THE DYNAMICS OF MODE-SWITCHING: FINDINGS FROM A MOBILITY BIOGRAPHY STUDY IN CAPE TOWN

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ABSTRACT

Mode use changes are dynamic and not only one directional as sometimes assumed in comparisons of cross-sectional time-series data. They are a two way process, for example, while some people are switching from bus use to car use, others are switching from car use to bus use – a concept known as 'churning'. The observed one directional change is in fact a net change due to unequal changes in both directions, resulting in 'asymmetric churning'. This paper investigates the dynamics of mode use changes to find evidence of 'churning', and its underlying causes, and to explore the implication this has for the formulation of appropriate travel demand management (TDM) interventions. Mode use changes have been observed to occur over extended periods of time. Such dynamism can therefore only be detected through the analysis of longitudinal data. Through a (n=70) qualitative retrospective survey, commuter 'mobility biography' data were collected. Event and commuting history calendars were used to aid memory recall. Mode use to work was found to be habitual, reflected in an average interval between changes of about six years, with the net change towards private transport. Underlying this net change were reciprocal changes between different modes of transport – providing evidence of 'asymmetric churning' in the non-representative respondent sample. The main key events triggering mode use change were changes in employment, residence and car ownership. The recognition of habit and 'churning' in mode choice, and the determination of key events affecting travel patterns, have implications for the formulation and implementation of effective TDM strategies. TDM measures should be targeted at those groups most susceptible to change, and sustained over a period long enough to break old habits and to form new ones.

Keywords: churning, mobility biography, key events, retrospective survey

1. INTRODUCTION

Travel congestion and its associated externalities have long been one of the major problems confronting transport and city planners. Travel demand management (TDM) has been seen as a way of managing congestion and promoting the use of more sustainable modes of transport. An understanding of travel behaviour patterns and changes is vital in the formulation of an effective TDM strategy. Also important in the support of TDM strategies by decision-makers is the reliability of forecast behaviour change. Most often, behavioural change is assumed to be unidirectional. It is, however, a two way process – a concept introduced by Goodwin (1999) as 'churning'.

The aim of the study reported in this paper is to investigate the dynamics of mode use changes over time in the context of Cape Town, and to test for evidence for 'churning' or otherwise. It is hypothesized that, while exhibiting considerable levels of intra-personal variability, lower middle-income car commuters in Cape Town engage for long periods of time in non-deliberative habitual mode choice behaviours, which are only changed when infrequent key life course events or incidents induce deliberation.

The paper is divided into five sections. The following section provides a theoretical overview of the dynamics in the travel behaviour patterns of commuters. Section 3 then describes the method used in the research. The analysis of the data is then presented and discussed in section 4. The paper concludes in section 5 with a discussion on some of the implications of the study for TDM formulation and implementation.

2. TRAVEL BEHAVIOUR DYNAMICS

Many studies have been conducted, in various contexts, to understand the dynamics of travel choices resulting in behaviour patterns. Cutting across most of these studies is an observation that travel behaviour is repetitious. A question arising in the literature is therefore the extent of deliberation in making travel choices. Some studies have suggested, or at least implied, that decision makers do deliberate on their alternatives whenever they are faced with a decision making problem (e.g. Fishbein and Ajzen, 1975, Ajzen, 1991). These studies may be thought of as drawing from the rational choice making theory as advanced by Simon (1957, 1955, 1991). Each available alternative is evaluated based on its utility and disutility. The alternative with the highest probable utility outcome to the individual is chosen, and this is done whenever a decision is to be made. Travel patterns resulting from this theoretical framework may be stable only when the outcome after deliberation is always the same – signifying a stable travel environment. It may result in variable outcomes in an unstable environment, introducing variability in travel patterns.

Other studies have suggested that travel behaviour is habitual in nature (Verplanken et al., 1997, Gärling et al., 2001, Bamberg et al., 2003, Gärling and Axhausen, 2003, Garvill et al., 2003). Travel choice-making has been argued to be a complex process, and the fact that

commuters make choices swiftly implies that they do not always deliberate fully (Cullen, 1978, Gärling et al., 2001). These studies suggest that commuters engage in rational deliberation of alternatives only when faced with a decision making problem for the first time. If the outcome proves successful, the same alternative is chosen whenever the commuter is faced with a decision making problem in the same or similar context. As the same choice is repeated over and over again, it becomes habitual and deliberation becomes less and less whenever choices are being made.

With little or no deliberation over alternatives, the same choice may be transferred to other contexts different from the one within which such a choice was made. Inducing deliberation in choice making has been seen to be a means of potentially breaking such habits (Garvill et al., 2003). After habit is broken, different travel alternatives are tried (typically sequentially from those requiring least to most planning effort) until a satisfactory outcome is obtained. This satisfactory choice may be repeated whenever similar decisions are to be made, forming another habit. This process introduces some short term variability in commuting behaviour while transitioning from one habit to another.

Measures for inducing deliberation include the provision of information about alternatives, creation of awareness, provision of incentives etc. (Fujii et al., 2001, Fujii and Kitamura, 2003, Gärling and Fujii, 2006). These measures may, however, be overlooked by individuals, depending on the strength of the habitual behaviour.

Van der Waerden *et al* (2003) identified 'key events' and 'critical incidents' as two factors that may compel commuters to reconsider their travel behaviour. Key events are defined as major foreseen occurrences in one's personal life. Examples of key events include: the acquisition of a driver's license, changes in employment, residential relocation, marriage, etc. Critical incidents on the other hand are defined as unforeseen events that can impact on one's behaviour. Examples of such critical incidents include: involvement in crashes, muggings, termination of employment, etc. These may be considered as naturally occurring as they do not require any policy intervention.

Goodwin (1989), from a study about the stability of public transport use, discovered that individuals whose circumstances changed in terms of these key events and critical incidents were much more susceptible to travel behaviour change. These changes are usually reciprocal, thus while some are moving from alternative 'A' to 'B', others are moving from alternative 'B' to 'A', a phenomenon known as 'churning' (Goodwin, 1999, Chatterjee, 2001). Most often the magnitude of these changes are not the same in opposite directions, introducing an asymmetric pattern of churn (Goodwin, 1999). The unequal magnitudes of change in the two directions results in a net change. This net change can be swayed in either direction. It is considered positive if it is favourable and negative if unfavourable. This innate phenomenon introduces variability in all aspects of travel choices including mode choice. The extent of variability in mode use choices is however minimal compared to changes in route and departure times, since people have been found to first consider changing their routes and departure times before changing their modes (Dowling and Colman, 1995).

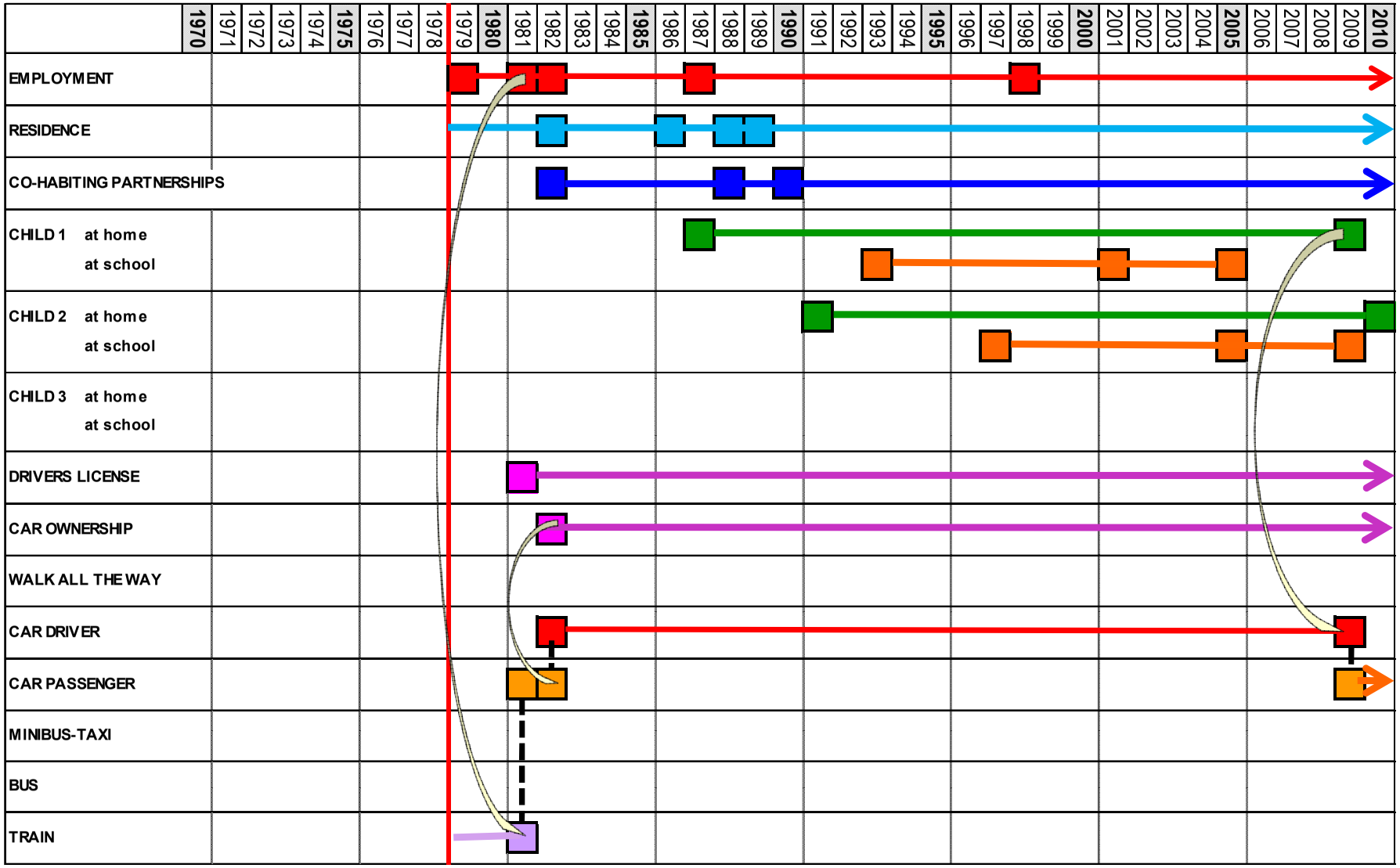

Figure 1: Example of an event and commuting history calendar (male, 56 years, high income neighbourhood)

3. RESEARCH METHOD

Longitudinal data are needed if personal variability in travel patterns is to be observed (Huff and Hanson, 1986, Schlich and Axhausen, 2003). Longitudinal data help in the construction of an individual's lifetime commuting history, known as a 'mobility biography' (Lanzendorf, 2003, Beige and Axhausen, 2006, Lanzendorf, 2006, Otto, 2010).

Panel, pseudo-panel and retrospective surveys have been identified as the three major methods for the collection of longitudinal data (Axhausen, 1995, Lanzendorf, 2003). Panel surveys involve the repeated survey of a group of people over a period of time at regular intervals (Lanzendorf, 2003, Stopher et al., 2009). It is considered the most reliable method for the collection of longitudinal data since errors due to memory loss are minimal as time between activity and data collection is not long. However, there are some drawbacks in the use of this method, among which include the length of time before data is delivered, respondent attrition, conditioning effects on respondents, and the high cost of surveys (Lanzendorf, 2003). Pseudo-panel surveys may provide a remedy for the duration of survey and cost as it involves the construction of cohorts which are traced through several cross-sectional data that are already available. The main drawback of this method is that observations are done at an aggregate level and changes in individual behaviour are not observable. This makes it impossible to construct a mobility biography – which involves an individual – from this method. Due to the limitations and infeasibilities of panel and pseudo-panel surveys in the construction of mobility biographies, a retrospective survey was seen to be the only viable survey method for this study.

Retrospective surveys are a once-off survey used in the collection of information about an individual's past activities (Auriat, 1991, Beckett et al., 2001, Behrens and Del Mistro, 2006). They are a quicker way of collecting information about a person's travel behaviour history compared to panel survey methods (Auriat, 1991, Beckett et al., 2001, Lanzendorf, 2003).

The main problem with data collected through a retrospective survey is related to memory biases – forgetfulness and telescoping – since they rely on the memory recall of respondents over extended periods (Auriat, 1991, Beckett et al., 2001, Belli et al., 2001). Several techniques have been used in attempts to improve the recall accuracy of respondents – including joint interviewing (Allan, 1980) and cueing (Belli, 1998). These methods are argued to improve respondents' recall of past events. Joint interviewing may be difficult to achieve with respect to personal commuting behaviour as it involves bringing two or more people together who may have experienced the same event. In view of this Belli's cueing method was used in this study. Survey instruments were designed to take into consideration the three memory retrieval pathways – top-down (i.e. remembrance of major events triggering that of smaller events), sequential (i.e. chronological sequencing of events usually within one life domain – e.g. employment, residential, car ownership domains, etc.) and parallel (i.e. relationships across major life domains) – proposed by Belli (1998). A history calendar was formulated by plotting life domains on the vertical axis and years on the horizontal axis. History calendars – events and commuting – were used as memory recall aids as they are

seen to encourage the use of multiple and interconnected memory pathways (Belli, 1998, Belli et al., 2001). They have been known to improve memory recall as it makes the recording of detailed events easier and it also makes it possible to easily detect inconsistencies in the sequence of events across the different life domains (Freedman et al., 1988, Belli et al., 2001).

Using a semi-structured interview, commuters were asked questions about their work trips over their working life. To ensure that respondents who would be useful for the purposes of the study were targeted, some screening questions were asked before the interview began. To ensure the possibility of habit formation in terms of mode use, respondents were required to be employed at the time of the survey, and requiring regular travel to the same place of work. Since the aim of the study was to find out the causes of mode use changes to work over long periods, respondents were also required to have changed their mode use at least once in their working life, and needed to be between the ages of 30 and 63 years. As the study was to be done in Cape Town, respondents were required to have lived more than half of their working life in the city. The study was also targeted at the lower middle income group, in which car ownership rates begin to increase and switching between public and private travel modes is most common (see SA DoT, 2012:42), although income and age criteria were relaxed to enable the capturing of some high-income respondents and young professionals.

Prior to questions relating to the trip to work, participants were asked to recall the occurrence of selected lifetime events (e.g. employment, residence, co-habiting, child birth, driver's licence and car ownership). These responses were used to construct a life history calendar to aid respondents in cross-referencing their responses and improving the reliability of their recall (see figure 1). A total of 70 full-time workers who commute to the same workplace on a regular basis (i.e. excluding service providers like plumbers and sales representatives who travel to different work destinations) were interviewed. Most of these commuters (60%) belonged to the middle to lower income band.

Due to the small qualitative sample size of the study, none of the findings presented in this paper may be deemed to be representative of the larger commuter population of Cape Town. The purpose of the study was to investigate whether there is evidence supporting the existence of churning in mode use choice, to establish some of the major key events triggering behaviour changes, and to consider implications for TDM strategy formulation. It is argued that understanding the causes of changes in mode use, even in non-representative qualitative research samples, is important as it can aid in the development of the knowledge required for the formulation of targeted and more effective TDM strategies.

4. RESEARCH FINDINGS AND DISCUSSION

Findings from the data collected in the semi-structured interview and trip diary surveys are presented and discussed in this section. First, we investigate whether there is evidence of churning in mode use choices over the working life of commuters. The annual mode use

share will be determined. This will help in estimating the annual rate of change for public, private and non-motorised transport modes within the respondent sample. The key events triggering these changes will then be explored.

As depicted in Table 1, mode use choices were found to be fairly habitual as it took about 6.2 years on average for a commuter to change his or her regular main mode of transport to work (i.e. disregarding occasional once-off changes associated with events like car servicing or public transport service strikes). The mean mode use duration for female commuters was a little longer than that of male commuters, even though the difference was not significant. In general, the mean mode use duration was found to increase with age. This may be due to the relative increased stability in life styles (and constraints on choice) in terms of residence, employment, child birth, etc. as one ages.

Table 1: Mean duration between sustained mode use changes

	Gender		**Age (years)**				**Total**
	Male	**Female**	**<30**	**31-40**	**41-50**	**51-65**	
Number of respondents	37	33	6	22	23	19	70
Mean duration between sustained mode use changes (years)	5.9	6.5	4.0	5.7	5.3	8.3	6.2

The habitual nature of mode choice could also be observed in how respondents made their choices, as illustrated in the below examples.

> *"… when I started working in 1995, I was using the train. I lived in Grassy Park and worked in Cape Town [city centre] to 2006, so it was convenient for me to take the train; I knew what to do with the train. In 2006, I got a new job which required me to live on the work premises. You could say that I walked to work at that time. In 2008, I was retrenched and I moved back to Grassy Park. I didn't have a job for a while. When I got a new job in Cape Town [city centre], I went back to using the train, just like I used to do when I first started working. I suppose I was used to the train from before, that is why I went back to using it." (33 year old male lower income respondent)*

> *"… once I got my first car, I never used anything else. I suppose I got comfortable using a car. Even if me and my husband are forced to share a car, I will always be the driver because I often go out at lunchtime and I need to have the freedom to go where I need to when I need to" (65 year old female high income respondent)*

From some of responses, it is clear that available alternatives were only evaluated by respondents when he or she was faced with choice problem for the first time, as illustrated in the below example.

> *"… in 1981, I moved house after marriage… I lived close to the train station. I just stopped and thought through things and thought, let me take the train. I was closer to the station and it was cheaper. … When I was deciding on the way to travel to my work place in 2000, I decided to use the train, partly because I was used to the train. I knew what to expect. You know I have never thought about why I have only used the train, why I have never considered using another public transport mode" (52 year old male lower income respondent)*

Table 2 provides an indication of the main 'key events' that were found to trigger mode use changes. Changes in employment were reported to be the major key event causing changes in mode use, accounting for about 50% of all mode use changes. This was followed by changes in residences and car ownership, accounting for about16% and 17% of the mode use changes observed respectively. Changes in children's schooling and the attainment of a driver's license were found to be the least common key events in triggering changes. The small effect of driver license acquisition on mode switching was expected as these changes only occur once in a commuter's life. 'Critical incidents' were not found to be a significant cause of mode switching (these form of the 'other reasons' category in table 2).

Table 2: Life course events (LCE) triggering mode use changes

Life course events	LCEs observed		LCEs causing changes in mode use		% of mode use change in relation to occurrence of the LCE
	No.	%	No.	%	
Residence	197	17.3	42	16.3	21.3
Employment	290	25.5	130	50.4	44.8
Household size growth	210	18.5	11	4.3	5.2
Co-habiting partnership	90	7.9	11	4.3	12.2
Child schooling	228	20.1	1	0.4	0.4
Driver's license	38	3.3	1	0.4	2.6
Car ownership	64	5.6	43	16.7	67.2
Others reasons	19	1.7	19	7.4	100
Total	**1136**	**100**	**258**	**100**	

To further investigate the impact of these life course events on mode use change, the number of mode use changes in relation to the frequency of a particular life course event is also expressed in table 2. This analysis indicates that changes in car ownership are most likely to trigger changes in mode use. About 67% of changes in car ownership led to a change in mode use. Also evident were changes in employment where about 46% of such changes led to changes in mode use. As seen from the following respondent comments (and other comments in this paper), acquiring a car usually led to changes from public transport to car use while loss of the car led to the use of public transport.

> *":.. in 1999, I bought my first car, so I started driving and not using the train. I had wanted a car to be more independent. I had many different activities that required travel at that time. A car was the best mode to use to meet all my needs. I got to a stage in my life where I just felt it was the right time to buy a car and start driving…" (35 year old male high income respondent).*

> *"… I changed from bus to car use when I got a car in 2002. It was very old but still better than no car. I was happy to get the car, very happy. I had a car accident in 2007 and the car was written-off. I didn't want to stop using the car, but I had to because I didn't have enough money to fix it. (29 year old low income male respondent).*

In contrast to changes in car ownership, changes in employment led to changes in all directions, as illustrated in the below examples.

> *"…I moved into a new house in 1986 that was very close to work, so I walked every day… When I changed jobs in 1991, I worked further away and so I started using the train. I used the train every day to travel to work for about two years. When I changed jobs in 1999, I would usually walk to work as I was again closer to work, and catch a train home, as I was usually more tired after work. When I changed jobs in 2005, I worked further from home and was consistently a car passenger." (52 year old female high income respondent).*

> *"… when I started working in 2003 near my home, I used to walk to work. There weren't actually many public transport options on that route, so I didn't have much of a choice… when I got a new job in Cape Town [city centre] in 2005, I started using public transport. I would take a taxi from my house to the train station and then a train into town… when I started working in Claremont at the end of 2009, I got a lift to and from work from my boss…" (24 year old male low income respondent)*

As expected, the 'other reasons' cited in table 2 resulted in a 100% change in mode use with most of them being from other modes to private car use. Some of these reasons included the high cost of maintaining the operation of the private car; negative experiences being verbal abuse or car crashes; and awareness of public transport as can be seen from the following comments from respondents.

> *"… in 1987, I was verbally abused when I was travelling by bus… Nothing like that had happened before, but the experience was so negative I decided to never use the bus again…." (63 year old female high income respondent)*

> *"… in 1997 when I turned 21, I was given a car from my parents. In 2000, I had to sell the car because I could not afford keeping it anymore. I started using public transport again, taking the bus to and from work. In 2002, I changed back to car use when I was able to afford one…" (31 year old female middle income respondent)*

> *"… in 2009, before the World Cup 2010, there were a lot of promotion of public transport on the radio, so I thought, 'let me try it' … Upon trying it, I realised the train was not as scary as I thought it would be. This was my first time using the train and I have since been using the train…" (43 year old female high income respondent)*

> *"… at first I did not know what timetable the buses worked to, and what bus to take to get to work. After I had an accident in a mini-bus taxi, I decided to give the bus a try. I went to the station and found out about the schedule and since then I have been using the bus to work as it is convenient for me..." (46 year old female low income respondent)*

Figures 2, 3 and 4 show the mode use changes of commuters currently using private transport, public transport and non-motorised (walk) transport over their working life. The vertical axis represents the different modes of transport being used with the horizontal axis representing years of mode use. Each point on the chart represents the mode of transport used by a particular commuter in that year. These points are then joined with a line – showing the longitudinal pattern of mode use behaviour. The different shades of colour are used to show different modes. Points in the same shade of colour therefore mean the number of respondents using that mode in a particular year.

As seen from the figures, the most dominantly used mode of transport over the years amongst the respondent sample was the car as a driver, followed by the train. The crossing lines show that mode use changes were not only in one direction by in several directions – evidence of long term 'churning'. Changes were observed between different transport domains, and also within domains. For example, in 2003, as commuter A was changing from private transport (car driver) use to public transport (train), commuter B was changing from public transport (bus) to private transport (car driver) use (figure 2). Even though most of the long term 'churning' observed was between two transport domains, some changes were observed within domains. For example, in 2007, as commuter C was changing from mini-bus taxi to bus use, commuter D was changing from bus to mini-bus taxi – both modes located within the public transport domain (figure 3).

Figure 5 shows the different mode use shares over the years. The main mode of transport amongst the respondent sample over the years has been private car as a driver, followed by the train. Low mode use shares were found for walking and the car as a passenger. Comparing the different transport domains, public transport mode use share was higher than private transport in 2001, 2002, 2003 and 2004. It then declined relative to private transport use from 2005 onwards. From 2006, the mode use of a car as a driver was higher than all public transport combined. The long term churn evident in the respondent sample is therefore asymmetrical in nature, and moving in the opposite direction to stated South African transport policy objectives.

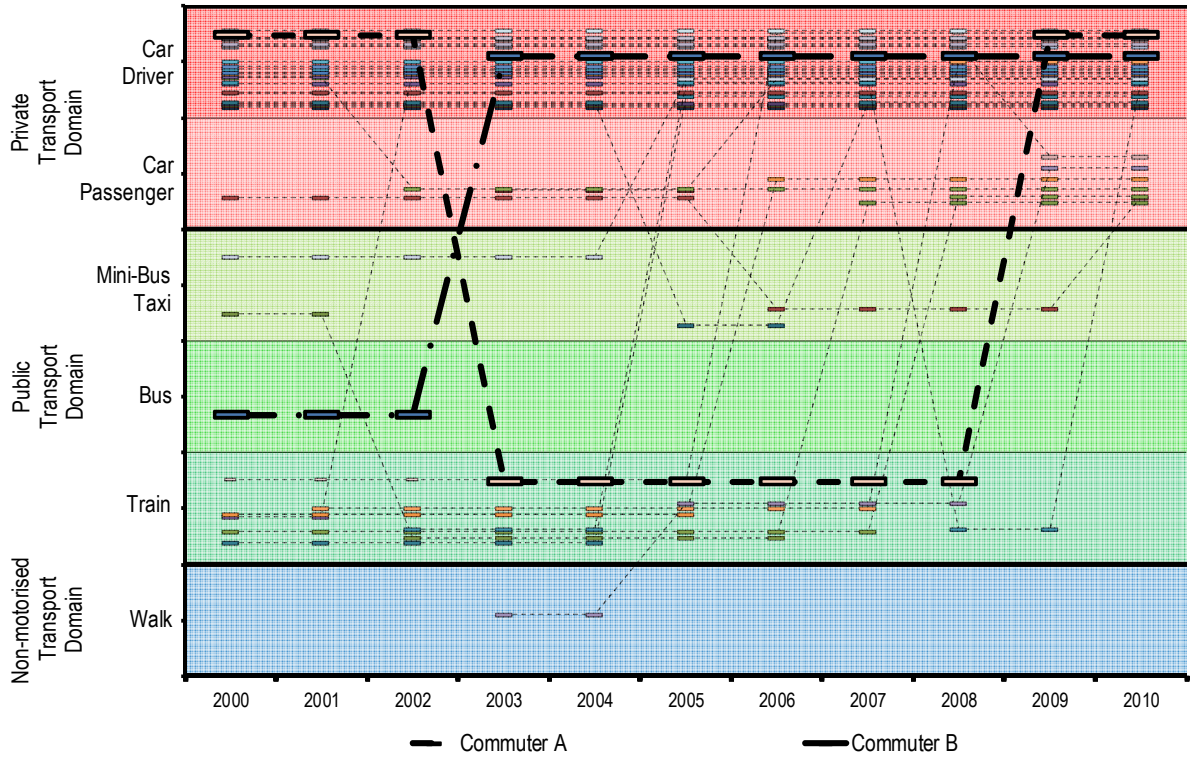

Figure 2: Mode use changes among current private transport users (2000-2010)

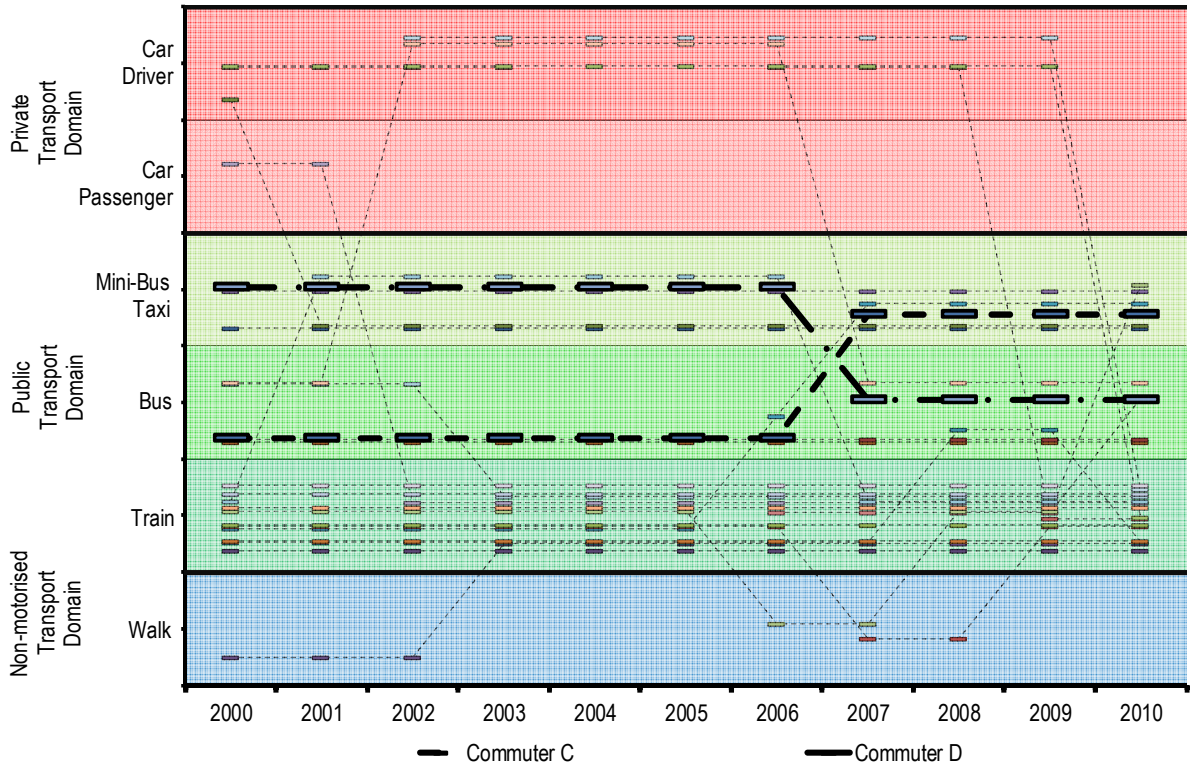

Figure 3: Mode use changes among current public transport users (2000-2010)

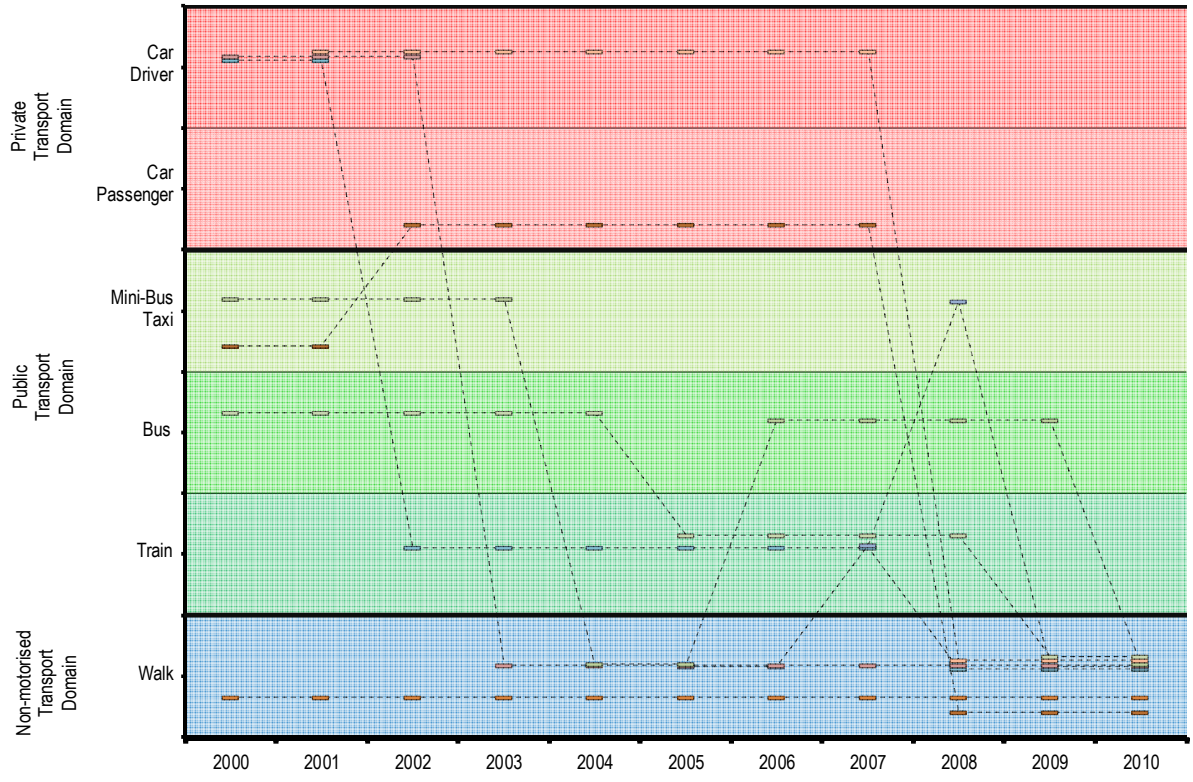

Figure 4: Mode use changes among current non-motorised transport (walk) users

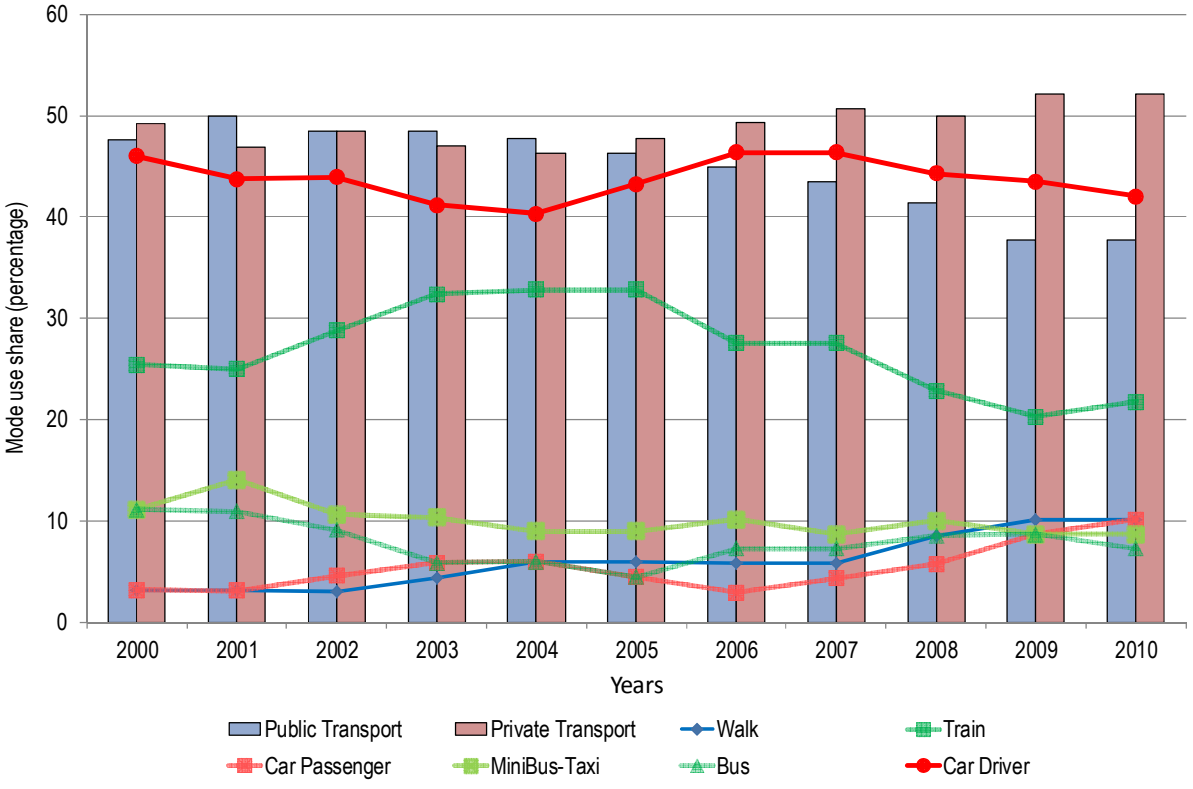

Figure 5: Mode use share of respondents (2000 - 2010)

5. CONCLUSION

The study reported upon in this paper aimed at investigating the dynamics of mode use changes over a commuter's working life, as well as the major key events leading to these changes. The study was also aimed at exploring whether or not there was evidence for the existence of long term 'churning' in mode use changes.

To investigate the dynamics in mode use changes, a mobility biography was constructed for each respondent. A retrospective survey was employed to record the modes used by commuters for their past working trips. On average commuters were found to take about six years before changing mode. This finding confirms the enduring and habitual nature of mode use.

Mode use change was observed in all directions – providing some evidence of 'churn'. Over the long-term, net change amongst the respondent sample was from public to private transport domains – indicating a pattern of 'asymmetric churn'. Also evident, however, were travel behaviour changes within transport mode domains.

Changes in car ownership were found to affect mode use changes the most in terms of the number of changes in mode compared to the number of occurrences of that particular key event. In terms of the total number of changes observed, however, changes in employment were found to be the main causative factor, followed by changes in residential location and car ownership.

The habitual nature of travel behaviour has significant implications for the formulation and implementation of effective TDM strategies. In particular, the long mean duration between sustained mode use changes implies responses to voluntary TDM measures occur at a slow pace, and that consequently effective TDM measures are unlikely to be short-term or once-off implementations, but rather sustained over a period long enough for old habits to be broken and for new ones formed. An understanding of the main triggers of mode use habit-breaking also has the potential to inform the formulation and implementation of targeted TDM measures – which is likely to improve effectiveness. The evidence presented in this paper suggests that for targeting to be most effective, TDM interventions should be aimed at new employees, and new home buyers. This raises the importance of, hitherto largely unexplored, workplace and household travel planning practices in contemporary South African cities.

ACKNOWLEDGEMENTS

The research presented in this paper was funded by the Volvo Research and Educational Foundations, and forms part of a broader research programme conducted by the African

Centre of Excellence for Studies in Public and Non-motorised Transport (ACET, www.acet.uct.ac.za). The assistance of Mr Tom Jackson, Mr Nigel Le Grange and Mr Olebogeng Mothelesi in data collection is gratefully acknowledged.

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