LOW CARBON LIVING CRC

RP2015: Carbon Reductions and Co-benefits: Final Report – Part II, An analysis of current levels of active transport usage in Australia – towards a measure of baseline activity

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Date	April 2015
Title	RP- 2015 Carbon Reductions and Co-benefits: Literature and practice review of Australian policies relating urban planning and public health Final Report – Part II An analysis of current levels of active transport usage in Australia – towards a measure of baseline activity
ISBN	
Format	
Keywords	
Editor	
Publisher	CRC for Low Carbon Living
Series	
ISSN	
Preferred citation	

Australian Government
Department of Industry and Science

Business
Cooperative Research
Centres Programme

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ACKNOWLEDGEMENTS

The authors wish to sincerely thank the Victorian Department of Transport, Planning and Local Infrastructure and especially Stephen Roddis, Manager Information Services and Joshua Stewart, Senior Analyst Information Services for their kind support of this study through the provision of the VISTA database and their advice about its contents and use. The analysis, its results and their interpretations are, however, strictly those of the authors.

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ACRONYMS

ABS	Australian Bureau of Statistics
AURIN	Australian Urban Research Infrastructure Network (see www.aurin.org.au)
BTS	NSW Bureau of Transport Statistics
CATI	Computer assisted telephone interview
CBD	Central Business District
CDF	Cumulative density function: the integral of a probability density function (pdf(x)) – see below – indicating the probability that a variable takes a value ≤ x
CRCLCL	Cooperative Research Centre for Low Carbon Living
DTPLI	Victorian Department of Transport, Planning and Local Infrastructure
GPS	Global Positioning System
hhld	Household
HTS	Household Travel Survey
LRT	Light Rail Transit
pdf	Probability density function: the normalised histogram of the statistical distribution of a variable x
PHT	Person-hours of travel
PKT	Person-kilometres of travel
TLFD	Trip length frequency distribution
VISTA	Victorian Integrated Survey of Travel and Activity
VTBC	Voluntray Travel Behaviour Change

EXECUTIVE SUMMARY

This report is the second output of the scoping study RP2015 'Carbon Reductions and Co-benefits: Literature and practice review of Australian policies relating urban planning and public health' and provides an analysis of (current) base line levels of usage of the active transport modes (walking and cycling) in urban Australia. As such the report meets the Cooperative Research Centre for Low Carbon Living's (CRC LCL) milestone R2.4.2 'Base line survey of current levels of active transport usage, including understanding of the environmental and human health benefits in the studied communities (Living Labs) plus constraints on the uptake of those'.

The analysis uses the VISTA (Victorian Integrated Survey of Travel and Activity) database collected by the Victorian Department of Transport, Planning and Local Infrastructure, which is a major household travel survey (HTS) conducted in Melbourne and major regional centres in Victoria. It contains comprehensive data on the daily travel and activity patterns of households and persons, and provides an authoritative record of travel for all purposes by people from all socio-economic groupings, including data on the usage of the active transport modes for their own purposes and as part of trip chains (i.e. travel by all modes that can include trip segments of walking and cycling).

Travel in Melbourne is dominated by the private car, which accounts for nearly half of trip numbers, over 60 per cent of travel distance, and just over half of travel time consumed. In terms of trip numbers, walking is the second most popular mode (22 per cent), just ahead of (private) vehicle passenger (21 per cent), although the latter is the second most used mode in terms of distance and time. Walking only accounts for 2.0 per cent of travel distance. Distances travelled on foot would be expected to be much less than those for the wheeled modes, but walking is the third highest mode in terms of travel time (12.7 per cent of all travel time). Public transport, taken as the combination of train, tram, school bus and public bus, accounts for 8.2 per cent of trip numbers, 10.7 per cent of travel distance and 10.6 per cent of travel time. Train is the dominant public transport mode used in the region, especially for distance travelled. Bicycle use is small, constituting 1.5 per cent of trip numbers, 1.0 per cent of distance travelled and 2.1 per cent of travel time of all travel undertaken in the Melbourne region.

Variations to the overall modal split statistics by trip purpose are of particular interest for the active modes. Walking is the most popular mode for education trips accounting for just over 40 per cent total trip numbers. Similarly, it is the most used mode in terms of travel time (at 26.5 per cent, although noting that the second most popular mode, vehicle passenger, is 26.4 per cent of travel time). In terms of travel distance, walking is only 6.3 per cent of the usage for education trips. Cycling only accounts for about two per cent of education travel by trip numbers and travel time, and one per cent by travel distance. Recreation trips include both travel to a place to take part in recreation (e.g. playing tennis) and travel that is the recreation, which will include walking and cycling activities. This is evident in the modal splits for cycling under recreation, which provides 5.7 per cent of trip numbers, 4.6 per cent of travel distance and 8.8 per cent of travel time – these are the highest percentages recorded for cycling under any of the trip purposes.

Walking emerges as a universal activity, undertaken by many people and at similar levels across the socio-economic groups, whereas cycling activity is very much undertaken by a small minority and shows differences between different groups, especially in terms of age and (household) income. This finding for cycle usage needs to be put in the context of the observation that overall household bicycle ownership is comparable to household car ownership. As assessed from VISTA, just over two per cent of people reported cycle usage for transport purposes, while 22.8 per cent of people reported walking for transport purposes.

A further general observation on travel activity is that the distributions of travel (as measure by trip length frequency distributions) are asymmetric distributions, strongly skewed to the right (i.e. the upper tail) and thus implying that some users of each mode (by trip purpose and socio-economic characteristics) make much greater usage of the modes compared to the population at large. Given this feature of travel, the best descriptor of trave; activity (trip numbers, travel distance and travel time) is thus the median value rather than the mean, and variations in the distributions are better represented by (say) considering percentile values rather than the standard deviation.

Access to public transport was identified as a significant task undertaken by the active modes, especially walking. The computed distance results for public transport access and egress include median walking distances of (1) train access 0.61 km, egress 0.64 km, (2) tram access 0.34 km, egress 0.32 km, and (3) public bus access 0.47 km, egress 0.48 km, and 85th percentile distances of (1) train access 1.19 km, egress 1.21 km, (2) tram access 0.71 km, egress 0.73 km, and (3) public bus access 0.99 km, egress 1.02 km.

A stark reality emerges from this study, which must have important consideration for policy development aimed at encouraging greater use of the active modes: the majorities of people and households did not undertake any reportable active transport usage. Indeed cycling, in particular, is a transport activity only undertaken by a very small proportion of the population. In the Melbourne region, 97.9 per cent of people reported no cycling activity, while 77.2 per cent reported no walking activity (and 75.8 per cent of people reported no walking or cycling travel activity), i.e. less than a quarter of the population undertook (reportable) travel on foot and just over two per cent travelled anywhere by bicycle. There are differences in both gender and age group in these results. Cycling activity is concentrated in the age groups between 10-54 years. Walking is most common in the 5-39 year age groups, and at least 20 per cent of people across the 5-79 year age groups also report walking. The very young (0-4 years) and the very old (90+ years) are much less likely to walk. Females participate slightly less in cycling but slightly more in walking than males.

INTRODUCTION

The Cooperative Research Centre for Low Carbon Living (CRCLCL) is a national research and innovation hub that seeks to enable a globally competitive low carbon built environment sector.

The CRCLCL has three research programs, reflecting the three pivotal “bridges” that must be crossed in order to deliver a low carbon built environment.

- Program 1: Integrated Building Systems
- Program 2: Low Carbon Precincts
- Program 3: Engaged Communities

Program 2: Low Carbon Precincts overview

The Low Carbon Precincts Program focuses on reducing the carbon footprint of our urban systems, with key consideration being given to integrating the interlinked aspects of energy, water, waste, transport and buildings – all of which have significant carbon signatures as well as human health impacts.

The challenge is to reduce the carbon footprint of precinct infrastructure through the development of better tools and planning techniques. As a result, low carbon precincts will become highly desirable lifestyle options. Improved planning of precincts will allow carbon footprint to be reduced to zero in the longer term, at the same time as quality of life continues to grow.

Delivering low carbon precincts, the building blocks of our urban areas, is a prime example of direct action in climate change and a key research objective of the CRC. The evaluation and assessment of carbon performance of precincts is the fundamental area of interest in – and the main thrust of – Research Program 2. This requires modelling and analysis leading to quantitative assessment of carbon performance and comparisons between alternative policies, plans, designs and scenarios. The principal objective of Research Program 2’s research is the development of a world class precinct design and assessment method, with associated tools and supported by scientifically verified data.

The development of this method is encapsulated in CRCLCL Pathway 4 ‘Designing integrated low carbon precincts’ shown in Figure 1 below. This pathway applies and integrates the research undertaken in the four activity areas of:

- Activity 2.1 – Digital information platform for informed precinct design
    - establish a world-first spatial database platform in an open standard format able to integrate with proprietary databases in both the Geographic Information Systems (GIS) and Building Information Model (BIM) domains
- Activity 2.2 – Integrated assessment of eco-efficiency during precinct design
    - develop and test assessment models for precinct design, embodied in automated software applications based on Precinct Information Model (PIM) technology
- Activity 2.3 – Precinct-level demand forecasting for distributed infrastructure networks
    - develop a comprehensive, integrated tool set that enables measurement and assessment of precinct performance based on PIM technology and which forecasts demand at precinct level in terms of low carbon living
- Activity 2.4 – Health and productivity co-benefits
    - develop a suite of co-benefit calculators suitable for different stakeholders (government regulators, developers, precinct planners and designers and community end users) based on rigorous research to identify measurable metrics.

This report forms part of the initial investigations in Activity 2.4 (Health and productivity co-benefits), and focusses on existing travel behaviour in Australian urban areas, with particular regard to active transport (walking and cycling). Travel and transport activity and resultant carbon emissions are of interest to CRCLCL, especially for its research on low carbon precincts and engaged communities. In particular, the potential health and productivity co-benefits from increased usage of the active transport modes from low carbon precinct planning and design have been identified as an important topic for consideration by the CRC.

The assessment of increased levels of usage of active transport modes requires the establishment of baseline data on the present levels of usage of these modes in urban transport. Public transport usage is of importance here to, on the basis that travel by public transport often requires access to and egress from transit services on foot, or perhaps by bicycle.

Transport planners have regularly collected data on the travel behaviour of people as a core resources for the planning, provision, design and operation of transport infrastructure and services in urban areas. The general method for collection of these data is through large-scale sample surveys known as Household Travel Surveys (HTS). Modern HTS methods include the collection of the activities undertake by survey respondents as well as their travel movements, as this is known to produce better and more complete data on the travel movements themselves. The household is used as the basic unit of analysis because it is also known that interactions between the members of a household strongly influence the behaviour of its individual members. Travel and activity data is collected for each individual in the household using travel-activity diaries (and increasingly with the use of new technologies such as GPS), of at least one-day (24 hour) duration, although some surveys use longer periods. Travel days in most modern surveys cover all days of the week and weekend. The science of HTS has been continually developed and refined over the past 60 years, and a detailed account of the modern methodology and practice of HTS is available in Richardson, Ampt and Meyburg (2005).

HTS data can thus be used to establish a comprehensive picture of the travel movements and behaviours of a sampled population. Data on usage of the active transport modes can be extracted from the HTS databases.

For the baseline analysis study the main information sought from the HTS data is as follows:

- total annual numbers of trips, person-km of travel and person-hours of travel by each of the active modes, by trip purpose
- modal split percentages for the active modes, in terms of numbers of trips, person-km of travel and person-hours of travel, by trip purpose
- overall trip length frequency distributions (TLFD), by distance and by travel time, for each of the active modes, by trip purpose, and
- TLFD for each of the active modes by demographic variables (gender and age (groups)).

This report provides a baseline analysis of active transport usage in Melbourne in 2009/10, and may be taken as providing a baseline study representing urban Australia more widely.

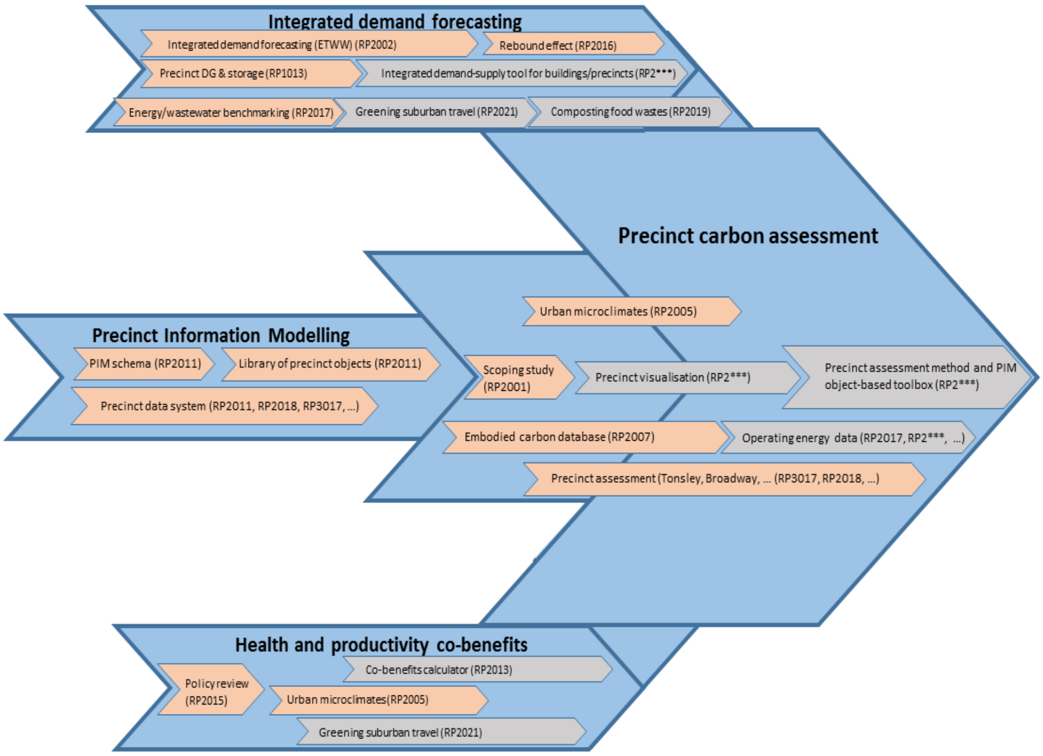


Figure 1: CRCLCL Pathway 4 'Designing integrated low carbon precincts' – the principal thrust of Research Program 2

(current at 20/02/15; Projects with grey backgrounds have yet to be approved)

For more information regarding CRCCLC and its research programs, see www.lowcarbonlivingcrc.com.au

LITERATURE REVIEW

Active transport – walking and cycling – is an integral part of sustainable transport and offers potential health and social benefits as well. Opportunities for increased usage of the active transport modes should result from low carbon urban planning and design, both at the precinct scale and at the broader urban regional level. The purpose of this report is to describe and provide data on current and hence baseline levels of usage of the active transport modes in Australia. It is also then useful to compare Australia with other places, to seek other baseline performance information and perhaps benchmarks for enhanced performance.

An important benchmarking study is that conducted in the USA by the Alliance for Biking and Walking (ABW, 2014), which is an ongoing analysis of published data from 52 large cities in the USA. The most recent study found that 5.0 per cent of commuters in those cities walked to work and 1.0 per cent rode bicycles, whereas 76.7 per cent of commuters travelled by private car. Men were slightly more likely than women to commute using the active modes: 46.5 per cent of walking commuters and 26.9 per cent of cycling commuters were women.

Pucher, Buehler, Merom and Bauman (2011) used the US National Household Travel Survey databases to examine the frequency, duration and distance of walking and cycling amongst Americans over the period 2001-2009. They found that walking activity was increasing albeit at a slow rate (an increase in the number of people walking 30 min or more per day from 7.2 per cent to 8.0 percent, while cycling levels were static (1.7 per cent of people did some cycling while 0.9 per cent cycled 30 min or more per day). Active travel appeared to be declining for women, children and the elderly.

Plaut (2005) also considered non-motorised commuting in the USA, using published US journey to work data. She found that higher income people had a greater propensity to work at home, but were less likely to walk or cycle – although university graduates did exhibit higher use of the active modes. There were also regional differences. At the urban level central city and inner suburb residents were more likely to use the active modes, while at the national scale US west coast residents were less likely to do so.

Plaut's findings on intra-urban regional differences raise the question on the impacts of alternative land use environments on active transport activity. Senbel et al (2014) examined different neighbourhoods in Vancouver, in different locations and of different design layouts, though all were characterised by low public transport service frequencies. They found that denser residential development, in both inner area and suburban locations, yielded reduced carbon emissions when compared to developments of large single family homes. Senbel et al (2014) concluded that while higher densities coupled with high frequency public transport could be most effective in reducing car usage, higher density development before or without public transport could still yield some reductions in carbon emissions.

Koh and Wong (2013) considered land use environment influences on pedestrian activity in Singapore, in both residential and commercial areas. Distance to destination and a lack of local bus services were the factors most affecting the generation of walking trips in residential areas, whereas infrastructure-related factors such as stairs and slopes, traffic accident risk, detour, crowded walkways/roadways, security, number of crossings and delays, and directional signage as well as distance were important factors in commercial areas. Similar findings were reported by Légaré (2010) in a review of local government initiatives for improving walking and cycling opportunities in Melbourne. Loutzenhaiser (1997) focused on walking access to transit stations in San Francisco. He concluded that people were more likely to walk the closer they lived to a station (for each additional 0.5 km from a station, the probability of an individual walking decreased by 50 per cent). Housing also needed to be attractive to a diversity of household types, and minimum parking standards were needed to make housing marketable and to reduce the land requirements needed for cars. Mixed housing and local retailing allowed chaining of trips together by walking. Negron-Poblete, Seguin and Apparicio (2014) noted that pedestrian activity was not dependent on distance alone, but was also affected by the occurrence of obstacles to movement, that resulted from urban planning and design decisions favouring the private car. This was a special concern for elderly people.

Some researchers have also considered potential impacts on property prices in terms of walking accessibility to public transport. Munoz-Raskin (2010) considered the bus rapid transit system in Bogota on this matter, and concluded that there were impacts, both positive and negative on property values. Middle income housing values improved, but lower income property values fell. He concluded that the impacts were case specific.

Ogilvie et al (2004) provided a systematic review of research studies from Europe, the USA and Australia concerned with interventions to promote active transport usage. They found consistent evidence that transport policies were increasingly seeking to reduce traffic congestion by discouraging car use and encouraging the use the active modes of transport. However, there was a lack of good evidence on which interventions are likely to be effective in promoting a shift from cars to active transport wards walking and cycling and on the actual effects of such interventions on population health. Taylor and Philp (2011) provided a review of 'voluntary travel behaviour change' (VTBC) programs in Australia, as examples of currently employed interventions.

Policies and initiatives to increase active transport usage are generally predicated on two grounds: improved sustainability and improved health outcomes. On the latter grounds, walking and cycling may be undertaken expressly for the purpose of recreation and exercise, but walking and cycling activity is also undertaken for more utilitarian transport purposes, e.g. for access to public transport or for local trip purposes. Much recent research has focussed on the ability of active transport activity, either for recreation/exercise or for transport, to meet targets for physical activity by individuals. Pucher et al

(2010) considered health and travel data for 14 countries, all 50 US states and 47 of the 50 largest US cities and concluded that there was strong evidence for the population level health benefits of active travel.

In an early study, Giles-Corti and Donovan (2003) surveyed residents in Perth and determined that although most survey respondents walked for recreation or transport, less than 20 per cent walked sufficiently to accrue health benefits. Those who walked in conjunction with engagement in other physical activities were better placed to achieve recommended levels of physical activity, so they concluded that promotion of walking would require comprehensive strategy.

More recent research has suggested more positive outcomes. Tudor-Locke et al (2005) used ABS Time Use Survey data to consider representative patterns of walking for transport and exercise. They concluded that although walking for transport was often undertaken in multiple brief episodes, the accumulated durations approximated the desired levels of activity in the public health guidelines. Cole et al (2006) also considered walking activity with respect to the guidelines (using a guideline value of at least 150 min/week moderate-to-brisk walking activity), using the results of a CATI (computer assisted telephone interview) survey. They found that rates of sufficient walking for transport were slightly lower than those for walking for recreation and exercise, and there were some socio-demographic differences. Men over 60 years were less likely to walk for transport, while men 45-59 years were more likely to walk for recreation and exercise. Women were more likely to meet the public health guideline than men. Wasfi, Ross and El-Geneidy (2013) studied daily walking activity in Montreal. They confirmed the role of public transport in supporting active transportation and indicated that suburban rail users could meet recommended health activity guidelines by commuting to work or school.

Morency, Trapnier and Demers (2011) used Household Travel Survey (HTS) data from Montreal to study walking distances to public transport and to estimate the actual level of physical activity undertaken in this. They did so by first estimating pedestrian walk access distances to transit stations using actual travel behaviour and pedestrian network path calculations, and then converting these distances in numbers of steps, for different socio-demographic groups (the relevant parameters: average length of an adult stride 0.7621 m, so 1250 steps/km for people aged 15-64 years, 1375 steps/km for 65 years and over, 1565 steps/km for 10-14 years, 1875 steps/km for 5-9 years. The Montreal travel data indicated that a public transport trip involved 1250 steps on average (covering walking access to, egress from, and transfer during the trip). Thus a return trip represented 2500 steps, taken to represent 25 per cent of the recommended daily quantity of physical activity.

The Morency-Trapnier-Demers study suggests that socio-demographic factors should be considered in studies of active transport, as physical and mental capabilities may have a role in determining the capacity to use these modes and the benefit extracted by doing so. As discussed above and exemplified by the Cole et al (2006) study, gender and age factors feature in observed levels of walking activity. Frank, Kerr, Chapman and Sallis (2007), for instance, considered walking activity by children in Atlanta, Georgia using travel diary data from an HTS. They concluded that urban form had a strong influence on walking activity by 12-15 year olds. Poulos et al (2015) surveyed adult cyclists in NSW, and found that transport cyclists tended to be younger, travelled more often over the course of a week, and cycled more in morning and evening peak periods than did recreational cyclists. Recreational cyclists were more likely to nominate fitness as a purpose for cycling. For transport purposes more generally, two aspects of active transport need consideration: school travel by children (e.g. Ermagum and Samimi, 2015) and public transport access (Zhao and Deng, 2013), and especially by older people e.g. Hess (2012) and Negron-Poblete, Seguin and Apparicio (2014).

Access to public transport is a key consideration in urban planning and design, especially for low carbon urban developments when use of public transport in preference to private car travel is important. Certain ‘rule of thumb’ metrics have been recognised in urban and transport planning as indicators of a minimum level of access to public transport in terms of walking distances from residences to the nearest bus stop or railway station. These ‘ped shed’ distances as commonly accepted for Australian metropolitan areas are 400 m to a bus stop and 800 m to a train station. The origins of these values are unclear, but perhaps they represent walking times of five and ten minutes respectively? In addition, the distances are usually taken to be straight line distances, so that actual distances to be traversed may be longer, depending on network layout. From observed data collected at five suburban stations in Perth, Ker and Ginn (2003) concluded that many people walked significantly more than 800 m to their station.

O’Sullivan and Morrall (1996) studied walking access to bus and light rail transit (LRT) services in Calgary, Canada. They found that people walked further to reach an LRT station than a bus stop. The average walking distance to suburban stations was 649 m (75th percentile 840 m), while at CBD stations the average distance was 326 m with 75th percentile 419 m. Dill (2003) in San Francisco, Crowley, Shalaby and Zarel (2009) in Toronto, Hess (2012) in New York and Garcia-Palomares, Gutierrez and Cardozo (2013) in Madrid found similar results concerning station location, with those stations further from the CBD having larger pedestrian catchments. Garcia-Palomeres et al (2013) also found that young adults, immigrants and public transport captives were willing to walk longer distances and were less sensitive to the effect of distance when accessing public transport. Loutzenhaiser (1997) found that suburban station areas with high levels of retail activity contained higher proportions of walk trips. Hoback, Anderson and Dutta (2008) reported average walking distances of 1.3 km total (i.e. access plus egress) per round trip for public transport riders in Detroit, while El-Geneidy et al (2014) reported 85th percentile walking distances of 524 m to access bus and 1.259 km to access rail in Montreal. In a study of walking access to suburban rail services in Mumbai, Rastogi and Rao (2003) found a mean walking distance of 910 m and an 85th percentile distance of 1.25 km. The maximum observed walking distance in Mumbai was 2.50 km.

A major Australian study relevant to this report on baseline active transport is that by Burke and Brown (2007), who used HTS data for South East Queensland to analyse all walking trip segments in the database and produce statistical distributions of walking distances for home-based and non-home-based travel in Brisbane. They found that single mode walk trips (i.e. trips made entirely on foot) tended to be longer than walk trip segments (e.g. for accessing public transport), although there were twice as many walk trip segments accessing public transport as there were single mode walk trips. For home-based single mode walk trips the median trip distance was 780 m with 85th percentile 1.45 km; the median and 85th percentile walk distance to access public transport from home were 600 m and 1.30 km and the median and 85th percentile egress distances from public transport stops to end destinations were 470 m and 1.09 km.

Children's travel behaviour especially travel to school has become a major topic of research, as part of general health concerns for children and learned habits taken into adulthood – see Mackett (2012) for a general review of this topic. Kelly and Fu (2014) focussed on primary school students, in an Irish case study of an area where more than 60 per cent of primary school students were driven to school. They identified distance to travel as the most important determinant of mode choice, and identified a 2 km distance as the threshold between walking or using motorised transport. The 'walking school bus' concept (see Mackett, 2012) was suggested as a viable alternative to private car drop off for distances less than 2 km. In addition, students having siblings and living in safe areas also walking to school. Ermagum and Samimi (2015) developed a discrete choice model of school travel mode choice. This model confirmed the importance of travel distance and of perceived safety issues as major factors in influencing the mode choice.

Mackie (2010) studied school children cycling to school in New Zealand. His survey indicated the existence of a strong latent demand for cycling to school, especially at intermediate school age. Generally, approximately 20 per cent of students wanted to cycle to school, although only about half of those actually did so. He found that the main barrier to cycling to school was the traffic environment and a lack of cycling infrastructure provision at busy traffic locations, which built on parental concerns about their child's safety (stranger danger as well as road safety).

While many of the reported studies have used special purpose surveys to provide data on walking and cycling behaviour, the HTS databases (and especially the travel-activity diaries that form the core data for them) have been used by some researchers. As discussed in the introduction to this report, HTS data allow a full picture of respondents' daily travel and activity patterns to be established. This allows the analyst to determine the levels of active transport in the community and relate these to socio-demographic and spatial characteristics, and to examine why and when active travel is undertaken, both for its own purposes or as part of more complex journeys.

As discussed above, examples of the use of HTS data to study active transport include Burke and Brown (2007) in Brisbane, Crowley, Shalaby and Zarel (2009) in Toronto, and Morency, Trapnier and Demers (2011), Wasfi, Ross and El-Geneidy (2013) and El-Geneidy et al (2014) in Montreal.

A useful descriptor of travel behaviour in an urban area is the trip length frequency distribution (TLFD). The TLFD is a statistic distribution showing the relative distribution of travel by travel cost, time or distance for a given purpose or by a given socio-economic group in a study region. Figure 2 shows an archetypal TFLD. The distribution indicates the range of travel costs incurred (time taken or distances travelled) and the intensity of travel activity at each travel cost. The TLFD may be represented either by a histogram (probability density function, pdf) or by a cumulative density function (CDF) plot, where the latter indicates the probability of trip lengths equal to or less than each value of travel cost (c). Both curves are shown in Figure 2. The CDF plot is useful for comparing TLFD for different criteria (e.g. trip purpose or socio-economic factors).

Thus developing sets of TFLD for different travel modes, for different trip purposes and for different socio-economic groups can provide a broad picture of travel behaviour in a region, when combined with information on the choice of different travel modes. The use of TFLD in estimating carbon emissions and energy consumption in transport is described in Holyoak (2014). In terms of active travel, Bargh and Kelly (2011) provided examples of TLFD for cycling in Hastings, New Zealand, while Rastogi and Rao (2003) developed TLFD for walking and cycling access to suburban rail in Mumbai.

The remainder of this report considers the HTS database for Melbourne and uses these data to describe and analyse active travel in that metropolis, which may be taken as representative of current levels of active travel in large Australian cities.

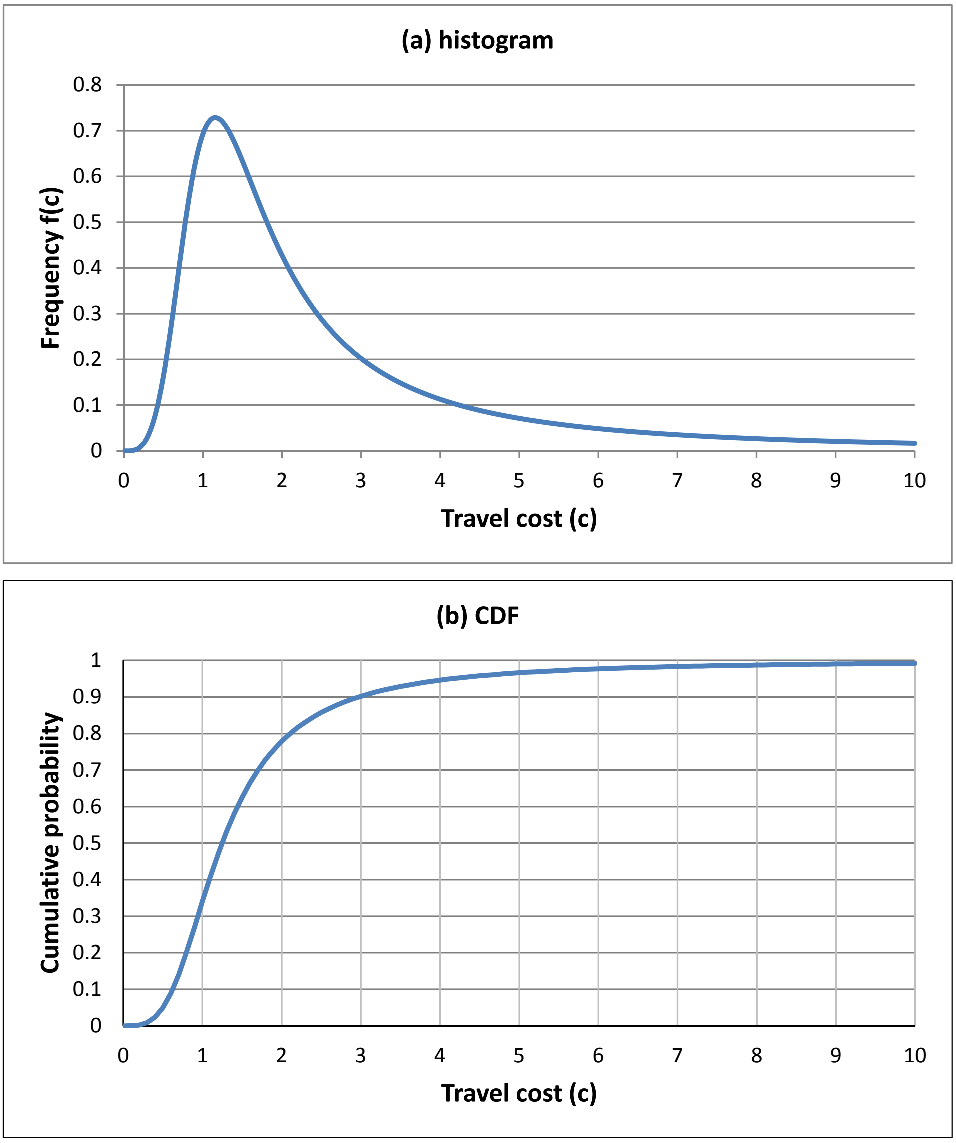


Figure 2: A schematic trip length frequency distribution, shown as (a) histogram or (b) equivalent cumulative density function (CDF)

MELBOURNE CASE STUDY

The VISTA (Victorian Integrated Survey of Travel and Activity) database collected by the Victorian Department of Transport, Planning and Local Infrastructure (DTPLI) is a major household travel survey (HTS) conducted in Melbourne and major regional centres in Victoria. It contains comprehensive data on the daily travel and activity patterns of households and persons, and provides an authoritative record of travel for all purposes by people from all socio-economic groupings, including data on the usage of the active transport modes for their own purposes and as part of trip chains (i.e. travel by all modes that can include trip segments of walking and cycling). The database thus contains data on travel by the active modes and accounts for travel by all modes and all purposes over all days of the week by all inhabitants of the study region.

VISTA data is collected through an ongoing set of survey cycles, and DTPLI provided the CRC with a copy of the 2009/10 dataset, which is the current production version of the database. The database comprises five tables:

1. *Household table*, including household variables such as household size and structure, numbers of vehicles and bicycles in the household, household income, dwelling type and dwelling location (at the ABS Census SA1 level at the finest level)
2. *Person table*, including personal variables such as age, gender, occupation/activity type and licensed driver status, for each individual in the household
3. *Vehicle table*, containing information on each vehicle available to the household, including vehicle type, make, year of manufacture, fuel/energy type, engine type and capacity, and responsibility for running costs (e.g. privately paid or company vehicle)
4. *Stops table*, including data on all 'stops' or trip segments (sometimes called 'unlinked trips') undertaken by each individual in the survey. A trip segment is for travel between successive decision points (nodes), where the traveller either changes activity at the decision point (e.g. arrives at work, school or shopping centre) or changes mode of travel (e.g. walks to a bus stop (trip segment *i*) and then catches a bus (trip segment *i*+1) to the next decision point). Data recorded for each trip segment include origin (start point) and destination (end point), at SA1 level, purpose of travel on trip segment, purpose of activity at end point, mode of travel used, vehicle occupancy (number of people in private vehicle), departure time, arrival time, travel time, travel distance, and time of day (and day of week)
5. *Trips table*, which provides the combinations of trip segments into 'linked trips' and so provides information on travel undertaken between activity points by an individual. For instance, a parent travelling to work by car and dropping two children at school along the way would make a linked trip from home to work comprising two trip segments, the first being the travel from home to the school (vehicle occupancy 3), followed by a trip segment from the school to workplace (vehicle occupancy 1). A journey by public transport might involve at least three trip segments: a walk trip segment from home to bus stop, a trip segment by bus, and a final trip segment on foot to the destination.

Thus the *Stops* table includes all travel activity, and how, where, when and by which means it was made. The *Trips* table provides the context for the travel. The *Stops* table includes all walking and cycling activity undertaken by survey respondents and is the main information source used in the analysis of active transport usage. The *Trips* table provides valuable secondary information on active travel, especially for the use of walking and cycling to access public transport services.

Only the VISTA data for the metropolitan Melbourne region was used in the analysis. The database for this region comprised 11 061 households containing a total of 28 705 individuals. Sets of weighting factors for households, persons, vehicles, stops and linked trips enable the sample data to be scaled to indicate the full population of the region and its aggregate behaviour.

More details about the VISTA database and published reports on it can be found at www.transport.vic.gov.au/vista.

Similar HTS databases exist for all Australian capital cities. VISTA was selected and used in the analysis reported in this report because of its currency and immediate availability, which fitted into the time frame of the project. Data from the Adelaide HTS is also available, but this HTS is from 1999 and so was not included in the study. The Sydney HTS database was not made available in time for its use in the project, but broad parameters from Sydney are available and these can be compared to those for Melbourne. The Melbourne data can be taken as broadly representative of the major Australian cities and so may be used to provide initial benchmarks of baseline usage of the active transport modes (walking and cycling).

The analysis of VISTA data focussed on the use of the active transport modes placed in the context of the overall travel behaviour of Melbourne residents. The results of the analysis are presented in the next chapter of this report.

DATA ANALYSIS

To establish baseline active transport levels on the basis of the VISTA data for Melbourne, the following data analyses were undertaken and are reported here:

- population characteristics and vehicle and bicycle ownership
- total travel statistics, overall and by trip purpose
- mode splits, total and by purpose
- TFLD by distance and travel time for active modes, total and by trip purpose
- TFLD by public transport modes, total and by trip purpose
- TFLD by active modes and demography (age, gender, income)
- access to and egress from public transport (distance)
- household and person activity levels by active modes, also considering people and households with no recorded walking or cycling activity.

The household variables used in the analysis were household structure and household income group. The classifications of these variables as used in VISTA are shown in Table 1.

Table 1: VISTA household variables used in active transport data analysis

Household structure		Household income groups		
	Household type		Weekly income	Annual income
1	Single person	1	< $650	< $33930
2	Couple without children	2	$650 - $1099	$33930 - $57419
3	Couple with children	3	$1100 - $1649	$57420 - $86129
4	Single parent (with children)	4	$1650 - $2499	$86130 - $130499
5	Other household structures	5	≥ $2500	≥ $130500

The person variables used in the analysis were gender (male, female) and age group. There are 21 age groups recorded in VISTA, in five year age cohorts from 0 years to 100+ years. For purposes of this analysis these 21 groups were compressed into six larger groupings, on the basis of ensuring sufficient statistical sample sizes in the data, especially for bicycle travel and for travel by older people. The VISTA age groups and the combined groupings used in the analysis are shown in Table 2. As can be seen in the table, the older age groups are the most compressed, with all people 70 years and over combined into a single age group. The reason for this will become apparent in the analysis of distances walked and cycled in terms of age and gender.

The trip characteristics considered in the analysis were mode of transport and purpose of travel, as well as travel distance and travel time, and origin and destination locations. Eleven transport modes were considered, along with seven trip purposes, as recorded in VISTA[3]. The transport modes and the specific trip purposes used in the analysis are shown in Table 3.

Table 2: VISTA person age groups and age groupings used in` this report

VISTA age groups		Age groupings in the analysis	
1	0-4 y	1	0-9 y
2	5-9 y		
3	10-14 y	2	10-19 y
4	15-19 y		
5	20-24 y	3	20-39 y
6	25-29 y		
7	30-34 y		
8	35-39 y		
9	40-44 y	4	40-54 y
10	45-49 y		
11	50-54 y		
12	55-59 y	5	55-69 y
13	60-64 y		
14	65-69 y		
15	70-74 y	6	70+ y
16	75-79 y		
17	80-84 y		
18	85-89 y		
19	90-94 y		
20	95-99 y		
21	100+ y		

Public transport is taken as the four modes of suburban train, tram, public bus and school bus. Taxi is excluded from the set of public transport modes in this case, on the grounds that in general terms taxi provides a 'door to door' service whereas the other four modes all require access to be made to stops or stations by travellers using those modes. This access (and egress, when the traveller leaves the vehicle) may involve measurable

[3] VISTA includes identifies 13 separate trip purposes, but the sample numbers for cycling and walking trips for some seven of these were generally insufficient to permit analysis on an individual trip purpose basis. The six specific trip purposes for which analysis was possible were shopping, education, work, personal business, social and recreation trips. The other seven purposes were combined into a seventh 'other' trip purposes.

walking or cycling activity – as is recorded in VISTA.Travel by all modes and for all purposes is also considered in the analysis.

Household vehicle ownership comprises all motor vehicles owned by the household or readily available to the household. Household bicycle ownership is similar (noting that the VISTA database also distinguishes between adults' and children's bicycles). In addition, the database also indicates the number of bicycles actually used by the household during the survey period for the household.

Table 3: Transport modes and main trip purposes in the VISTA database

Transport modes			Trip purpose		
1	Car driver		1	Shopping	
2	Car passenger		2	Education	
3	Motorcycle		3	Work	
4	Walk		4	Personal business	
5	Cycle		5	Social	
6	Taxi		6	Recreation	
7	Train	For purposes of this analysis, these four modes represent public transport	7	Other	This aggregated purpose includes travel made to accompany someone, and pick up/drop off something or someone
8	Tram				
9	Public bus				
10	School bus				
11	Other				

Population characteristics

The VISTA database represents a population of 3 825 680 people in the Melbourne region, living in 1 364 484 households (2.80 persons/hhld), owning 2 314 233 motor vehicles (including 1 824 920 cars) and 1 836 488 bicycles (household ownership rates 1.70 veh/hhld, 1.34 cars/hhld, 1.35 bicycles/hhld). Thus household bicycle ownership is about the same as car ownership. However, only 649 378 bicycles were used (0.48 bicycles used/hhld). Appendix A provides tabulated data on the household characteristics and vehicle, car and bicycle ownership.

Figure 3 shows the distribution of household size in terms of household income group.

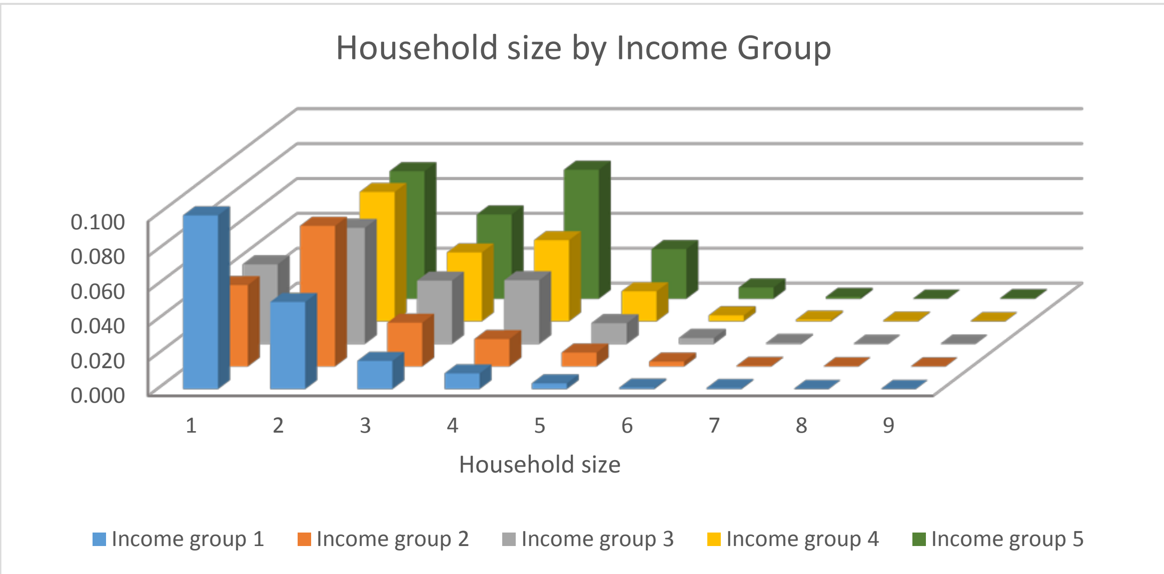


Figure 3: Household size and income groups in the Melbourne region

Single person households dominate the low income group (income group 1), while high income households (income group 5) are predominantly 2-5 person households.

In terms of household structure (see Figure 4), household type 3 (couples with children) are more represented in the higher income groups, while household type 2 (couples without children) are more evenly spread but still tend to be in the higher income groups. Single person households are largely lower income households.

The Melbourne study region population comprised 1 949 433 females and 1 876 247 males. Figure 5 shows the age pyramid for this population, in five year age cohorts (0-4, 5-9, etc) i.e. the VISTA cohorts in Table 2.

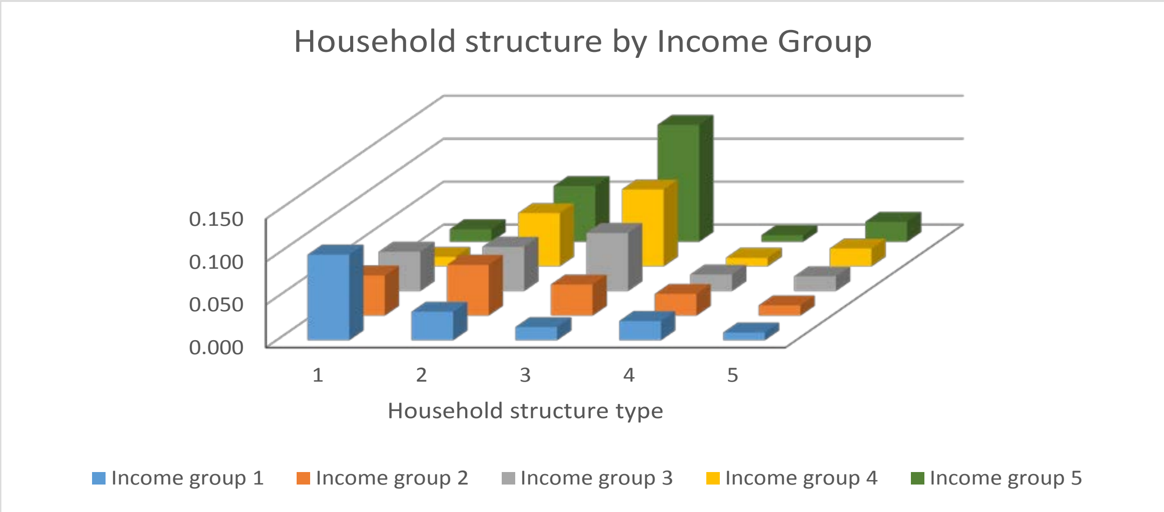


Figure 4: Household structure and income groups in the Melbourne region

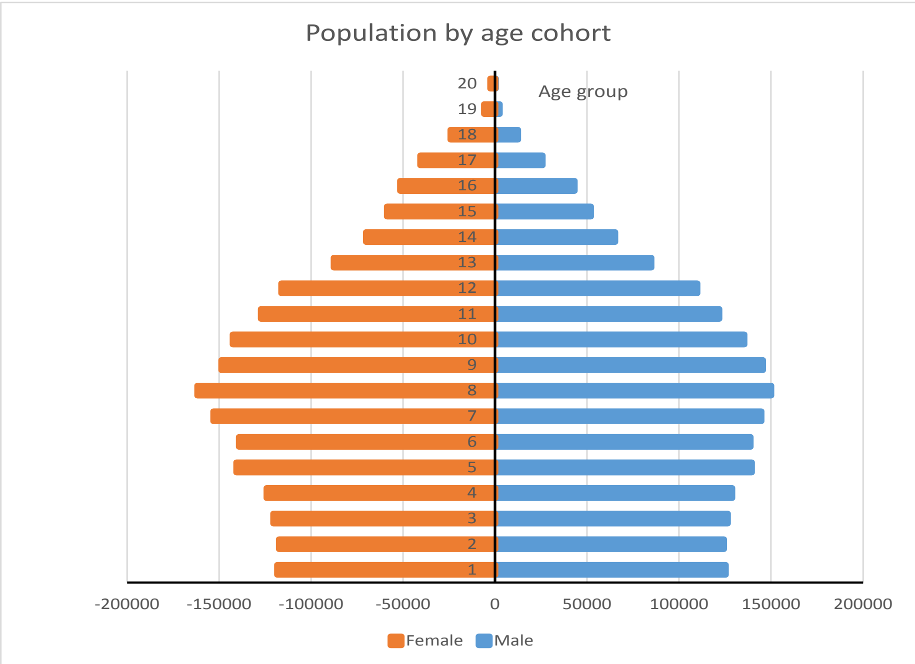


Figure 5: Age pyramid for the Melbourne region

Figure 6 shows distribution of people by income group and the gender split between income groups for the study region. There is a trend for more people in the higher (household) income, and there is also a suggestion that females may be relatively more common in the lower household income groups.

Vehicle ownership numbers by household income group for the Melbourne region are shown in Figure 7, and Figure 8 shows car ownership levels for the region

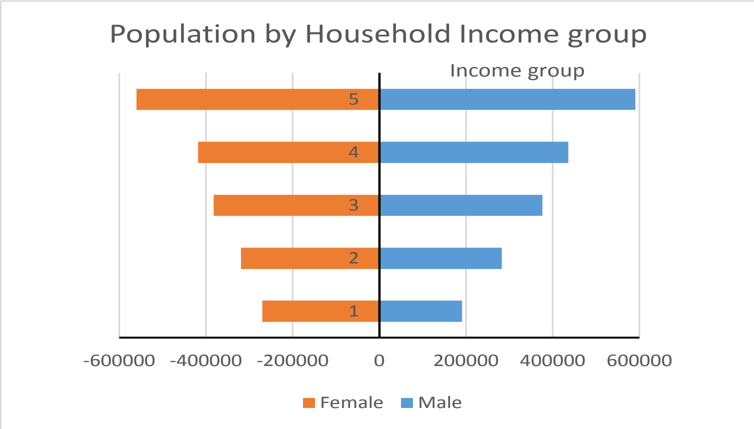


Figure 6: Population distribution over household income groups

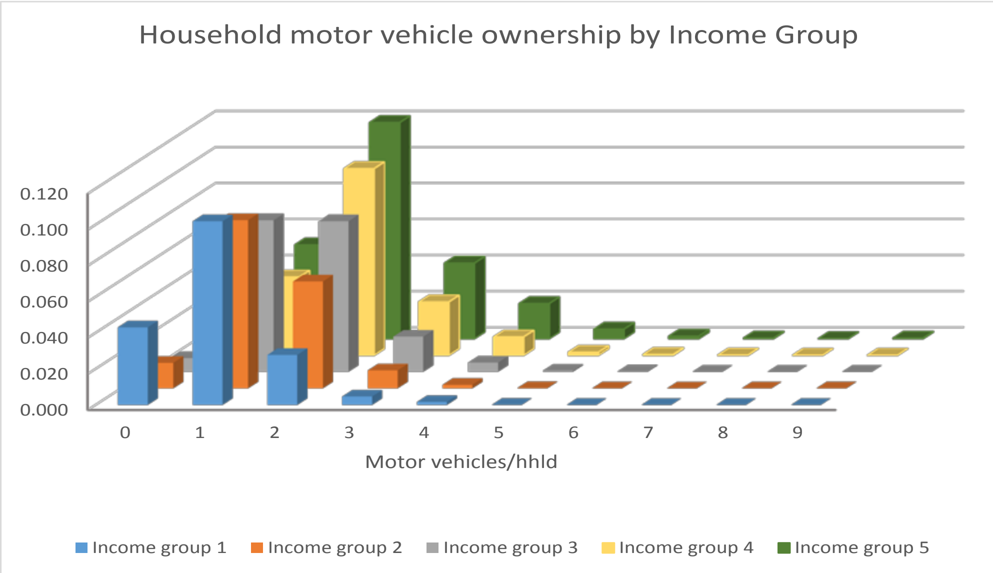


Figure 7: Vehicle ownership by household income group for the Melbourne region

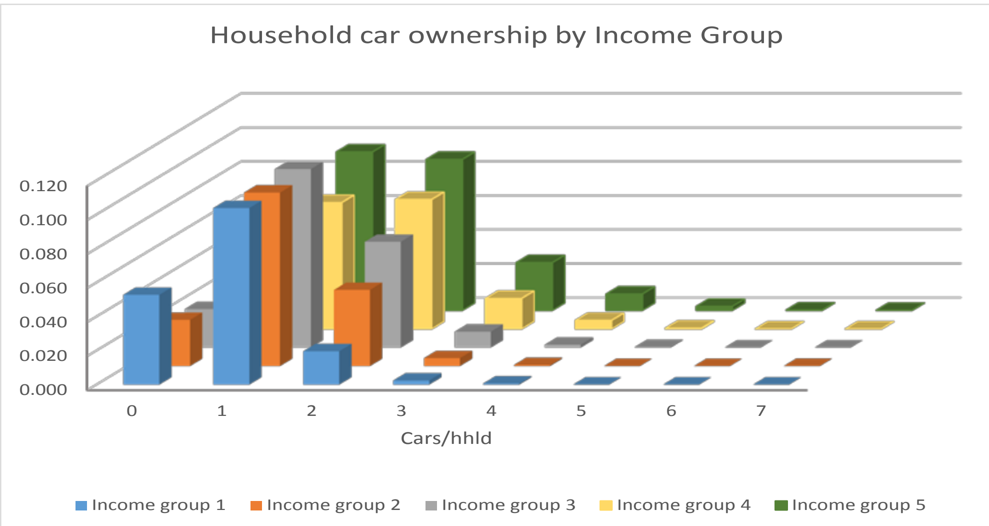


Figure 8: Car ownership by household income group for the Melbourne region

Figures 7 and 8 suggest that multiple vehicle ownership is highest in the higher income household groups and that most households have access to at least one vehicle. However, 14.7 per cent of households have no cars and 7.5 per cent have no motor vehicles available (note that motor vehicles include all other vehicles as well as cars, and motorcycles). See Tables A.5 and A.6 (Appendix A) for full details on vehicle and car ownership levels.

As indicated previously, aggregate household bicycle ownership is comparable to car ownership, although household bicycle usage is somewhat lower than ownership – perhaps reflecting a potential for the greater usage of this mode? Figure 9 and Table A.7, Appendix A indicate the distribution of bicycles between households by household income group, while Figure 10 and Table A.8 (Appendix A) show the numbers of bicycles used by households in each income group. Bicycle ownership is concentrated into just over half of the households (45.3 per cent of households do not possess bicycles). 12.2 per cent of all households are income group 1 households and without bicycles, while about 7 per cent each of all households are in income groups 4 and 5 and do not possess bicycles. Households in income group 5 owning two bicycles are the largest single percentage of bicycle ownership (5.4 per cent). From Figure 10, bicycle usage is strongest in income group 5 households with one or two bicycles. 73.9 per cent of all households reported no usage of bicycles, implying that just over half (52.3 per cent) of households possessing bicycles did not use them in the survey period.

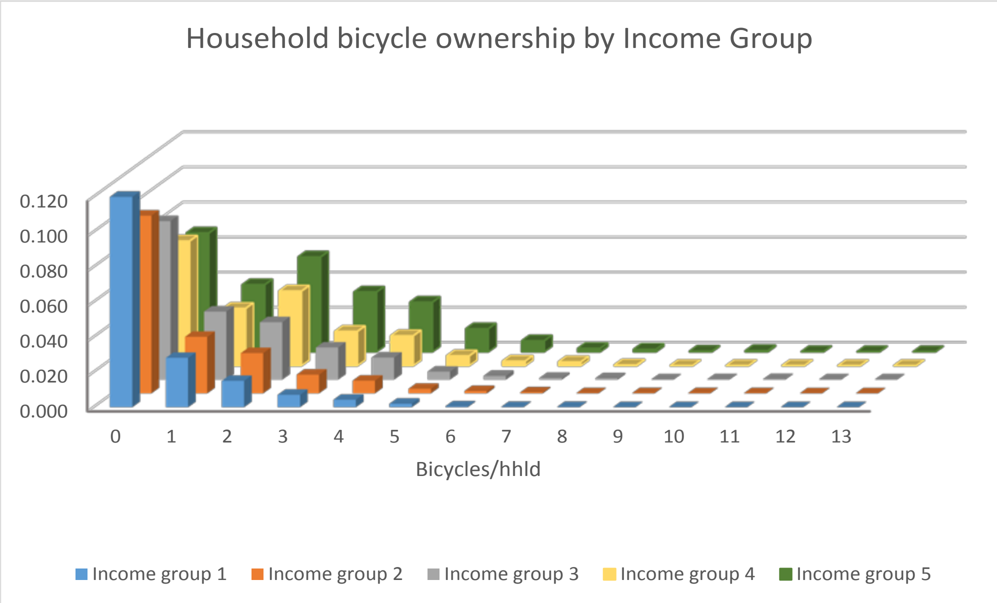


Figure 9:Bicycle ownership by household income group for the Melbourne region

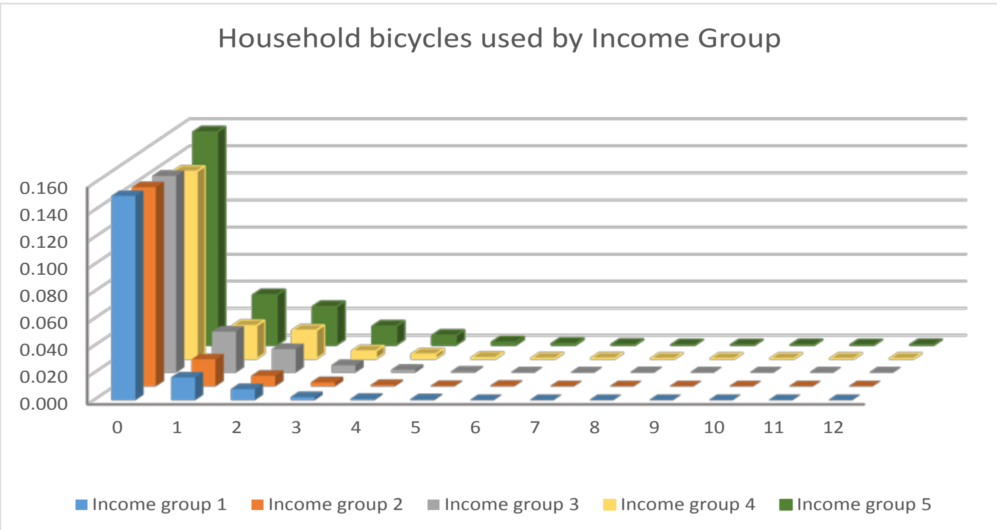


Figure 10: Bicycles used by household income group for the Melbourne region

The data tables relating to Figures 3-10 on population characteristics and vehicle ownership are provided in Appendix A

Total travel statistics

Travel activity can be described in three main ways: travel decisions, travel effort, and travel exposure. Travel decisions may be seen in the number of trips made. Travel effort can be described by the distance covered in travel, and travel exposure by the time taken in travelling. The aggregate statistics for reporting effort and exposure in terms of personal travel are, respectively, person-kilometres of travel (PKT) and person-hours of travel (PHT). One person travelling one kilometres is one PKT, and one person travelling for one hour is one PHT. Total daily travel activity for the Melbourne region was calculated from the Stops table in the VISTA database. This activity is summarised in Table 4, which shows the total travel load on an average day (14 429 040 trip segments, 1 128 538 523 PKT/day, and 4 124 761 PHT/day) and splits these travel load by trip purpose.

Trip purposes by percentage of total travel are shown in Table 5, which shows the percentages for each of travel decisions (i.e. trip numbers), travel effort (PKT) and travel exposure (PHT). On all of these work trips are the single largest purpose, though never accounting for more than 32 per cent of total travel. Social trips are the next highest proportion (in terms of PKT and PHT), followed by 'other' trips (i.e. those purposes not explicitly defined in the table). Shopping trips are the second highest category in terms of trip numbers but are lower ranked in terms of PKT and PHT, implying that many of these trips are relatively short.

Table 4: Total travel load by trip purpose in the Melbourne region (2009)

Trip purpose	Total trips on average day	Person-km of travel per day	Person-hours of travel per day	Mean trip distance (km)	Mean trip time (min)	Mean trip speed (km/h)
Shopping	2541421	12153094.6	537916.2	4.78	12.7	22.6
Education	1363166	6535938.4	329334.2	4.79	14.5	19.8
Work	3420557	36115752.4	1239767.4	10.56	21.7	29.1
Personal business	1186156	10232010.9	348516.9	8.63	17.6	29.4
Social	2265561	21056871.2	700876.0	9.29	18.6	30.0
Recreation	806338	6568357.5	254387.7	8.15	18.9	25.8
Other	2845840	20191827.3	713962.3	7.10	15.1	28.3
All trips	14429040	112853852.3	4124760.7	7.82	17.2	27.4

Table 5: Trip purpose percentages by number of trips, distance travelled and time taken, Melbourne region (2009)

Trip purpose	Total trips on average day	Person-km of travel	Person-hours of travel
Shopping	17.6%	10.8%	13.0%
Education	9.4%	5.8%	8.0%
Work	23.7%	32.0%	30.1%
Personal business	8.2%	9.1%	8.4%
Social	15.7%	18.7%	17.0%
Recreation	5.6%	5.8%	6.2%
Other	19.7%	17.9%	17.3%
All trips	100.0%	100.0%	100.0%

Another factor of interest in total travel statistics is the travel rates, i.e. total daily numbers of trips made, distance travelled and time taken per household and per person. Table 6 shows these data for the Melbourne region. The table indicates an average household trip generation rate of about 10.6 trips/day, composed of 82.7 km of travel and covering 3.0 hours. For individuals, the average number of trips made is 3.8 per day for a total travel distance of 29.5 km taking 65 minutes. Note that all these statistics include households and individuals who recorded no travel for their travel day in the survey responses.

Table 6: Travel rates for households and persons for trip numbers, distance travelled and time taken, Melbourne region (2009)

	Households			Persons		
Trip purpose	Trips/hhld/ day	PKT/hhld/ day	PHT/hhld/ day	Trips/person/day	PKT/person/day	PHT/person/day
Shopping	1.86	8.91	0.39	0.66	3.18	0.14
Education	1.00	4.79	0.24	0.36	1.71	0.09
Work	2.51	26.47	0.91	0.89	9.44	0.32
Personal business	0.87	7.50	0.26	0.31	2.67	0.09
Social	1.66	15.43	0.51	0.59	5.50	0.18
Recreation	0.59	4.81	0.19	0.21	1.72	0.07
Other	2.09	14.80	0.52	0.74	5.28	0.19
All trips	10.57	82.71	3.02	3.77	29.50	1.08

Modal split

This study of baseline active transport usage is concerned with the amounts of walking and cycling travel undertaken, the starting point for which is the proportional share of total travel activity which is undertaken using the active modes. The VISTA database identifies eleven separate transport modes: private vehicle driver, private vehicle passenger, motorcycle, walking, cycling, taxi, train, tram, public bus, school bus, and (all) other. The splits of travel between these modes can again be analysed in terms of the three broad descriptors of travel behaviour: decisions, effort and exposure and the percentages of usage of different modes can be very different between these descriptors. Table 7 shows the overall modal split (percentage use of each identified mode) for all travel in the Melbourne region, in terms of trip numbers, PKT and PHT. These data are plotted in Figure 11.

Table 7: Travel mode splits for trip numbers, distance travelled and time taken, Melbourne region (2009)

Transport mode	Trip numbers	Travel distance	Travel time
Vehicle Driver	46.1%	60.1%	52.1%
Vehicle Passenger	21.3%	25.4%	21.6%
Motorcycle	0.2%	0.4%	0.3%
Walking	22.2%	2.0%	12.7%
Bicycle	1.5%	1.0%	2.1%
Taxi	0.4%	0.4%	0.5%
Train	3.8%	7.4%	5.9%
Tram	2.2%	0.9%	1.9%
School Bus	0.5%	0.8%	0.8%
Public Bus	1.7%	1.6%	2.0%
Other	0.1%	0.0%	0.1%

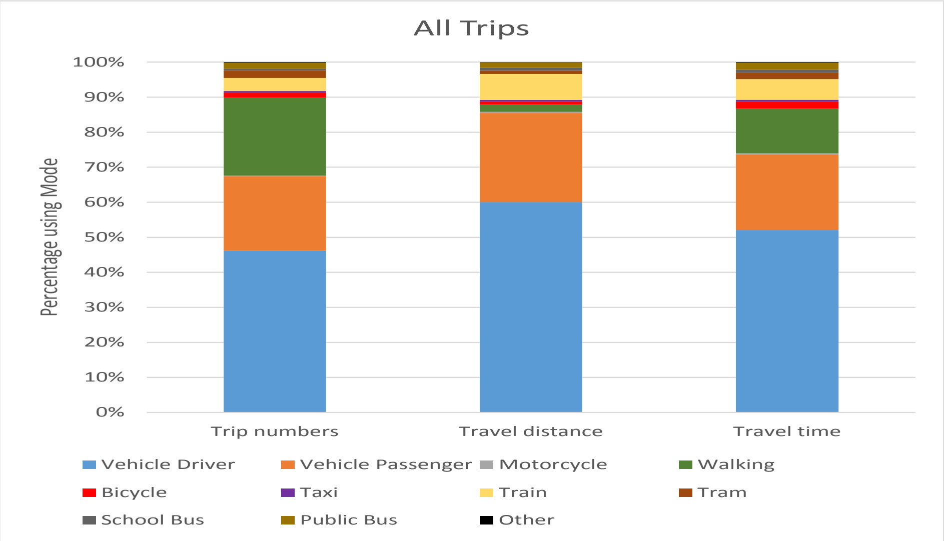


Figure 11: Modal split percentages, all trips in the Melbourne region (2009)

The dominance of the private car, especially the vehicle driver mode, is clear from these results. It accounts for nearly half of trip numbers, over 60 per cent of travel distance, and just over half of travel time. In terms of trip numbers, walking is the second most popular mode (22 per cent), just ahead of vehicle passenger (21 per cent), although the latter is the second most used mode in terms of distance and time. Walking only accounts for 2.0 per cent of travel distance, and for 12.7 per cent of travel time. Distances travelled on foot would be expected to be much less than those for the wheeled modes, but note that walking is the third highest mode in terms of travel time. Public transport, taken as the combination of train, tram, school bus and public bus, accounts for 8.2 per cent of trip numbers, 10.7 per cent of travel distance and 10.6 per cent of travel time. Train is the dominant public transport mode used in the region, especially for distance travelled.

Bicycle use is small, constituting 1.5 per cent of trip numbers, 1.0 per cent of distance travelled and 2.1 per cent of travel time of all travel undertaken in the Melbourne region.

There are variations to the overall modal split statistics in terms of trip purpose, which are of particular interest for the active modes. Figure 12 shows the modal split charts for the following trip purposes: shopping, education, work, personal business, social and recreation (as previously identified). The tables in Appendix B provide the data displayed in the charts of Figure 12. Given a focus on active transport usage, the modal splits for education and recreation trips (Figures 12(b) and 12(f) respectively, see also Tables B.2 and B.6) are of particular interest.

In terms of trip numbers, walking is the most popular mode for education trips accounting for just over 40 per cent of the total. Similarly, it is the most used mode in terms of travel time (at 26.5 per cent), although noting that the second most popular mode, vehicle passenger, has 26.4 per cent of this travel load. [In terms of travel distance, walking covers only 6.3 per cent of the usage for education trips.] Cycling only accounts for about two per cent of education travel by trip numbers and travel time, and one per cent by travel distance. Note that education trips as presented here include trip by primary, secondary, tertiary and further education students together.

Recreation trips include both travel to a place to take part in recreation (e.g. playing tennis) and travel that is the recreation, which will include walking and cycling activities. This is evident in the modal splits for cycling under recreation, which provides 5.7 per cent of trip numbers, 4.6 per cent of travel distance and 8.8 per cent of travel time – these are the highest percentages recorded for cycling under any of the trip purposes. Vehicle driver has the highest mode share for all three travel descriptors, with nearly half of the modal share for travel distance. Vehicle passenger is the second highest mode share for travel distance and travel time. Walking is the second highest mode for trip numbers and third highest for travel time.

The picture for work trips (see Figure 12(c) and Table B.3) is the one with the starkest pattern (and one which fits the popular stereotype of transport mode choice in our cities). Solo vehicle driving dominates on all three descriptors – vehicle driver accounting for more than three quarters of travel distance and more than two thirds of travel time. Vehicle passengers account for just under five per cent on all three descriptors, hence the commonly perceived phenomenon of the 'single occupant vehicle' for commuter travel. Walking rates at 23 per cent of trip numbers (hence second largest under this criterion) and nine per cent of travel time, but only 1.4 per cent of travel distance. Cycling covers 2.1 per cent of trip numbers, 1.3 per cent of travel distance and 2.5 per cent of travel time. Public transport overall is 13.6 per cent of trip numbers, 14.5 per cent of travel distance and 14.3 per cent of travel time (train is the main public mode, at 8.1 per cent of trip numbers, 12.3 per cent of travel distance and 10.2 per cent of travel time).

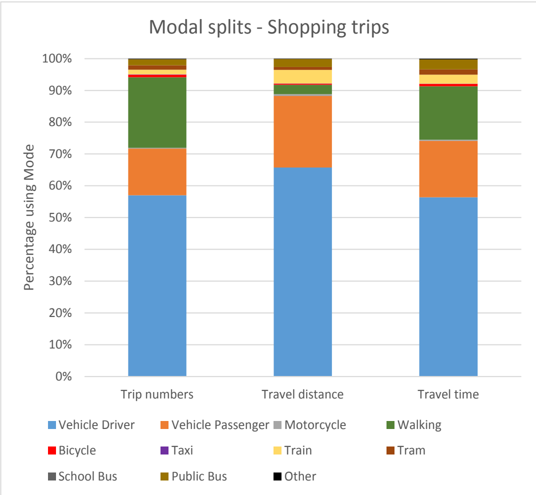
Trip length distributions

Trip length frequency distributions (TLFD) indicate the range of travel activity by travel mode, trip purpose and socio-demographic factors for a study region. From the VISTA data these distributions may be derived for both travel time and travel distance. A comprehensive set of TLFD for the active modes were developed, and are presented in this section of the report. In addition, TFLD were also extracted for each of the public transport modes. These distributions are also presented here.

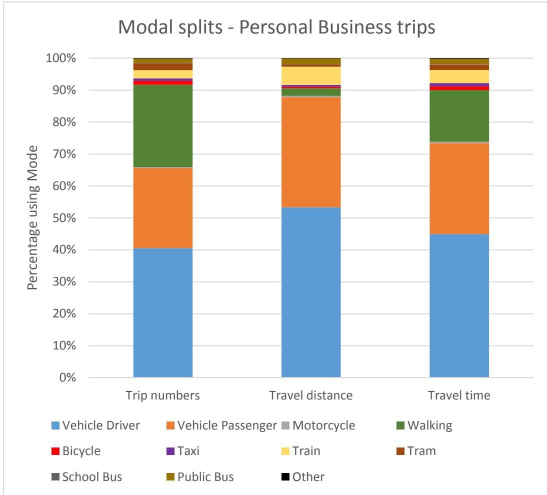
The issue of walking access to and egress from public transport services was raised as an important issue in the literature review, so that distributions of walking access and egress distances were also developed, and are presented in Section 4.6.

As a starting point, the overall picture of active travel in Melbourne can be determined from the TLFD for all walking and cycling activity in the region. Summary statistics and percentile values from the cumulative frequency distributions (CDF) for all walking and cycling travel are presented in Table 8 (travel distance) and Table 9 (travel time). These data are for all recorded walking and cycling trip segments ('unlinked trips') in the VISTA database. The travel distances are computed network travel distances based on the origin and destination information provided by the survey respondents in their travel-activity diaries. The travel times are those as recorded directly by the respondents[4]. While, not unexpectedly, the distances travelled by walking and cycling are quite different, the ranges of the travel times are similar. In general though, cycling trips tend to cover longer distances and take more time than walking trips. Figures 13 and 14 show the CDFs for distance and travel time TLFDs by the two modes, which shows this comparison.

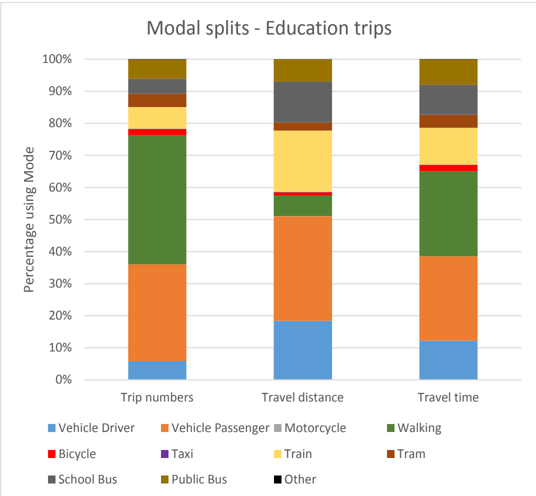
[4] There is a tendency for some 'lumpiness' in the travel times, with values such as '5 min', '10 min', '15 min' more frequently recorded than say '4 min', '11 min' or '14 min'.



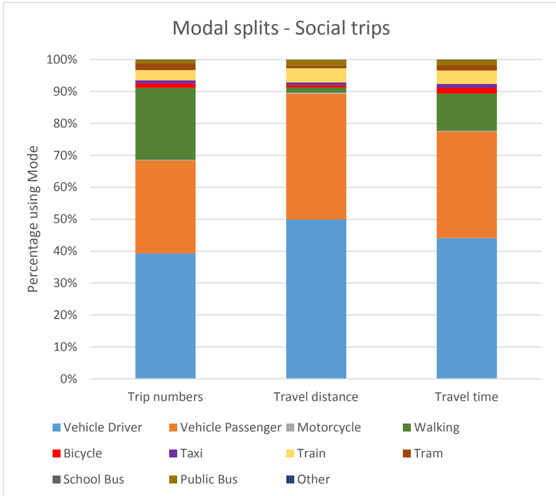
(a) Shopping trips



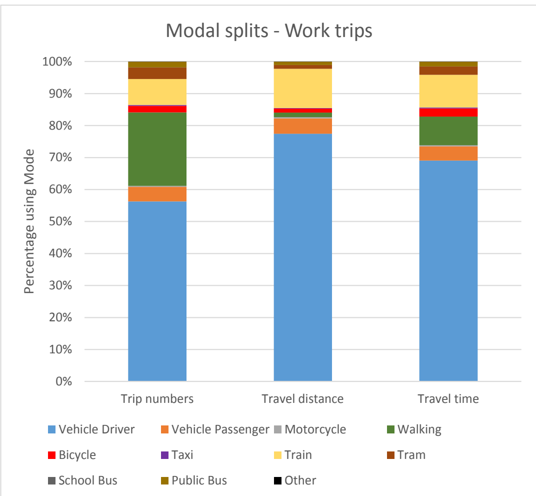
(d) Personal business trips



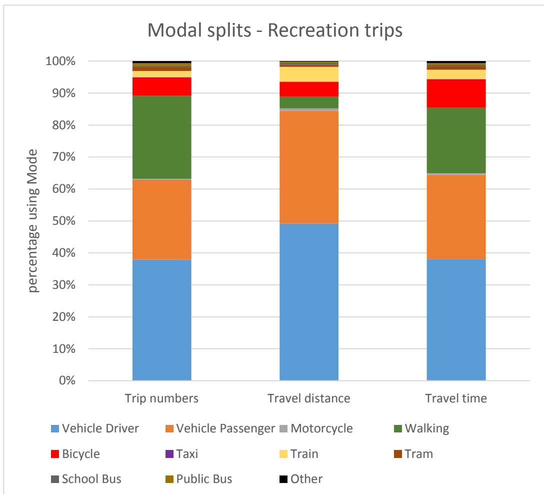
(b) Education trips



(e) Social trips



(c) Work trips



(f) Recreation trips

Figure 12: Modal splits by trip numbers, distance and travel time for different trip purposes

Another feature of these TLFD is that the distributions are skewed to the upper tail, which is reflected in the shape of the CDFs (Figures 13 and 14) and in the differences between the mean (average) and median (50th percentile) values for the distributions (see Table 8 and 9). The asymmetric nature of the underlying distributions, skewed towards the upper tail, means that the average value is much higher than the median value. This effect is especially pronounced for cycling (average travel distance 4.84 km, median 2.98 km; average travel time 23.2 min, median 15.0 min).

The skew towards the upper tail is a characteristics of all the TLFD presented here. A further explanation for it is that there can always be very long (maximum) observations of travel time or distance, but these can never be matched by very short observations because the minimum value possible must exceed zero.

In terms of trip purpose, Figures 15 and 16 show the walking mode TLFD for shopping, education, work, personal business, social and recreation trips by travel distance and travel time respectively. Figures 17 and 18 show the corresponding TLFD for the cycling mode. Recreation trips tend to be longer than all other purposes for both walking and cycling.

Table 8: Summary statistics and percentiles for walking and cycling trip length frequency distributions (TFLD) for travel distance in the Melbourne region (2009)

	Walking	Cycling
Summary statistics		
Sample size	19914	1458
Mean (km)	0.72	4.84
Standard deviation (km)	0.65	5.20
Coefficient of variation	90.3%	107.3%
Mode (km)	0.11	0.75
Percentiles		
10th (km)	0.16	0.75
15th (km)	0.21	0.95
25th (km)	0.29	1.34
50th (median) (km)	0.54	2.98
75th (km)	0.93	6.66
85th (km)	1.24	8.92
90th (km)	1.48	10.75
IQR (km)*	0.64	5.32

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table 9: Summary statistics and percentiles for walking and cycling trip length frequency distributions (TFLD) for travel time in the Melbourne region (2009)

	Walking	Cycling
Summary statistics		
Sample size	19914	1458
Mean (min)	9.9	23.2
Standard deviation (min)	8.4	19.6
Coefficient of variation	84.2%	84.4%
Mode (min)	5.0	10.0
Percentiles		
10th (min)	3.0	5.0
15th (min)	4.0	5.0
25th (min)	5.0	10.0
50th (median) (min)	8.0	15.0
75th (min)	13.0	30.0
85th (min)	15.0	45.0
90th (min)	20.0	45.0
IQR (min)*	8.0	20.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Appendix C provides details of the summary statistics and percentile values for all of the distributions shown in Figures 14-17.

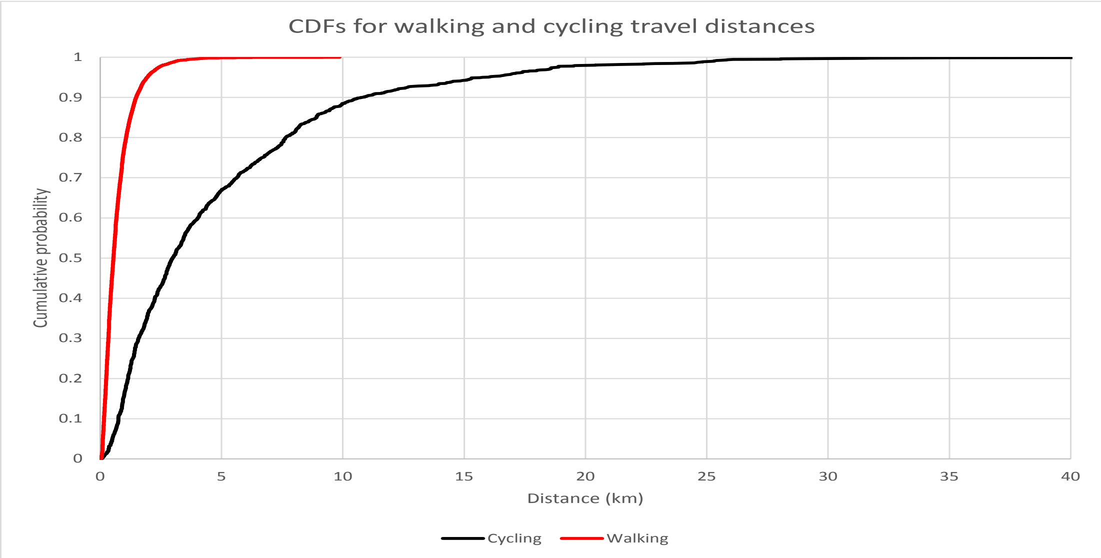


Figure 13: Trip length frequency distributions as CDFs of travel distances for all walking and cycling activity in Melbourne (2009)

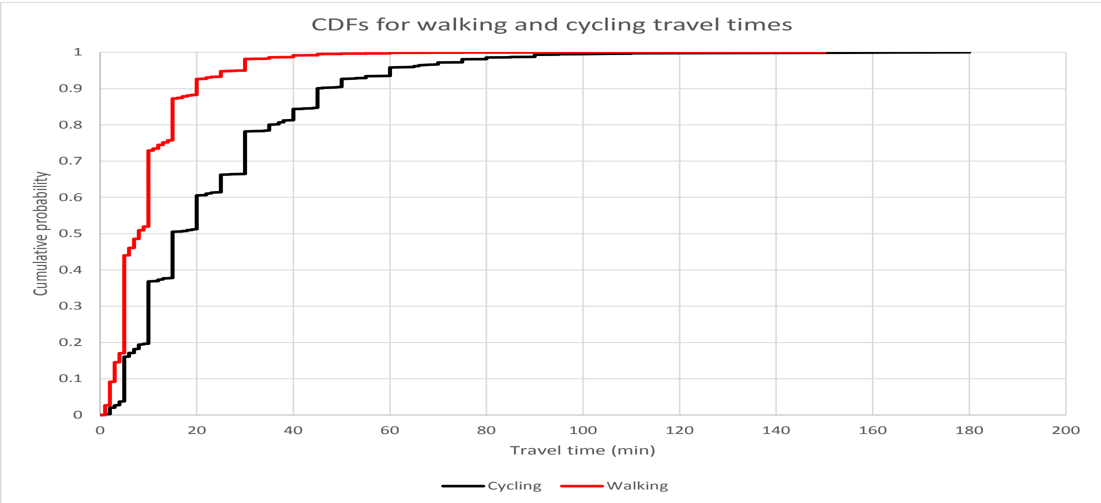


Figure 14: Trip length frequency distributions as CDFs of travel times for all walking and cycling activity in Melbourne (2009)

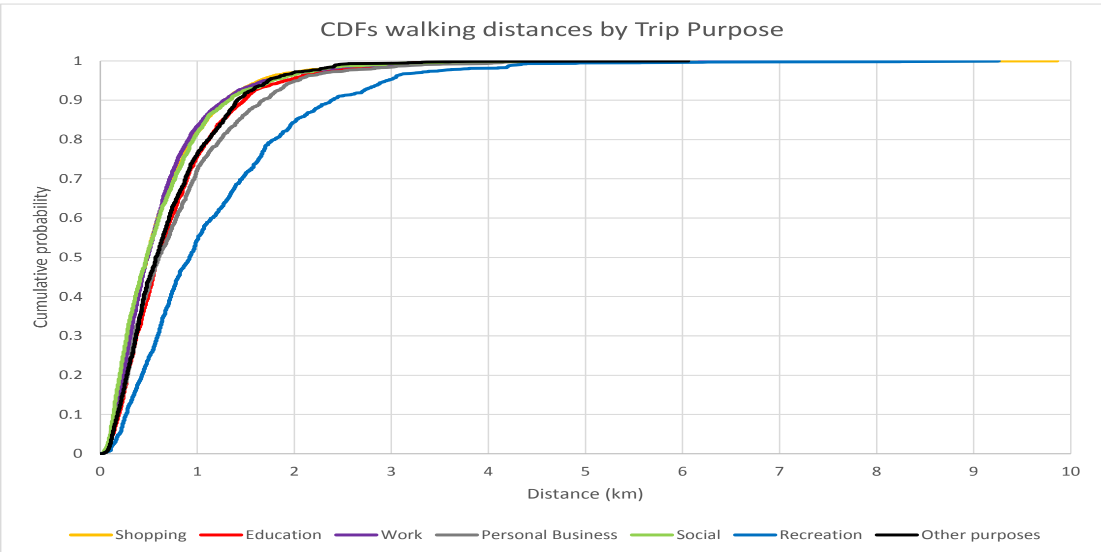


Figure 15: Walking trip length frequency distributions as CDFs of travel distances for different trip purposes in Melbourne (2009)

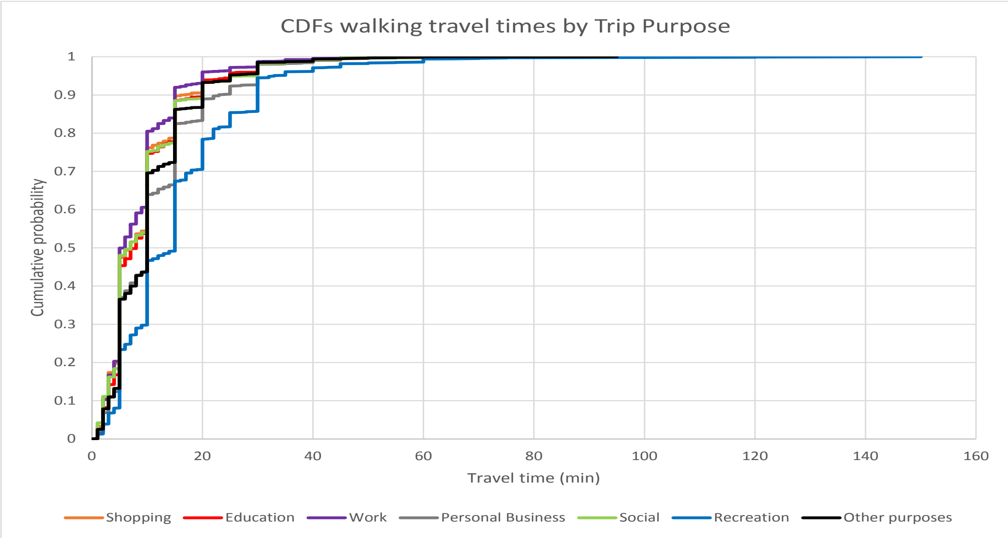


Figure 16: Walking trip length frequency distributions as CDFs of travel times for different trip purposes in Melbourne (2009)

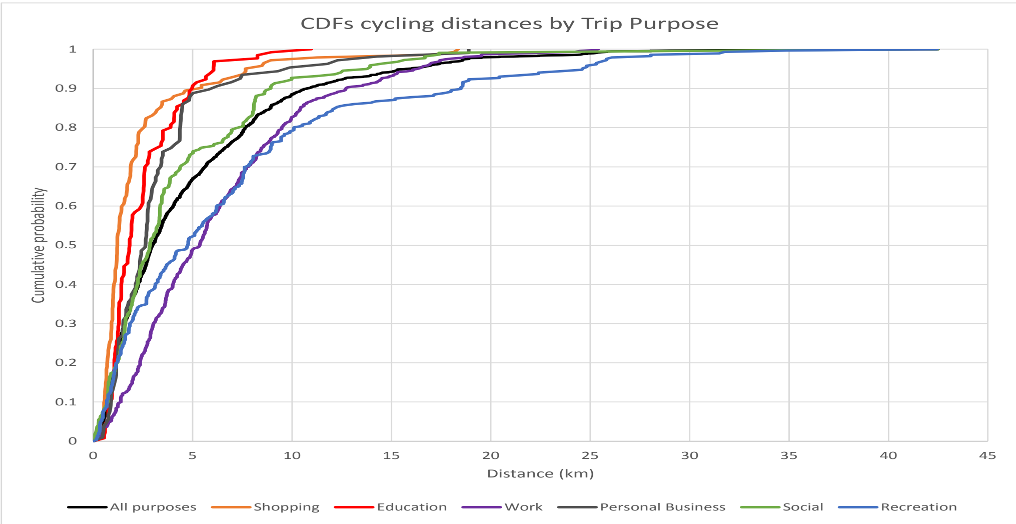


Figure 17: Cycling trip length frequency distributions as CDFs of travel distances for different trip purposes in Melbourne (2009)

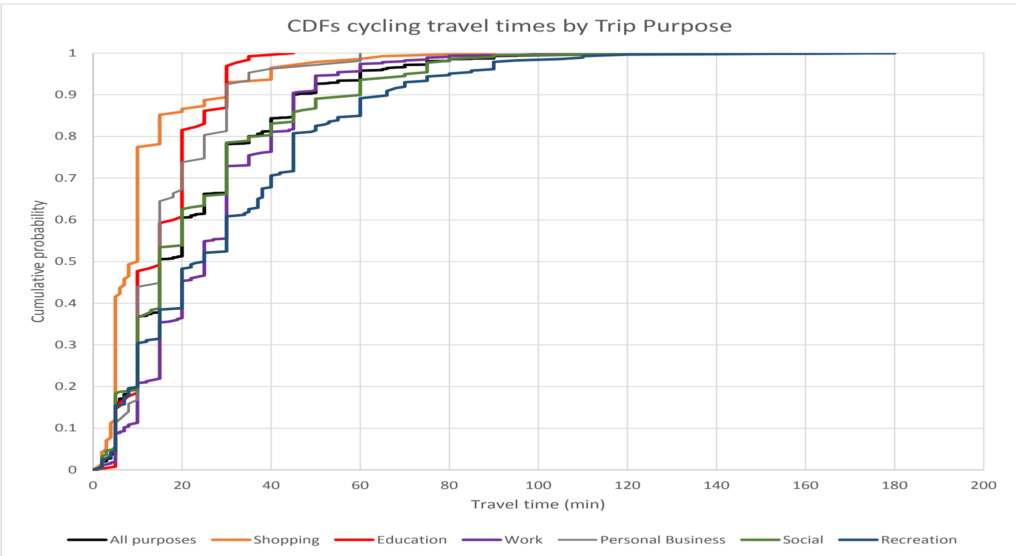


Figure 18: Cycling trip length frequency distributions as CDFs of travel times for different trip purposes in Melbourne (2009)

Socio-demographic factors may also affect the TLFD for the active transport modes. Separate TLFD were derived for gender, age and household income variables, for travel distance and travel time by walking and cycling.

TLFD for males and females for walking are shown in Figures 19 (travel distance) and 20 (travel time). There are no observable practical differences between these TLFD for the walking mode, except perhaps a tendency for males to walk a little further (see also Tables C.7 and C.8 in Appendix C, for summary statistics and percentile values).

For cycling, the situation is slightly different. There is an observable tendency for males to ride further and perhaps for longer, as seen in the TLFDs of Figures 21 (distance) and 22 (travel time). For instance, while the lower tails of the distance distributions are indistinguishable between males and females, there is divergence in the upper tails, with some males riding distances up to 40 km. Something similar occurs in the travel time TLFD for cycling, with some males riding for periods up to three hours continuously. At the same time the travel time CDFs show some differences in the lower tail, with a tendency for proportionally more males to make short time trips than females (for trip travel times up to 20 min). The spread of individual cycling travel times for males is greater than for females (male standard deviation 21.0 min, female 16.4 min).

The summary statistics and percentile values for the gender-specific distributions in Figures 19-22 are shown in Tables C.7 and C.8

Figure 19: Walking trip length frequency distributions as CDFs of travel distances by gender in Melbourne (2009)

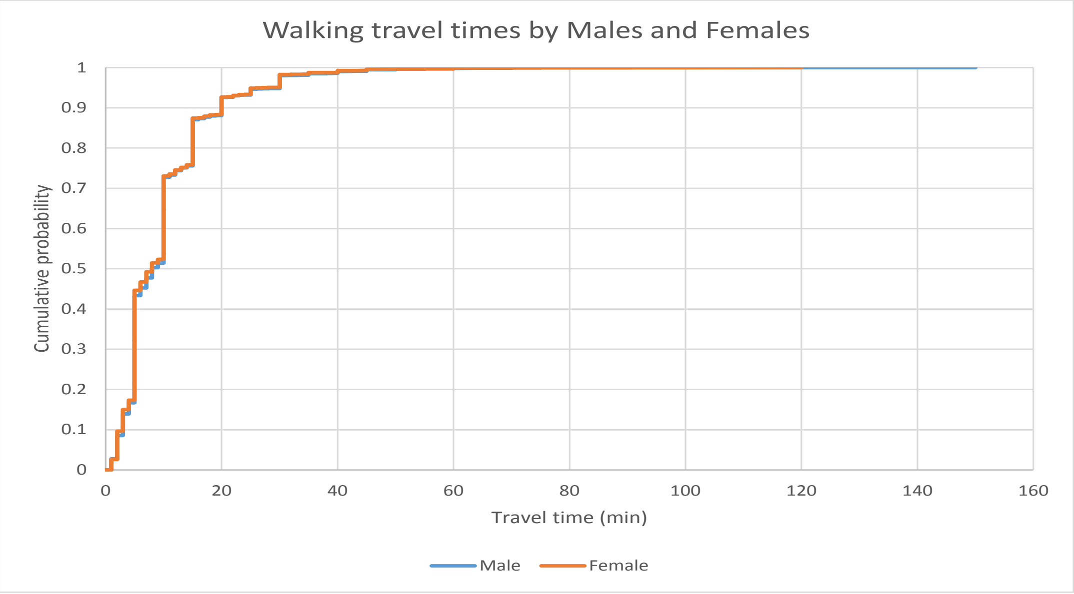


Figure 20: Walking trip length frequency distributions as CDFs of travel times by gender in Melbourne (2009)

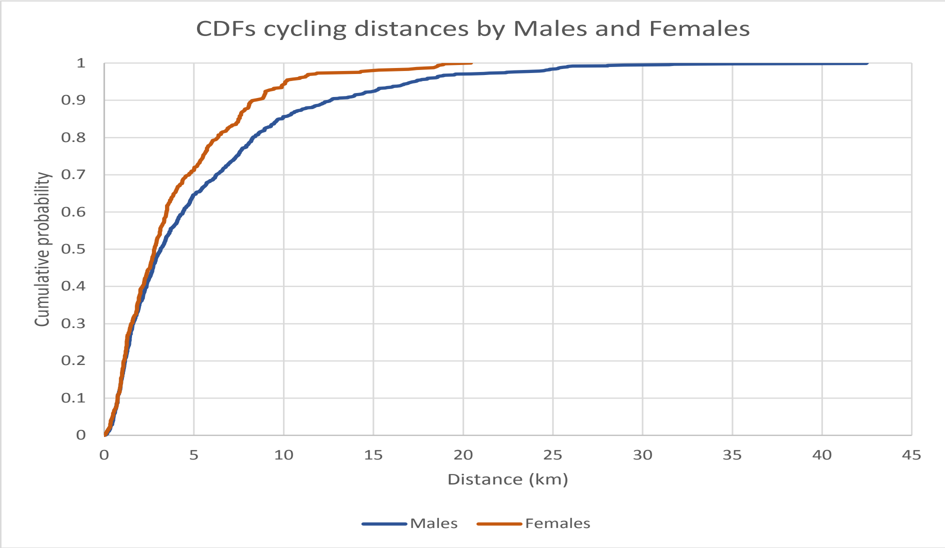


Figure 21: Cycling trip length frequency distributions as CDFs of travel distances by gender in Melbourne (2009)

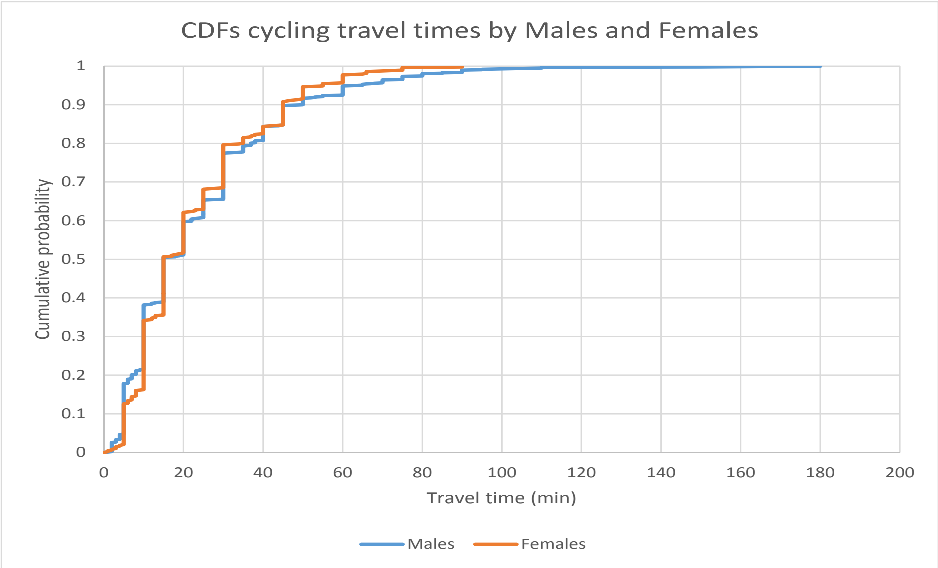


Figure 22: Cycling trip length frequency distributions as CDFs of travel times by gender in Melbourne (2009)

Age group seems to have little impact on walking distances (Figure 23 and Table C.9), although 20-39 year olds perhaps walk a little less distance than other adults: the 40-54 and 55-69 year age groups include those who walk the furthest. Children 0-9 years tend to walk shorter distances than other groups, perhaps not surprisingly. Those seniors (70 years and over) who reported walking activity are quite similar to other adults. Similar results are seen for walking travel time (Figure 24 and Table C.10).

There are however some larger differences in cycling behaviour (Figures 25 and 26 and Tables C.11 and C.12). Children and teenagers (0-9 years and 10-19 years) ride the least distances, while 40-54 year olds ride the longest distances. In terms of travel time, these differences still exist but are less pronounced, perhaps suggesting something about the riding speeds of the different age groups.

Figures 27 and 28 (and Tables C.13 and C.14) indicate that there is little difference in walking behaviour between the five household income groups, although there are perhaps more recorded walking episodes for the higher income groups (which may be a factor of household size, and is further discussed in Section 4.7).

Cycling behaviour does however vary between the income groups, with the higher income groups undertaking more and more extensive cycling than the lower income groups. The TLFD in Figures 29 and 30 and the data in Tables C.15 and C.16 show these differences.

The TLFD suggest that walking is a universal activity, undertaken by many people and at similar levels across the socio-economic factors, whereas cycling activity is very much undertaken by a small minority and has differences between different groups, especially in terms of age and (household) income. The sample sizes (which indicate the numbers of walking and cycling episodes undertaken by people in the different socio-economic groups) for all of the groupings presented in the tables of Appendix C are the clearest evidence for this assertion.

A further general observation is that all of the TLFD are asymmetric distributions, strongly skewed to the right (i.e. the upper tail). This may be seen in Figures 13-30 and the corresponding tables (Tables 7 and 8 and Tables C.1-C.16) which show summary statistics and selected percentile values. The best descriptor of travel in each TLFD is thus the median value rather than the mean, and variations in the distributions are better represented by (say) considering percentile values rather than the standard deviation.

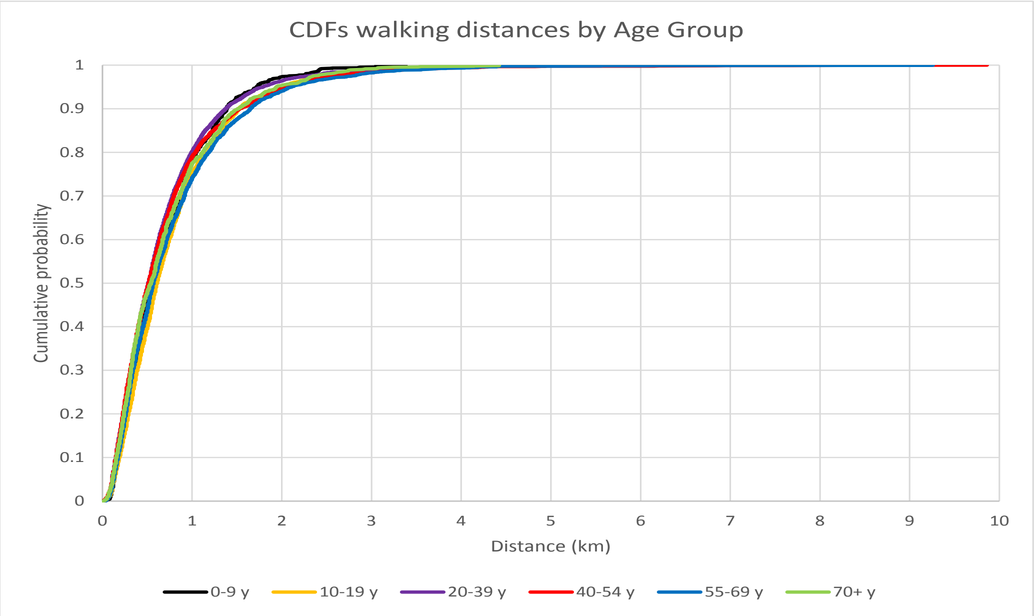


Figure 23: Walking trip length frequency distributions as CDFs of travel distances by age group in Melbourne (2009)

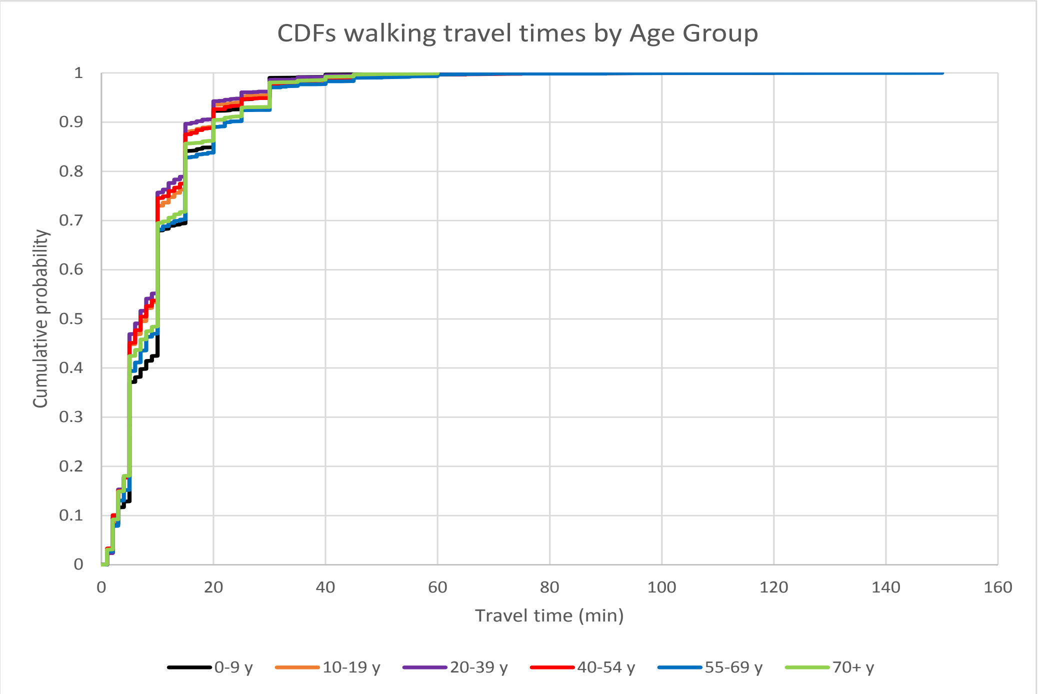


Figure 24: Walking trip length frequency distributions as CDFs of travel times by age group in Melbourne (2009)

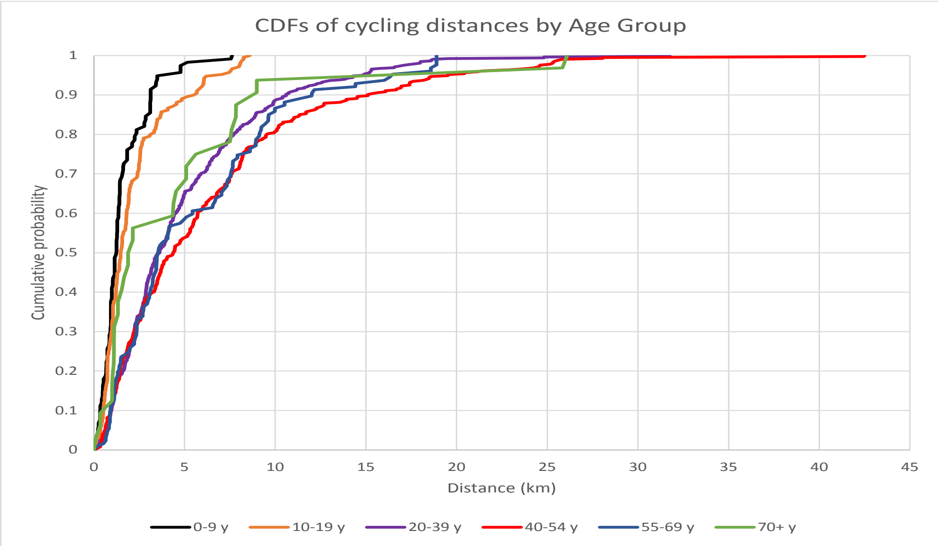


Figure 25: Cycling trip length frequency distributions as CDFs of travel distances by age group in Melbourne (2009)

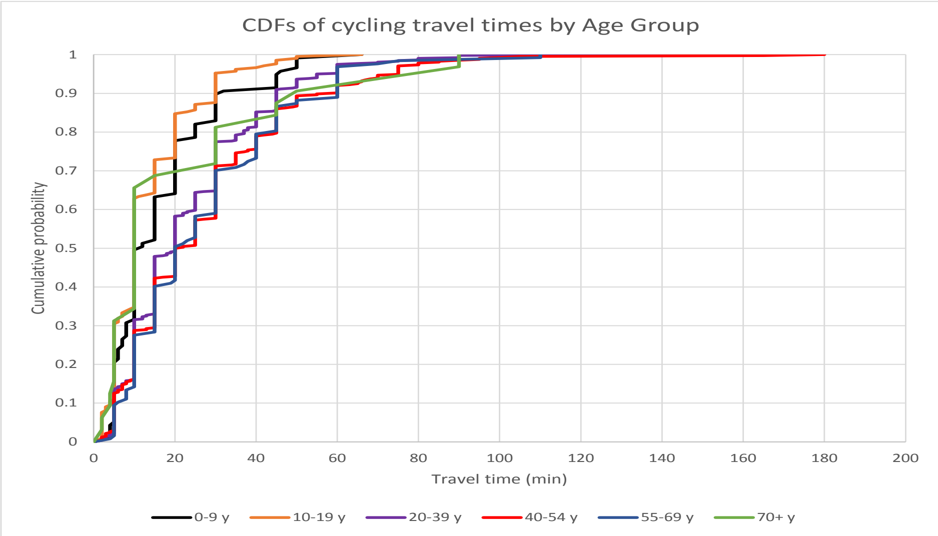


Figure 26: Cycling trip length frequency distributions as CDFs of travel times by age group in Melbourne (2009)

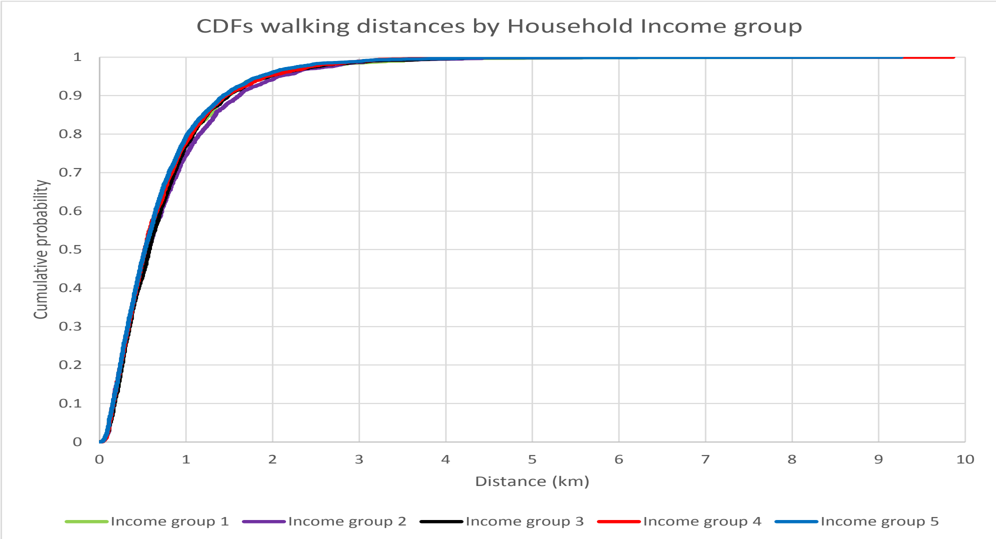


Figure 27: Walking trip length frequency distributions as CDFs of travel distances by household income group in Melbourne (2009)

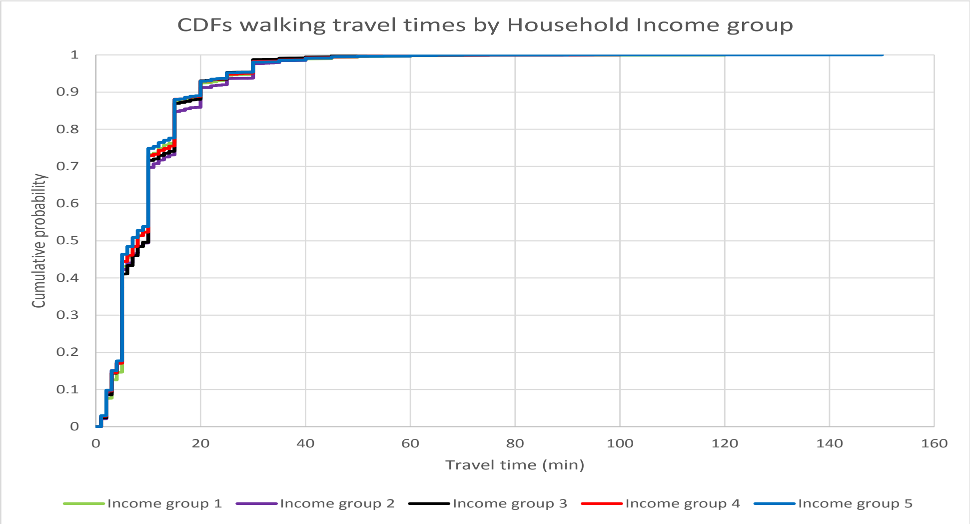


Figure 28: Walking trip length frequency distributions as CDFs of travel times by household income group in Melbourne (2009)

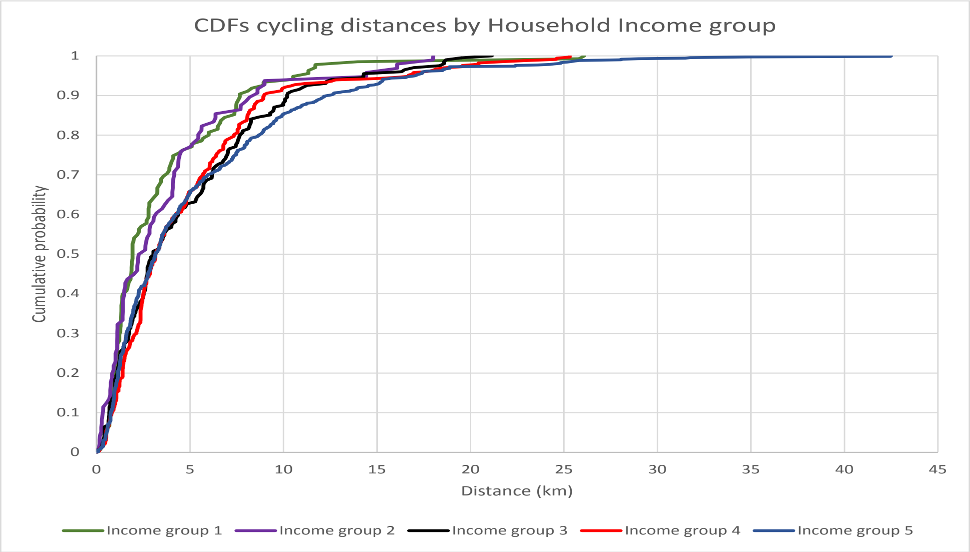


Figure 29: Cycling trip length frequency distributions as CDFs of travel distances by household income group in Melbourne (2009)

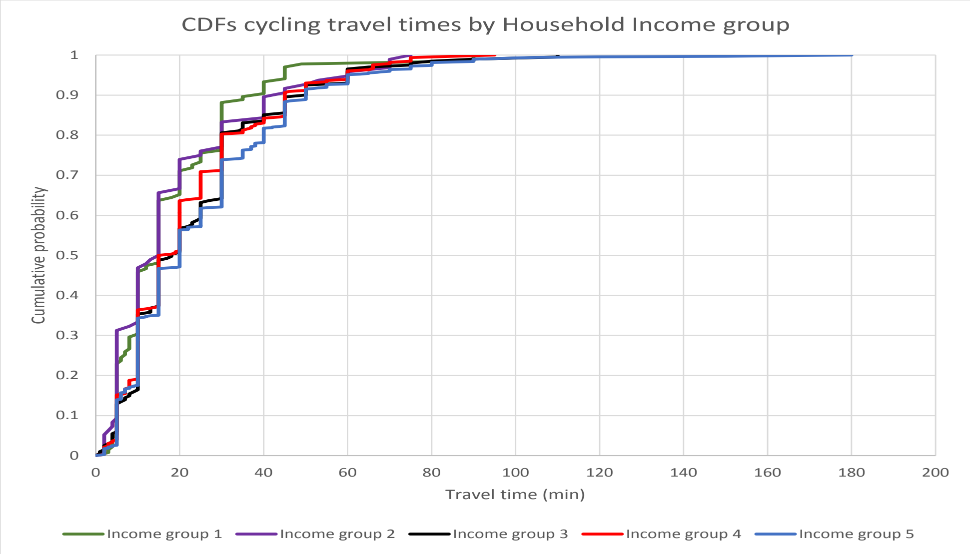


Figure 30: Cycling trip length frequency distributions as CDFs of travel times by household income group in Melbourne (200

TLFD for public transport modes

As well as the TLFD for the active modes, this study also considered the TFLD for the four public transport modes available in Melbourne. Public transport is considered as complementary to the active modes. Access to public transport, especially on foot, is recognised as an important component of, and factor influencing, the use of public transport. The question of this access using active transport is discussed in more detail in the following section of this report (Section 4.6) but it is also useful to gain a better understanding of the usage of the public modes in terms of distances travelled and travel time spent on-board these services.

The TLFD for public transport are presented in two alternative forms in the main body of this report. Firstly, Figures 31 and 32 show TLFD for travel by each of the four identified public transport modes (train, tram, school bus and public bus). Figure 31 shows the TLFDs for distances travelled by each of these modes, while Figure 32 shows the travel times on the modes. Tables C.17 and C.18 show the summary statistics and selected percentile values for the two figures.

Trips by train tend to be longer in both distance and time, while tram trips are relatively short. This reflects the topology of the Melbourne public transport networks. The rail system is a radial network with lines fanning out from the city centre to terminals at the edges of the metropolitan area. The tram network is largely centred on the CBD and the surrounding inner suburbs. Middle and outer suburbs are served by public buses. The school bus mode is a special public mode, effectively a subscription service for a certain group (school children attending particular schools (probably independent schools) located some distance from home). Its TLFD is longer than that for public bus, reflecting the more extended nature of travel made using that mode. It is second only to train in terms of trip distance, and curiously shadows (though not replicating) the travel time TLFD for train (see Figure 32).

The alternative summary view is provided in Figures 33 and 34, which show TLFD for trips on public transport for different trip purposes (shopping, education, work, personal business, social and recreation). Tables C.19 and C.20 show the corresponding summary statistics and percentiles.

Work trips by public transport tend to be the longest in distance (Figure 33) and travel time (Figure 34), although the time differences are less than those for distance. Shopping trips tend to be shorter than other trip purposes. Personal business trips exhibit longer upper tails, commensurate with those for work trips.

As with the TLFD for walking and cycling, the distributions for the public transport modes are strongly skewed to the right (upper tail).

TLFD were also derived for each trip purpose and each public transport mode. Summary details of these distributions are provided in Tables C.21-C.232.

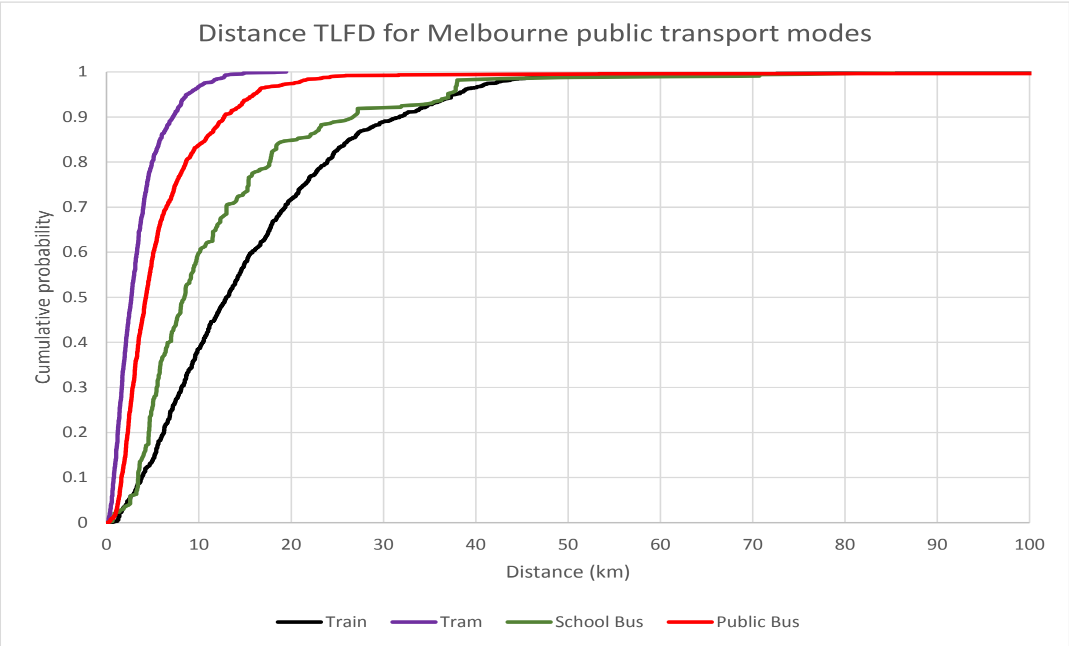


Figure 31: Trip length frequency distributions for public transport modes as CDFs of travel distances in Melbourne (2009)

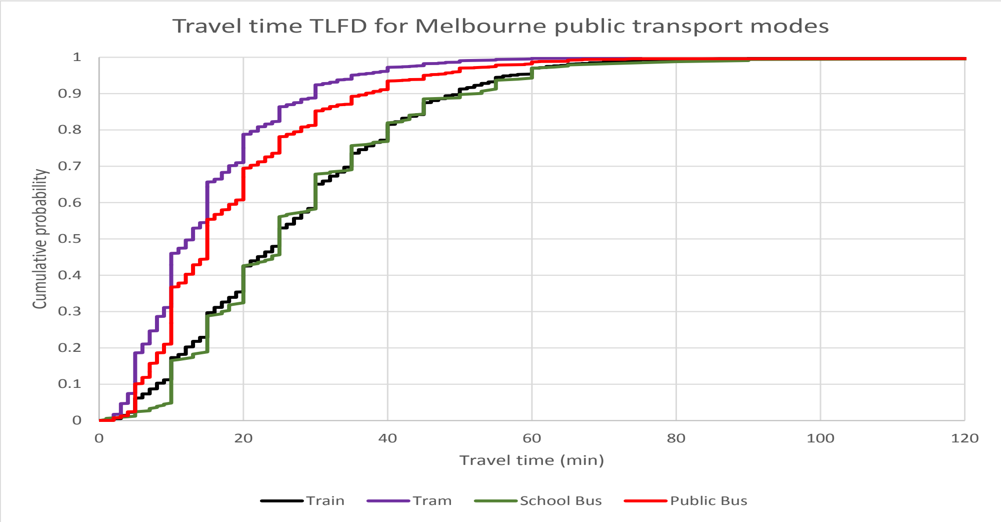


Figure 32: Trip length frequency distributions for public transport modes as CDFs of travel times in Melbourne (2009)

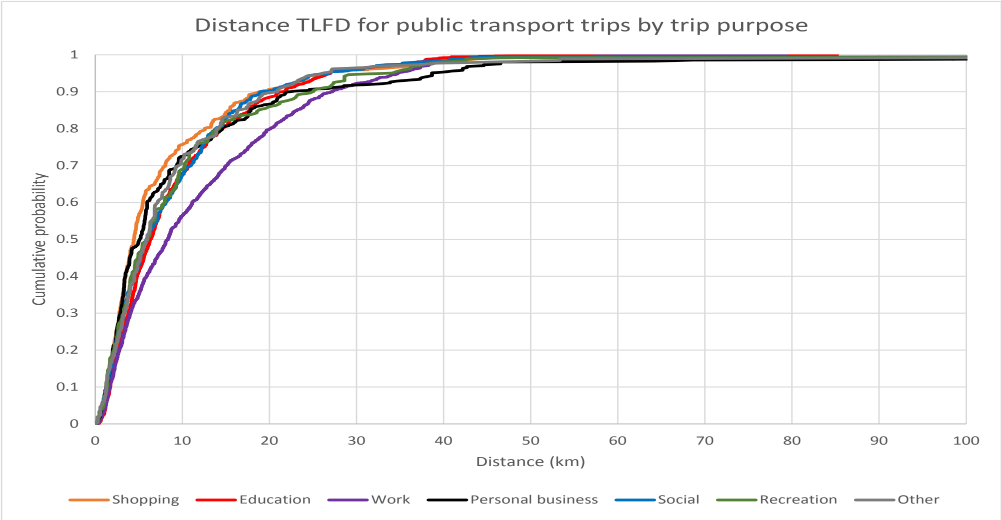


Figure 33: Trip length frequency distributions for trips on public transport for different trip purposes as CDFs of travel distances in Melbourne (2009)

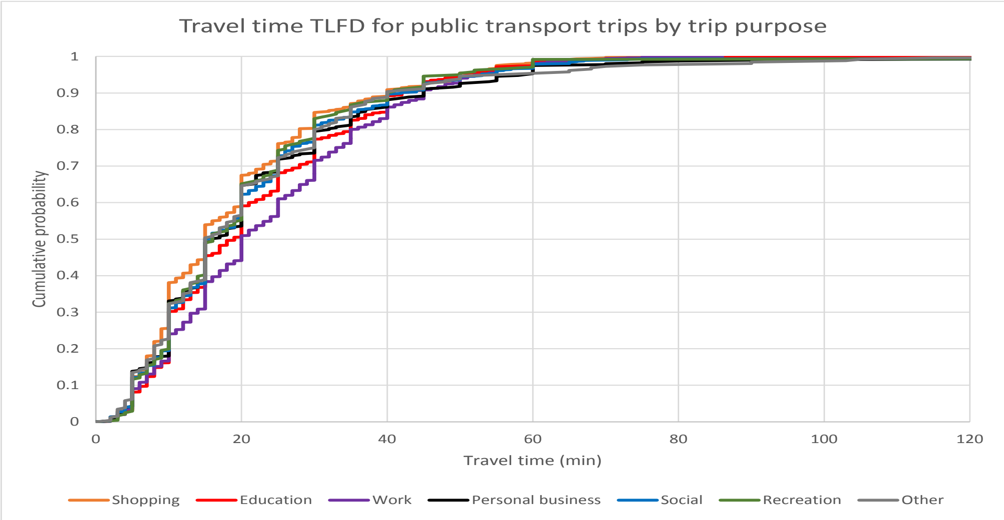


Figure 34: Trip length frequency distributions for trips on public transport for different trip purposes as CDFs of travel times in Melbourne (2009

Access to public transport

As discussed in the literature review (Section 2 above0, access to public transport is a key consideration in urban planning and design, especially for low carbon urban developments when use of public transport in preference to private car travel is important. The analysis of the VISTA HTS data provides a baseline view of the distance that people are currently prepared to walk to access public transport services. This analysis also included cycling access to public transport, but as is discussed later in this section the numbers of cycling access trip segments are very small.

Active mode access to and egress from public transport can be determined from the 'linked trip' table (the *trips table*) in VISTA. This table combines an individual's consecutive trip segments (from the VISTA *stops table*) into a full journey (linked trip) from one activity location (e.g. home) to another activity location (e.g. work, school or shops). Figure 35, taken from the VISTA online guide, provides a schematic view of the relationship between trip segments (stops) and linked trips and journeys. All are valid descriptors of travel, but each is better suited to different areas of analysis.

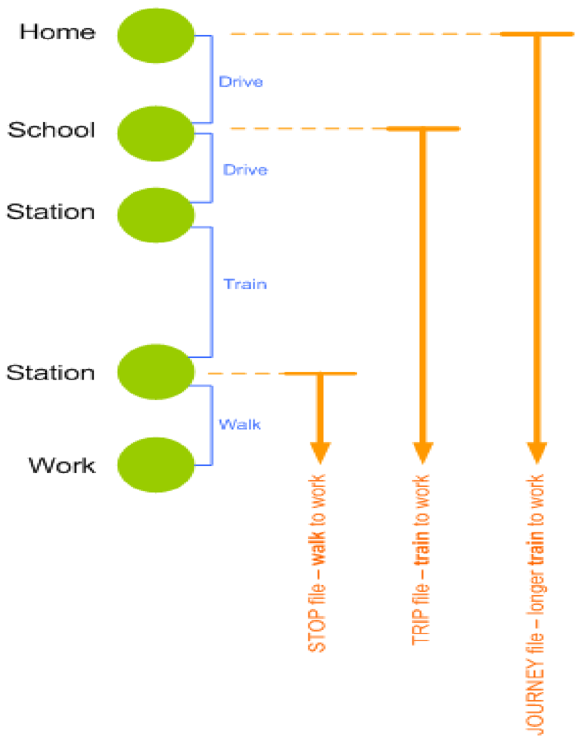


Figure 35: Stops, trips and journeys in the VISTA database[5]

The journey described in this figure is for an individual driving their children to school and then continuing to a railway station (where the car is then parked), travelling by train to work, and finally walking from the destination station to their workplace. The trip/journey thus includes a walking trip segment (egress from the railway station to workplace).

All trips involving any or all trip segments (stops) involving active transport access to or egress from a public transport mode (train, tram, school bus and public bus) were extracted from the VISTA *Trips* table, and the active transport segments of those trips were then analysed. Analysis was undertaken for access trip segments, egress trip segments, and combined access and egress segments (where both were included in the same journey to give a total active transport distance for public transport trips[6].

Figure 36 shows the combined set of observed access, egress and total walking distance distributions for travel by the public transport modes of train, tram and public bus in Melbourne.

There are two main features in Figure 36. The first is that the distributions of access and egress distances for each mode are very similar. The second is that the distributions for each mode are quite different to those of the other modes. Walking distances for train tend to be longer than those for public bus, which are in turn longer than those for tram. Longer observed walking distances for train services are expected, both from the literature review and because the spacings between railway stations are generally longer than those between bus stops or tram stops, i.e. because of the way that the service infrastructure is designed.

The similarity of the access and egress distributions for each mode raises the question about the degree of correlation between the access component of an individual journey and the egress component. Correlation analysis of paired access and egress walking distances indicates that the two distances are statistically independent, i.e. there is no significant correlation between the access and egress components. Figure 37 shows the scatter plots for the access and egress distances, and Table 10 shows the results of the statistical test of independence.

5

6 In a limited number of journeys there were also transfer trip segments, involving a walk from one public transport service to another mid journey. In these cases the total active transport activity for the trip was the sum of the access, transfer and egress trip segments.

Source: DTPLI (2015)

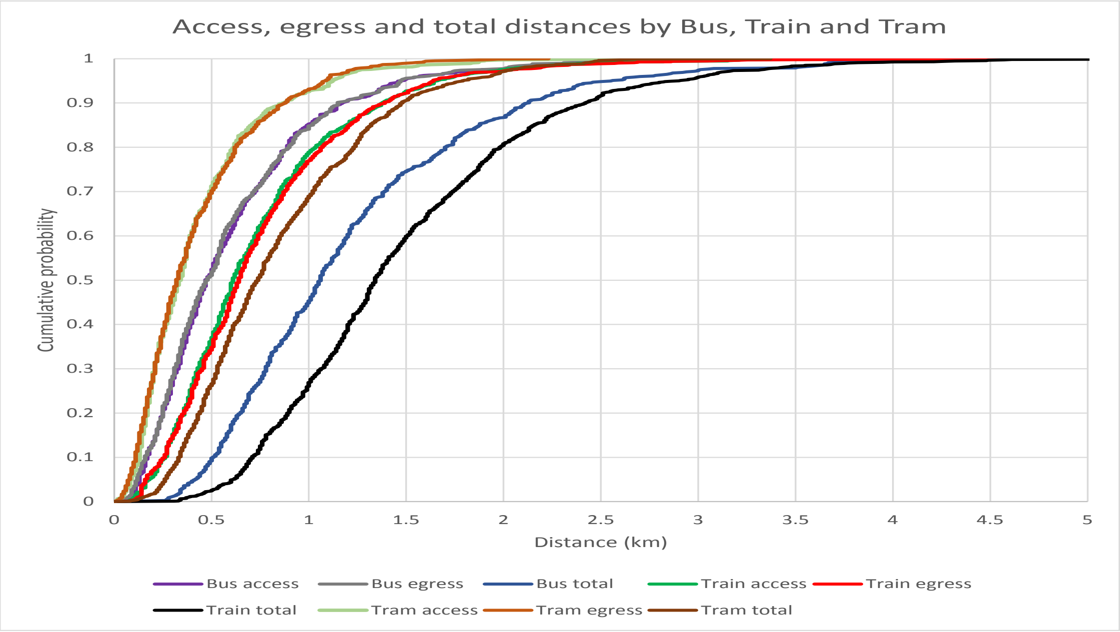


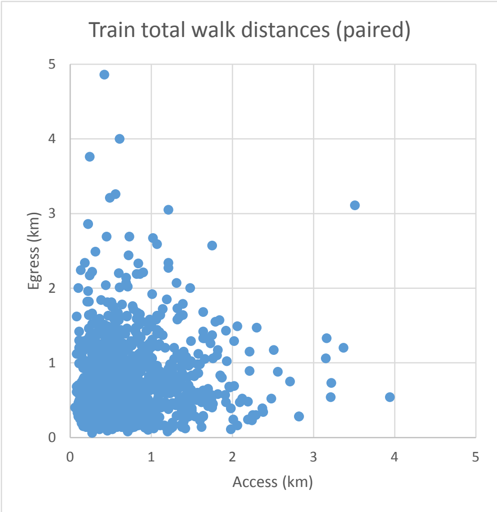
Figure 36: Cumulative distributions for access, egress and total walking distances in public transport trips in Melbourne, 2009

Table 10: Tests of correlation between access and egress walking distances for train, tram and public bus trips

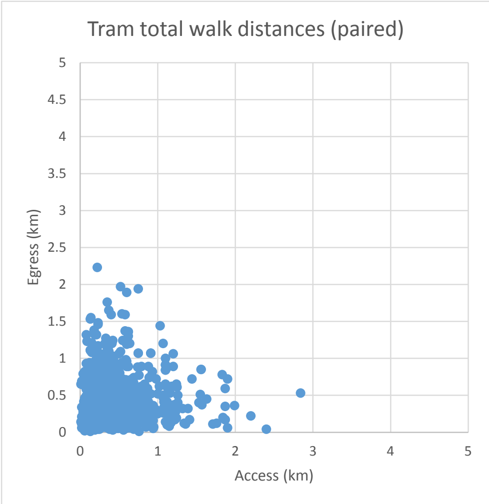
	Train	Tram	Public bus
Sample size (n)	1199	1048	772
Coefficient of determination (R^2)	0.0013	0.0012	0.0068
Correlation coefficient (r)	0.0361	0.0346	0.0825
Fisher's Z	0.0157	0.0151	0.0359
σ(Z)	0.0289	0.0309	0.0361
z-statistic	0.5418	0.4865	0.9954
Result	*Not significant (at p = 0.05)*	*Not significant (at p = 0.05)*	*Not significant (at p = 0.05)*

[Null hypothesis: r = 0]

A) Train



B) Tram



C) Public bus

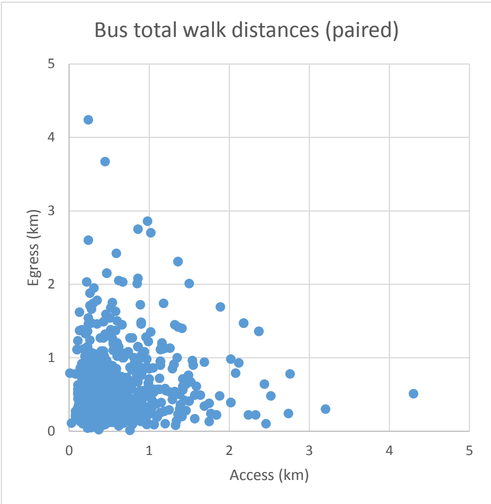


Figure 37: Scatter plots for paired access and egress walking distances for train, tram and public bus trips

The important results from the analysis of travel by public transport are the computed distances for public transport access and egress. These results are summarised in Table 11. Median walking distances are: (1) train access 0.61 km, egress 0.64 km, (2) tram access 0.34 km, egress 0.32 km, and (3) public bus access 0.47 km, egress 0.48 km. The corresponding 85th percentile distances are: (1) train access 1.19 km, egress 1.21 km, (2) tram access 0.71 km, egress 0.73 km, and (3) public bus access 0.99 km, egress 1.02 km[7].

Tables C.33-C.35 provide more detailed results for the access, egress and total distance walked in using public transport.

[7] The most immediate comparisons for these results are those found by Burke and Brown (2007) for Brisbane: median bus access 0.60 km and egress 0.47 km, 85th percentile access 1.30 km, egress 1.09 km. These are quite similar to the Melbourne results although Brisbane access distances appear longer. The Canadian studies cited previously (O'Sullivan and Morrall (1996) and El-Geneidy et al (2014)) provided distances slightly shorter than the Australian results, with the exception of the 85th percentile access distance to rail in Montreal (1.25 km). See Section 2 of this report for more discussion of the international research results on access to public transport.

Table 11: Summary statistics for access, egress and total walking distances for public transport trips

Statistic	Public transport mode								
	Train			Tram			Public bus		
	Access	Egress	Total	Access	Egress	Total	Access	Egress	Total
15th percentile (km)	0.30	0.30	0.78	0.14	0.13	0.38	0.22	0.22	0.58
25th percentile (km)	0.39	0.40	0.98	0.19	0.18	0.48	0.29	0.28	0.71
Median (km)	0.61	0.64	1.34	0.34	0.32	0.74	0.47	0.48	1.06
75th percentile (km)	0.94	0.96	1.87	0.56	0.56	1.11	0.81	0.80	1.52
85th percentile (km)	1.19	1.21	2.16	0.71	0.73	1.32	0.99	1.02	1.88
Mean (km)	0.74	0.75	1.49	0.43	0.42	0.84	0.61	0.60	1.22
Standard deviation (km)	0.50	0.51	0.73	0.35	0.32	0.48	0.48	0.48	0.70
Coefficient of variation	68%	68%	49%	81%	78%	57%	78%	79%	58%

Household and person activity levels

The above analyses focus on trip movements by people. A further aspect of active transport to be considered is the total amounts of travel activity undertaken on a daily basis, for both households and individuals.

Table 12 lists summary statistics for daily amounts of walking and cycling activity by those residents of Melbourne who reported doing so in the VISTA HTS database. The table shows person-stops[8] per day, person-km per day and person-min per day for each of the active transport modes. Figure 38 shows the histograms for each of these variables. All of the distributions are skewed to the right (upper tail).

Median values for person daily total stops, distance and travel time are:

- for walking, medians 2.0 person-stops/day, 1.82 person-km/day, and 25.0 person-min/day
- for cycling, medians 2.0 person-stops/day, 7.79 person-km/day, and 44.0 person-min/day.

As a comparison, the average values for person daily total stops, distance and travel time are:

- for walking, average values 3.1 person-stops/day, 2.25 person-km/day, and 31.0 person-min/day
- for cycling, average values 2.4 person-stops/day, 11.47 person-km/day, and 55.0 person-min/day.

Table 13 shows the equivalent data for those households which reported cycling or walking activity in VISTA. The histograms in Figure 39 support this table, and again the distributions are skewed to the right. The median values for household daily total stops, distance and travel time are:

- for walking, medians 4.0 hhld-stops/day, 2.56 hhld-km/day, and 35.0 hhld-min/day
- for cycling, medians 2.0 hhld-stops/day, 8.90 hhld-km/day, and 50.0 hhld-min/day.

As a comparison, the average values for household daily total stops, distance and travel time are:

- for walking, average values 4.8 hhld -stops/day, 3.47 hhld -km/day, and 47.8 hhld -min/day
- for cycling, average values 2.9 hhld -stops/day, 13.75 hhld -km/day, and 66.1 hhld -min/day.

These results indicate that some individuals and households participate in much greater levels of active transport than others, as is also seen in Figures 38 and 39. The results in these figures and in Tables 12 and 13 are for those people and households in VISTA who reported undertaking active transport.

This point about levels of active transport participation by different individuals and households needs to be pursued further, for there is a stark reality which emerges from this study, and one which must have important consideration for policy development aimed at encouraging greater use of the active modes: the large majorities of people and households in VISTA did not undertake any reportable active transport usage. Indeed cycling, in particular, is a transport activity only undertaken by a very small proportion of the population.

[8] Reminder note: a ‘stop’ is a trip segment, i.e. part of a longer journey as shown in Figure 35. Each stop corresponds to a travel decision made by the individual traveller.

Table 12: Daily amounts of walking and cycling by individuals participating in those active transport activities

	Persons engaged in active transport by					
	Walking			Cycling		
Statistic:	Stops (person-stops/day)	Distance (person-km/day)	Time (person-min/day)	Stops (person-stops/day)	Distance (person-km/day)	Time (person-min/day)
Sample size	6393	6393	6393	605	605	605
Mean	3.1	2.25	31.0	2.4	11.47	55.0
Standard deviation	1.8	1.77	23.3	1.0	11.47	43.7
Coefficient of variation	58%	79%	75%	40%	100%	80%
Median	2.0	1.82	25.0	2.0	7.79	44.0
Mode	2.0	0.50	20.0	2.0	2.30	20.0

Table 13: Daily amounts of walking and cycling by households participating in those active transport activities

	Households engaged in active transport by					
	Walking			Cycling		
Statistic:	Stops (hhld-stops/day)	Distance (hhld-km/day)	Time (hhld-min/day)	Stops (hhld-stops/day)	Distance (hhld-km/day)	Time (hhld-min/day)
Sample size	4077	4077	4077	509	509	509
Mean	4.8	3.47	47.8	2.9	13.75	66.1
Standard deviation	3.7	3.18	43.7	2.0	14.36	63.7
Coefficient of variation	76%	92%	91%	69%	105%	96%
Median	4.0	2.56	35.0	2.0	8.90	50.0
Mode	2.0	1.00	20.0	2.0	2.58	20.0

Walking **Cycling**

(a) stops

(b) distance

(c) time

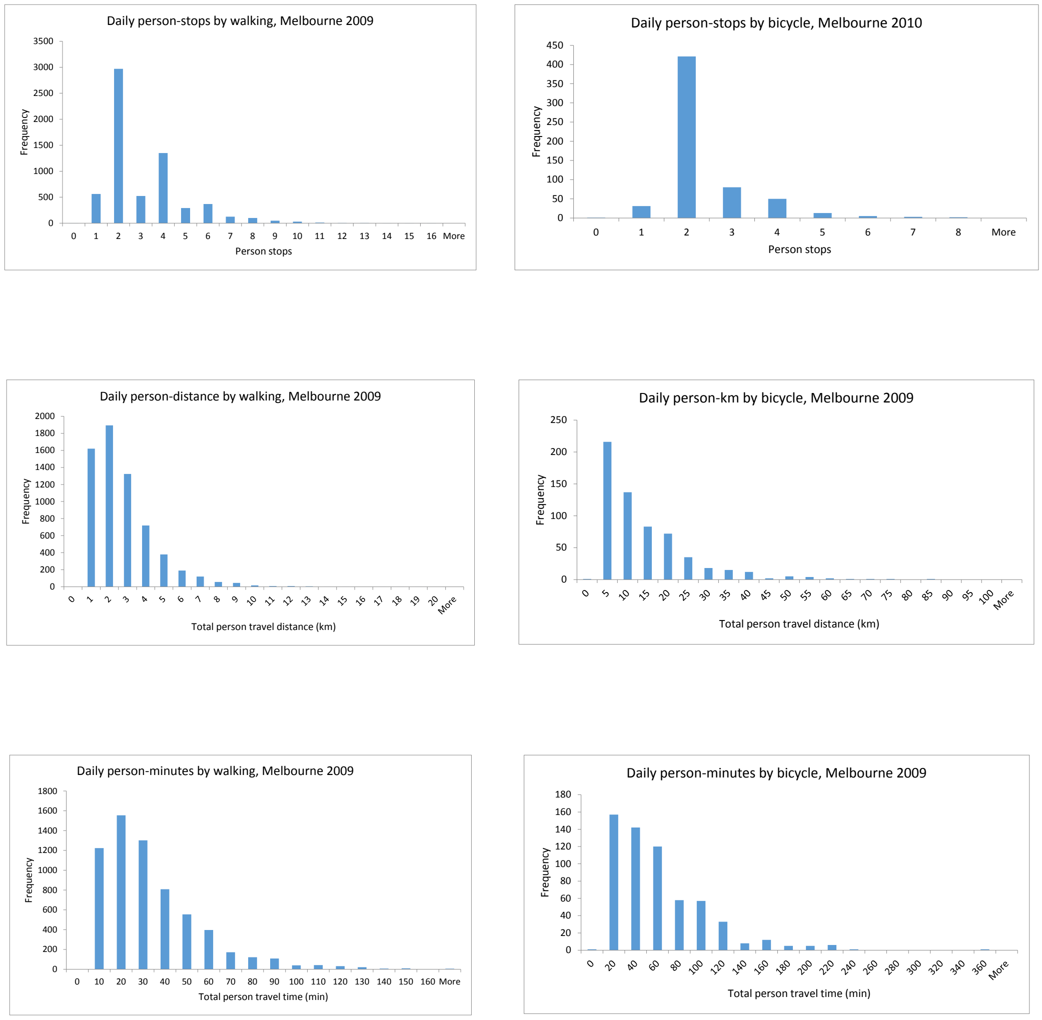


Figure 38: Histograms of daily activity levels of active transport usage by individuals using these modes, Melbourne (2009)

Walking **Cycling**

(a) stops

(b) distance

(c) time

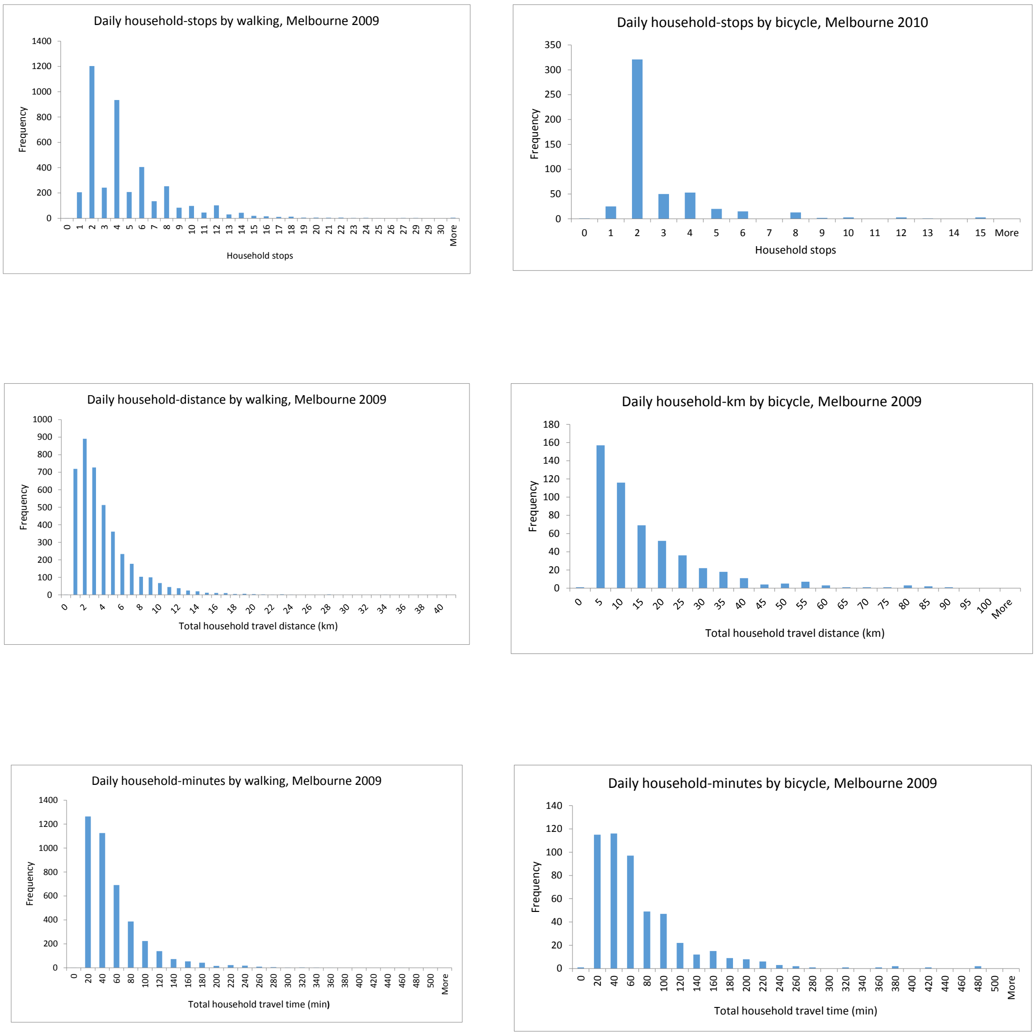
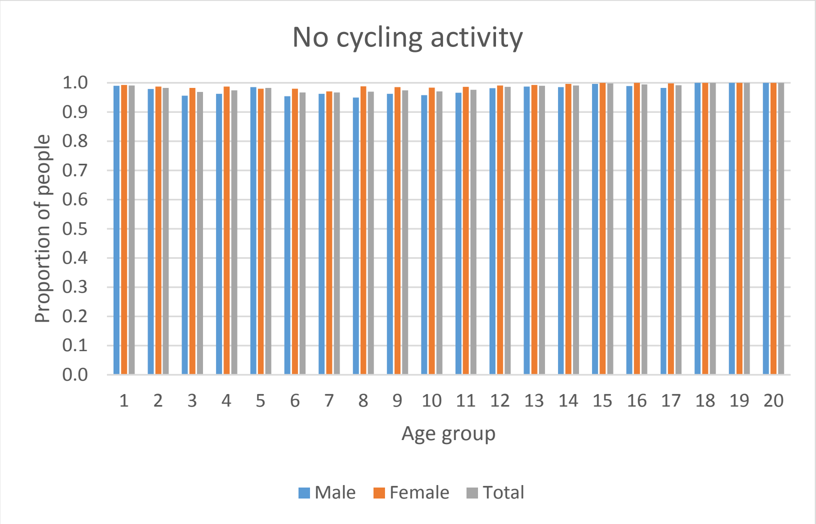


Figure 39: Histograms of daily activity levels of active transport usage by households using these modes, Melbourne (2009)

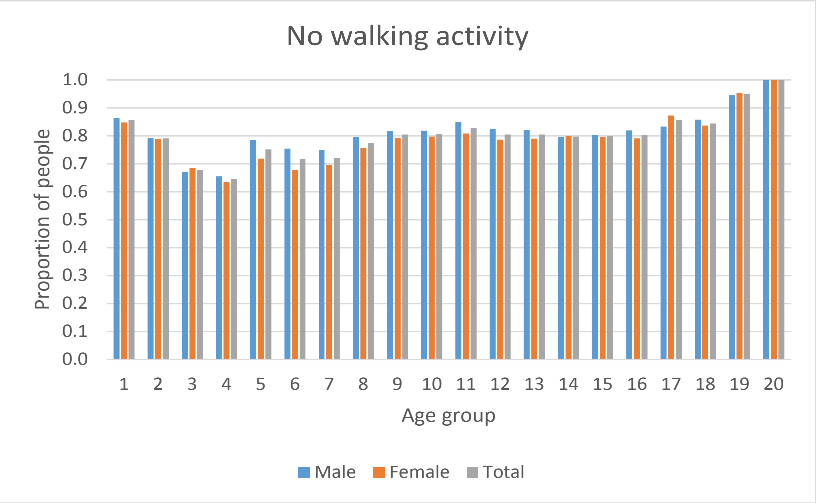
Analysis of the VISTA database indicates that, for the population of the Melbourne region, 97.9 per cent of people reported no cycling activity, while 77.2 per cent reported no walking activity (and 75.8 per cent of people reported no walking or cycling travel activity), i.e. less than a quarter of the population undertook (reportable) travel on foot and just over two per cent travelled by bicycle.

There are differences in both gender and age group in these results, as seen in in Figure 40 – which shows the VISTA age cohorts rather than aggregated cohorts used in Section 4.4 (see also Table 2). Tables C.36-C.38 list the proportions by gender and age group. Cycling activity is concentrated in the age groups between 10-54 years, albeit at very low levels in each of those. Walking is most common in the 5-39 year age groups, and at least 20 per cent of people across the 5-79 year age groups also report walking. The very young (0-4 years) and the very old (90+ years) are much less likely to walk. Females participate slightly less in cycling but slightly more in walking than males.

(a) no cycling



(b) no walking



(c) no walking or cycling

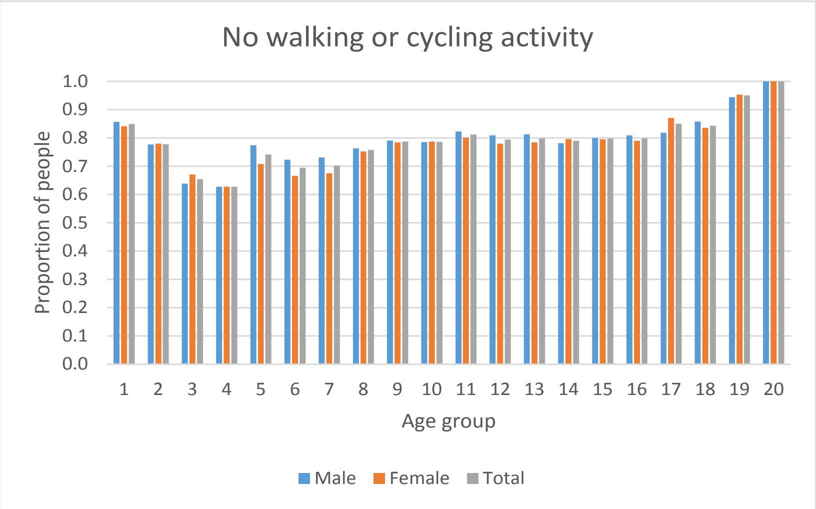


Figure 40: Proportions of people reporting no walking or cycling activity, by gender and age group (Melbourne, 2009)

DISCUSSION AND CONCLUSIONS

The main purpose of this report was to describe baseline levels of active transport usage in Australian cities, and thus to provide a platform from which future interventions in low carbon precinct planning and design can be assessed in terms of their capability to increase the levels of active transport. In doing so, the report satisfies the CRC's milestone R2.4.2 'Base line survey of current levels of active transport usage, including understanding of the environmental and human health benefits in the studied communities (Living Labs) plus constraints on the uptake of those'. The results provided in the report can be used as indicators of current active transport activity in large Australian cities.

The analysis presented in this report demonstrates the utility and richness of information available from HTS. It has provided a detailed account of active transport usage in Melbourne, and as such may be taken as providing a statement of baseline activity levels using these modes (walking and cycling) in Australian cities.

Transport usage was considered in three dimensions: travel decisions (numbers of trips), transport load (distance travelled) and travel exposure (travel time taken).

Travel in Melbourne is dominated by the private car, which accounts for nearly half of trip numbers, over 60 per cent of travel distance, and just over half of travel time. In terms of trip numbers, walking is the second most popular mode (22 per cent), just ahead of vehicle passenger (21 per cent), although the latter is the second most used mode in terms of distance and time. Walking only accounts for 2.0 per cent of travel distance, and for 12.7 per cent of travel time. Distances travelled on foot would be expected to be much less than those for the wheeled modes, but note that walking is the third highest mode in terms of travel time. Public transport, taken as the combination of train, tram, school bus and public bus, accounts for 8.2 per cent of trip numbers, 10.7 per cent of travel distance and 10.6 per cent of travel time. Train is the dominant public transport mode used in the region, especially for distance travelled.

Bicycle use is small, constituting 1.5 per cent of trip numbers, 1.0 per cent of distance travelled and 2.1 per cent of travel time of all travel undertaken in the Melbourne region.

There are variations to the overall modal split statistics in terms of trip purpose, which are of particular interest for the active modes. Walking is the most popular mode for education trips accounting for just over 40 per cent total trip numbers. Similarly, it is the most used mode in terms of travel time (at 26.5 per cent), although noting that the second most popular mode, vehicle passenger, has 26.4 per cent of this travel load. In terms of travel distance, walking covers only 6.3 per cent of the usage for education trips. Cycling only accounts for about two per cent of education travel by trip numbers and travel time, and one per cent by travel distance.

Recreation trips include both travel to a place to take part in recreation (e.g. playing tennis) and travel that is the recreation, which will include walking and cycling activities. This is evident in the modal splits for cycling under recreation, which provides 5.7 per cent of trip numbers, 4.6 per cent of travel distance and 8.8 per cent of travel time – these are the highest percentages recorded for cycling under any of the trip purposes. Vehicle driver has the largest mode share for all three travel descriptors, with nearly half of the modal share for travel distance. Vehicle passenger is the second largest mode share for travel distance and travel time. Walking is the second highest mode for trip numbers and third highest for travel time.

Work travel provides a somewhat different story. Solo vehicle driving dominates on all three descriptors – vehicle driver accounting for more than three quarters of travel distance and more than two thirds of travel time. Vehicle passengers account for just under five per cent on all three descriptors, hence the commonly perceived phenomenon of the 'single occupant vehicle' for commuter travel. Walking is the second most important mode in terms of trip numbers (23 per cent of total trip numbers) and accounts for nine per cent of travel time, but only 1.4 per cent of travel distance. Total transport share for work trips is 13.6 per cent of trip numbers, 14.5 per cent of travel distance and 14.3 per cent of travel time (train is the main public mode, at 8.1 per cent of trip numbers, 12.3 per cent of travel distance and 10.2 per cent of travel time). Cycling covers 2.1 per cent of trip numbers, 1.3 per cent of travel distance and 2.5 per cent of travel time for work travel.

In terms of general usage, the analysis of trip length frequencies by mode and socio-economic characteristics suggest that walking is a universal activity, undertaken by many people and at similar levels across the socio-economic factors, whereas cycling activity is very much undertaken by a small minority and has differences between different groups, especially in terms of age and (household) income. This finding for cycle usage needs to be put in the context of the observation that overall household bicycle ownership is comparable to household car ownership. As assessed from VISTA, just over two per cent of people reported cycle usage for transport purposes, while 22.8 per cent of people reported walking for transport purposes.

A further general observation on travel activity is that the distributions of travel (as measured by the TLFD) are asymmetric distributions, strongly skewed to the right (i.e. the upper tail) and thus implying that some users of each mode (by trip purpose and socio-economic characteristics) make much greater usage of the modes compared to the population at large. Thus the best descriptor of travel is thus the median value rather than the mean, and variations in the distributions are better represented by (say) considering percentile values rather than the standard deviation.

While it was not possible to repeat the analysis of travel activity for other Australian cities due to time and resources constraints, there are some comparisons that can be made on the basis of published data from other cities. In particular, the NSW Bureau of Transport

Statistics (BTS) makes reports on overall travel patterns in Sydney available on its website (BTS, 2015). The data available from this source is not completely compatible with the VISTA data for Melbourne, but some broad comparisons are possible. For instance, Table 14 compares mode split statistics for Sydney and Melbourne, using the following modes: vehicle driver, vehicle passenger, train, bus, walk and other as available from BTS. While the Sydney data are weekday averages, the Melbourne data are all day averages (weekdays and weekends). In addition, the public transport systems of the two cities are different. Melbourne has an extensive tram network while Sydney has limited LRT services, and also cross-harbour ferry services. Both cities have extensive (radial) suburban train networks. Melbourne bus mode splits are less than those in Sydney, perhaps because of the tram alternative. Otherwise, the numbers are quite comparable. Sydney cycling data was not available in the BTS summaries, but is presumably included in the 'Other' mode category.

Table 14: Comparison of daily mode split statistics for Melbourne and Sydney

	Trip numbers		Distance travelled		Travel time taken	
Mode	Melbourne	Sydney	Melbourne	Sydney	Melbourne	Sydney
Vehicle driver	46%	47%	60%	59%	52%	51%
Vehicle passenger	21%	22%	25%	22%	22%	20%
Train	4%	5%	7%	11%	6%	8%
Bus	2%	6%	2%	5%	3%	7%
Walk	22%	17%	2%	2%	13%	10%
Other	5%	2%	4%	2%	4%	4%

Note: Sydney data are weekday averages, while the Melbourne data (from Table 7) are all day (week day plus weekend) averages

The positive view from this baseline analysis is that there is significant potential for increased use of the active transport modes. For walking, policy measures and urban design measures, especially at the precinct scale, to offer more destination alternatives that can be easily accessed on foot could be particularly useful. Travel on foot is an activity for most if not all socio-economic groups and trip purposes, if suitable destinations are available. Mixed use developments at the precinct scale can provide this suitability, and when coupled with frequent and high quality public transport services can offer a wider set of alternatives still. The median walking distance for single episode walking trip segments (i.e. stops) in Melbourne is 540 m, while the 85th percentile walking distance is 1.24 km.

Planning and urban design measures could increase walking opportunities and activity, but this would require a paradigm shift in planning and design practice. As noted by Negron-Poblete, Seguin and Apparicio (2014), pedestrian activity is not dependent on distance alone, but can also be adversely affected by the occurrence of obstacles to movement resulting from previous urban planning and design decisions favouring the private car. This is a special concern for elderly people in suburban locations.

Overall walking and cycling travel activity in Melbourne is summarised in Tables 12 and 13 above. In particular, Table 13 shows the activity levels for those households which reported cycling or walking activity in VISTA. The median values for household daily total stops, distance and travel time are:

- for walking, medians 4.0 hhld-stops/day, 2.56 hhld-km/day, and 35.0 hhld-min/day
- for cycling, medians 2.0 hhld-stops/day, 8.90 hhld-km/day, and 50.0 hhld-min/day.

As a comparison, the average values for household daily total stops, distance and travel time are:

- for walking, averages 4.8 hhld -stops/day, 3.47 hhld -km/day, and 47.8 hhld -min/day
- for cycling, averages 2.9 hhld -stops/day, 13.75 hhld -km/day, and 66.1 hhld -min/day.

These results indicate that some individuals and households participate in much greater levels of active transport than others, as was also seen in Figures 38 and 39.

This point about levels of active transport participation by different individuals and households needs to be pursued further, for there is a stark reality which emerges from this study, and one which must have important consideration for policy development aimed at encouraging greater use of the active modes: the majorities of people and households in VISTA did not undertake any reportable active transport usage in their survey responses. Indeed cycling, in particular, is a transport activity only undertaken by a very small proportion of the population.

For the population of the Melbourne region, 97.9 per cent of people reported no cycling activity, while 77.2 per cent reported no walking activity (and 75.8 per cent of people reported no walking or cycling travel activity), i.e. less than a quarter of the population undertook (reportable) travel on foot and just over two per cent travelled by bicycle. There are differences in both gender and age group in these results. Cycling activity is concentrated in the age groups between 10-54 years, albeit at very low levels in each of those. Walking is most common in the 5-39 year age groups, and at least 20 per cent of people across the 5-79 year age groups also report walking. The very young (0-4 years) and the very old (90+ years) are much less likely to walk. Females participate slightly less in cycling but slightly more in walking than males.

Access to public transport was identified as a significant task undertaken by the active modes, especially walking. The computed distances for public transport access and egress, from Table 11 are as follows

- Median walking distances: (1) train access 0.61 km, egress 0.64 km, (2) tram access 0.34 km, egress 0.32 km, and (3) public bus access 0.47 km, egress 0.48 km
- 75th percentile distances: (1) train access 0.94 km, egress 0.96 km, (2) tram access 0.56 km, egress 0.56 km, and (3) public bus access 0.81 km, egress 0.80 km
- 85th percentile distances are: (1) train access 1.19 km, egress 1.21 km, (2) tram access 0.71 km, egress 0.73 km, and (3) public bus access 0.99 km, egress 1.02 km.

These distances may be compared to those from earlier studies in Canada, India and Australia. O'Sullivan and Morrall (1996) studied walking access to bus and light rail transit (LRT) services in Calgary, Canada. They found that people walked further to reach an LRT station than a bus stop. The average walking distance to suburban stations was 649 m (75th percentile 840 m), while at CBD stations the average distance was 326 m with 75th percentile 419 m. Hoback, Anderson and Dutta (2008) reported average walking distances of 1.3 km total (i.e. access plus egress) per round trip for public transport riders in Detroit, while El-Geneidy et al (2014) reported 85th percentile walking distances of 524 m to access bus and 1.259 km to access rail in Montreal. Rastogi and Rao (2003) found a mean walking distance of 910 m and an 85th percentile distance of 1.25 km for train aces in Mumbai, India.

For Australia, Burke and Brown (2007) reported median and 85th percentile walk distances to access public transport in Brisbane of 600 m and 1.30 km from home and median and 85th percentile egress distances from public transport stops to end destinations of 470 m and 1.09 km. BTS (2014) reported that 79 per cent of walking access trips to rail stations in Sydney were 1.0 km or less, with a further 17 per cent of walking access trips between 1-2 km.

The literature review of Section 2 explored the contribution of walking activity to public health. Cole et al (2006) found that Australian rates of walking for transport were slightly lower than those for walking for recreation and exercise, and there were some socio-demographic differences. Men over 60 years were less likely to walk for transport, while men 45-59 years were more likely to walk for recreation and exercise. Women were more likely to meet public health guidelines than men. Morency, Trapnier and Demers (2011) studied walking distances to public transport in Montreal and estimated the actual level of physical activity undertaken in this activity. They did so by first estimating pedestrian walk access distances to transit stations using actual travel behaviour and pedestrian network path calculations, and then converting these distances in numbers of steps, for different socio-demographic groups. Their results indicated that a public transport trip involved 1250 steps on average (covering walking access to, egress from, and transfer during the trip). Thus a return trip represented 2500 steps, taken to represent 25 per cent of the recommended daily quantity of physical activity (nominally 10 000 steps).

Using the step stride data of Morency et al (2011), similar calculations can be performed for the Melbourne data on walking as access to public transport. Table 15 summarises these results, in terms of numbers of steps taken for median, 75th and 90th percentile total distances walked in using public transport modes.

Table 15: Summary of total distances walked in using public transport and equivalent number of steps taken, Melbourne 2009

	Train		Tram		Public bus	
	Distance (km)	Steps	Distance (km)	Steps	Distance (km)	Steps
Median	1.34	1828	0.74	1010	1.06	1446
75th percentile	1.87	2552	1.11	1515	1.52	2074
90th percentile	2.42	3302	1.48	2019	2.12	2893

Note: using step stride parameters from Morency et al (2011)

The results in Table 15 suggest that the 75th percentile walker using the train in Melbourne would cover about one quarter of the recommended daily quantity of physical activity (10 000 steps), while the 90th percentile train user would cover just under one third of the recommendation. The steps taken for the other modes are less than these – the 90th percentile tram user would meet one fifth of the daily recommendation, as would the 75th percentile public bus user[9].

This calculation on recommended levels of physical activity can also be undertaken using the total distance walked by individuals in Melbourne (as described in Section 4.7). Results of the calculations of steps taken in all transport-related walking activities over a day are shown in Table 16. This table also shows daily time spent in walking, taken from the data shown in Table 12.

Table 16 indicates that the median total daily distance walked in transport would be just under one quarter of the recommended daily number of steps (2482 steps out of 10 000). The 85th percentile walking activity would account for more than half of the requirement (5171 steps). Travel activity is one component of daily activity, and individuals will be taking more steps as parts of their other regular activities, or as separate activities (e.g. sport or physical exercise not counted as travel) so there are other ways to amass the daily recommendation of steps taken. The utility of the travel activities in this regard is that they are undertaken for different purposes, and are incidental not deliberate contributions to meeting a daily target.

[9] Walking is undertaken in many other daily activities not included in the analysis of travel behaviour. In addition public transport users may make other trips on foot during the day, not connected with their travel by public transport. Thus the daily total steps taken will be greater than the numbers of steps estimated in this analysis of public transport access. The important point is that public transport usage can be a significant contributor to individual health through the walking activity required to use it.

Table 16: Summary statistics and percentiles for total daily walking distances, steps taken and times by individuals in the Melbourne region (2009)

Travel descriptor	Walking (person-km)	Walking† (person-steps)	Time (person-min)
Summary statistics			
Sample size	6393	6393	6393
Mean	2.25	3070	31.0
Standard deviation	1.77	2415	23.3
Coefficient of variation	78.9%		75.3%
Mode	0.50	682	20.0
Percentiles			
10th	0.53	723	10.0
15th	0.69	941	10.0
25th	1.00	1364	15.0
50th (median)	1.82	2483	25.0
75th	2.97	4052	40.0
85th	3.79	5171	50.0
90th	4.47	6099	60.0
IQR*	1.97	2688	25.0
100th (maximum)	18.51	25255	240.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*
† steps taken are calculated using the person walking stride parameters cited by Morency et al (2011)

The cumulative density functions (CDF) for total daily walking distances and travel times are shown in Figures 41 and 42.

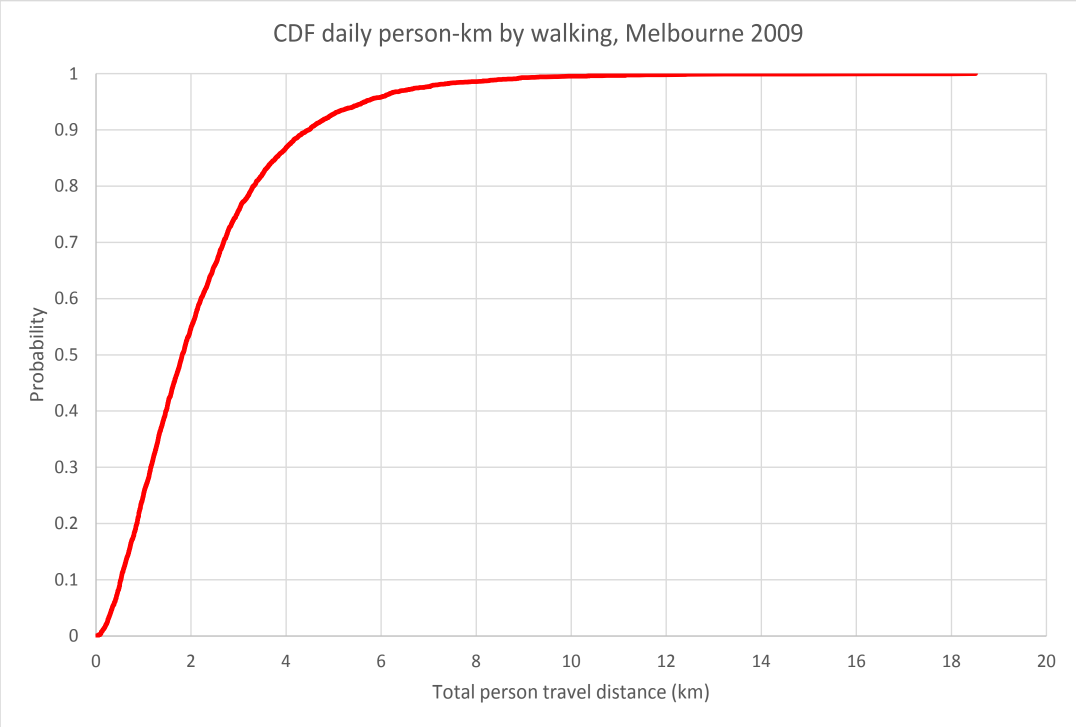


Figure 41: CDF of total daily walking distances by individuals in Melbourne, 2009

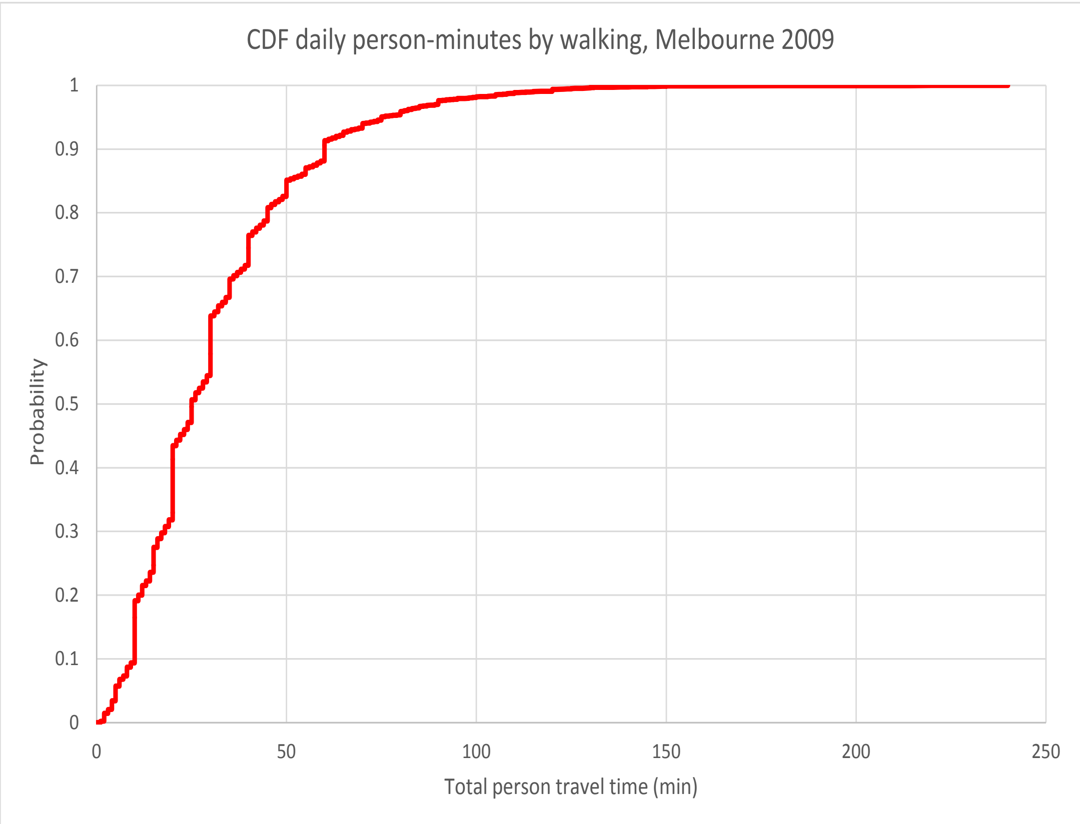


Figure 42: CDF of total daily walking times by individuals in Melbourne, 2009

This study provides a useful first account of baseline usage of the active transport modes in Australian cities. Further work is needed to extend the analysis to test and ensure that the results derived for Melbourne can be taken as representative of other major cities in Australia. In particular, similar analysis of HTS data for Sydney and Adelaide could be undertaken to make comparisons with Melbourne, and to extend the results. In this regard the work of AURIN[10] Lens 5 on urban transport may be of particular relevance, for this includes a project on the harmonisation of the HTS databases for the three cities (there are, not unexpectedly, some differences in methodology and definitions between the three databases).

The comparisons that have been made and are cited in this report suggest that the results for Melbourne are definitely indicative of the situation across the Australian metropolises.

One further area where research should be undertaken and for which the HTS data are particularly suited is comparison of the spatial aspects of differences in travel behaviour and usage of the active transport modes, especially between CBD, inner suburbs, middle suburbs and outer suburbs. This analysis has not been possible in the present study due to lack of time and resources, but it is considered essential for a full understanding of the implications for low carbon precinct research. In particular, the consideration of isochrones of travel times and access, as reported by O'Sullivan, Morrison and Shearer (2000) for UK cities and by Sekhar, Susilawati and Taylor (2015) for Adelaide may offer a new approach for understanding active travel in our cities.

The opportunity to undertake this additional, valuable research should be taken at the earliest opportunity. In the meantime, this report provides good indications of the current levels of active transport usage at the metropolitan level in our cities.

[10] See www.aurin.org.au.

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APPENDIX A: Population characteristics for the Melbourne region

Table A.1: Number of households by household size and income group

	Household size									
Income group	1	2	3	4	5	6	7	8	9	Total
1	135928	68169	22032	12239	4446	1077	715	0	0	242814
2	63714	110083	34262	21466	10882	3789	416	123	0	240407
3	62270	90909	49575	49912	16229	4600	690	0	73	268895
4	15233	101318	53948	63562	23537	4702	1310	547	87	257598
5	19929	99872	65992	101029	38916	8845	1483	109	468	325738
Total	297073	470352	225809	248208	94011	23013	4614	778	628	1364484

Table A.2: Number of households by household structure group and income group

	Household structure group					
Income group	1	2	3	4	5	Total
1	135928	45177	20817	30512	12172	244605
2	63714	80868	49458	34447	16248	244735
3	62270	70226	92283	26244	23236	274258
4	15233	84644	122367	13637	28365	264245
5	19929	88608	185858	10505	31742	336642
Total	297073	369522	470782	115344	111763	1364484

Table A.3: Age cohorts for the Melbourne population

Age group	Years	Male	Female	Total
1	0-4	125306	118263	243569
2	5-9	124266	117331	241598
3	10-14	126393	120395	246788
4	15-19	128867	124109	252976
5	20-24	139454	140485	279940
6	25-29	138735	139105	277839
7	30-34	144735	152936	297671
8	35-39	150059	161734	311793
9	40-44	145475	148669	294144
10	45-49	135455	142486	277941
11	50-54	121819	127110	248929
12	55-59	109793	116106	225899
13	60-64	84795	87541	172336
14	65-69	65152	70006	135158
15	70-74	51948	58659	110607
16	75-79	43135	51508	94643
17	80-84	25738	40550	66288
18	85-89	12407	24120	36527
19	90-94	2429	5782	8210
20	95+	289	2537	2826
Total		1876247	1949433	382567980

Table A.4: Income group distributions for the Melbourne region

Income group	Weekly income	Male	Female	Total
1	< $650	190832	270105	460937
2	$650 - $1099	282805	318881	601686
3	$1100 - $1649	376114	382107	758221
4	$1650 - $2499	435675	418091	853766
5	≥ $2500	590822	560248	1151070
Total		1876247	1949433	3825680

Table A.5: Vehicle ownership by household income group

Income group	Household vehicles										Total
	0	1	2	3	4	5	6	7	8	9	
1	58795	139124	37920	6399	2270	98	0	0	0	0	244605
2	19356	127484	81011	13679	2746	252	62	0	31	114	244735
3	10313	114853	114074	26697	7002	872	369	77	0	0	274258
4	6360	59237	141360	40398	13912	2258	601	119	0	0	264245
5	7262	71085	164306	57227	26638	7253	1906	469	48	448	336642
Total	102086	511783	538670	144400	52568	10733	2937	665	79	562	1364484

Table A.6: Car ownership by household income group

Income group	Household cars										Total
	0	1	2	3	4	5	6	7	8	9	
1	72037	141650	26787	3269	863	0	0	0	0	0	244065
2	37034	139201	61130	6367	858	0	0	145	0	0	244735
3	30844	143206	84866	12722	2222	400	0	0	0	0	274258
4	26956	101409	103908	24484	6877	611	0	0	0	0	264245
5	33083	127131	121225	38367	13179	3231	332	94	0	0	336642
Total	199953	652596	397915	85209	23999	4242	332	239	0	0	1364484

Table A.7: Bicycle ownership by household income group

Income group	Household bicycles										Total
	0	1	2	3	4	5	6	7	8	9+	
1	166670	38391	20478	9577	5827	2648	610	196	209	0	244605
2	138400	43974	31327	14595	9887	3551	1782	809	61	351	244735
3	123328	52942	44654	24956	17099	6106	2799	1164	927	283	274258
4	97046	44549	58051	26652	23263	7616	3477	2984	528	1772	264245
5	92445	52236	73885	46553	38633	17981	8565	2632	1962	2383	336642
Total	617889	232091	228395	122333	94708	37902	17234	7785	3686	4789	1364484

Table A.8: Bicycles used by household income group

Income group	Household bicycles used										Total
	0	1	2	3	4	5	6	7	8	9+	
1	205829	22841	11056	3051	1153	674	0	0	0	0	244605
2	200726	27208	10598	4044	1296	302	562	0	0	0	244735
3	198189	41277	23630	7365	2687	899	0	0	211	0	274258
4	188688	33258	28537	7705	4553	932	274	297	0	0	264245
5	214566	50371	38605	18817	9543	2865	1325	368	0	78	336642
Total	1007998	174955	112427	40982	19232	5672	2161	665	211	78	1364484

APPENDIX B: Modal split percentages by trip purpose, Melbourne region (2009)

Table B.1: Shopping trip mode splits in terms of trip numbers, distance travelled and time taken, Melbourne region (2009)

Transport mode	Trip numbers	Travel distance	Travel time
Vehicle Driver	57.0%	65.7%	56.4%
Vehicle Passenger	14.7%	22.5%	17.7%
Motorcycle	0.2%	0.5%	0.4%
Walking	22.2%	3.0%	16.8%
Bicycle	0.8%	0.4%	0.8%
Taxi	0.1%	0.1%	0.1%
Train	1.4%	4.3%	2.8%
Tram	1.4%	0.9%	1.6%
School Bus	0.0%	0.0%	0.0%
Public Bus	1.9%	2.5%	3.1%
Other	0.2%	0.1%	0.3%

Table B.2: Education trip mode splits in terms of trip numbers, distance travelled and time taken, Melbourne region (2009)

Transport mode	Trip numbers	Travel distance	Travel time
Vehicle Driver	5.9%	18.4%	12.2%
Vehicle Passenger	30.1%	32.6%	26.4%
Motorcycle	0.0%	0.0%	0.0%
Walking	40.3%	6.3%	26.5%
Bicycle	1.9%	1.1%	2.0%
Taxi	0.1%	0.1%	0.1%
Train	6.7%	19.1%	11.5%
Tram	4.2%	2.6%	4.1%
School Bus	4.7%	12.7%	9.3%
Public Bus	6.0%	6.9%	7.9%
Other	0.1%	0.0%	0.1%

Table B.3: Work trip mode splits in terms of trip numbers, distance travelled and time taken, Melbourne region (2009)

Transport mode	Trip numbers	Travel distance	Travel time
Vehicle Driver	56.3%	77.4%	69.0%
Vehicle Passenger	4.6%	4.8%	4.5%
Motorcycle	0.3%	0.4%	0.4%
Walking	23.0%	1.4%	9.0%
Bicycle	2.1%	1.3%	2.5%
Taxi	0.3%	0.2%	0.3%
Train	8.1%	12.3%	10.2%
Tram	3.7%	1.2%	2.6%
School Bus	0.0%	0.0%	0.0%

Public Bus	1.8%	1.0%	1.5%
Other	0.0%	0.0%	0.0%

Table B.4: Personal business trip mode splits in terms of trip numbers, distance travelled and time taken, Melbourne region (2009)

Transport mode	Trip numbers	Travel distance	Travel time
Vehicle Driver	40.6%	53.3%	44.9%
Vehicle Passenger	25.1%	34.5%	28.5%
Motorcycle	0.3%	0.4%	0.5%
Walking	25.8%	2.4%	16.2%
Bicycle	1.2%	0.4%	1.1%
Taxi	0.8%	0.6%	1.0%
Train	2.6%	5.7%	4.1%
Tram	2.2%	0.8%	1.7%
School Bus	0.1%	0.1%	0.1%
Public Bus	1.3%	1.7%	1.7%
Other	0.1%	0.1%	0.2%

Table B.5: Social trip mode splits in terms of trip numbers, distance travelled and time taken, Melbourne region (2009)

Transport mode	Trip numbers	Travel distance	Travel time
Vehicle Driver	39.3%	49.9%	44.1%
Vehicle Passenger	29.2%	39.4%	33.4%
Motorcycle	0.1%	0.4%	0.2%
Walking	22.6%	1.6%	11.6%
Bicycle	1.4%	0.7%	1.8%
Taxi	1.0%	0.9%	1.2%
Train	3.2%	4.5%	4.2%
Tram	2.1%	0.8%	1.7%
School Bus	0.0%	0.0%	0.0%
Public Bus	1.1%	1.9%	1.6%
Other	0.1%	0.0%	0.1%

Table B.6: Recreation trip mode splits in terms of trip numbers, distance travelled and time taken, Melbourne region (2009)

Transport mode	Trip numbers	Travel distance	Travel time
Vehicle Driver	37.9%	49.2%	38.0%
Vehicle Passenger	25.0%	35.3%	26.3%
Motorcycle	0.2%	0.7%	0.6%
Walking	26.0%	3.7%	20.5%
Bicycle	5.7%	4.6%	8.8%
Taxi	0.1%	0.1%	0.1%
Train	1.9%	4.6%	2.9%
Tram	1.4%	0.6%	1.1%
School Bus	0.4%	0.7%	0.5%
Public Bus	0.7%	0.3%	0.5%
Other	0.6%	0.2%	0.6%

APPENDIX C: Statistics for bicycle and walking trip length frequency distributions (TFLD), Melbourne region (2009)

This appendix provides the following statistics for bicycle and walking trip length frequencies, for:

- trip purpose
- gender
- age groups
- household income groups.

It also provides TFLD for each of the public transport modes used in the Melbourne region.

These data are presented to provide background support for the TFLD graphs provided in Section 4.4.

Tables C.1 and C.2 show summary statistics and percentile values of the TLFD for all walking and cycling activity, and are reproductions of Tables 8 and 9 in the main body of the report. They are repeated for completeness, to allow comparison with the subsequent tables in this appendix which show the summary statistics and percentiles for TLFD for trip purposes and for the socio-demographic variables studied. These variables include household income group, age and gender.

Table C.1: Summary statistics and percentiles for walking and cycling distance trip length frequency distributions (TLFD) in the Melbourne region (2009)

Trip purpose	Walking	Cycling
Summary statistics		
Sample size	19914	1458
Mean (km)	0.72	4.84
Standard deviation (km)	0.65	5.20
Coefficient of variation	90.3%	107.3%
Mode (km)	0.11	0.75
Percentiles		
10th (km)	0.16	0.75
15th (km)	0.21	0.95
25th (km)	0.29	1.34
50th (median) (km)	0.54	2.98
75th (km)	0.93	6.66
85th (km)	1.24	8.92
90th (km)	1.48	10.75
IQR (km)*	0.64	5.32

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.2: Summary statistics and percentiles for walking and cycling travel time trip length frequency distributions (TLFD) in the Melbourne region (2009)

Trip purpose	Walking	Cycling
Summary statistics		
Sample size	19914	1458
Mean (min)	9.9	23.2
Standard deviation (min)	8.4	19.6
Coefficient of variation	84.2%	84.4%
Mode (min)	5.0	10.0
Percentiles		
10th (min)	3.0	5.0
15th (min)	4.0	5.0
25th (min)	5.0	10.0
50th (median) (min)	8.0	15.0
75th (min)	13.0	30.0
85th (min)	15.0	45.0
90th (min)	20.0	45.0
IQR (min)*	8.0	20.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.3: Summary statistics and percentiles for *cycling trip distance* trip length frequency distributions (TLFD) by *trip purpose* in the Melbourne region (2009)

Trip purpose	Shopping	Education	Work	Personal business	Social	Recreation
Summary statistics						
Sample size	142	130	461	107	219	286
Mean (km)	2.26	2.48	6.28	3.31	4.31	6.90
Standard deviation (km)	3.03	1.89	4.75	3.26	4.86	7.33
Coefficient of variation	133.8%	76.1%	75.6%	98.6%	112.7%	106.3%
Mode (km)	0.66	0.75	1.39	1.15	0.74	0.49
Percentiles						
10th (km)	0.19	0.87	1.39	0.89	0.72	0.69
15th (km)	0.28	1.00	1.96	1.08	0.77	0.98
25th (km)	0.82	1.18	2.73	1.28	1.47	1.55
50th (median) (km)	1.21	1.83	5.36	2.64	2.86	4.77
75th (km)	2.17	3.26	8.53	3.99	5.73	8.93
85th (km)	3.34	4.22	10.43	4.46	8.07	12.17
90th (km)	5.40	4.96	12.71	5.90	8.92	18.49
IQR (km)*	1.35	2.08	5.80	2.71	4.26	6.38

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.4: Summary statistics and percentiles for *walking trip distance* trip length frequency distributions (TLFD) by *trip purpose* in the Melbourne region (2009)

Trip purpose	Shopping	Education	Work	Personal business	Social	Recreation
Summary statistics						
Sample size	3823	2916	5127	1976	3089	1483
Mean (km)	0.64	0.75	0.64	0.80	0.64	1.19
Standard deviation (km)	0.58	0.61	0.60	0.68	0.58	0.98
Coefficient of variation	90.4%	81.0%	93.6%	84.9%	90.3%	82.6%
Mode (km)	0.16	0.27	0.11	0.32	0.11	0.28
Percentiles						
10th (km)	0.15	0.19	0.15	0.17	0.14	0.27
15th (km)	0.18	0.24	0.19	0.23	0.17	0.35
25th (km)	0.25	0.33	0.27	0.32	0.24	0.51
50th (median) (km)	0.48	0.59	0.49	0.60	0.48	0.92
75th (km)	0.85	0.98	0.80	1.07	0.86	1.63
85th (km)	1.10	1.26	1.06	1.43	1.09	2.02
90th (km)	1.28	1.48	1.27	1.68	1.33	2.39
IQR (km)*	0.60	0.65	0.53	0.75	0.62	1.12

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.5: Summary statistics and percentiles for *cycling trip travel time* trip length frequency distributions (TLFD) by *trip purpose* in the Melbourne region (2009)

Trip purpose	Shopping	Education	Work	Personal business	Social	Recreation
Summary statistics						
Sample size	142	130	461	107	219	286
Mean (min)	12.1	15.6	26.6	17.3	24.1	30.9
Standard deviation (min)	13.1	8.6	17.2	11.8	22.1	25.9
Coefficient of variation	108.7%	55.1%	64.7%	68.4%	91.6%	83.6%
Mode (min)	5.0	10.0	30.0	10.0	10.0	5.0
Percentiles						
10th (min)	4.0	5.0	7.0	5.0	5.0	5.0
15th (min)	5.0	5.6	10.0	8.0	5.0	5.0
25th (min)	5.0	10.0	15.0	10.0	10.0	10.0
50th (median) (min)	10.0	15.0	25.0	15.0	15.0	25.0
75th (min)	10.0	20.0	35.0	35.0	30.0	45.0
85th (min)	15.0	25.0	45.0	30.0	6.0	66.0
90th (min)	30.0	30.0	45.0	30.0	60.0	66.0
IQR (min)*	5.0	15.0	20.0	15.0	20.0	35.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.6: Summary statistics and percentiles for *walking trip travel time* trip length frequency distributions (TLFD) by *trip purpose* in the Melbourne region (2009)

Trip purpose	Shopping	Education	Work	Personal business	Social	Recreation
Summary statistics						
Sample size	3514	2916	5127	1976	3089	1483
Mean (min)	9.3	9.5	8.5	11.4	9.5	15.4
Standard deviation (min)	8.1	7.5	7.0	8.7	8.2	12.2
Coefficient of variation	86.4%	78.7%	82.3%	76.1%	86.0%	79.6%
Mode (min)	5.0	5.0	5.0	5.0	5.0	15.0
Percentiles						
10th (min)	3.0	3.0	2.0	3.0	2.0	5.0
15th (min)	4.0	4.0	3.0	5.0	3.0	5.0
25th (min)	5.0	5.0	5.0	5.0	5.0	7.0
50th (median) (min)	7.0	8.0	6.0	10.0	7.0	15.0
75th (min)	11.0	11.0	10.0	15.0	10.0	20.0
85th (min)	15.0	15.0	15.0	20.0	15.0	25.0
90th (min)	20.0	20.0	15.0	23.0	20.0	30.0
IQR (min)*	6.0	6.0	5.0	10.0	5.0	13.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.7: Summary statistics and percentiles for *cycling and walking trip distance* trip length frequency distributions (TLFD) by *gender* in the Melbourne region (2009)

	Walking			Cycling	
Gender	Male	Female	Gender	Male	Female
Summary statistics			Summary statistics		
Sample size	8981	10933	Sample size	972	486
Mean (km)	0.75	0.70	Mean (km)	5.31	3.89
Standard deviation (km)	0.68	0.62	Standard deviation (km)	5.79	3.55
Coefficient of variation	91.9%	88.7%	Coefficient of variation	109.9%	91.3%
Mode (km)	0.27	0.11	Mode (km)	0.75	0.94
Percentiles			Percentiles		
10th (km)	0.16	0.16	10th (km)	0.75	0.74
15th (km)	0.21	0.20	15th (km)	0.96	0.94
25th (km)	0.30	0.28	25th (km)	1.39	1.25
50th (median) (km)	0.56	0.53	50th (median) (km)	3.15	2.80
75th (km)	0.95	0.92	75th (km)	7.39	5.52
85th (km)	1.28	1.21	85th (km)	9.79	7.48
90th (km)	1.53	1.44	90th (km)	12.61	8.36
IQR (km)*	0.65	0.64	IQR (km)*	6.00	4.27

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.8: Summary statistics and percentiles for *cycling and walking trip travel time* trip length frequency distributions (TLFD) by *gender* in the Melbourne region (2009)

	Walking			Cycling	
Gender	Male	Female	Gender	Male	Female
Summary statistics			Summary statistics		
Sample size	8981	10933	Sample size	972	486
Mean (min)	10.1	9.9	Mean (min)	23.7	22.4
Standard deviation (min)	8.5	8.2	Standard deviation (min)	21.0	16.4
Coefficient of variation	84.8%	83.7%	Coefficient of variation	88.8%	73.2%
Mode (min)	5.0	5.0	Mode (min)	10.0	10.0
Percentiles			Percentiles		
10th (min)	3.0	3.0	10th (min)	5.0	5.0
15th (min)	4.0	3.0	15th (min)	5.0	6.0
25th (min)	5.0	5.0	25th (min)	10.0	10.0
50th (median) (min)	8.0	8.0	50th (median) (min)	15.0	15.0
75th (min)	13.0	13.0	75th (min)	30.0	30.0
85th (min)	15.0	15.0	85th (min)	45.0	45.0
90th (min)	20.0	20.0	90th (min)	49.5	45.0
IQR (min)*	8.0	8.0	IQR (min)*	20.0	20.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.9: Summary statistics and percentiles for *walking trip distance* trip length frequency distributions (TLFD) by *age group* in the Melbourne region (2009)

Age group	0-9 y	10-19 y	20-39 y	40-54 y	55-69 y	70+ y
Summary statistics						
Sample size	1544	3193	6799	4140	2930	1308
Mean (km)	0.70	0.77	0.67	0.72	0.79	0.72
Standard deviation (km)	0.52	0.63	0.61	0.72	0.73	0.62
Coefficient of variation	74.3%	81.5%	89.7%	100.3%	93.6%	86.4%
Mode (km)	0.40	0.11	0.11	0.27	0.27	0.30
Percentiles						
10th (km)	0.18	0.19	0.15	0.15	0.17	0.16
15th (km)	0.23	0.24	0.19	0.19	0.22	0.20
25th (km)	0.32	0.34	0.27	0.27	0.30	0.28
50th (median) (km)	0.56	0.61	0.51	0.52	0.57	0.54
75th (km)	0.95	1.00	0.88	0.91	1.03	0.95
85th (km)	1.23	1.32	1.15	1.24	1.37	1.31
90th (km)	1.38	1.52	1.37	1.53	1.65	1.51
IQR (km)*	0.62	0.66	0.61	0.64	0.73	0.67

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.10: Summary statistics and percentiles for *walking trip travel time* trip length frequency distributions (TLFD) by *age group* in the Melbourne region (2009)

Age group	0-9 y	10-19 y	20-39 y	40-54 y	55-69 y	70+ y
Summary statistics						
Sample size	1544	3193	6799	4140	2930	1308
Mean (min)	10.8	9.7	9.3	9.8	11.2	10.5
Standard deviation (min)	7.6	8.0	7.5	8.9	10.0	8.5
Coefficient of variation	70.9%	82.5%	80.5%	90.3%	89.1%	80.9%
Mode (min)	10.0	5.0	5.0	5.0	5.0	5.0
Percentiles						
10th (min)	3.0	3.0	3.0	2.0	3.0	3.0
15th (min)	5.0	4.0	3.0	3.0	4.0	4.0
25th (min)	5.0	5.0	5.0	5.0	5.0	5.0
50th (median) (min)	10.0	8.0	7.0	7.0	10.0	10.0
75th (min)	15.0	13.0	10.0	12.0	15.0	15.0
85th (min)	20.0	15.0	15.0	15.0	20.0	15.0
90th (min)	20.0	20.0	17.0	20.0	23.0	20.0
IQR (min)*	10.0	8.0	5.0	7.0	10.0	10.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.11: Summary statistics and percentiles for *cycling trip distance* trip length frequency distributions (TLFD) by *age group* in the Melbourne region (2009)

Age group	0-9 y	10-19 y	20-39 y	40-54 y	55-69 y	70+ y
Summary statistics						
Sample size	117	210	520	414	127	32
Mean (km)	1.58	2.16	5.00	6.38	5.62	4.75
Standard deviation (km)	1.34	1.95	4.52	6.39	4.82	6.22
Coefficient of variation	85.0%	90.4%	90.3%	100.3%	85.8%	131.0%
Mode (km)	0.94	1.06	1.15	0.75	0.89	1.01
Percentiles						
10th (km)	0.35	0.52	0.97	0.92	0.91	0.49
15th (km)	0.49	0.63	1.15	1.20	1.14	1.01
25th (km)	0.75	0.83	1.95	1.20	1.14	1.01
50th (median) (km)	1.25	1.48	3.62	4.39	3.56	2.00
75th (km)	1.82	2.56	6.84	8.24	8.09	5.62
85th (km)	2.99	3.69	8.93	11.34	9.64	7.83
90th (km)	3.13	5.52	10.60	15.11	12.02	8.76
IQR (km)*	1.08	1.73	4.89	6.41	6.16	4.51

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.12: Summary statistics and percentiles for *cycling trip travel time* trip length frequency distributions (TLFD) by *age group* in the Melbourne region (2009)

Age group	0-9 y	10-19 y	20-39 y	40-54 y	55-69 y	70+ y
Summary statistics						
Sample size	117	210	520	414	127	32
Mean (min)	16.7	13.4	23.5	27.5	27.3	21.2
Standard deviation (min)	13.0	10.7	17.8	22.7	20.3	24.4
Coefficient of variation	77.9%	80.1%	75.7%	82.3%	74.2%	115.3%
Mode (min)	10.0	10.0	10.0	30.0	10.0	10.0
Percentiles						
10th (min)	5.0	4.0	5.0	5.0	5.8	4.0
15th (min)	5.0	5.0	7.0	8.0	10.0	4.7
25th (min)	7.0	5.0	10.0	10.0	10.0	5.0
50th (median) (min)	12.0	10.0	20.0	21.0	20.0	10.0
75th (min)	20.0	20.0	30.0	37.5	40.0	30.0
85th (min)	30.0	21.5	40.0	45.0	45.0	30.0
90th (min)	30.7	30.0	45.0	57.5	60.0	48.3
IQR (min)*	13.0	15.0	20.0	27.5	30.0	25.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.13: Summary statistics and percentiles for *walking trip distance* trip length frequency distributions (TLFD) by *income group* in the Melbourne region (2009)

Household income group	Income group 1	Income group 2	Income group 3	Income group 4	Income group 5
Summary statistics					
Sample size	2341	2941	3569	4031	7032
Mean (km)	0.73	0.77	0.74	0.71	0.70
Standard deviation (km)	0.68	0.69	0.64	0.64	0.64
Coefficient of variation	93.4%	90.6%	86.1%	90.2%	91.2%
Mode (km)	0.27	0.13	0.16	0.11	0.11
Percentiles					
10th (km)	0.16	0.16	0.17	0.16	0.16
15th (km)	0.22	0.20	0.22	0.20	0.20
25th (km)	0.30	0.29	0.30	0.29	0.28
50th (median) (km)	0.54	0.57	0.57	0.52	0.53
75th (km)	0.92	1.02	0.96	0.92	0.91
85th (km)	1.28	1.34	1.24	1.23	1.20
90th (km)	1.49	1.61	1.49	1.46	1.43
IQR (km)*	0.62	0.73	0.66	0.63	0.63

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.14: Summary statistics and percentiles for *walking trip travel time* trip length frequency distributions (TLFD) by *income group* in the Melbourne region (2009)

Household income group	Income group 1	Income group 2	Income group 3	Income group 4	Income group 5
Summary statistics					
Sample size	2341	2941	3569	4031	7032
Mean (min)	10.1	10.5	10.0	9.9	9.7
Standard deviation (min)	8.8	8.8	7.7	8.4	8.4
Coefficient of variation	87.7%	83.6%	76.7%	84.8%	86.5%
Mode (min)	5.0	5.0	5.0	5.0	5.0
Percentiles					
10th (min)	3.0	3.0	3.0	3.0	3.0
15th (min)	5.0	3.0	4.0	4.0	3.0
25th (min)	5.0	5.0	5.0	5.0	5.0
50th (median) (min)	8.0	10.0	10.0	8.0	7.0
75th (min)	13.0	15.0	15.0	14.0	11.0
85th (min)	15.0	16.0	15.0	15.0	15.0
90th (min)	20.0	20.0	20.0	20.0	20.0
IQR (min)*	8.0	10.0	10.0	9.0	6.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.15: Summary statistics and percentiles for *cycling trip distance* trip length frequency distributions (TLFD) by *income group* in the Melbourne region (2009)

Household income group	Income group 1	Income group 2	Income group 3	Income group 4	Income group 5
Summary statistics					
Sample size	135	96	201	330	696
Mean (km)	3.55	3.70	4.76	4.79	5.29
Standard deviation (km)	4.05	4.01	4.44	4.72	5.85
Coefficient of variation	114.2%	108.1%	93.2%	98.6%	110.6%
Mode (km)	1.93	1.41	0.99	1.06	0.75
Percentiles					
10th (km)	0.75	0.34	0.68	0.82	0.76
15th (km)	0.89	0.74	0.96	1.06	0.94
25th (km)	1.11	1.02	1.28	1.56	1.39
50th (median) (km)	1.93	2.43	3.05	3.16	3.16
75th (km)	4.35	4.45	6.98	6.40	7.45
85th (km)	7.23	6.37	9.18	8.08	9.93
90th (km)	7.66	8.34	10.19	8.96	12.35
IQR (km)*	3.24	3.43	5.70	3.84	6.06

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.16: Summary statistics and percentiles for *cycling trip travel time* trip length frequency distributions (TLFD) by *income group* in the Melbourne region (2009)

Household income group	Income group 1	Income group 2	Income group 3	Income group 4	Income group 5
Summary statistics					
Sample size	135	96	201	330	696
Mean (min)	18.2	18.8	23.6	22.3	25.2
Standard deviation (min)	15.9	17.6	19.1	17.4	21.3
Coefficient of variation	87.7%	93.7%	80.8%	78.2%	84.7%
Mode (min)	5.0	5.0	10.0	10.0	10.0
Percentiles					
10th (min)	5.0	5.0	5.0	5.0	5.0
15th (min)	5.0	5.0	8.0	5.0	6.0
25th (min)	6.8	5.0	10.0	10.0	10.0
50th (median) (min)	15.0	15.0	18.0	16.5	20.0
75th (min)	25.0	25.0	30.0	30.0	35.0
85th (min)	30.0	40.0	40.0	45.0	45.0
90th (min)	37.5	41.3	49.0	45.0	50.0
IQR (min)*	18.2	36.3	20.0	20.0	25.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.17: Summary statistics and percentiles for *distance* trip length frequency distributions (TLFD) for *all trips by public transport modes* in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	3480	1865	333	1491
Mean (km)	15.97	3.38	12.27	6.69
Standard deviation (km)	14.96	2.72	11.85	14.75
Coefficient of variation	93.7%	80.5%	96.6%	220.7%
Mode (km)	8.62	1.17	12.98	2.06
Percentiles				
10th (km)	3.82	0.79	3.44	1.60
15th (km)	5.25	1.04	3.99	2.05
25th (km)	7.05	1.43	4.91	2.55
50th (median) (km)	13.03	2.70	8.43	4.26
75th (km)	21.41	4.38	15.39	7.47
85th (km)	26.28	5.82	20.62	10.71
90th (km)	31.72	7.19	26.68	12.76
IQR (km)*	14.36	2.95	10.48	4.92

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.18: Summary statistics and percentiles for *travel time* trip length frequency distributions (TLFD) for *all trips by public transport modes* in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	3480	1865	333	1491
Mean (min)	27.3	15.2	28.3	19.3
Standard deviation (min)	17.5	10.6	18.4	16.9
Coefficient of variation	64.1%	70.1%	65.0%	88.0%
Mode (min)	20.0	10.0	10.0	10.0
Percentiles				
10th (min)	8.0	5.0	10.0	5.0
15th (min)	10.0	5.0	10.0	7.0
25th (km)	15.0	8.0	15.0	10.0
50th (median) min)	25.0	13.0	25.0	15.0
75th (min)	37.0	20.0	35.0	25.0
85th (min)	45.0	25.0	45.0	30.0
90th (min)	50.0	30.0	52.0	37.0
IQR (min)*	22.0	12.0	20.0	15.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.19: Summary statistics and percentiles for *distance* trip length frequency distributions (TLFD) for *trips made by public transport for different trip purposes* in the Melbourne region (2009)

Trip purpose	Shopping	Education	Work	Personal business	Social	Recreation
Summary statistics						
Sample size	738	1564	3068	405	894	241
Mean (min)	8.00	9.36	11.87	11.63	9.92	11.20
Standard deviation (min)	9.25	9.15	10.90	25.35	18.68	23.86
Coefficient of variation	115.6%	97.8%	91.8%	218.0%	188.3%	213.0%
Mode (min)	3.17	1.17	1.38	5.95	4.18	2.64
Percentiles						
10th (min)	1.31	1.72	1.65	1.25	1.31	1.34
15th (min)	1.63	21.7	2.23	1.71	1.75	1.58
25th (min)	2.43	3.17	3.39	2.44	2.65	2.64
50th (median) (min)	4.44	6.35	8.34	5.14	5.91	6.01
75th (min)	9.59	12.44	17.65	11.71	12.25	11.49
85th (min)	15.42	17.78	23.17	17.83	16.17	18.78
90th (min)	18.93	21.64	27.24	22.24	19.04	25.06
IQR (min)*	7.16	9.27	14.26	9.27	9.60	8.85

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.20: Summary statistics and percentiles for *travel time* trip length frequency distributions (TLFD) for *trips made by public transport for different trip purposes* in the Melbourne region (2009)

Trip purpose	Shopping	Education	Work	Personal business	Social	Recreation
Summary statistics						
Sample size	738	1564	3068	405	894	241
Mean (min)	19.3	22.1	23.9	22.6	21.6	21.4
Standard deviation (min)	14.3	15.4	15.2	22.6	19.7	21.6
Coefficient of variation	74.2%	69.6%	63.7%	99.9%	91.2%	100.8%
Mode (min)	10.0	10.0	15.0	10.0	15.0	10.0
Percentiles						
10th (min)	5.0	7.0	6.0	5.0	5.0	5.0
15th (min)	7.0	9.0	8.0	7.0	7.0	7.0
25th (min)	9.0	10.0	11.0	10.0	10.0	10.0
50th (median) (min)	15.0	19.0	20.0	16.0	15.0	16.0
75th (min)	25.0	30.0	33.0	30.0	27.0	26.0
85th (min)	32.0	40.0	40.0	37.0	36.0	34.7
90th (min)	40.0	42.0	45.0	45.0	42.0	40.0
IQR (min)*	14.0	20.0	22.0	20.0	17.0	16.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.21: Summary statistics and percentiles for *distance* trip length frequency distributions (TLFD) for *shopping trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	247	219	0	272
Mean (km)	14.98	3.28		5.46
Standard deviation (km)	12.19	2.54		4.89
Coefficient of variation	81.4%	77.3%		89.5%
Mode (km)	9.59	3.17		2.12
Percentiles				
10th (km)	2.86	0.74		1.42
15th (km)	3.82	0.95		1.61
25th (km)	5.46	1.42		2.20
50th (median) (km)	11.37	2.94		3.80
75th (km)	20.53	4.32		6.90
85th (km)	26.27	4.90		9.19
90th (km)	35.04	5.83		13.54
IQR (km)*				

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.22: Summary statistics and percentiles for *travel time* trip length frequency distributions (TLFD) for *shopping trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	247	219	0	272
Mean (min)	25.3	14.7		17.6
Standard deviation (min)	17.3	10.0		12.5
Coefficient of variation	68.4%	67.7%		70.6%
Mode (min)	15.0	10.0		10.0
Percentiles				
10th (min)	5.0	5.0		6.0
15th (min)	7.0	7.0		7.0
25th (min)	10.0	8.0		10.0
50th (median)(min)	21.0	13.0		15.0
75th (min)	36.0	20.0		20.0
85th (min)	45.0	25.0		28.0
90th (min)	52.0	28.0		30.0
IQR (min)*	26.0	12.0		10.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.23: Summary statistics and percentiles for *distance* trip length frequency distributions (TLFD) for *education trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	528	281	302	453
Mean (km)	14.07	3.01	12.51	5.70
Standard deviation (km)	9.35	2.43	12.11	3.90
Coefficient of variation	66.4%	80.7%	96.8%	68.4%
Mode (km)	8.62	1.17	12.98	3.06
Percentiles				
10th (km)	3.95	1.04	3.44	1.76
15th (km)	5.37	1.17	4.21	2.19
25th (km)	7.03	1.33	4.93	2.80
50th (median) (km)	11.16	2.22	8.55	4.51
75th (km)	19.90	4.02	15.39	7.33
85th (km)	24.60	5.11	21.89	9.93
90th (km)	26.43	6.22	26.69	11.99
IQR (km)*	12.17	2.69	10.46	4.53

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.24: Summary statistics and percentiles for *travel time* trip length frequency distributions (TLFD) for *education trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	528	281	302	453
Mean (min)	25.4	13.8	28.6	18.9
Standard deviation (min)	15.3	10.0	18.7	12.5
Coefficient of variation	60.2%	72.8%	65.2%	65.4%
Mode (min)	10.0	10.0	10.0	10.0
Percentiles				
10th (min)	8.0	5.0	10.0	6.0
15th (min)	10.0	5.0	10.0	8.0
25th (min)	13.0	7.0	15.0	10.0
50th (median) (min)	22.0	10.0	25.0	15.0
75th (min)	36.0	18.0	36.3	25.0
85th (min)	41.0	21.0	45.0	30.3
90th (min)	45.0	25.0	53.0	37.7
IQR (min)*	23.0	11.0	21.3	15.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.25: Summary statistics and percentiles for *distance* trip length frequency distributions (TLFD) for *work trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	1858	778	3	429
Mean (km)	16.68	3.53	5.03	6.22
Standard deviation (km)	11.28	2.71		5.14
Coefficient of variation	67.6%	76.6%		82.6%
Mode (km)	1.38	3.10		2.23
Percentiles				
10th (km)	3.98	0.83		1.87
15th (km)	5.49	1.13		2.12
25th (km)	8.08	1.57		2.47
50th (median) (km)	14.52	2.85	3.86	4.44
75th (km)	22.99	4.55		8.37
85th (km)	28.27	6.33		11.16
90th (km)	33.49	7.47		12.91
IQR (km)*	14.91	2.98		5.90

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.26: Summary statistics and percentiles for *travel time* trip length frequency distributions (TLFD) for *work trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	1858	778	3	429
Mean (min)	28.3	16.2	16.7	18.6
Standard deviation (min)	15.7	11.0		12.0
Coefficient of variation	55.5%	67.8%		64.9%
Mode (min)	30.0	15.0		10.0
Percentiles				
10th (min)	9.0	5.0		5.0
15th (min)	10.0	6.0		7.0
25th (min)	15.0	9.5		7.0
50th (median) (min)	27.0	15.0	17.0	15.0
75th (min)	39.0	20.0		25.0
85th (min)	45.0	20.0		31.0
90th (min)	50.0	21.0		35.0
IQR (min)*	24.0	10.5		15.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.27: Summary statistics and percentiles for *distance* trip length frequency distributions (TLFD) for *personal business trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	172	137	6	90
Mean (km)	20.34	3.22	8.60	7.99
Standard deviation (km)	31.88	2.35	9.38	26.11
Coefficient of variation	156.7%	73.0%	109.1%	326.9%
Mode (km)	8.48	3.32		1.03
Percentiles				
10th (km)	3.10	0.77		1.03
15th (km)	3.89	0.98		1.50
25th (km)	5.83	1.49		2.03
50th (median) (km)	13.30	2.73	4.29	3.39
75th (km)	20.91	3.94		5.88
85th (km)	34.61	5.71		7.94
90th (km)	40.02	5.95		10.41
IQR (km)*	14.08	2.45		3.85

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.28: Summary statistics and percentiles for *travel time* trip length frequency distributions (TLFD) for *personal business trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	172	137	6	90
Mean (min)	29.9	14.8	22.2	20.8
Standard deviation (min)	26.9	9.2	13.0	24.3
Coefficient of variation	90.0%	62.3%	58.8%	116.7%
Mode (min)	20.0	10.0		10.0
Percentiles				
10th (min)	5.0	4.3		5.0
15th (min)	10.0	5.0		10.0
25th (min)	14.0	7.0		10.0
50th (median) (min)	22.5	15.0	21.5	15.0
75th (min)	40.0	20.0		21.5
85th (min)	49.3	22.0		35.0
90th (min)	57.5	25.6		37.0
IQR (min)*	26.0	13.0		11.5

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.29: Summary statistics and percentiles for *distance* trip length frequency distributions (TLFD) *for social trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	44.2	298	4	149
Mean (km)	13.38	3.52	5.80	12.57
Standard deviation (km)	12.01	3.13	1.85	39.09
Coefficient of variation	89.8%	89.0%	31.9%	310.9%
Mode (km)	4.18	3.50		4.03
Percentiles				
10th (km)	4.18	0.63		1.67
15th (km)	5.03	0.83		2.08
25th (km)	6.25	1.30		2.46
50th (median) (km)	11.13	2.40	5.77	3.71
75th (km)	16.71	4.51		8.05
85th (km)	21.61	7.39		13.69
90th (km)	24.65	8.59		14.72
IQR (km)*	10.46	3.21		5.49

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.30: Summary statistics and percentiles for *travel time* trip length frequency distributions (TLFD) for *social trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	44.2	298	4	149
Mean (min)	25.2	14.6	26.8	24.8
Standard deviation (min)	15.7	10.8	10.8	35.0
Coefficient of variation	62.0%	73.9%	40.2%	141.3%
Mode (min)	15.0	10.0		15.0
Percentiles				
10th (min)	10.0	4.0		5.0
15th (min)	10.0	5.0		7.0
25th (min)	15.0	5.5		9.2
50th (median) (min)	21.0	10.0	26.0	15.0
75th (min)	32.0	20.0		25.0
85th (min)	40.0	25.0		35.0
90th (min)	45.0	30.0		49.1
IQR (min)*	17.0	14.5		15.8

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.31: Summary statistics and percentiles for *distance* trip length frequency distributions (TLFD) for *recreation trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	107	77	15	42
Mean (km)	19.70	3.54	10.92	3.69
Standard deviation (km)	33.61	2.87	9.68	2.51
Coefficient of variation	170.7%	81.0%	88.7%	67.8%
Mode (km)	6.25	2.64	6.97	1.36
Percentiles				
10th (km)	3.98	0.47	3.45	1.33
15th (km)	6.12	0.91	3.89	1.36
25th (km)	6.82	1.38	5.42	1.45
50th (median) (km)	12.91	2.64	6.97	3.11
75th (km)	23.00	4.56	11.31	4.60
85th (km)	28.61	6.52	14.34	5.41
90th (km)	34.26	8.01	16.67	6.71
IQR (km)*	16.18	3.18	5.89	3.15

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.32: Summary statistics and percentiles for *travel time* trip length frequency distributions (TLFD) for *recreation trips* by public transport in the Melbourne region (2009)

Transport mode	Train	Tram	School bus	Public bus
Summary statistics				
Sample size	107	77	15	42
Mean (min)	28.9	15.7	21.4	13.0
Standard deviation (min)	28.7	11.6	10.5	6.7
Coefficient of variation	99.1%	73.7%	49.0%	51.5%
Mode (min)	20.0	5.0	10.0	10.0
Percentiles				
10th (min)	10.0	5.0	10.0	5.0
15th (min)	11.0	5.0	10.0	7.0
25th (min)	14.0	6.3	13.3	10.0
50th (median) (min)	24.0	15.0	20.0	10.0
75th (min)	36.9	20.0	26.0	15.0
85th (min)	45.0	25.0	27.8	19.0
90th (min)	45.0	30.0	30.0	20.0
IQR (min)*	22.9	13.7	12.7	5.0

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.33: Summary statistics and percentiles for *walking access and egress distance to train*, Melbourne (2009)

	Access	Egress	Total
Summary statistics			
Sample size	1199	1199	1199
Mean (km)	0.74	0.75	1.49
Standard deviation (km)	0.50	0.51	0.73
Coefficient of variation	67.5%	67.9%	48.7%
Mode (km)	0.27	0.14	1.30
Percentiles			
10th (km)	0.26	0.26	0.71
15th (km)	0.30	0.30	0.78
25th (km)	0.39	0.40	0.98
50th (median) (km)	0.61	0.64	1.34
75th (min)	0.94	0.96	1.87
85th (min)	1.19	1.21	2.16
90th (min)	1.38	1.39	2.42
IQR (min)*	0.55	0.56	0.89

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.34: Summary statistics and percentiles for *walking access and egress distance to tram*, Melbourne (2009)

	Access	Egress	Total
Summary statistics			
Sample size	1048	1048	1048
Mean (km)	0.43	0.42	0.84
Standard deviation (km)	0.35	0.32	0.48
Coefficient of variation	81.2%	77.6%	57.1%
Mode (km)	0.13	0.24	0.53
Percentiles			
10th (km)	0.13	0.11	0.33
15th (km)	0.14	0.13	0.38
25th (km)	0.19	0.18	0.48
50th (median) (km)	0.34	0.32	0.74
75th (min)	0.56	0.56	1.11
85th (min)	0.71	0.73	1.32
90th (min)	0.87	0.88	1.48
IQR (min)*	0.37	0.38	0.63

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.35: Summary statistics and percentiles for *walking access and egress distance to public bus*, Melbourne (2009)

	Access	Egress	Total
Summary statistics			
Sample size	772	772	772
Mean (km)	0.61	0.60	1.22
Standard deviation (km)	0.48	0.48	0.70
Coefficient of variation	77.8%	79.4%	57.8%
Mode (km)	0.34	0.25	1.03
Percentiles			
10th (km)	0.17	0.16	0.51
15th (km)	0.22	0.22	0.58
25th (km)	0.29	0.28	0.71
50th (median) (km)	0.47	0.48	1.06
75th (min)	0.81	0.80	1.52
85th (min)	0.99	1.02	1.88
90th (min)	1.17	1.15	2.12
IQR (min)*	0.52	0.52	0.81

** IQR = interquartile range, the difference between the 75th and 25th percentile values*

Table C.36: Proportions of Melbourne population reporting no cycling activity

Age group	Male	Female	Total
1	0.990	0.993	0.991
2	0.979	0.988	0.983
3	0.956	0.983	0.969
4	0.963	0.987	0.975
5	0.985	0.980	0.983
6	0.954	0.980	0.967
7	0.963	0.971	0.967
8	0.950	0.988	0.970
9	0.963	0.986	0.975
10	0.958	0.984	0.971
11	0.967	0.986	0.977
12	0.982	0.991	0.987
13	0.988	0.993	0.991
14	0.985	0.997	0.991
15	0.997	1.000	0.998
16	0.990	1.000	0.995
17	0.983	0.998	0.992
18	1.000	1.000	1.000
19	1.000	1.000	1.000
20	1.000	1.000	1.000
Total population	0.970	0.987	0.979

Table C.37: Proportions of Melbourne population reporting no walking activity

Age group	Male	Female	Total
1	0.863	0.848	0.856
2	0.793	0.789	0.791
3	0.672	0.685	0.678
4	0.655	0.635	0.645
5	0.785	0.718	0.751
6	0.754	0.678	0.716
7	0.749	0.695	0.721
8	0.795	0.755	0.775
9	0.817	0.792	0.804
10	0.818	0.797	0.808
11	0.849	0.809	0.828
12	0.823	0.786	0.804
13	0.821	0.790	0.805
14	0.796	0.799	0.797
15	0.803	0.796	0.799
16	0.819	0.791	0.804
17	0.833	0.872	0.857
18	0.858	0.836	0.844
19	0.945	0.953	0.951
20	1.000	1.000	1.000
Total population	0.786	0.759	0.772

Table C.38: Proportions of Melbourne population reporting no walking or cycling activity

Age group	Male	Female	Total
1	0.857	0.842	0.850
2	0.777	0.780	0.778
3	0.639	0.671	0.655
4	0.627	0.628	0.628
5	0.775	0.709	0.742
6	0.724	0.666	0.695
7	0.732	0.676	0.703
8	0.764	0.752	0.758
9	0.791	0.785	0.788
10	0.786	0.788	0.787
11	0.823	0.801	0.812
12	0.809	0.781	0.795
13	0.813	0.785	0.799
14	0.782	0.797	0.790
15	0.801	0.796	0.798
16	0.809	0.791	0.799
17	0.819	0.871	0.850
18	0.858	0.836	0.844
19	0.945	0.953	0.951
20	1.000	1.000	1.000
Total population	0.765	0.751	0.758