FINDINGS OF AN ACTIVITY-BASED HOUSEHOLD TRAVEL SURVEY IN CAPE TOWN, WITH PARTICULAR REFERENCE TO WALKING AS A TRAVEL MODE

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1. INTRODUCTION

This paper reports on an activity-based household travel survey administered in Cape Town. It begins with a discussion on the objectives of the survey (section 2). It goes on to describe the survey instrument and sample (sections 3 and 4). It then presents, given the imposed paper length constraint, nothing more than highlights of survey findings on the nature, extent and relative significance of walking as a travel mode (section 5). Finally, it concludes with a reflection on the implications of the hitherto poorly understood importance of walking in South African cities (section 6).

2. SURVEY OBJECTIVES

The bulk of travel data collection and analysis methods applied in South Africa have been drawn from a stream of methods developed in the United States in the 1950s and 1960s in the context of a 'predict-and-provide' transport policy environment. While these methods – principally in the form of inter-zonal O-D surveys and four-step traffic forecasting models – have been refined and improved over time, they by and large remain, procedurally and substantively, the same as those first developed in the late 1950s in cities like Detroit and Chicago. They also remain centrally focused on the problem of traffic congestion, and the construction of highways in its alleviation. A focus on traffic congestion, together with the labour transportation requirements of urban apartheid, led to a focus on home-based work trips and morning peak periods in past South African travel analysis. In Cape Town in particular, representations of travel need and behaviour have been dominated by baseline surveys and future predictions of motorised commuter or peak period travel (Behrens 2001a). As a result little is currently understood of non-home-based, non-work, off-peak and non-motorised trip-making generally, and how this behaviour varies across different individuals and households. With regard to walking in particular, past commuter surveys have found that this mode accounts for only 5-15% of main mode splits, creating a perception that travel by foot is relatively unimportant.

The general objective of the survey was to demonstrate the diversity of travel needs and behaviour through empirical observation, and in doing so to begin to fill some of these gaps in understanding. The study attempts to indicate the degree to which current representations of travel behaviour misrepresent the full diversity (and complexity) of travel needs, and to indicate what the true extent of these may be. The more detailed research questions addressed in the study are as follows:

- What is the nature and extent of all travel (across 24 hours and across the week) in terms of amongst other things, trip purpose, mode use, range, chaining and timing – and in particular, what is the relative importance and nature of non-work, informal work, non-motorised and off-peak travel?
- What is the influence of household income, and access to private transportation, on travel behaviour – and thus in a pseudo way, what are the dynamics of behavioural change in response to households becoming wealthier and poorer?
- What is the influence of neighbourhood form (i.e. land use distribution and street pattern) and residential location on travel behaviour?
- What is the influence of household life-cycle stage on travel behaviour – and thus in a pseudo way, what are the dynamics of behavioural change in response to households ageing, separating and forming?
- What is the influence of personal circumstance on travel behaviour in terms of amongst other things, trip purpose, frequency, mode use and range – and in particular, what are the impacts of (un/under)employment, household divisions of responsibility and survival strategies on travel behaviour?

3. SURVEY INSTRUMENT

A paper presented by the author at this conference in 2000 provides a description of activity-based travel analysis methods (Behrens 2000). Suffice to say here that, in contrast to earlier methodological streams, its emphasis is not solely on trips, but on people's participation in activities and on the everyday lives within which household travel decisions are embedded. This method was selected on the grounds that it appeared to be best suited to analysing travel behaviour within a personal and household context, and because its diary format has proven to be better at collecting data on all travel.[1]

The survey procedure and instrument underwent a pilot, and a subsequent pre-test, before it was applied in the main survey. The pilot and pre-test surveys took the form of leave-behind self-completed 2-day activity diaries in pen-and-paper format administered by trained university students (see figure 1). The following key problems were experienced:

- It was apparent that amongst many respondents, particularly from lower income households, (and indeed amongst some interviewers) there was a difficulty in reading and completing diary tables as a series of intersecting columns and rows. A common problem was the completion of travel details in the same row as a sedentary activity (e.g. the completed diary table might read that the first activity of the 24-hour day was sleeping, and this was done by minibus-taxi two to three times a week).
- There was often a lack of symmetry between forward and return trips recorded in diary tables (e.g. the forward journey might include a walking trip to a bus station and a bus trip, whereas the return journey [between the same O-D pair] indicates only a bus trip).
- There was often a failure to account for all time on the 24-hour diary table.

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[1] International studies (in the United Kingdom, Australia and the United States) which have compared the quality of travel data collected using conventional trip diaries and activity dairies, have shown that trip recall – particularly short trips, non-home-based trips and trips made by non-motorised modes – tends to be higher (perhaps by around 13-22%) in activity diaries (Arentze *et al* 1997, Barnard 1986, Clarke *et al* 1981, Stopher 1992). The better trip recall in activity-based survey methods is generally attributed to the fact that in activity diaries the respondent is required to account for his or her time continuously and is therefore forced to recall past events more rigorously, and that recounting activity participation (as opposed to trip-making) matches more closely the way people think and function.

- There was a general respondent unwillingness to keep a diary for two consecutive days – some household members who initially agreed to do this, subsequently failed to do so once the effort that was entailed became clear, while others agreed to keep diaries only if they were for one day.

Figure 1 *Pre-test survey activity diary*

Household member name: _____ Day: _____ Date: _____

WHAT DID YOU DO TODAY?

Start time	What kind of activity was this?	Where did you do it?	Which suburb?	End time

IF THE ACTIVITY YOU LISTED INVOLVED TRAVELLING ...

How did you travel?								How many minutes were spent travelling ?	Who, if anyone, did you travel with?	How many times a week do you make this trip?
by walking	by bicycle	by m-bus taxi	by bus	by train	car driver	car passenger	?			

continued for 24 hour day ... ↓

As a result of these problems the following instrument changes were made:

- The 2-day diary period was replaced by previous 24-hour day recall.
- The leave-behind self-completion questionnaire were replaced by recall interviews.
- The pen-and-paper format of the survey instrument was converted to an electronic one, so that the interview could be conducted with the use of computer-assisted personal interviewing (CAPI) *In2quest* software, and the interview transcript was translated into the three main languages spoken in the study area (Afrikaans, English and isiXhosa). An advantage of CAPI interviews, in terms of the pre-test experience, was that the completion of tables are avoided altogether, interviewers can prompt respondents when it becomes apparent that trip segments or waiting times have been omitted, and logical checks can be put into place that prevent gaps in diary time or missing/beyond range data.
- The use of students as interviewers was discontinued, in favour of a more reliable and experienced market research company with professional interviewers of all racial groups (with concomitant impacts on cost and sample size);

Data were collected during school terms – between 23 October and 29 November 2000, and 26 January and 3 February 2001.

4. SURVEY SAMPLE

It was clear from the outset that resources were not available with which to undertake a survey that would yield data that are statistically representative of metropolitan Cape Town's population as a whole. In the context of limited research funds, the sample size was determined simply as the largest amount of sampling units affordable. Table 1 illustrates that 95% confidence levels and 5% confidence intervals for each of the sampling areas would have necessitated a total sample size of 1 797 households. This would have necessitated almost nine times the resources available. With the available resources it was only possible to survey 204 households. The data collected and analysed is thus 'indicative' of diversity, rather than 'representative' of reality. In strict statistical terms the best that can be claimed is that one can be 95% confident that the actual mean of a simple dichotomous variable falls within 15.2% to 17.6% on either side of the sample mean, depending on the sampling area. Given the objectives of the survey this was justifiable.

The data has not been used to calibrate a predictive model, nor to make claims of statistical representivity. It has been used to investigate diversity and the size of gaps in understanding, and to explore an innovative research method under South African conditions.[2]

The sample of 204 households was stratified into three equally sized – high, middle and low – combined household (gross) income bands. Census data were analysed to determine the cut off points for these bands, and these values were then adjusted, using the Consumer Price Index, to relate more accurately to current incomes. The sample was distributed proportionately across these three bands. Thus about 68 households in each income band were surveyed.

The sample of households was then clustered into selected transport zones (TZs) of the CMA (see figure 2). For each income stratification, two TZs were selected. Thus about 34 households were surveyed in each of the six TZs (see table 1). The two TZs were selected on the basis of ease of access to commercial and employment opportunities. The first was a residential neighbourhood with a mixed pattern of land use, and an open, pedestrian-oriented street pattern. These 'inner location' TZs have local access (meaning within a 2.5-3 km walking distance) to commerce and employment opportunities. The second was a residential neighbourhood with little or no local access to (formal) commerce and employment opportunities, and a closed, car-oriented street pattern. These were called 'outer locations'.

Table 1: *Sampling areas*

	HIGH-INCOME R5 501/month or more		MIDDLE-INCOME R1 801-R5 500/month		LOW-INCOME R1 800/month or less	
	inner loc. ✶1	outer loc. ✶2	inner loc. ✶3	outer loc. ✶4	inner loc. ✶5	outer loc. ✶6
suburb(s)	Rondebosch (TZ 706)	Kleinbosch, Welgelegen (TZ 1005)	Salt River, Woodstock (TZ 203)	Rocklands, Westridge (TZ 3008)	Langa (TZ 1203)	Mfuleni (TZ 3214)
number of people (1996)	4 337	5 163	4 216	20 416	46 505	10 036
number of households (1996)	1 224	1 591	1 440	4 187	14 187	2 904
mean household size (1996)	3.54	3.25	2.93	4.88	3.28	3.46
target population (1996)[1]	918	1 082	504	2 177	9 931	2 207
ideal sample size[2]	271	284	218	327	370	327
actual sample size	34	31	34	41	31	33
actual confidence interval[3]	16.5	17.4	16.3	15.2	17.6	16.9

Notes: 1= The target population in each TZ is that portion of the entire population falling within the specified income band stratification. 2= The ideal sample size is calculated to have a confidence level of 95% and a confidence interval of 5%. 3= The actual confidence interval is calculated to have a 95% level of confidence.

Households were selected at random from a sampling frame in each of the sampling areas. The sampling frame took the form of an inventory of street or shack addresses. Only households falling within the appropriate income band were interviewed. Randomly selected households who fell into the wrong band were substituted, as were households unable to provide previous day recall diaries for at least 70% of household members (who were either independently mobile or generated their own individual activity schedule). Thus, in summary, the sample may be described as randomly selected, proportionately stratified and quasi-clustered.

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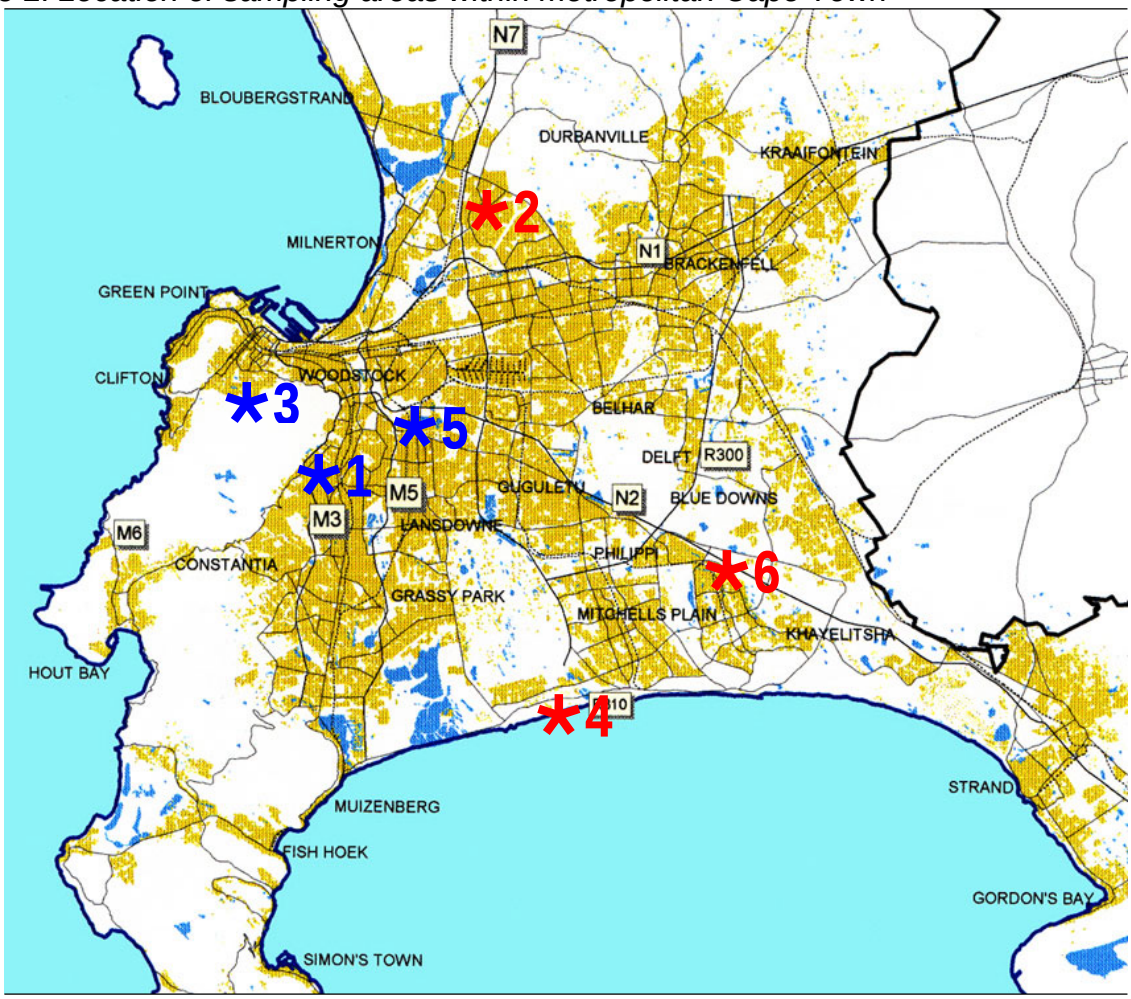
[2] A paper presented at the International Conference on Transport Survey Quality and Innovation in August 2001 provides a discussion on methodological insights gained from administering the survey in the South African context. (Behrens 2001b)

Figure 2: *Location of sampling areas within metropolitan Cape Town*



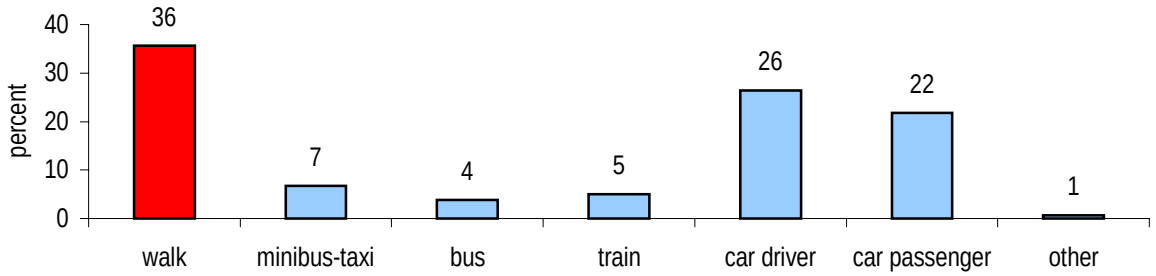
4. SURVEY FINDINGS

Bearing in mind the relatively low confidence interval of the sample, the findings of the survey with regard to the nature, extent and relative importance of walking as a travel mode are discussed briefly below, in terms of trip generation, trip purpose, trip timing, travel time, and travel distance.

4.1 Trip generation

The mean household trip generation finding for the sample as a whole is 8.35 trips/day (or 2.37 person trips/day) for the entire 7-day week, and 9.67 trips/weekday (or 2.74 person trips/weekday). Figure 3 indicates that 36% of all trip purposes were undertaken on foot as the main travel mode. The mean household main mode walking trip generation of the sample is therefore in the region 3.01 trips/day (or 0.85 person trips/day). The sample data indicate that the motor car is the single most utilised main mode (48%), followed by walking, while public transport is the main mode for 16% of all trips. Interestingly the 48% car share is very similar to that portion of households found to have access to cars (49%), suggesting that once a household gains access to a car its members switch modes extensively. The relative importance of walking as a travel mode is however underestimated in main mode use analysis as walking trip segments are invariably attached to both ends of public transport trips and sometimes to an end of motor car trips as well.

Figure 3: *Main mode use for all trip purposes (n = 204 h)*



Note: Despite a bicycle ownership ratio of 77 bicycles/1000 people, no bicycle use was recorded in the survey.

The survey data suggest that trip generation declines steadily with decreasing income – mean household trip generation is around 11.11 trips/weekday amongst high-income households (or 3.44 person trips), 9.69 trips/weekday amongst middle-income households (or 2.37 person trips), and 8.21 trips/weekday amongst low-income households (1.97 person trips). Figure 4 indicates that walking as a main travel mode increases rapidly as household incomes decline – at 9% amongst high-income households, 43% amongst middle-income households, and 61% amongst low-income households. Thus the mean household main mode walking trip generation of high-income households is around 1.00 trips/day (or 0.31 person trips), 4.17 trips/day (or 1.02 person trips) for middle-income households, and 4.93 trips/day (or 1.20 person trips) for low-income households.

Figure 4: *Main mode use for all trip purposes by household income (n = 204 h)*

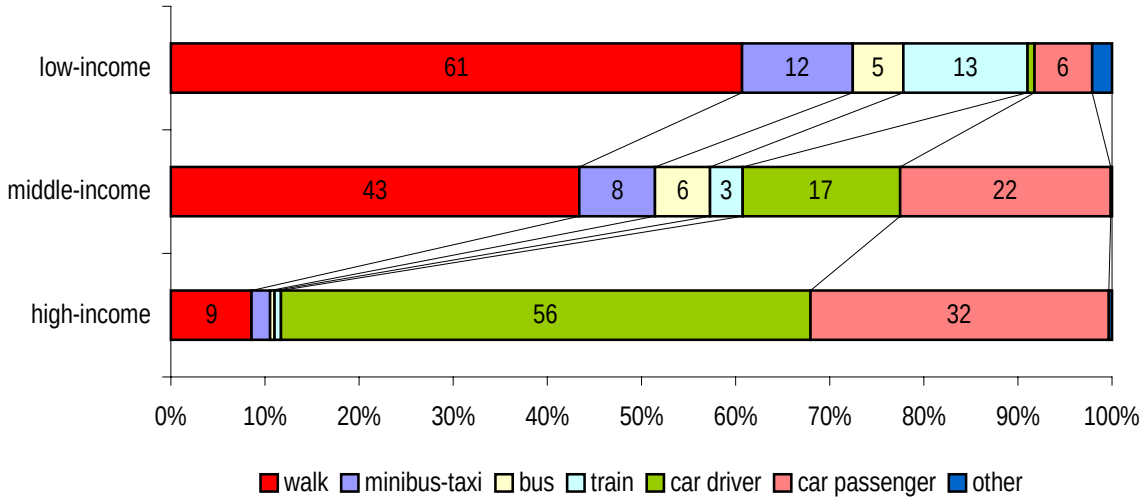


Table 2 illustrates the impact household car availability has on trip generation and mode use. Households with greater access to cars were found to generate more trips in both inner and outer location categories, but interestingly inner located households without a car, and those with access to just one car, were found to have the same trip generation rate. This suggests that a lack of private mobility is less of a hindrance in these areas, and is compensated for by greater walking. In outer locations, households without a car are unable to substitute car trips with walking trips to the same extent, and as a result generate fewer trips.

Table 2: *Mean household trips/day amongst inner and outer location households by main mode and vehicle availability (n = 204 h)*

		WALK	MINIBUS-TAXI	BUS	TRAIN	CAR DRIVER	CAR PASS.	OTHER	TOTAL TRIPS
inner location	no car	**5.18**	0.69	0.09	0.96	0.07	0.87	0.02	7.89
	1 car	**1.97**	0.62	0.07	0.21	2.86	2.14	0.00	7.86
	2 cars	**0.78**	0.11	0.00	0.00	7.56	4.44	0.11	13.00
	3 cars	**0.67**	0.00	0.17	0.00	10.83	1.00	0.00	12.67
outer location	no car	**3.25**	0.90	0.73	0.44	0.04	0.63	0.17	6.15
	1 car	**2.78**	0.37	0.67	0.11	2.26	2.70	0.00	8.89
	2 cars	**0.77**	0.15	0.08	0.08	5.35	3.46	0.04	9.92
	3 cars	**1.00**	0.00	0.67	0.00	8.33	7.33	0.00	17.33

4.2 Trip purpose

Table 3 indicates that for the sample as a whole walking is the most common main mode in trips to social, education, personal business and recreation activities, while the motor car is the most common main mode used for all other trip purposes. Table 4 indicates that while walking as a main travel mode seldom accounts for more than 10% of mode splits amongst high-income households (recreation is the exception), amongst middle- and low-income households main mode walking has the largest share of numerous trip purposes. Amongst low-income households in particular it has the largest mode share in all trip purpose categories, with the exception of work trips.

Table 3: *Percentage main mode use by trip destination activity purpose (n = 204 h)*

	WORK	EDUC.	SHOP.	BUS.	SOC.	P. BUS.	REC.	SERVE	HOME
walk	**16.94**	**41.83**	**33.13**	**6.25**	**52.04**	**28.85**	**39.77**	**12.28**	**37.90**
bicycle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
taxi	11.48	10.46	5.42	0.00	1.53	19.23	4.68	0.00	6.77
bus	9.84	5.23	2.41	0.00	0.51	0.00	1.75	0.00	4.47
train	13.66	3.27	1.20	6.25	0.51	13.46	2.92	0.00	5.48
car driver	34.43	16.34	34.94	68.75	19.39	21.15	23.39	54.39	23.34
car passenger	10.38	22.22	22.89	18.75	26.02	17.31	27.49	33.33	21.47
other	3.28	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.58

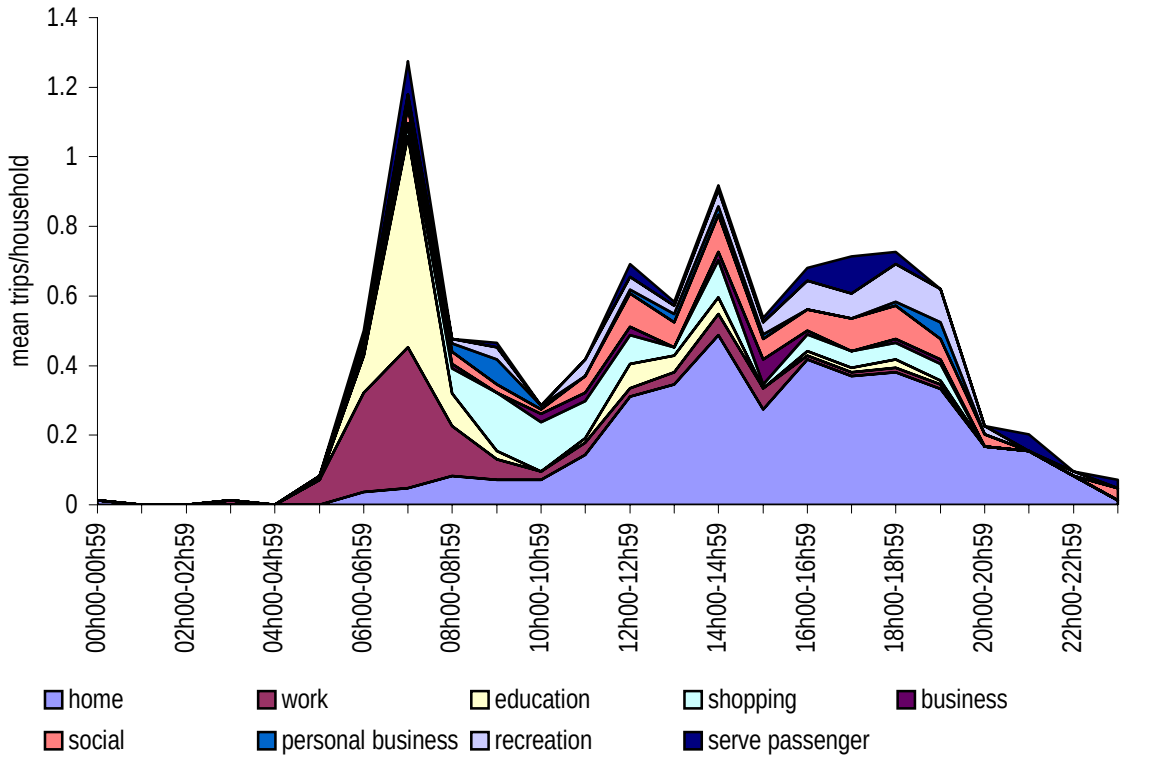
4.3 Trip timing

Figure 5 illustrates weekday (all travel mode) trip timing by trip destination activity purpose. This profile suggests that across the day four peaks occur: one in the morning (associated with trips to schools and work) and the remaining three in the afternoon. This triple afternoon peak – which is atypical of developed world cities (see for instance Papacostas and Prevedouros 1993: Fig. 8.2.2) presumably due to equal proportions of education and work trips in the South African context – involves a smaller peak around lunch time, a second larger peak around 14h00 when most school days end, and a third peak around 17h00-18h00 when most working days end.

Table 4: *Percentage main mode use by trip destination activity purpose and household income (n = 204 h)*

		WORK	EDUC.	SHOP.	BUS.	SOC.	P. BUS.	REC.	SERVE	HOME
high-income	**walk**	**8.88**	**6.80**	**10.26**	**4.55**	**7.89**	**0.00**	**15.71**	**5.56**	**9.34**
	taxi	0.00	13.16	1.28	0.00	0.00	0.00	0.00	0.00	2.38
	bus	1.85	2.63	0.00	0.00	0.00	0.00	0.00	0.00	0.44
	train	1.72	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.48
	car driver	78.54	39.11	57.16	81.82	54.91	69.70	46.90	60.83	53.02
	car pass.	7.28	36.92	31.31	4.55	37.19	30.30	37.38	33.61	34.35
	other	1.72	1.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00
middle-income	**walk**	**19.15**	**63.21**	**47.15**	**16.67**	**53.17**	**75.00**	**44.01**	**17.86**	**45.39**
	taxi	18.68	11.13	9.11	0.00	2.28	0.00	4.78	0.00	8.22
	bus	14.11	3.63	8.70	0.00	0.89	0.00	1.09	0.00	6.91
	train	10.05	1.25	2.17	0.00	0.00	0.00	4.78	0.00	3.62
	car driver	22.18	6.13	17.03	47.62	13.69	25.00	14.76	52.47	14.80
	car pass.	15.83	14.64	15.84	35.71	29.96	0.00	30.60	29.67	20.72
	other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33
low-income	**walk**	**23.41**	**62.35**	**73.21**	**0.00**	**91.74**	**38.33**	**73.18**	**100.00**	**61.10**
	taxi	18.33	7.50	8.33	0.00	2.38	25.00	11.21	0.00	10.48
	bus	10.53	12.94	0.00	0.00	0.00	0.00	6.67	0.00	5.67
	train	30.31	11.76	7.14	0.00	1.47	22.50	2.27	0.00	14.50
	car driver	1.72	0.00	0.00	0.00	0.00	0.00	3.33	0.00	0.54
	car pass.	3.45	5.44	11.31	0.00	4.41	14.17	3.33	0.00	5.79
	other	12.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.92

Figure 5: *Weekday hourly trip timing by destination activity purpose (n = 84 h)*



The fact that the second of the afternoon peaks mentioned above (i.e. trips departing 14h00-14h59) is generally not reflected in congestion patterns in Cape Town can be attributed to the fact that most school to home trips are undertaken by foot. Figure 6 illustrates trip timing by motorised and non-motorised modes, and here it can be seen that the timing profile of motorised trips resembles more closely those of developed world cities, and reflects more closely the timing of observable congestion patterns. As might be expected, figure 7 indicates that the 14h00-14h59 peak in non-motorised trip departures is reflected in the timing of child pedestrian road accident casualties. While not corresponding exactly with the non-motorised trip timing profile indicated in figure 6, and clearly illustrating that pedestrian casualties are greatest in the evening when visibility is poor, these data do indicate that national urban pedestrian casualties amongst children occur earlier in the day than other age groups, and this is probably associated with home-based education trips.

Fig. 6: *Weekday hourly trip timing by motorised and non-motorised modes (n = 84 h)*

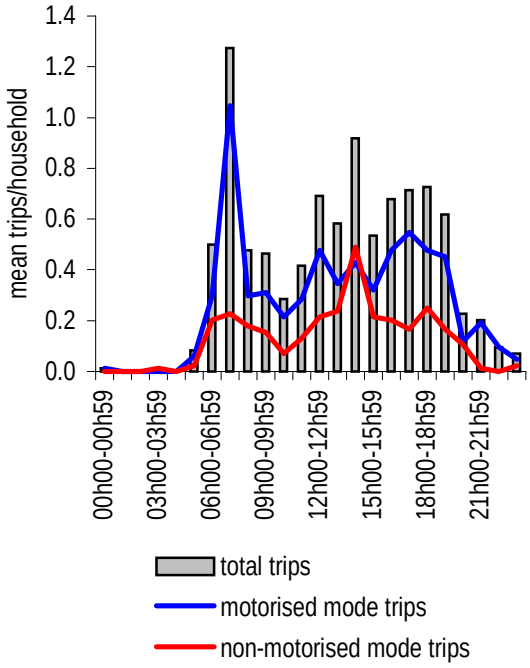
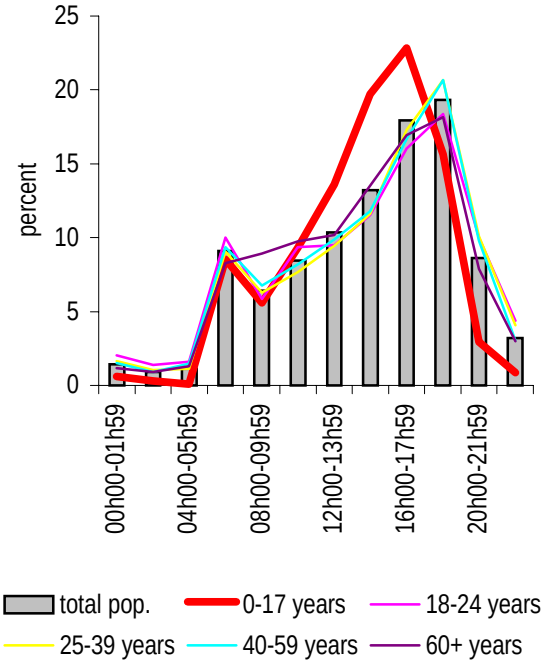


Fig. 7: *National urban pedestrian casualties by age and known time of day (1997)*



Source: Makhanya *et al* 1998:3

4.4 Travel time

Internationally it is commonly assumed that maximum acceptable walking trip times to local neighbourhood or town centres and public transport stops are 5-10 minutes (roughly equivalent to maximum walking distances of 400-800 m), that walking trips are internal to local neighbourhoods, and thus higher speed arterials spaced at 1.5-2 km intervals minimise pedestrian conflict. The survey data suggest however that only 20% and 39% of low-income household walking trip segments are less than 5 and 10 minutes respectively (see figure 8). Thus the majority (61%) of walking trip segments in this income band are longer than 10 minutes, and some 18% of trip segments are longer than 30 minutes – in fact 8 respondents in the sample recorded walking trips in excess of 3 hours. Amongst middle-income households, 33% and 62% of walking trip segments are less than 5 and 10 minutes respectively. In this income band 38% of walking trip segments last longer than

10 minutes, but the majority (96%) are less than 30 minutes. As discussed earlier, amongst high-income households walking as a travel mode is less significant (see figure 4), and the most common walking trip purpose is recreational (see table 4). These data, while not necessarily implying that all walking trips traverse neighbourhood boundaries, do suggest that the international walking trip assumptions that underpin conventional parallel arterial frequency and safe neighbourhood delimitation, do not hold true in middle- and low-income local areas in South Africa.

Figure 8: *Walking trip segment travel time by household income (n = 139 h)*

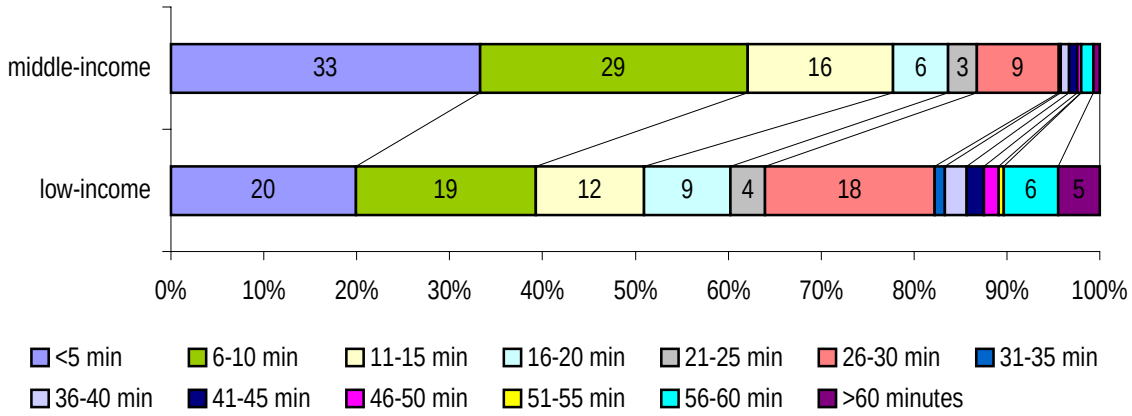
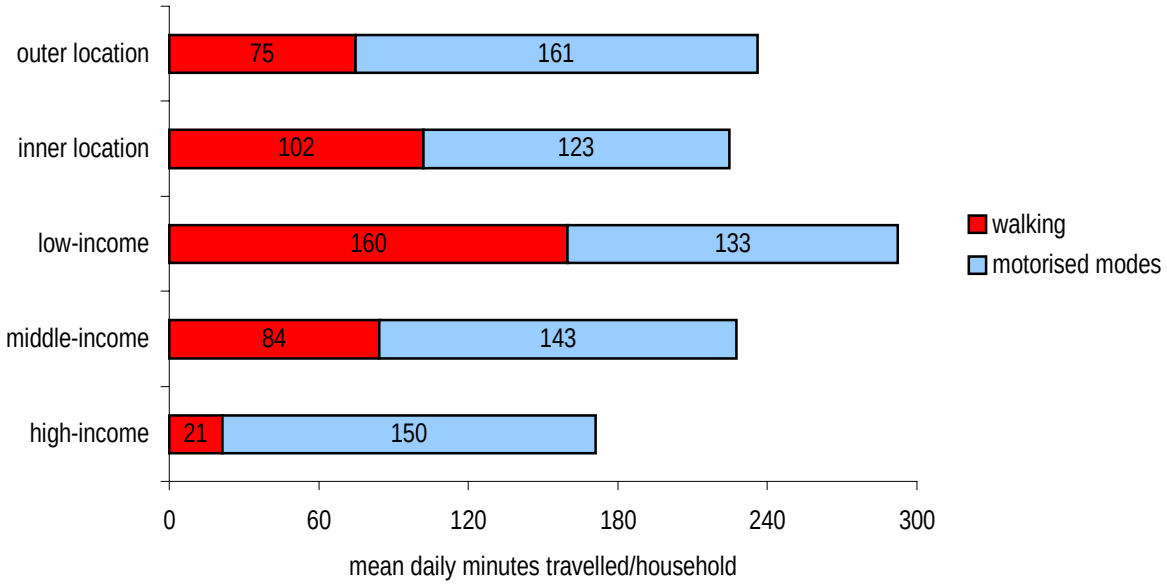


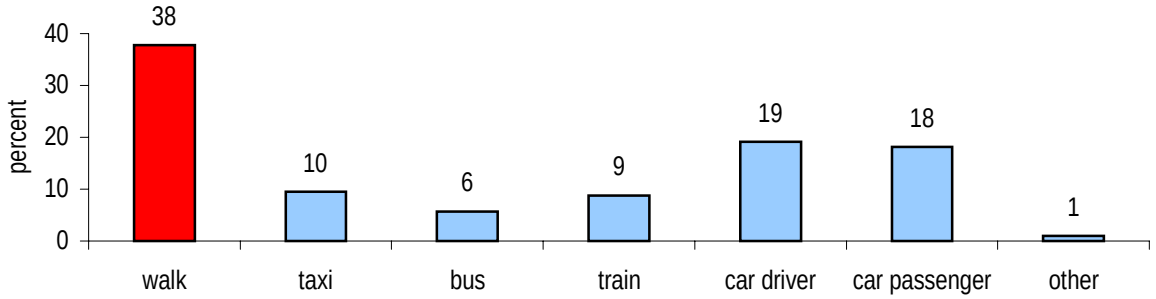
Figure 9 indicates the amount of time households in inner and outer locations (as well as those in different income bands) spend travelling. The figure suggests, somewhat surprisingly, that outer location households travel for only slightly longer periods of the day than inner location households – the greater time spent travelling by motorised modes in outer locations would appear to be offset by greater walking time in inner locations. The figure also suggests that income has a greater influence on daily time use than location – due to the considerable increase in the use of walking as a travel mode amongst lower income households.

Figure 9: *Daily household travel time by location and income band (n = 204 h)*



Data for the sample as a whole suggest that on average 5% of daily personal time (72 minutes over a 24-hour period) is taken up on travel activities. Walking accounts for about 38% of this time, and the motor car for 37% (see figure 10). The average time spent walking per person daily is therefore in the region of 28 minutes.

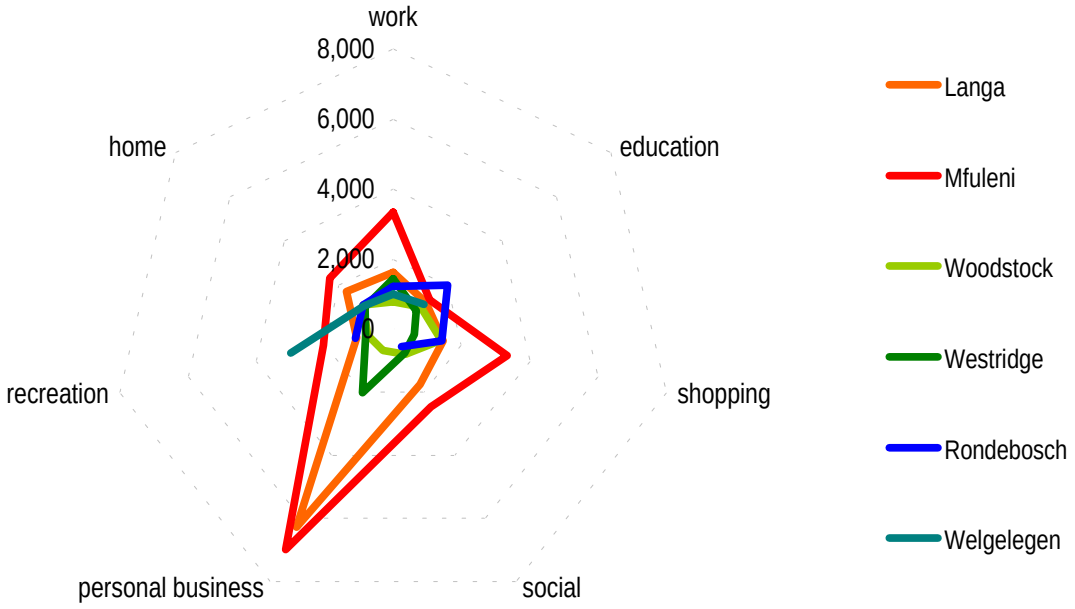
Figure 10: *Time use by travel mode (n = 204 h)*



4.5 Travel distance

It is possible, assuming a mean walking speed of 4 km/h (or 67 m/min), to convert data on travel time into data on travelled distance. Figure 11 indicates that poorer households (living in Langa and Mfuleni) have considerably larger notional walking trip ranges than wealthier households. The mean (main mode) walking trip length amongst low-income households was found to be 2 800 m – a finding broadly consistent with earlier studies of walking in South African cities in which mean distances for different trip purposes were found to vary between 1 600 m and 2 300 m (de Lange and Vorster 1989, Pienaar 1994).

Figure 11: *Mean imputed (main mode) walking trip distance (metres) by destination activity purposes and sampling area (n = 204 h)*



5. CONCLUSION

The general conclusion of this paper is that, while accounting for a relatively small share of commuter mode use, walking is an important travel mode amongst middle- and low-income households. The foot, more than any other mode in South African cities, rivals the motor car as a means of transportation. Just as wealthier households spiral into a condition of 'car dependence', poorer households are forced into a condition of 'foot dependence'. The focus on commutes and peaks in past surveys has in all likelihood distorted widely held perceptions of travel needs and patterns. As a result of being routinely excluded or underestimated in past travel surveys, the importance of walking trips – in terms of their roles in satisfying travel needs and in analysing road safety problems – has not been fully understood. At best this exclusion or underestimation has introduced a routine bias in the way in which the urban transportation problem has been framed and skewed transport planning resources away from pedestrian network planning issues, and at worst has led to neglect in the planning and design of infrastructure improvement for the poor and vulnerable road users. Walking needs to be analysed as a travel mode in its own right, and accommodated equitably in plans and improvement programmes.

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FINDINGS OF AN ACTIVITY-BASED HOUSEHOLD TRAVEL SURVEY IN CAPE TOWN, WITH PARTICULAR REFERENCE TO WALKING AS A TRAVEL MODE

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