysis for Cape Town (2008).

### *Age:*

Table 5.1 below shows how Cape Town's population, which in 2007 was estimated at 3 497 097, comprised of 48.4% male and 51.6% female. The gender proportion was equal up to the age of 17, after which the number of females were higher for all age groups.

**Table 5.1: Age distribution in Cape Town for 2007**

Age Group	Male		Female		Total	
	Number	%	Number	%	Number	%
0 - 5	192,956	5.5%	193,910	5.5%	386,866	11.1%
6 - 12	202,248	5.8%	201,332	5.8%	403,580	11.5%
13 - 17	148,697	4.3%	149,498	4.3%	298,195	8.5%
18 - 34	537,400	15.4%	560,912	16.0%	1,098,312	31.4%
35 - 54	425,138	12.2%	462,065	13.2%	887,203	25.4%
55 - 64	104,932	3.0%	124,930	3.6%	229,862	6.6%
65+	81,888	2.3%	111,191	3.2%	193,079	5.5%
<b>Total</b>	<b>1,693,259</b>	<b>48.4%</b>	<b>1,803,838</b>	<b>51.6%</b>	<b>3,497,097</b>	<b>100.0%</b>

Source: CCT, 2008



### *Disabled:*

In 2007 there were 114,297 people in Cape Town with disabilities, which accounts for 3.3% of the total population, up from 107,837 in 2001. The City runs an on-demand service for persons unable to use mainstream public transport, called Dial-a-Ride.

At a rate in excess of R350 per person per day, the value of the service (more than R7 000 per month) is in the same order as buying a fairly luxury car, and is also incomparable to rail and bus subsidies that are in the order of R10 to R20 per day. Despite the significant subsidy, this service is only available to about 500 registered users, while excluding many more that are in need of it.

### *Economic status:*

Analysis of Table 5.2 shows that 56% of households earn less than R38 400 per annum, or R3 200 per month. A further 17%, and about 73% of all households, earn less than R6 400 per month. This illustrates that, not only does the majority of citizens in Cape Town not have access to private transport, yet almost three quarters should rely solely on public transport, and should not have to consider purchasing a car.

### *Gender:*

In all the categories below R12, 800 there are more females than males with exception of R1 601 to R3 201 where there are 18% males and 17.4% females. This category also has the highest percentage of any of the categories (see Figure 5.2). In all categories above R12 000 there are more males than females. This alludes to the fact that women are still marginalised in Cape Town, and are therefore more dependent on public transport than men.

**Table 5.2: Annual income categories in Cape Town**

<b>Income categories</b>	<b>Black African (%)</b>	<b>Coloured (%)</b>	<b>Indian or Asian (%)</b>	<b>White (%)</b>	<b>Grand Total (%)</b>
None	9.01	2.89	0.09	1.14	13.13
R1–R4800	1.99	0.75	0.01	0.17	2.93
R4801–R9600	4.62	3.17	0.05	0.67	8.51
R9601-R19200	7.45	5.70	0.08	1.08	14.32
R19201-R38400	5.14	8.99	0.18	2.54	16.86
R38401-R76800	2.47	9.50	0.27	4.94	17.18
R76801-R153600	1.02	6.08	0.31	6.68	14.09
R153601-R307200	0.40	2.23	0.21	5.83	8.68
R307201-R614400	0.12	0.40	0.06	2.40	2.99
R614401-R1228800	0.03	0.09	0.02	0.56	0.70
R1228801-R2457600	0.05	0.09	0.01	0.24	0.39
R2457601 and more	0.02	0.04	0.00	0.18	0.24
<b>Total</b>	<b>32.32</b>	<b>39.93</b>	<b>1.29</b>	<b>26.45</b>	<b>100.00</b>

Source: DBSA from PGWC, 2006

### *Safety:*

Traffic accident statistics show a steady increase in Slight or Serious accidents, but a decrease in the number of fatal accidents from 1997 to 2007. The estimated cost of traffic accidents in Cape Town was in excess of R2.1 billion in 2003 and over R2.5 billion in 2004 and 2005. This amount dwarfs the concurrent investment in both capital and operational costs of providing public transport, which would result in a significant reduction in the number and cost of accidents.

It would be informative to learn whether the investment in BRT services along the West Coast region of the City will play a significant role in improving transport safety in that corridor.

## **6 DISCUSSION AND CONCLUSIONS**

### a. Discussion

The South African land use and transport planning, as a result of apartheid policies, was designed to exclude people from employment centres and opportunities. This was achieved by the location of township development on the outskirts of cities. Segregation within the public transport system resulted in inefficiencies that, together with rising popularity of the private car, led to the steady decline in the public transport systems of all major cities.

When the new government came into power in 1994, it listed transport as one of its five top priorities. The demand for transport arises from the fact that neither needs nor resources are spread equally or uniformly. From the supply side, government is tasked with the provision of road and rail infrastructure. It is also tasked with supplying services such as subsidised bus and train services, maintenance of infrastructure and regulation of the use of these facilities.

The spatial structure of our country can be divided into rural and urban areas. Cities are fragmented into areas of specialised land uses through zoning. The need for transport is derived from the need to access opportunities presented by the specialised land uses. The cost of transport influences wealth, as it reduces the resources that could be saved, invested or spent on other uses.

### b. Conclusions

The following conclusions are derived from the above discussion:

- A car-based city works well for everyone who has access to private car transport.
- A car-based city entrenches the disadvantages experienced by those already marginalised by virtue of not having access to a car.
- A car-based city is expensive to both the poor, as well as higher income communities who provide a dualistic transport system through their taxes.
- Women are currently marginalised in South African cities due to poor transit systems.
- Car-based cities typically exhibit much worse transport safety records than transit cities.
- Car-based cities result in unhealthy communities, both from the lack of exercise while spending long periods in a car, but also from inhaling noxious gases as a pedestrian travelling among cars.

- A strong social motivation for the aim to move toward the development of compact Cities in South Africa to be realised currently exists

## REFERENCES

City of Cape Town (October 2008), 2007 Community Survey Analysis for Cape Town

City of Cape Town (2009), Review of 2006 – 2009 Consolidated Integrated Transport Plan, Cape Town

Department of Transport (DoT) (2005), Key results of the National Household Travel Survey, Pretoria

Glaeser EL, Kahn ME (May 2003), Sprawl and Urban Growth, National bureau of economic research, Cambridge

Mercer Human Resource consulting (2010),  
[http://en.wikipedia.org/wiki/List\\_of\\_cities\\_by\\_quality\\_of\\_living](http://en.wikipedia.org/wiki/List_of_cities_by_quality_of_living)

Newman P, Kenworthy J (1999), Sustainability and cities, overcoming automobile dependence, Island Press, California

Newman P, Kenworthy J (2000), The ten myths of automobile dependence, World Transport Policy & Practice, Volume 6, Number 1, p15 – 25

Provincial Government Western Cape (PGWC) (November 2006), City of Cape Town Socio-Economic Profile

Salingaros NA (2006), Compact City Replaces Sprawl, chapter in Crossover: Architecture, Urbanism, Technology, Edited by Arie Graafland & Leslie Kavanaugh, Rotterdam, Holland, pages 100-115.

Stats SA (2010), Mid-year population estimates, 2010

Jhamba T (2009), <http://www.statssa.gov.za/isi2009/ScientificProgramme/IPMS/0689.pdf>

Vuchic V (1999), Transportation for Livable cities, Centre for Urban Policy Research, New Jersey

Wickham J (2006), Gridlock- Dublin's transport crisis and the future of the city, TASC (a Think tank for Action on Social Change), Dublin