Balancing Work, Life and Family Demands – Trip Chaining in South East Queensland

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1   Introduction

Theophrastus, a Greek philosopher from the third century BC said *"time is the most valuable thing a man can spend"*. More recently, Golob (1997) re-phrased this sentiment in terms of consumer behaviour theory when he noted that *"time is the ultimate resource constraint"*. So true, especially when one considers that *"even a long human life adds up to only about 650 000 hours"* (Bryson 2003).

The Australian Bureau of Statistics (ABS 1997) has been tracking the way Australian's spend this 'ultimate resource' through the national Time Use Survey, undertaken in 1992 and 1997. Important trends evident from these surveys include:

- employed persons are working longer hours;
- time spent on domestic and child care activities changed little;
- there was a marked decline in Australians' involvement in sport;
- time spent on recreational pursuits decreased significantly; and
- time spent travelling increased marginally.

A key observation in the ABS report was that 53% of couples with dependent children and 41% of lone parents always or often felt pressed for time. This demographic represents over 25% of households within South East Queensland.

Given this background, and other factors such as higher fuel prices and a greater awareness of environmental issues, we expect that the propensity for households to trip chain has increased. The question that we have attempted to answer in this paper is "how has the propensity to trip chain changed?"

2   Objective

The primary aim of this paper is to begin to redress the dearth of local research on trip chaining behaviour. In doing so, we aim to quantify temporal and spatial differences in trip chaining behaviour, using household travel data collected in South East Queensland over the last 20 years. We test the hypothesis that there has been an increase in local trip chaining behaviour. Finally, we aim to suggest useful areas for further study.

3   Definitions

Trip chaining in the fields of transport planning and modelling is a mature concept, having been a focus of research since at least the 1970s. Nevertheless, the topic suffers from a lack of common definitions for some its most basic elements. This probably reflects the disparate nationalities of researchers in the topic, including Asia (particularly Japan), North America and the European Union. Different researchers define a sequence of trips between given anchor points as a 'tour', 'chain' or 'sojourn'. Similarly, the choice of anchor point differs between researchers (eg home or work).

However, given that this research was inspired by Golob's excellent 1997 paper on trip chaining and activity modelling, we have adopted the definitions used therein, namely a:

- 'tour' is a series of trips that start and end at home;
- 'stop' occurs when the trip ends away from home;
- 'simple' tour comprises two trips (ie one stop away from home);
- 'complex' tour has three or more trips (ie two or more stops away from home); and
- stop can either be for 'work' or 'non-work' purposes.

Table 1 lists the six different combinations possible using Golob's definitions. The percentage of 'no purpose' tours with zero stops (eg walking the dog) is so small that this category can be safely ignored. The middle four categories of tour type are self explanatory. However, by their nature, all 'work/non-work' tours are complex, as they involve at least two stops (ie one for work and one for non-work purposes).

Table 1   Tour type definitions

Stopped for		Num of		
Work	Non-Work	Stops	Tour Type	Example
No	No	None	Zero Stop	Home-Home (eg walking the dog)
No	Yes	1	Simple Non-Work	Home-Shops-Home (eg to buy something)
No	Yes	2+	Complex Non-Work	Home-School-Gym-Home (eg drop children at school then exercise at gym)
Yes	No	1	Simple Work	Home-Work-Home (eg the journey to work and back)
Yes	No	2+	Complex Work	Home-Work-Hotel-Home (eg journey to work, present conference paper, return home)
Yes	Yes	2+	Complex Work / Non-Work	Home-Work-Shop-Home (eg journey to work, stopping to buy dinner on way home)

It would be possible to further refine the categorisation of tour types listed above, to differentiate between the more common non-work activities (eg shopping, education, recreation, personal business etc). This has already been done by others (eg McGuckin and Murakami 1995). However, the main purpose of our research is an initial 'top-line' examination of local trip chaining behaviour. Accordingly, we felt that a more detailed analysis of the specific non-work activities would be best saved for later.

4   Data Sources

Our efforts focussed on the last three rounds of household travel surveys undertaken in South East Queensland. Not only are we most familiar with these datasets, they allow analysis of both spatial (ie Brisbane, Gold Coast and Sunshine Coast) and temporal (ie 1986, 1992 and 2003/04) differences in trip chaining behaviour. An international flavour is added by including a comparison with Golob's data for Portland (Oregon), which was collected in 1994/95. The key demographic characteristics of the eight datasets used in this research are listed in Table 2.

Table 2   Study area demography

Location	Area (k.km²)	Year	Population (M.persons)	Pop Density (persons/km²)
Brisbane	4.67	1986	1.04	222
		1992	1.36	292
		2003/04	1.74	371
Gold Coast	1.40	1992	0.29	210
		2004	0.46	325
Sunshine Coast	3.13	1992	0.11	35
		2004	0.27	85
Portland	0.32	1994	0.51	1 580

The eight datasets span a population range of 0.11-1.74 million persons and densities ranging from 35 to 1 580 persons/km². This represents quite a diverse data source on which our analyses were based. Key characteristics of the eight datasets used in this research are listed in Table 3. Average household sizes ranged from 2.14 to 2.83 persons/household, while sample sizes ranged from 1 390 to 5 810 households. All of the local household travel data (eg for Brisbane, Gold Coast and Sunshine Coast) were obtained using a one day (ie weekday) travel diary. The 1986 dataset for Brisbane contains linked-trips, while the 1992 and 2003/04 datasets contain information on unlinked-trips (eg including change mode trips).

Table 3   Sample characteristics

Location	Year	Survey Type	Sample Size (HH)	HH Size (pers/HH)
Brisbane	1986	Personal Interview	1 960	2.79
	1992	Mail-out / Mail-back	5 810	2.83
	2003/04	Personal Delivery / Mail-back	4 120	2.62
Gold Coast	1992	Mail-out / Mail-back	2 700	2.46
	2003	Personal Delivery / Mail-back	1 470	2.54
Sunshine Coast	1992	Mail-out / Mail-back	2 830	2.56
	2003	Personal Delivery / Mail-back	1 390	2.51
Portland	1994	Unknown	3 220	2.14

Unfortunately, the key characteristic that varied significantly across the eight datasets was survey type. While all surveys collected information on essentially the same household, person and trip based variables, the different data collection methodologies employed would (undoubtedly) result in significant differences in reported trip making behaviour. Similarly, it is likely that any differences in trip chaining behaviour would be due (in part) to the different data collection methodologies employed. This suggests a need to focus on major differences (say >10%) when comparing datasets obtained using different data collection methods.

5   Methodology

All seven local datasets were cleaned and checked, prior to converting trips into tours. This involved excluding households with:

- missing trip data for one or more persons;
- in-complete or missing intermediate stop details (eg place or purpose); and
- in-complete tours (ie tours that did not start and end at home).

This pre-processing resulted in an average sample loss of 9% across all seven local datasets, as detailed in Table 4. Despite this loss, the final datasets still contained a considerable number of households for which full and complete information on trip chaining could be obtained.

Table 4 Sample loss

Location	Year	Original Num HH	Invalid HH	Valid HH	Sample Loss
Brisbane	1986	1 960	140	1 820	7%
	1992	5 810	550	5 260	9%
	2003/04	4 120	510	3 610	12%
Gold Coast	1992	2 700	240	2 460	9%
	2004	1 470	100	1 370	7%
Sunshine Coast	1992	2 830	250	2 580	9%
	2004	1 390	130	1 260	9%

A visual basic macro was written to derive tours from sequential trips records for each person in each household. As noted above, all tours commence and end at home, and the process kept track of the number and type of intermediate stops when the person was away from home. Tours were then categorised as being for either work only, non-work only or work/non-work. The number of intermediate stops (ie away from home) was used to categorise tours as being either simple (ie one non-home stop) or complex (ie two or more non-home stops). The actual number of non-home stops was also recorded for each tour, to allow a subsequent analysis of differences in the distribution of tour types.

6 Results

Over 187 000 trip records from the seven local databases were processed, resulting in over 60 100 home-based tours records. The challenge for us is to present a meaningful dissection of the data that helps quantify temporal and spatial differences in local trip chaining behaviour and tests the hypothesis that this has increased over time.

6.1 Trips

A brief review of household and person trip rates will help to put the subsequent assessment of trip chaining behaviour into context. These metrics are summarised in Table 5 for the seven local and one international datasets. Several important trends are evident, namely:

- average household and person trip rates have decreased over time in the Brisbane area, remained relatively stable on the Gold Coast and increased in the Sunshine Coast (by comparison, more stable trip rates have been observed in other Australian cities, such as Sydney);

- the most recent (ie 2003/04) household trip rates are 16-23% higher than the equivalent value for Portland; and

- the most recent (ie 2003/04) person trip rates are within ±5% of the equivalent value for Portland.

Table 5   Trip rates

Location	Year	Daily Trips/HH	Daily Trips/per
Brisbane	1986	11.1	3.96
	1992	10.3	3.61
	2003/04	9.20	3.49
Gold Coast	1992	8.59	3.45
	2003	8.78	3.42
Sunshine Coast	1992	9.04	3.50
	2003	9.36	3.72
Portland	1994	7.59	3.55

As noted above, a degree of the variation observed in the local trip rates could be due to the different data collection methodology used in each case. For example:

- the 1992 and 2003/04 data were collected during slightly different times of the year (ie October and November versus October, November, early-December, February and March);

- travel diaries were completed for children under five in 1992, while these were re-constructed from the diaries of other household members in the 2003/04 surveys;

- for the 2003/04 surveys, multi-purpose stops within regional shopping centres were coded as a single trip to the shopping centre, irrespective of the number of different activities undertaken while at the shopping centre;

- only personal travel of professional drivers was collected in the 1992 and 2003/04 surveys and this point was emphasised more in the 2003/04 surveys;

- the 2003/04 data are from a smaller sample of households and care should be taken when reporting analyses with significant segmentation of the data, since the sample sizes within some strata may be relatively low; and

- there were differences in the clustering of sample sizes for the 1986 and 2003/04 surveys (for efficiency purposes) versus the more random sample that could be achieved using the mail out/back technique adopted in the 1992 survey.

6.2 Tours

As shown in Table 6, the average number of tours per local household has been decreasing in Brisbane, but increasing on the Gold and Sunshine Coasts. Most recently (ie between 1992 and 2003/4), the average number of tours / person has increased slightly in all three areas. Over the same period, the average number of trips / tour has decreased. Taken together, these trends indicate a decrease in local trip chaining behaviour (ie more shorter tours versus fewer longer ones).

By comparison, the most recent 2003/04 data indicates fewer tours / person locally than in Portland (ie 1.15-1.24 versus 1.32), but with a higher number of trips / tour (ie 2.90-3.03 versus 2.68). In other words, residents of South East Queensland undertake fewer, but longer (in terms of trips), tours than their Portland counterparts.

Table 6   Tour rates

Location	Year	Daily Tours/HH	Daily Tours/per	Trips/tour
Brisbane	1986	3.87	1.38	2.86
	1992	3.22	1.13	3.21
	2003/04	3.04	1.15	3.03
Gold Coast	1992	2.73	1.09	3.15
	2003	3.02	1.18	2.90
Sunshine Coast	1992	2.87	1.11	3.15
	2003	3.13	1.24	2.99
Portland	1994	2.83	1.32	2.68

The results presented in Table 6 also indicate a greater spatial variation in tours / household amongst the three 1992 datasets, than in 2003/04. This might be a "regression to mean" effect, as all three areas become more homogeneous over time.

6.3 Stops

Table 7 highlights the variation in stops (ie away from home) per household and person for the eight datasets. Generally, both of the local versions of these metrics are diminishing with time, except for stops / person in the Sunshine Coast which increased sightly between 1992 and 2003/04. This indicates that local households and residents can meet their daily needs in fewer stops than previously.

Table 7   Stop rates

Location	Year	Daily Stops/HH	Daily Stops/per
Brisbane	1986	7.21	2.58
	1992	6.83	2.39
	2003/04	5.83	2.21
Gold Coast	1992	5.64	2.27
	2003	5.46	2.13
Sunshine Coast	1992	5.94	2.30
	2003	5.91	2.35
Portland	1994	4.76	2.23

This might be because, increasingly, multiple household and personal needs are able to be met at a single stop. For example, this could be due in part to the growth in the scope of services available at regional shopping centres over the past 20 years. Similarly, increasing co-location of other related uses, such as pharmacies and medical centres, have made it easier to fulfil related needs at the one location.

6.4 Tour Type

By expressing the number of simple and complex work and non-work tours as a percentage of the average number of tours / household, it is possible to correct for the underlying changes in trip rates identified above. This is done in Table 8, which also ignores the very small proportion of 'zero stop' tours.

Table 8   Tours by type

Location	Year	Work Only		Work / Non-Work	Non-Work		Chaining Propensity
		Simple	Complex	Non-Work	Simple	Complex	Propensity
Brisbane	1986	15%	4%	11%	49%	21%	0.55
	1992	16%	2%	17%	42%	23%	0.72
	2003/04	17%	2%	14%	45%	23%	0.63
Gold Coast	1992	16%	3%	15%	43%	24%	0.71
	2003	18%	1%	13%	44%	24%	0.61
Sunshine Coast	1992	13%	2%	13%	45%	26%	0.71
	2003	14%	1%	13%	48%	24%	0.61
Portland	1994	14%	2%	20%	43%	21%	0.75

The first point to note about the results listed in Table 8 is the high degree of similarity between study areas and across years, particularly for the proportion of work only tours (both simple and complex) and complex non-work tours. Secondly, the proportion of tours by type does not exhibit a consistent trend across years or study areas.

6.5 Trip Chaining Behaviour

To help discern any underlying trends in trip chaining behaviour, we have devised a new parameter called the 'chaining propensity ratio', or CPR for short. This is calculated by taking the ratio of the complex to simple tours, across all purposes (ie work or non-work). Thus, a CPR of 0.5 indicates that there are half as many complex tours as simple tours, while a CPR of 1.0 would indicate an equal number of simple and complex tours.

An increase in local trip chaining behaviour would result in an increase in the proportion of complex tours, together with a corresponding decrease in the proportion of simple tours, and hence an increase in the CPR. The CPR has been formulated in such a way as to magnify the difference in the proportion of simple and complex tours.

The spatial variation within in the local data for 1992 and 2003/04 is very low, confirming the homogeneity of the local trip chaining propensity. However, there has been a significant decrease in the CPR between 1992 and 2003/04. This indicates an increase in the proportion of simple tours and a reduction in trip chaining behaviour. This result is contrary to our expectations, given reported increases in peoples' time pressures, worsening traffic congestion and rising petrol prices.

This result was examined in more detail by calculating the CPR for households within Brisbane City. The presumption being that the households in this more developed and more congested part of the study area would exhibit a greater propensity for trip chaining. However, the findings were identical to that of the wider area - a significant decrease in the CPR between 1992 and 2003/04.

The explanation of this initially counterintuitive result is not immediately obvious. However, the model developed by Golob (1997) predicts that an increase in work related travel time (eg due to worsening traffic congestion) would be accompanied by a reduction in trip chaining behaviour (ie complex tours). Perhaps people's limited travel time budgets are being further eroded by increases in work related travel, leaving even less time for secondary activities and associated travel.

Perhaps the trend could be due to the growth in scale and number of regional shopping centres around South East Queensland, where one can meet an increasing range of personal, social and recreational needs at the one location. This would be a suitable topic for further study.

By comparison, the CPR for Portland is significantly higher than for any of the seven local datasets. This might provide an indication of what could be achieved in the local context, given the correct land use and transport policy environment. However, the difference could also be due partly to the Portland data being obtained from a two-day activity diary, which would be expected to result in a higher respondent workload and hence potential under-reporting of trips and stops than the briefer travel diaries used locally.

7   Conclusions

This paper represents the first step in the journey towards a better understanding of local trip chaining behaviour. Many more are needed and suitable areas for further investigation are suggested below. In this paper, we have analysed over 187 000 trips records from seven household travel surveys undertaken in South East Queensland during the last 20 years. Based on these analyses, it is concluded that:

- average household and person trip rates have decreased in the Brisbane area, remained relatively stable on the Gold Coast and increased in the Sunshine Coast;

- the most recent household trip rates are 16-23% higher than the equivalent values for Portland;

- the most recent person trip rates are within ±5% of the equivalent value for Portland;

- the number of tours / household has decreased in Brisbane and increased on the Gold and Sunshine Coasts;

- the number of tours / person has increased across South East Queensland, while the average number of trips / tour has decreased, which indicates a decrease in trip chaining behaviour (ie more shorter tours versus fewer longer ones);

- stops / household and stops / person have been diminishing with time;

- the propensity for trip chaining decreased significantly in all three local areas between 1992 and 2003/04, which is contrary to our expectations; and

- there are several possible causes for this counterintuitive result which would make suitable topics for further study.

8   Further Research

Our review of recent trends in trip chaining behaviour in South East Queensland highlights the need for further research in the area. The local household travel survey data provide a rich source of the household, person and travel information needed for this work. Using these data as a starting point, it is suggested that further work be done to:

- extend the temporal scope of future travel surveys to include weekends – as it is not possible to examine what (if any trade-offs) households are making between weekday and weekend travel;

- provide greater insight into the types and number of non-work activities undertaken by trip chaining households;

- identify the demographic and locational characteristics of households that exhibit high and low trip chaining behaviour; and

- given the above, quantify any temporal changes in trip chaining behaviour for these categories of households.

9   Acknowledgement

10   References

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