The Function of Individual Factors on Travel Behaviour: Comparative Studies on Perth and Shanghai

Abstract

Perth and Shanghai represent developed and developing cities, being diverse in urban development, population densities and economic development. Of significant interest is that as one city seeks to move away from car reliance by developing public transport as an alternative mode of travel, the other seeks to avoid increasing car use. No matter what "mobility life-stage" they are belonging to, public transport has received renewed attention in both cities as a sustainable and environmentally sensitive alternative to car travel. At the city level, it has been demonstrated that both Perth and Shanghai are pre-dominantly monocentric urban structures. Also the public transport planning in both cities likely downplays the importance of a user focus in public transport planning. Residents will not see public transport as favouring their needs. Similar underlying urban structures and planning approaches have made public transport solutions particularly challenging in both cities. To draw a research from a world perspective both of these two contexts should be considered. World wide a diverse range of transport and land use planning strategies support and promote public transport. However the outcome for travel behaviour change is still uncertain. The aim of this paper is to provide an understanding of the extent that personal travel behaviour is affected by individual factors such as socio-economic characteristics and travel attitudes rather than by external factors such as land use system and the transport system. Two neighbourhoods in Perth and Shanghai are chosen to be used as case studies for comparative analysis of residents attitudes based on their good public transport accessibility within their own city context. Drawing secondary data from travel diaries and primary data from intercept surveys, the findings confirm the expected importance of socio-economic characteristics on motorisation and the traveller's decision on travel mode choice.

1. Introduction

Rising car ownership, income growth and the declining real cost of using cars have been identified as the key factors that have shaped personal travel patterns around the world (Paulley, Balcombe et al. 2006). The consequence has been a reduction in the demand for public transport modes and an increasing average trip length. This is not only an issue for developed countries but also for fast developing countries. As a sustainable and environmentally sensitive alternative to car travel, public transport has received renewed attention in the world. This has led to a diverse range of transport and land use planning strategies supporting and promoting public transport. However the outcome for travel behaviour change is still uncertain.

There is already a substantial body of academic literature on travel behaviour (Handy 2002, Curtis and Olaru 2010) and the related issues of travel mode choice and energy consumption for mobility purposes (Jenks, Burton et al. 1996, Newman and Kenworthy 1999). The focus has been on "external" built environment dimensions and the transport system. Individual factors such as socio-economic characteristics, or some qualitative and experiential variables such as travel preference and attitude, are seldom included in travel demand analysis and the design of public transport systems is rarely led by this dimension (Zhao 2009). This represents a significant gap in the knowledge required for considering public transport system design from the perspective of individual needs of potential users. The main interest of this research is whether there are significant individual factors associated with mode choice when land use and public transport accessibility factors are controlled. Two neighbourhoods in Perth and Shanghai are used as case studies for comparative analysis.

The paper is structured as follows. A review of the relevant literature on individual factors on travel behaviour research is in section 2. Section 3 presents the characteristics and selection process of the two case studies. Section 4 discusses the methods used in travel behaviour research and describes the secondary data and reports the findings; Section 5 describes the methods used in travel attitude research, the collection of primary data and the empirical results. The paper concludes with a discussion of the problems faced in travel behaviour research and recommendations for future research.

2. Individual factors on travel behaviour research

At the most general level observed travel behaviour depends on the three main factors: first is from a

spatial perspective, second considering the transport system and the third perspective is from the characteristics of travellers (Hanson and Schwab 1986). This can be summarized as external factors and internal factors (outlined in Table 1). Travel patterns are significantly influenced by various physical characteristics which reflect on the concept of "accessibility - the ability to reach activities or locations by means of a travel mode" (Van Acker and Witlox 2010)(p 66). Generally, a higher mode accessibility will increase the usage of that mode (Rajamani, Bhat et al. 2003, Geurs and VAn Wee 2004). Land use and transportation are both important components of accessibility which affect travel behavior.

Table 1: **The External and Internal Factors Affecting Observed Travel Behaviour**

Travel Components	**External factors : Policy, economic, physical environment while people are travelling**	**Internal factors: Characteristics of travellers**
Trip purpose (Activity choice) Travel mode choice Travel time Travel cost Travel distance Trip frequency	Built environment Infrastructure Transit service quality Transport policy Economic situation	Income Car ownership Possession of drivers' licence Working status Employment type Gender Age group Family structure Level of education Attitudes Personality type

Physical characteristics, however, reflect only one part of the factors influencing travel behaviour, travellers' socio-economic and demographic factors also affect travel patterns (Kollmuss and Agyeman 2002). There are a large number of socio-economic and demographic variables that need to be taken into consideration. From the literature eight types of factors and their potential impacts can be summarized (see Table 2). According to their investigations some factors have a significant relationship with travel variation; the other factors such as gender or level of education do not have clear relationship with trip frequency or travel. In measuring the socio-economic and demographic variables of a traveller, while not problem free, Hanson (1982) argued it is considerably less straightforward than measuring the spatial constraints facing an individual. Another difficulty is those factors are always interconnected and it is difficult to separate the effect of one from another (Hanson 1982). Among the travel behaviour studies, the most constantly used research method involves an analysis of travel survey data and a household travel survey can give the information of individual characters as well as travel patterns (Domencich 1975).

Table 2: Examples of How Socio-economic and Demographic Factors Affect Travel Patterns

Socio-economic and demographic factors	Travel Pattern	Reference
Household Income ↑	Trip frequency ↑	(Hanson 1982)
	Travel distance ↑	(Cervero 1996, Naess and Sandberg 1996)
	Proportion of car journey ↑	(Flannelly and McLeod Jr 1989)
	Transport energy consumption ↑	(Næss 1993)
Car ownership ↑	Trip frequency ↑	(Hanson 1982)
	Trip frequency →	(Prevedouros and Schofer 1991)
	Travel distance ↑	(Naess and Sandberg 1996, Kockelman 1997)
	Proportion of car journey ↑	(Næss 1993)
	Travel time ↑	(Ewing 1995)
Possession of driver's license per household ↑	Using car ↑	(Flannelly and McLeod Jr 1989)
Workers per household ↑	Trip frequency (Per household) ↑	(Ewing, DeAnna et al. 1996)
	Travel time ↑	(Ewing 1995)
Gender	Trip frequency →	(Hanson 1982)

Age ↑	Trip frequency →	(Hanson 1982)
	Proportion of car journey →	(Flannelly and McLeod Jr 1989)
	Transport energy consumption ↑	(Naess and Sandberg 1996)
Household size ↑	Trip frequency ↑	(Hanson 1982, Kockelman 1997)
	Travel time ↑	(Ewing 1995)
	Transport energy consumption ↑	(Banister, Watson et al. 1997)
Level of education ↑	Proportion of car journey ↑	(Flannelly and McLeod Jr 1989)
	Proportion of public transport use↑	(Kockelman 1997, Boarnet and Sarmiento 1998, Stead 2001)

Note: "↑" stands for increasing the number of amount, speed or percentage. "→"stands for remaining the same.

Travel behaviour is the outcome of a series of complex travel related decision-making process, besides socio-economics' impacts some other individual factors such as perception, identity, social norms and habit has attracted researchers' attention in the study of travel behaviour (Lanken, Aarts et al. 1994, Tertoolen, van Kreveld et al. 1998, Bamberg and Schmidt 2001, Stradling 2003). To build up a comprehensive framework of travel behaviour research it is necessary to take all pertinent attributes into account: objectively measured variables as well as subjective factors. There will be various difficulties encountered when measuring and forecasting attitudes (Flamm 2006). Qualitative research methods such as interviews, focus groups have been introduced into travel attitude research(Dandekar 1986, Clifton and Handy 2001). Yet doing qualitative research well is more challenging than quantitative research. It raises several issues concerning research design, data collection, analysis, and interpretation as conventional quantitative methodologies. Qualitative research has been criticized for lack of scientific rigor and the threat of subjective interpretation long time ago (Sandelowski 1986). To avoid the weakness there is a growing trend of using attitudinal questionnaire survey to supplement the results of attitude-caused travel behaviour (Clifton and Handy 2001). The following literature (Table 3) shows some examples of attitudinal questionnaire design in travel behaviour research. These arose in developing the questionnaires for two case studies.

Table 3: Examples of Attitudinal Questionnaire Design

Researcher(s)	Aim of survey	Attitudinal questions
Kuppam et al. (1999)	To explore the role of attitudinal and preference variables in explaining mode choice for commute trips	• Performance ratings of different modes • Questions about the need for a car, the availability of transit, the availability of a possible co-rider • Importance ratings for a variety of transportation system characteristics
Kitamura et al. (1997)	To explore the association between the attitude factors and the travel demand	• Preferences and feelings about current neighbourhood. • The reasons for selecting particular modes • Attitudinal questions about transportation, time, the environment, housing, and the economy. • Lifestyle question about reading habits, the use of leisure time, and participation in a variety of outdoor activities and sports, entertainment and events, and hobbies.
Anable (2005)	To compare travellers' psychological sense with their observed travel behaviour	• 105 attitude statements related to moral norm, environmental attitudes, efficacy, behavioural norm and habit for identification • 25 statements measured "life values" • 9 measuring attitudes to transport policy options
Jensen (1999)	To explore how transport has become part of everyday life on behaviour, on attitudes, on environmental consciousness etc...	• Actual travel behaviour • Attitudes towards transport • About their interest in and knowledge of environmental problems

3. Motivation of choosing the two case studies

By international standards, Chinese cities, like cities in other Asian countries, are well-known for their wide use of non-motorized transport: for many years walking and cycling were the predominant mode. Also the transport mode was related to urban form which maintained the level of car use at a low point (Kenworthy and Hu 2002). However, with Chinese economy booming, the speed of motorization is rapid, beyond the imagination. From 2000 to 2010, the total number of cars and motorcycles in China increased 20 times (National Bureau of Statistics of China, 2010). Chinese economic policies which support the car industry exacerbate this trend. It has become a great challenge to develop quality public transport systems to compete with private transport (Han 2009). On the contrary, Australia's major cities have an extreme reliance on the car which gives them the reputation of the most car dependent cities in the world, aside from American cities (Newman and Kenworthy 1999). The rapid rise in car ownership, the highly suburbanized and low density urban structure by world standards have made the car essential for most of their people. Despite considerable differences in the economic situation, urban land use and 'mobility life-stage', both Chinese and Australian governments are taking action to develop and promote public transport as the preferred mode of motorized transport for their residents. The Australian response is seen as a solution to car dependence, and in China where car ownership is in its infancy - the concern is to ensure car dependence does not take hold (Næss 1993, Pacala and Socolow 2004, Van Acker and Witlox 2005). However the challenge of behaviour change toward public transport in face of the love affair with cars is a worldwide problem, not only for developed countries also for fast developing countries. To draw an understanding of individual attitudes from these two contexts should be considered. This is the original motivation for a comparative study of a Chinese and Australian city. With both Chinese and Australian background the authors are equipped with strong knowledge on the planning affairs in China and Australia. This also brings a keen interest to the authors in doing cross-culture studies. To put the research interests into a world-wide analysis will enrich the international scope of this research theme also help to exchange ideas around public transport use.

At the city level, it has been demonstrated by the researchers that both Perth and Shanghai are predominantly monocentric urban structures (Curtis 2005, Pan 2010). The municipal government of Shanghai has put great attention to de-centralize its city structure; however, the de-centralization strategy to encourage the people to stay in the satellite town has not been success (Pan 2010). Perth developed historically has been characterised as its low density and mono land use (Curtis 2005). This affects both cities' travel patterns in a similar way which has created the problem of congestion in the city centre and on radial links into the centre. Also of the public transport planning policy, both cities likely downplays the importance of a 'people' centred public transport system. Residents will not see public transport as favouring their needs. Similar underlying urban structures and planning approaches have made public transport solutions particularly challenging in both cities. Therefore, an investigation of travel behaviour is important for such cities. As discussed earlier travel behaviour is affected by various factors, to find out whether there are significant individual factors associated with mode choice there is a need to control the other factors, in this case land use and public transport service (Figure 1). This has directed the selection of case study areas.

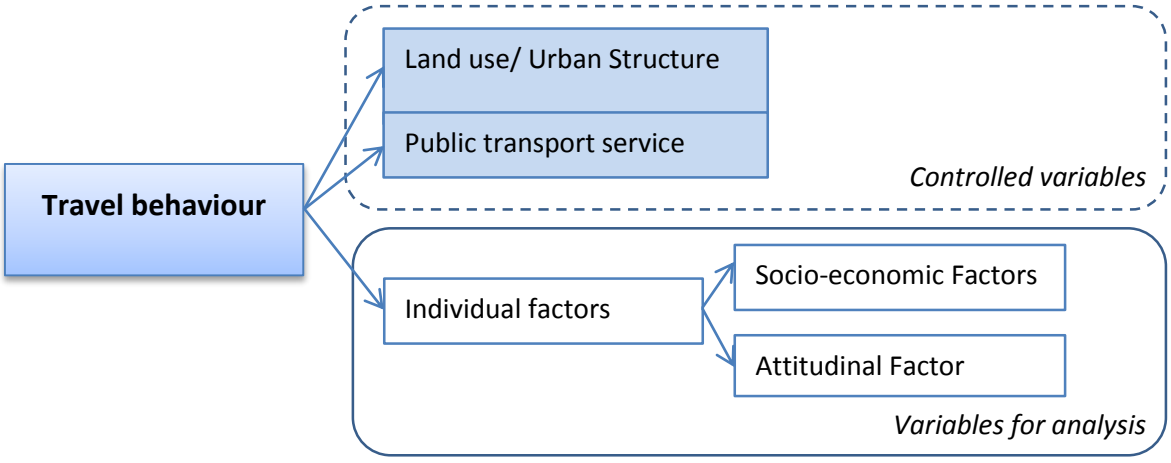

Figure 1: Research Approach - Conceptual Framework

At the neighbourhood level, prior to this research, there were two existing projects respectively in Perth, Australia and Shanghai, China which examined resident's travel behaviour using household travel surveys. These two studies coincide with the above rationale for study area selection. The secondary data are from two Household Travel Survey (HTS): the Perth new railway station precincts HTS (Curtis and Olaru 2010) and the Shanghai four neighbourhoods HTS (Pan, Shen et al. 2009). Both of the surveys are neighbourhood scale and travel information from the household is obtained for individual household members. Considering the data availability, sample size and relevant public transport accessibility (the train in Bull Creek was introduced in December 2007), this research uses Bull Creek data of 2009 to compare with Kangjian 2001(Table 4). Those two sets of data are similar in size and also in public transport accessibility at the time data were collected. They also located a similar distance from the city centre in terms of urban structure (Figure 2 and Figure 3). To provide further justification for the choice of cases, Spatial Network Analysis of Multimodal Transport System (SNAMUTS) tool has been used to justify the selection. SNAMUTS is a strategic planning tool to assess the congruence of movement and urban structure (Scheurer, Curtis et al. 2008). Based on the analysis it has been identified that Bull Creek in Perth and Kangjian in Shanghai locate at relatively high public transport accessibility places of their cities. Population density, of course, is very different.

Table 4: Details of Two Case Studies

		Bull Creek	**Kangjian**
City		Perth, Australia	Shanghai, China
Distance to CBD		12 km	10km
Population density		1925 persons/km^2	23000 persons/km^2
Transit access in 1km radius (10-15 minutes walking distance)	Number of bus stops	32	56
	Number of rail transit stations in 1 km radius	2	3
Year of data collection		2009	2001
Valid Number of Households		196 (drawn from a total population of 2081)	153 (drawn from a total population of 21,000)

Source: Pan, Shen et al. (2009); Curtis and Olaru (2010)

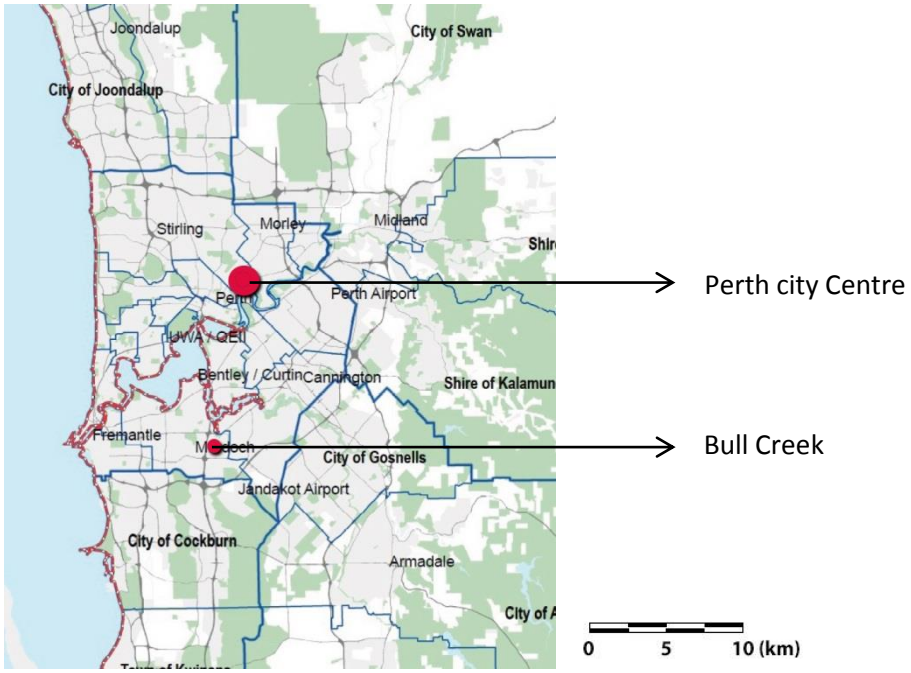

Figure 2: Bull Creek location map of Perth: distance to city centre

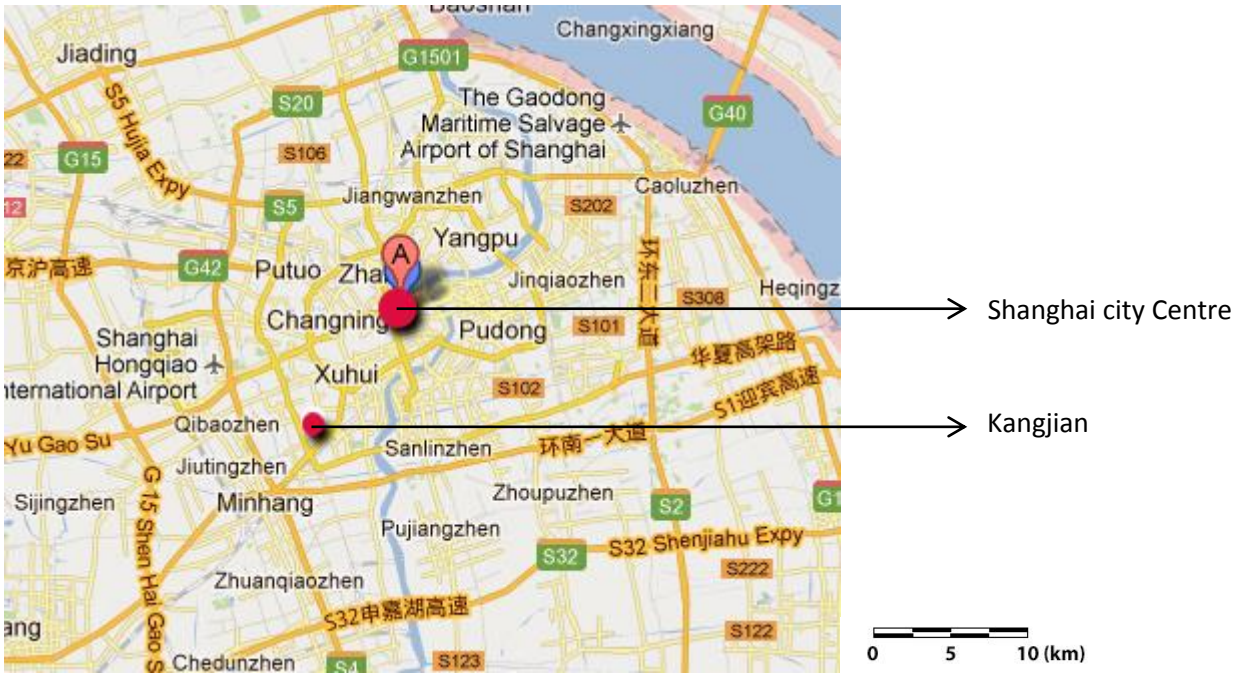

Figure 3: Kangjian location map of Shanghai: distance to city centre

4. Findings - Travel behaviour (secondary data)

4.1 Analysis of Travel Mode Choice - All Trips

The distribution of mode choice in the two neighbourhoods is shown in Table 5. It is clear that mode share for car was very high in Bull Creek area. The transit share is only 10.7% and even less than non-motorised travel. In comparison, transit was the most popular transport mode with 50.1% share in Kangjian. Non-motorised travel also took a significant portion of mode share 36.6%, much higher than Bull Creek. In Shanghai, in spite of rapid growth in income and motorisation; walking/cycling remained preferred modes of travel for work and non-work trips.

It is evident that travel patterns in the two cases display different pictures. In a policy environment aimed at high public transport use – how will governments maintain and increase Kangjian's high level of public transport use in the face of rising car ownership, and reduce Bull Creek's reliance on the car – is it possible for travel to shift to public transport? Understanding where, when and for what purpose these samples use particular modes will give some insights.

Table 5: Travel modal shares (number of trips, all journey purpose) in the two neighbourhoods

Travel mode	Bull Creek		Kangjian	
	Number	Percentage	Number	Percentage
Non-motorised	337	21.3%	160	36.6%
Transit	168	10.7%	219	50.1%
Private Motor Vehicle	1077	68%	58	13.3%
Total	*1582*	*100%*	*437*	*100%*

Source: Pan, Shen et al. (2009); Curtis and Olaru (2010)

4.2 Trip Distance by Mode in Work and Non-work trips

Trip distance is a component of the observed travel pattern. Here the average trip distance of travellers from the two neighbourhoods is compared, grouped by travel mode and trip purpose (Table 6). Perth and Shanghai both belong to mono-centric city structure and those two cases are located a similar distance away from their city centre; with similar public transport accessibility, the travel distance by car and transit of both neighbourhoods did not show much difference in their work trips. It

is evident that, by work trip the high car a mode share in Bull Creek does not necessarily lead to high travel distance compared to Kangjian. Differences occur, however, for non-work trips. Here Bull Creek resident's driving distance is much higher than Kangjian residents. Driving is still the first option for people living in Bull Creek for the non-work trips. It is also evident that the walk travel distance increased for the non-work trip compared with work trip in Bull Creek. However there is not much difference in trip distance among transport mode for both trip purposes in Kangjian. This diversity needs to be further explained by some other factors – is it lifestyle tempered by cultural difference that accounts for this difference? It is also apparent that trip distance increased with motorisation for both trip purposes in both neighbourhoods.

Table 6: Daily Trip Distance (km) by Mode

Travel mode		**Bull Creek** in Perth (n= 229)	**Kangjian** in Shanghai (n= 437)
Work trips	Walk	0.48	2.2
	Bicycle	5.86	4.4
	E-bike or motorcycle(Moped)	6.73	5.9
	Bus or rail transit	9.24	8.5
	Car	12.54	12.8
Non-work trips	Walk	2.81	2.2
	Bicycle	3.44	4.0
	E-bike or motorcycle(Moped)	2.31	5.4
	Bus or rail transit	7.98	8.1
	Car	19.98	8.5

Source: Pan, Shen et al. (2009); Curtis and Olaru (2010)

4.3 Vehicle Ownership by Income

Vehicle ownership, especially motor vehicle ownership, historically is evident of economic development (Dargay, Gately et al. 2007). It should be noted that vehicles considered in this research include cars, bicycles and mopeds. Mopeds are motorised, but have less engine power and lower operating speeds than cars. Mopeds are in popular use in China, not only because of their low operation fee but also they take much less road and parking space which is so important in the high density city. Mopeds often function as a transition mode from the non-motorised modes, such as bicycles, to fully motorised modes, such as cars. Studies have suggested a worldwide trend: as income grows, demand for faster and more comfortable transport means will increase, which leads to an increase in motorisation (Ingram and Liu 1999). Of interest in this research is whether there are trend variations among the two study neighbourhoods. In order to assess this, vehicle ownership is compared to income using three income categories with the sample data from these two neighbourhoods. Obviously, there can't be a unique qualification to define the three categories. Income level in Kangjian uses Pan (2009) definition due to the data limitation, Australian Bureau of Statistics Census 2011 is used to define Bull Creek's income level. Monthly income has been applied for comparison (see Table 7).

Table 7: The Defined Income Level of Bull Creek and Kangjian.

	Bull Creek (per month)	**Kangjian (per month)**
Low income	≤ AU$2500	≤ AU$250
Medium income	AU$2500-7000	AU$250-500
High income	≥ AU$7000	≥AU$500

Car ownership increases as income grows, a pattern existing in both of the two neighbourhoods (Table 8). In Kangjian, the lower-income group has a car ownership of 11 vehicles per 1000 people. The level of car ownership rises to 36 for the medium-income group and to 81 for the higher-income group. The level of moped ownership displays a pattern similar to that of cars in both neighbourhoods (with one exception in Kangjian for the higher-income group). Conversely, bicycle ownership declines along with income growth in Kangjian. A different trend is seen in Bull Creek with the bicycle ownership. This may be explained by car and moped ownership having a close relationship with motorized travel but high bicycle ownership is not necessarily equal to non-motorized travel especially in Perth, Australia. Riding a bicycle in a local area is more likely used for leisure purposes rather than as a transport mode. The general trends of car ownership increasing with income occur in both neighbourhoods but there is still some difference between them in the increasing rates. Compared

with the growing rates of household's car ownership among three categories, Kangjian shows a much stronger growing trend. This suggests that there is a more sensitive relationship between household's car ownership and income in Kangjian than in Bull Creek. The increased income contributes a lot to the fast growing speed of motorisation in Kangjian.

Table 8: Vehicle Ownership in Bull Creek and Kangjian (vehicles per 1000 persons) by Income Range

Variable		**Bull Creek** in Perth **(n=229)**	**Kangjian** in Shanghai **(n=437)**
Low income	Car	558 (61.7%)	11 (2.0%)
	Bicycle	317 (35.1%)	454 (84.1%)
	Moped	29 (3.2%)	75 (13.9%)
	Total	904 (100%)	540 (100%)
Medium income	Car	644 (61.9%)	36 (6.8%)
	Bicycle	362 (34.8%)	390 (73.2%)
	Moped	34 (3.3%)	107 (20%)
	Total	1040 (100%)	533 (100%)
High income	Car	732 (50.4%)	81 (17.0%)
	Bicycle	667 (46.0%)	337 (70.6%)
	Moped	52 (3.6%)	59 (12.4%)
	Total	1451 (100%)	477 (100%)

Source: Pan, Shen et al. (2009); Curtis and Olaru (2010)

The next question is whether, when income is controlled for, there is a pattern of vehicle ownership generalizable from cross neighbourhood comparisons. Table 9 shows that, in all the three income groups, households in Bull Creek have much higher level of car ownership, quite similar bicycle ownership, but a lower level of moped ownership than Kangjian. Moped often offers a transition mode from the non-motorised to fully motorised. The large percentage of moped ownership as well as the fast increasing speed of car ownership has indicated that Kangjian is in a period of transition from non-motorized to motorization; the income growth will become an important catalyst for this transition. Overall, the consistent observations from the two neighbourhoods, the lower- and the higher-income, concur with the existing body of knowledge regarding the relationship between neighbourhood socio-economic characteristics (in this case income) and the level of vehicle ownership.

Table 9: Vehicle Ownership Percentage Change in Bull Creek and Kangjian

		Car ownership		Bicycle ownership		Moped ownership	
		Number	Percentage	Number	Percentage	Number	Percentage
Bull Creek	Low income	558	29%	317	23%	29	25%
	Medium income	644	33%	362	27%	34	30%
	High income	732	38%	667	50%	52	45%
	Total	1934	100%	1346	100%	115	100%
Kangjian	Low income	11	9%	454	38%	75	31%
	Medium income	36	28%	390	33%	107	44%
	High income	81	63%	337	29%	59	25%
	Total	128	100%	1181	100%	241	100%

Source: Pan, Shen et al. (2009); Curtis and Olaru (2010)

5. Findings – Travel Attitudes (primary data)

The previous section confirms that 'internal' factors play an important role in travel behaviour of residents in both case study areas, bearing in mind that both case study areas have a high standard of public transport accessibility. As income increases so does car ownership, and in the case of Kangjian this is likely to lead to mode shifts away from public transport. For residents in both case study areas that use cars, they travel further distances. The role of attitudes towards transport mode use then becomes a critical question, one which should concern governments as they seek to retain or increase public transport use in both places.

To understand resident's attitudes a questionnaire survey was conducted. The questionnaire was administered as an intercept survey at those two case studies - Bull Creek and Kangjian. After

considering about Confidence Level (CL) and Confidence Interval (CI) for several socio-demographic statistics and parameter estimates a number of 120 respondents were set for each of the research precincts and with 240 people in total.

Building on the work of Ajzen (1991), Anable (2005) and Jensen (1999) a grouping method was used to identify the mobility types of travellers based on their transport attitudes. This also allowed for ease of comparison between the cases. Along with previous literature on attitudes, 28 attitude statements were designed to group the participants into 6 mobility types (Table 10). Those attitude statements can be summarised as follows:

- Favourable/unfavourable toward car/public transport
- Past behaviour (travel habit, life style)
- Subjective norm control (Environmental beliefs)
- Objective resource control

Table 10: The Survey Attitude Statements for Classifying Six Mobility Types

Mobility	Name	Main characters of each mobility type (according to literate review)	Attitude statements (variables can most highly reflect the mobility type)
Type 1	**CL**= Car Lover	a) Enjoyment of driving b) No or less moral responsibility to use the car less	• Can express yourself through a car • Enjoy driving a nice car • Can distinguish yourself from others by the car he own • Driving is sporty and adventurous • Your car gives you power in traffic • Driving is relaxing • Driving is your hobby
Type 2	**CH**=Car use of Habit	a) Attachment to the car b) Positive effects of car use c) Perceived behavioural control	• Using a car is a habit, it is hard to live without it • Using a car is the easiest way to travel • Using a car is the quickest way to travel • Using a car is often the cheapest way to travel • Your car is often the cheapest way to travel
Type 3	**CN**=Car use of Necessity	a) Negative effects of Public transport use b) Being ready to change when condition improves c) Social norms	• Your car is means of transport, nothing else • Public transport is not available in my area • When public transport has a better service, you will use it
Type 4	**PL**=Public transport Lover	a) Enjoyment of riding on public transport b) Belief in freedom to use the public transport c) View of nature	• You get freedom from driving responsibilities • Public transport provides time to relax/read/ listen to music • You enjoy the view out of the window • You like the company of fellow passengers
Type 5	**PH**=Public transport use of Habit	a) Perceived behavioural control b) Effect of congestion	• Public transport is the cheapest option for this journey purpose • Public transport is the fastest option for this journey purpose • Public transport is the most reliable option for this journey purpose
Type 6	**PN**=Public transport use of necessity	a) Negative effects of car use b) Social norms c) "Green" activism d) Being ready to change when condition improves	• A car or using a car is too expensive, you cannot afford • You can't drive • Using Public transport is better for environment • You like organic food • When you can afford a car, you will consider to drive • When you get a licence, you will drive

According to the theory of "Planned Behaviour"(Ajzen 1991), different mobility types also indicate the level of possibility on mode change (Table 11). In this case, classifying the people from the two case studies can also help to understand their future trends of mode change.

Table 11: Indicator of mode change for different mobility types

	Indicator of mode change	Possibility
Lover Group	Lowest desiring to change to another mode no matter how good the alternative is.	Low
Habit Group	Persuasion can make changes and better alternative experience can make differences	Medium
Necessity Group	Changing the situation can make large differences	High

There are large differences of the attitude towards car and public transport when the population composition of 6 mobility types in two case studies is examined (Table 12). Compared with Kangjian, Bull Creek's Car user group is larger than PT user. The largest mobility type in Bull Creek is "Car habit" - almost half the population, "PT habit" comes after; "Car lover" and "PT Lover" come third and fourth. The number of "Car necessity" and "PT necessity" people are both quite small. This suggests that people in Bull Creek who are using cars or public transport mostly do so because of a habit. This suggests that they get used to a certain type of traveling method resulting in less attention to the alternatives, regardless of the level of availability (bearing in mind that Bull Creek is a highly public transport accessible location). However it can also be suggested that an experience of an alternative mode could result in changes. In comparison, Kangjian's PT user group is larger than Car user group. It has the largest population of PT Habit Group. There is not as such an obvious difference as Bull Creek between the number of "Lover" groups and "Habit" groups in both travel modes.

Table 12: The Population Composition of 6 Mobility Types in Two Case Studies

		Bull Creek /Perth (n = 120)	**Kangjian/Shanghai** (n = 120)
Car users	Type 1: Car lover	16 (13.3%)	20(16.7%)
	Type 2: Car use of habit	58 (48.3%)	25(20.8%)
	Type 3: Car use of necessity	3 (2.5%)	11(9.2%)
	Total	77(64.1%)	56 (46.7%)
Public transport users	Type 4: PT lover	14(11.7%)	30(25.0%)
	Type 5: PT use of habit	25 (20.9%)	32(26.7%)
	Type 6: PT use of necessity	4 (3.3%)	2(1.6%)
	Total	43 (35.9%)	64(53.3%)
Total		120 (100%)	120(100%)

6. Conclusions and further research

After the external public transport accessibility and urban land use factors are controlled for as far as possible (the exception is density), the variation between precincts on the internal factors such as vehicle ownership from an income base and travel mobility types from an attitude perspective, can assist in understanding to the difference in travel behaviour. The following observations can be drawn:

Mode share: The travel mode share showed a greater difference between those two neighbourhoods. The driving share in Kangjian was still quite small compared with in Bull Creek but much higher in public transport use. The attitudinal questionnaire survey results have revealed that both cases have the largest population of habit group but the mode differs between cases: car habit group of Bull Creek and PT habit group of Kangjian. This "habit" has also revealed the possibility of mode change when better alternative experience or persuasion is possible. Turning "car habit" to use public transport will be good for Bull Creek's sustainable transport development. However, the reverse trend of turning from "PT habit" to using a car will have to be prevented from happening to Kangjian. The outstanding question is to address the different requirements for changing or maintaining "habits" - how to retain the "good" habits of using public transport (in Kangjian) and prevent from turning these to "bad" habits; and also what is the trigger for changing from "bad" habit of using a car for Bull Creek to "good" one.

Travel distance: With a similar distance away from their city centre and similar public transport accessibility, the travel distance by car and transit of both neighbourhoods did not show much difference in their work trips, but differences are evident in non-work trips, likely associated with other factors such as lifestyle. The unique observation is that trip distance increased with motorisation for

both trip purposes. This suggests that, compared with density, travel behaviour is more related to another built environment factor - urban structure. This hypothesis still requires further confirmation.

Income level: There is a significant variation in income levels and travel patterns between the two cases. People who live in Bull Creek had comparatively much higher incomes than that in Kangjian during the survey years. Consequently Bull Creek's vehicle ownership was much higher than Kangjian's at all income levels. Both places show evidence of the global trend that car ownership increases as income grows. Research also notes that, compared with Bull Creek, Kangjian's car ownership was sensitive to income. As Shanghai's economic growth speed is much faster than Perth, the economic gap between these cities will narrow resulting in less difference in household income, car ownership and using of a car. The effect of some socio-economic factors such as income and car ownership on travel behaviour also will become less pronounced over time. In this case travel attitude factors must be paid greater attention is sustainable travel outcomes are to be achieved. The extent to which travel behaviour is affected by this dimension is remains difficult to measure and will benefit from further research.

Socio-economic factors and attitudes: Analysing the secondary travel data in the two cases has enabled a detailed understanding of the travel patterns and the related socio-economic background (in this case income and car ownership). Due to data limitations, this study does not cross-compare the socio-economic characteristics of two cases based on travel mode choice except for income. Collecting the primary data through multi-dimensional attitude statements in the two cases has grouped participants into six distinct travel groups based on their travel attitude. Each group also indicates a different degree of mode change. The evidence of the different distribution of mobility types in the two cases clearly shows that travel behaviour is also impacted by internal attitude factors such as people's personality and lifestyles and is likely impacted by cultural differences.

In conclusion, the unique findings from both case studies are: travel patterns are closely related to internal socio-economic factors (in this case income and car ownership); travel behaviour is also impacted by internal attitude factors such as perceived attitude, personality and lifestyles. Even the current travel patterns are quite different in the two case studies, with the economic development, other socio-economic and demographic factors are likely to become less pronounced over time so travel attitude factors must be paid more attention. Of the current travel behaviour research, empirical evidence from the two neighbourhoods in Perth and Shanghai analysed in this research provides support for the understanding that individual factors especially travel attitude factors are an important dimension which should not be exclusive. To what extent the travel behaviour is affected by those individual factors and how to design more targeted sustainable transport policies start from this dimension is still a question that needs further research.

References

Ajzen, I. (1991). "The theory of planned behavior." Organizational Behavior and Human Decision Processes **50**(2): 179-211.

Anable, J. (2005). "'Complacent car addicts' or 'aspiring environmentalists'? Identifying travel behaviour segments using attitude theory." Transport Policy **12**(1): 65-78.

Bamberg, S. and P. Schmidt (2001). "Theory-Driven Subgroup-Specific Evaluation of an Intervention to Reduce Private Car Use1." Journal of Applied Social Psychology **31**(6): 1300-1329.

Banister, D., et al. (1997). "Sustainable cities: transport, energy, and urban form." Environment and Planning B **24**: 125-144.

Boarnet, M. G. and S. Sarmiento (1998). "Can land-use policy really affect travel behaviour? A study of the link between non-work travel and land-use characteristics." Urban studies **35**(7): 1155-1169.

Cervero, R. (1996). "Jobs-housing balance revisited: trends and impacts in the San Francisco Bay Area." Journal of the American Planning Association **62**(4): 492-511.

Clifton, K. J. and S. L. Handy (2001). Qualitative methods in travel behaviour research, Institute of Transportation Studies, University of California, Davis.

Curtis, C. (2005). "The windscreen world of land use transport integration: experiences from Perth, WA, a dispersed city." Town Planning Review **76**(4): 423-454.

Curtis, C. and D. Olaru (2010). The Impacts of a New Railway : Travel Behaviour Change of Residents in New Station Precincts. 12th WCTR.

Dandekar, H. C. (1986). "Some uses and potentials of qualitative methods in planning." Journal of planning Education and Research **6**(1): 42-49.

Dargay, J., et al. (2007). "Vehicle Ownership and Income Growth, Worldwide: 1960-2030." The Energy Journal **28**(4): 143-170.

Domencich, T. (1975). Urban travel demand : a behavioral analysis : a Charles River Associates research study / Thomas A. Domencich and Daniel McFadden.

Ewing, R. (1995). "Beyond density, mode choice, and single-purpose trips." Transportation Quarterly **49**(4).

Ewing, R., et al. (1996). "Land use impacts on trip generation rates." Transportation Research Record: Journal of the Transportation Research Board **1518**(1): 1-6.

Flamm, B. J. (2006). Environmental knowledge, environmental attitudes, and vehicle ownership and use, University of California.

Flannelly, K. J. and M. S. McLeod Jr (1989). "A multivariate analysis of socioeconomic and attitudinal factors predicting commuters' mode of travel." Bulletin of the Psychonomic Society **27**(1): 64-66.

Geurs, K. T. and B. VAn Wee (2004). "Accessibility evaluation of land-use and transport strategies: review and research directions." Journal of Transport Geography **12**(2): 127-140.

Han, J. (2009). "Evaluating land-use change in rapidly urbanizing China: Case study of Shanghai." Journal of urban planning and development **135**(4): 166-171.

Handy, S. L. (2002). "Travel Behaviour--Land Use Interactions: An Overview and Assessment of the Research. In: In Perpectual Motion: Travle behaviour Research Opportunities and Application Challenges " Pergamon, Amsterdam: pp. 223-236.

Hanson, S. (1982). "The determinants of daily travel-activity patterns: relative location and sociodemographic factors." Urban Geography **3**(3): 179-202.

Hanson, S. and M. Schwab (1986). "Describing disaggregate flows: individual and household activity patterns." The geography of urban transportation.

Ingram, G. and Z. Liu (1999). "Determinants of motorization and road provision." World Bank Policy Researach Working Paper(2042).

Jenks, M., et al. (1996). "Compact cities and sustainability: an introduction." The Compact City: a sustainable urban form: 11-12.

Jensen, M. (1999). "Passion and heart in transport — a sociological analysis on transport behaviour." Transport Policy **6**(1): 19-33.

Kenworthy, J. and G. Hu (2002). "Transport and urban form in Chinese cities: An international comparative and policy perspective with implications for sustainable urban transport in China." disP-The Planning Review **38**(151): 4-14.

Kitamura, R., et al. (1997). "A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay Area." Transportation **24**(2): 125-158.

Kockelman, K. M. (1997). "Travel behavior as function of accessibility, land use mixing, and land use balance: evidence from San Francisco Bay Area." Transportation Research Record: Journal of the Transportation Research Board **1607**(1): 116-125.

Kollmuss, A. and J. Agyeman (2002). "Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior?" Environmental Education Research **8**(3): 239-260.

Kuppam, A. R., et al. (1999). "Analysis of the role of traveler attitudes and perceptions in explaining mode-choice behavior." Transportation Research Record: Journal of the Transportation Research Board **1676**(1): 68-76.

Lanken, B., et al. (1994). "Attitude Versus General Habit: Antecedents of Travel Mode Choice1." Journal of Applied Social Psychology **24**(4): 285-300.

Næss, P. (1993). "Transportation energy in Swedish towns and regions." Scandinavian Housing and Planning Research **10**(4): 187-206.

Naess, P. and S. L. Sandberg (1996). "Workplace location, modal split and energy use for commuting trips." Urban studies **33**(3): 557-580.

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

Pacala, S. and R. Socolow (2004). "Stabilization wedges: solving the climate problem for the next 50 years with current technologies." Science **305**: 968-972.

Pan, H. (2010). Shanghai poly-center urban planning and the impact of transport system.

Pan, H., et al. (2009). "Influence of urban form on travel behaviour in four neighbourhoods of Shanghai." Urban studies **46**(2): 275-294.

Paulley, N., et al. (2006). "The demand for public transport: The effects of fares, quality of service, income and car ownership." Transport Policy **13**(4): 295-306.

Prevedouros, P. D. and J. L. Schofer (1991). "Trip characteristics and travel patterns of suburban residents." Transportation Research Record(1328).

Rajamani, J., et al. (2003). "Assessing impact of urban form measures on nonwork trip mode choice after controlling for demographic and level-of-service effects." Transportation Research Record: Journal of the Transportation Research Board **1831**(1): 158-165.

Sandelowski, M. (1986). "The problem of rigor in qualitative research." Advances in nursing science **8**(3): 27-37.

Scheurer, J., et al. (2008). Spatial Network Analysis of Multimodal Transport Systems: Developing a Strategic Planning Tool to Assess the Congruence of Movement and Urban Structure: a Case Study of Perth Before and After the Perth-to-Mandurah Railway, GAMUT, Australasian Centre for the Governance and Management of Urban Transport, University of Melbourne.

Stead, D. (2001). "Relationships between land use, socioeconomic factors, and travel patterns in Britain." Environment and Planning B **28**(4): 499-528.

Stradling, S. G. (2003). "Reducing car dependence." Integrated Futures and Transport Choices: 100-115.

Tertoolen, G., et al. (1998). "Psychological resistance against attempts to reduce private car use." Transportation Research Part A: Policy and Practice **32**(3): 171-181.

Van Acker, V. and F. Witlox (2005). "Exploring the relationships between land-use system and travel behaviour concepts: some first findings."

Van Acker, V. and F. Witlox (2010). "Car ownership as a mediating variable in car travel behaviour research using a structural equation modelling approach to identify its dual relationship." Journal of Transport Geography **18**(1): 65-74.

Zhao, J. (2009). Preference accommodating and preference shaping: incorporating traveler preferences into transportation planning, Massachusetts Institute of Technology.