

Trends in Urban Travel: Implications for Planning and Forecasting

David Kriger, P.Eng., MCIP, President
David Kriger Consultants Inc., Ottawa
(formerly with HDR | iTRANS at the time this work was conducted)

Rhys Wolff, P.Eng., Transportation Engineer, HDR | iTRANS, Toronto

Ahmad Subhani, P.Eng., Senior Project Manager, City of Ottawa, Ottawa

and

Donald Cleghorn, P.Eng., Senior Project Manager, HDR | iTRANS, Toronto

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ABSTRACT

Travel behaviour continues to evolve as a function of changes in demographics, economic conditions, urban form and the transportation system. How travel behaviour evolves can have important implications on urban transportation planning and investments. This evolution also influences policies, the choice of markets to be targeted for new initiatives and the achievement of progress towards goals such as sustainable transportation. Travel demand models also are impacted, as once-important determinants of travel behaviour are superseded by new influences.

Ottawa-Gatineau's TRANS Committee recently completed a study of trends in travel behaviour, as measured by its 1986, 1995 and 2005 regional household origin-destination travel surveys. The study developed several indicators of interest, from which the most significant trends were derived and then extrapolated over the long term. Based upon these, four key underlying influences or factors that explain changes in travel behaviour were identified. These were:

1. Shift of both population and employment from the inner areas to the suburbs and less dense areas. This was considered the primary influence on travel behaviour and mode choice.
2. Adjustment in the gender-based workforce and the resultant mode share distribution.
3. Decrease in trip rates per capita, especially for work trips.
4. Increase in the suburban transit mode share and in the CBD non-motorized mode share.

Several implications for future model development and data collection were proposed.

1. INTRODUCTION

1.1 Overview

Travel behaviour is evolving over time as a function of many factors: changing demographics, economic conditions, urban form and the 'supply' (or level of service) of transportation. For example, will students, who now constitute a core market for many transit systems, continue their environmentally-aware travel behaviour once they enter the workforce? There is some evidence that females, whose numbers now approximate half the labour force, have started taking on the auto-oriented commuting characteristics of their male counterparts as their incomes grow. Health-conscious baby boomers, who are now beginning to retire or work only part time, have started to choose active transportation, not necessarily for environmental reasons but as a means of keeping fit. How, or if, behaviour evolves over time can have important ramifications on the ways urban areas plan and invest for the future. They also can inform policies, identify target markets for new initiatives, and monitor progress towards goals, such as the promotion of more sustainable transportation.

Travel models also are impacted by this evolution. Patterns that were important determinants of travel behaviour in the past have disappeared, are diminished in importance or have been inverted. Particularly important is continued residential and job growth in ever-expanding suburbs, which can impact both the specification of model parameters and the development of meaningful land use scenarios for forecasting.

This paper presents the findings of a recent analysis of travel trends in the National Capital Region (NCR). It is based upon a study commissioned by TRANS, which is a long-standing, multi-agency committee that is responsible for travel surveys, data collection and travel demand modelling for the National Capital Region. TRANS is comprised of the cities of Ottawa and Gatineau, the two regional transit operators (OC Transpo and the Société de transport de

l'Outaouais), the ministries of transportation of Ontario and Québec, and the federal government's National Capital Commission. (See <http://www.ncr-trans-rcn.ca> for more information.) Since the 1970s, TRANS has conducted region-wide household origin-destination surveys at approximately ten-year intervals.

1.2 Study Process

The *National Capital Region Travel Trend Study* was conducted by HDR | iTRANS on behalf of TRANS.⁽¹⁾ The study was based upon TRANS' 1986, 1995 and 2005 origin-destination travel surveys. (An earlier TRANS study examined trends from the 1986 and 1995 surveys.) The study started by developing several indicators of interest over the three surveys: these were derived in consultation with the TRANS members through a day-long workshop that presented indicators from other studies, notably from the United States. The 60+ indicators were developed first for the 2005 survey, in order to serve as a stand-alone analytical basis for TRANS' most recent travel data set. Next, most of the indicators were developed for the 1986 and 1995 surveys; the choice of indicators largely reflecting the availability of comparable data from the previous two surveys. From this historical analysis, the study then derived the most important trends, which in turn were extrapolated over the long term. Throughout the process, comparisons were made with surveys in other cities, where appropriate.

The study complements nationwide comparisons such as TAC's *Urban Transportation Indicators* series. However, it is focused on a specific urban area, which in turn allows greater detailing of the findings: as such, the study will be of interest to communities across the country.

1.3 Organization of Paper

The remainder of the paper has three main sections: Section 2 reviews trends in key indicators, organized according to four main explanatory factors or influences. This is followed by Section 3, which discusses what these mean. Section 4 concludes the paper with a summary and a discussion of implications for modelling. Acknowledgements and a list of references follow in Sections 5 and 6, respectively.

2. OBSERVED CHANGES IN KEY INDICATORS, 1986 - 2005

An analysis of the three OD surveys identified several important demographic and trip-making trends within the NCR between 1986 and 2005. An analysis of the trends yielded four key underlying influences or factors that explain changes in travel behaviour. These were:

1. Shift of both population and employment from the inner areas to the suburbs and less dense areas. This was found to be the primary influence on travel behaviour and mode choice.
2. Adjustment in the gender-based workforce and the resultant mode share distribution.
3. Decrease in trip rates per capita, especially for work trips.
4. Increase in the suburban transit mode share and in the CBD non-motorized mode share.

The key trends associated with each of these four influences are discussed below.¹ Potential implications – extrapolations – also are discussed.

2.1 Shift to Suburbs

A shift in both residents and jobs occurred from central and urban districts towards suburban and less dense areas.² This may lead to changes (as described below) in demographic

¹ This discussion summarizes many trends at the NCR level. However, the actual study also differentiates these trends between Ottawa and Gatineau.

² The ensuing discussion breaks down the NCR into 26 districts.

properties and travel behaviour, as suburban trips increase faster than radial trips to and from the central areas. In terms of future model development, as TRANS considers its next generation of models, these changes may require adjustments to modelling parameters, or expansion of the modelling focus to consider suburban trips, to deal with the implications of these trends. Models focused only on forecasting trips to and from city centres will not capture the whole picture in light of these evolving trends.

Evidence of this shift is provided by the following findings:

2.1.1 Shift of population to suburban and rural areas. In 1986, 63% of NCR residents lived in central or urban districts, but in 2005 only 50% did. The areas of greatest growth in terms of both population and employment are the suburbs, with central areas growing only by 18-19% and areas outside the centres growing by nearly 60% on average, as shown for population in Figure 1. This trend of increasing suburban growth, if continued, will lead to two-thirds of NCR residents living in suburban and rural districts by 2031.

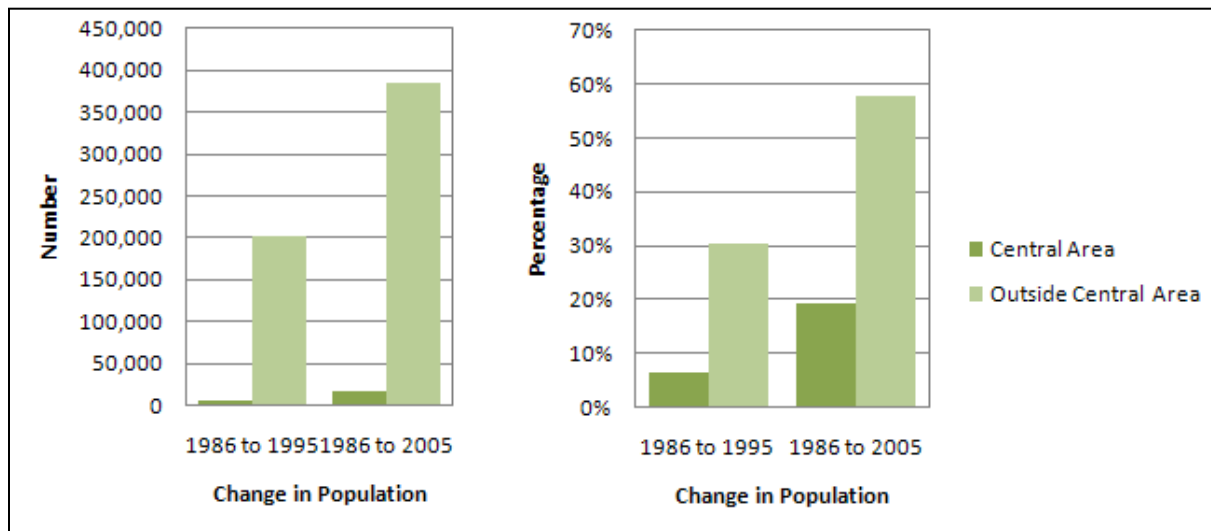


Figure 1: Change in population by area type, 1986-2005

2.1.2 Decrease in proportion of jobs located in central and urban areas. In 1986, 92% of jobs were located in central or urban districts, but by 2005 this proportion had dropped to 79%. At this rate of decrease, less than two-thirds of jobs will be in the central or urban areas by 2031. Between 1995 and 2005 the number of jobs in central Ottawa still increased by 22,700, but this 14% increase is much lower than the 22% increase in jobs in Ottawa as a whole. Jobs in central Gatineau decreased by 1,200, a 5% decline compared with a 17% increase for all of Gatineau.

Additionally, the areas where jobs are concentrated have spread out over time. Some suburban districts outside the central areas have become net generators of jobs, such as Hull Périphérie, Beacon Hill and Kanata/Stittsville. Kanata/Stittsville had two resident workers for every job in 1986, but more jobs than workers in 2005, despite a large increase in population. This is shown in Figure 2.

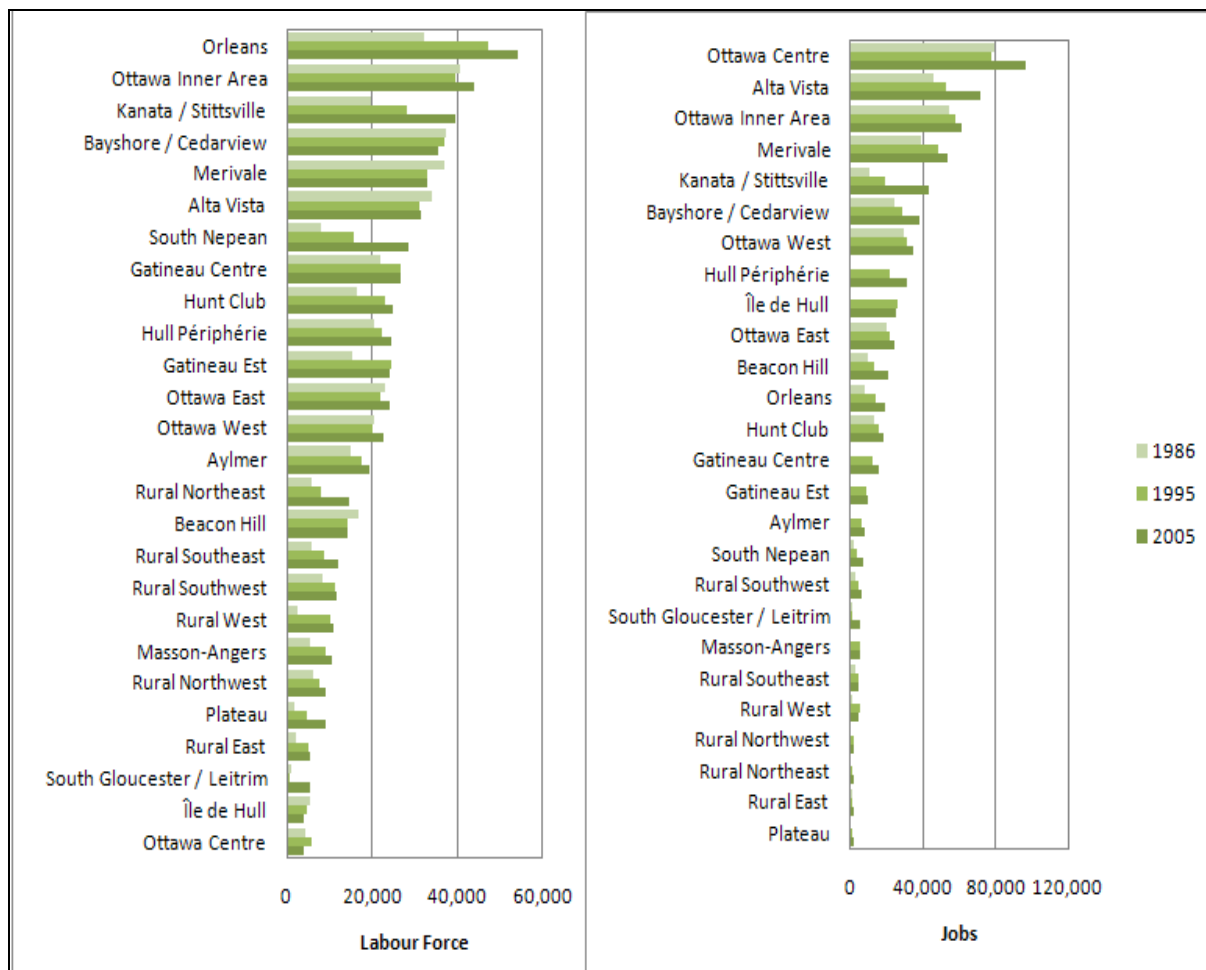


Figure 2: Resident workers and jobs by district, 1986-2005

2.1.3 Changes in commuter flows. Accompanying this widening of the employment area are changes in the flow of commuters.

The proportion of AM peak period trips headed to the CBDs of Ottawa (Ottawa Centre) and Gatineau (Île de Hull) has decreased gradually and steadily, from 23% in 1986 to 16% in 2005. Extrapolated, the trend indicates that, by 2031, 10% or fewer of AM peak-period trips will be to the downtown cores.

There has been a corresponding increase in the proportion of AM trips destined to suburban and rural areas. The proportion has increased from 15% in 1986 to 28% in 2005. This trend, if continued, would see over 40% of AM peak trips made to the suburban and rural districts by 2031. Meanwhile, half of all AM peak trips originate in the suburban or rural districts in 2005, up from 35% in 1986. This has implications for mode share calculations, as suburban and rural trips need to be given more attention. One implication is that, in future model development, TRANS may need to develop mode share functions that apply separately to trips destined to the downtowns; to elsewhere on the rapid transit system; to suburban town centres (key nodes); and to the suburbs generally.

Some districts have moved toward a much higher proportion of their labour force living and working within the district (Merivale), but others have gone in the opposite direction (Ottawa East). This is shown in Figure 3.

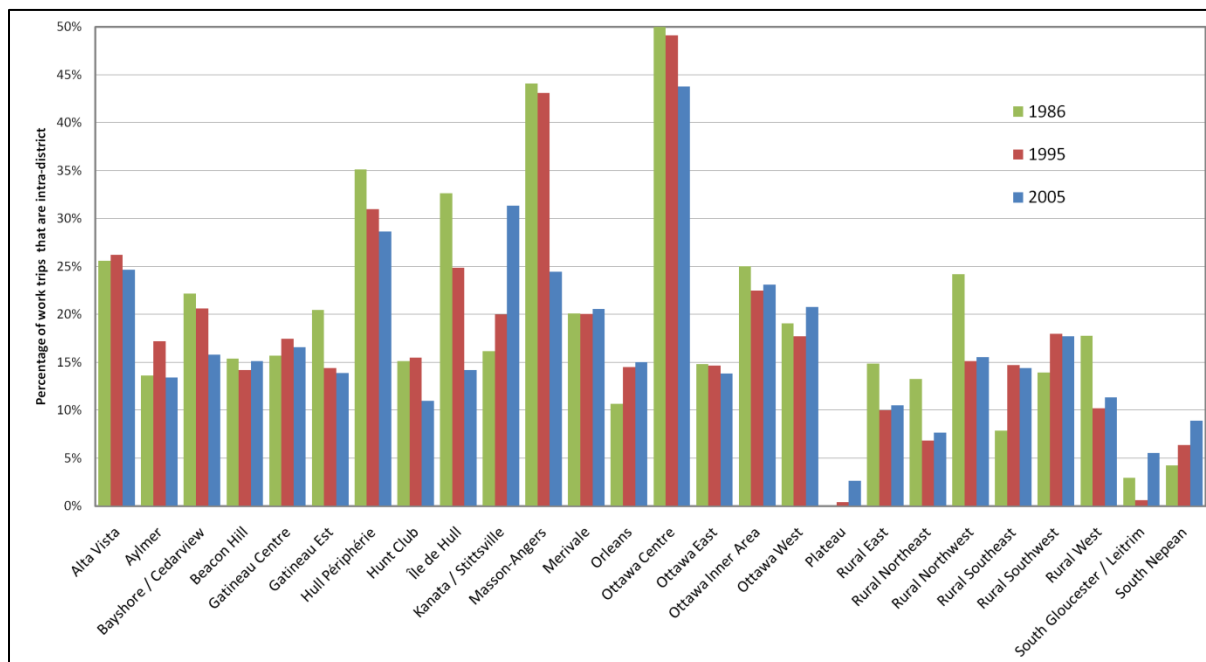


Figure 3: Percentage of residents who work in their home district, 1986-2005

2.1.4 Changes in household characteristics. Household auto ownership is a key indicator of trip rates and mode share. Overall, there has been an increase in the average number of vehicles per household. Between 1986 and 2005 the average number of household vehicles has increased from 1.33 to 1.41 (or from 1.27 to 1.41 between 1995 and 2005). Gatineau has grown slightly faster than Ottawa over this time. Based on the slower 1986-2005 growth rates, a continuing trend would see 1.53 vehicles per household by 2031 (1.47 in Ontario and 1.74 in Québec), which should be noted for forecasting auto ownership, which in turn influences mode share at the household level. In contrast, the TRANS model predicts a decline to 1.38 vehicles per household by 2031. However, survey trends indicate a difficulty in establishing a long-term pattern—after a decrease from 1986 to 1995, the average number of vehicles in a household has increased pronouncedly from 1995 to 2005, with a slightly faster increase in the less dense Gatineau districts compared with the Ottawa districts. This means that, depending on whether the short-term (1995-2005) or long-term (1986-2005, with the drop and subsequent recovery) trend is extrapolated, there is a large variation in the future number of vehicles per household, which could remain in the 1.4 to 1.6 range or climb towards 1.9. In summary, it is a difficult trend to project; nonetheless, the general upward trend still contrasts with the downward trend predicted by the model.

Looking at the NCR as a whole, with the growth of suburban areas the number of vehicles per household and percentage of households inhabiting detached housing have also increased from 1986 to 2005, despite the average household size remaining approximately the same. The number of household vehicles per worker has increased for all household sizes, but especially for one-person households (by 50%) and two-person households (by 20%).

At the same time, while the average number of vehicles per household has increased, the percentage of zero-car households has decreased from 16% in 1995 to 12% in 2005. This is consistent with the fact that the central districts are comprised of 35% to 40% zero-car households, and the proportion of residents living in these areas is decreasing (12.9% of NCR households were in the central districts in 1995, but only 11.5% in 2005). Additionally, with most new jobs not being located downtown, those who do live downtown are more likely to have to commute out of the central districts, a travel pattern that is not historically common. In a related finding, the average number of vehicles per worker, which indicates the level of accessibility people have to vehicles for work trips, also increases from 1.00 (Ottawa) and 1.02 (Gatineau) in 1986 to 1.20 (Ottawa) and 1.24 (Gatineau) in 2005.

Another important indicator is housing type. There has been an increase in the proportion of residents living in detached housing. The percentage of NCR residents in detached housing climbs from 48% in 1986 to 55% in 2005. Were this trend to continue it would reach 64% by 2031 (a proportion similar to that of comparable US cities *today*). The TRANS model also predicts an (even faster) increase, to 69% by 2031. This is likely connected to the trend of faster population increases in less dense areas, and the growth in number of cars per household which, if it continues, is likely to reduce the probability of choosing transit.

Many other demographic characteristics, such as properties of driver's licence holders, and auto occupancy/ridesharing patterns, remain essentially unchanged.

2.2 Gender Balance

Gender balance varies over the years between surveys, both in terms of work force participation and mode share distribution, as women's trip-making patterns come to resemble more closely those of men. This may require the adjustment of separate trip rates for trip forecasting over the long term, as overall the percentage of all trips (by those above the age of 10) made by females increases from 49.2% in 1986 to 50.7% in 2005. The overall trip rate per resident above the age of 10 is 11% higher for males than females in 1986, but only 4% higher in 2005.

2.2.1 Increase in female full-time work force representation. Between 1986 and 2005 the female proportion of the full-time work force grows from 41% to 45%, significantly increasing the evenness of the distribution, as seen in Figure 4. Based on continuing the increase from 1986 to 2005 it may approach equality (50%) by 2031, while based on the slower increase from 1995 to 2005 it may reach 48%. The female work force participation is expected to approach 50% over time (the Gatineau long-term trend indicates that 50% will be reached by 2021, so it is capped at that level as extending it beyond 50% would require additional assumptions about work patterns that cannot be inferred from the available surveys).

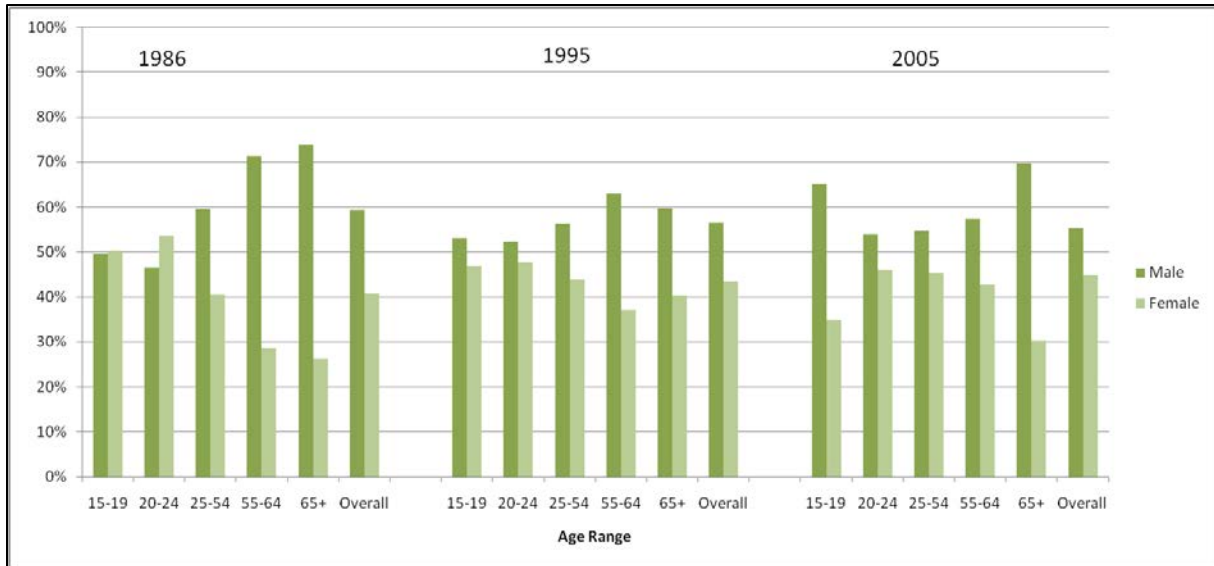


Figure 4: Work force representation by gender and age group, 1986-2005

2.2.2 Adjustment in mode shares by age group. Between 1986 and 2005, there have been notable fluctuations in the transit and auto drive mode shares, but the overall trend indicates that male and female mode share patterns are moving closer together. The gender auto/transit modal split is consistent through the years, with the female transit mode share greater than the male for age categories 25 and over. However, there is a large increase in the auto driver mode share for women, particularly those over the age of 55, as is shown in Figure 5.

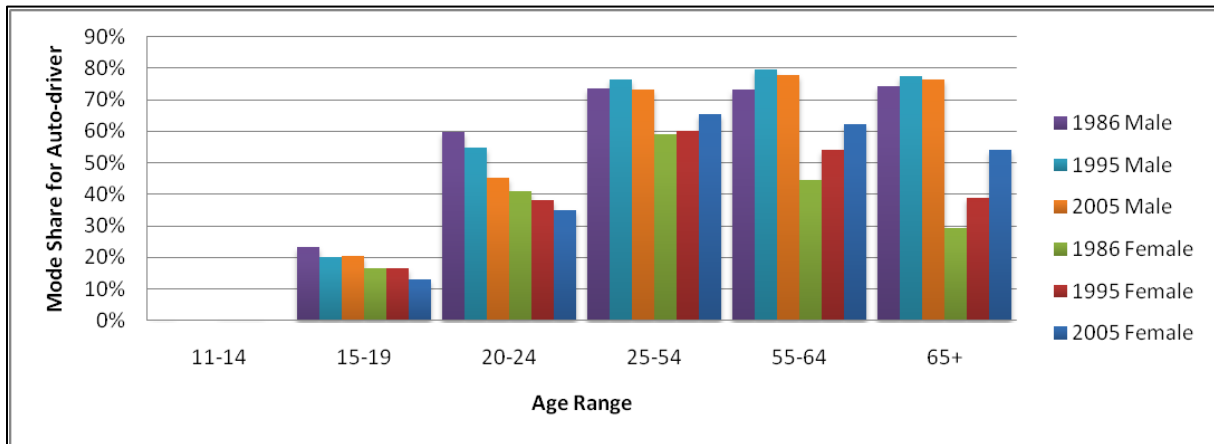


Figure 5: Percentage of trips made by driving by gender, 1986-2005

In 1986, almost as many women age 65 and over take transit (27% mode share) as drive (29% mode share), but in 2005 many more drive (54%) than take transit (8%). The male trend is less dramatic as men over age 65 were more likely to drive than take transit in all three survey years, and the mode share distribution in that category has remained almost unchanged since 1995, after a large drop in transit between 1986 and 1995.

If the trends are extrapolated as straight lines, some cross and then diverge in the future, which is unlikely to be the case in reality, but this only reflects what would happen if existing trends were maintained. If the decline in transit mode share by women in the 55-64 and over 65 age groups continues, then transit mode share will decrease to zero by 2031. This is an extreme

case, and one not likely to occur in reality, but the trends do indicate, that driving is becoming much more frequent among women over age 55, whereas in the past there was a great disparity between male and female auto drive mode shares.

Because of the difference in trend directions between 1986, 1995 and 2005, there is a substantial difference in forecasted future mode shares depending on whether the 1986-2005 or the 1995-2005 trend is followed. This applies particularly to the 55 and over age group, as changes in the main working-age group (25-54) are much less pronounced, and male and female auto and transit mode shares are close together.

2.2.3 Trip rate variability by gender. Historically, the daily trip rate for males has been higher than for females, but this difference has been lessening over time, to the extent that the rates are on a trend to converge in the near future, even as both male and female rates decline overall. Trip rate trends are investigated further in the next section.

2.3 Trip Rates

While the overall numbers of trips are increasing, the increases are not matching the growth in population. This suggests that a decrease in trip rates for future year modelling may lead to a more accurate portrayal of travel patterns. The observed trends indicate a sharp decline in trips between 1986 and 1995, followed by a levelling off between 1995 and 2005. This is the case for both work and non-work trips (although non-work trips have a shallower decline) except in the Québec districts, where there is an increase in the non-work trip rate between 1986 and 1995, but still a decline between 1995 and 2005.

Over time, there is a small decrease in the proportion of people in the primary working-age (20-54) age group and a small increase in the proportion of people in the 55+ age categories, reflecting a general aging of the population. This is particularly noticeable in Gatineau where, if the age split trend from 1995 to 2005 continues into the future, by 2031 people over age 65 will represent 17% of the population, and people under 25 will represent 18%.

2.3.1 Decline in work trip rates. From 1986 to 1995 the number of daily trips to work per NCR resident decreases from 0.67 to 0.48, and from 1995 to 2005 there is a further decline to 0.47. A continuation of this to 2031 would result in a rate of 0.26 work trips/capita if the 1986-2005 trend is followed, and 0.43 work trips/capita if the 1995-2005 trend is followed. Work trips per employed worker decline comparably from 1.23 (1986) to 1.00 (2005). Thus, the decline is not due to a reduction in the labour force proportion. The trip rates for 1986 seem particularly high (based both on comparing with other years and with the 1986-2006 Transportation Tomorrow Survey [TTS] trip rates for Toronto), but they then stabilize at a level more comparable with other cities from 1995 to 2005 (seen for the AM peak in Figure 6), suggesting a more reliable trend for future extrapolation is the one observed during this later period.

Working at home rates do not change appreciably between 1996 and 2006 (based on Census data), increasing from 6.4% to 6.5% of the workforce.³

The 1986-2005 work trips trend is influenced by a decline from a very high initial rate in 1986 which suggests that each worker makes an average of more than one work trip per day. Due to

³ Note that the 2005 OD survey showed an approximate 10% work-at-home rate, compared with the 6% rate in the 1995 survey. Further investigation revealed that the 2005 data may have included a broader interpretation of working at home to include some telecommuters, as the increase in working at home is not similarly reflected in Census data.

this, the 1995-2005 trend, showing a gradual decline, may be more probable for forecasting, as using this, the work trip per capita rates remain above the 0.40 mark up to 2031. These rates are also similar to the 0.41 used in the TRANS model for 2031.

The percentage of people over age 65 who work full or part-time increases from 6% to 9% from 1986 to 1995, but then decreases to 5% by 2005, so it is difficult to identify a trend in this case.

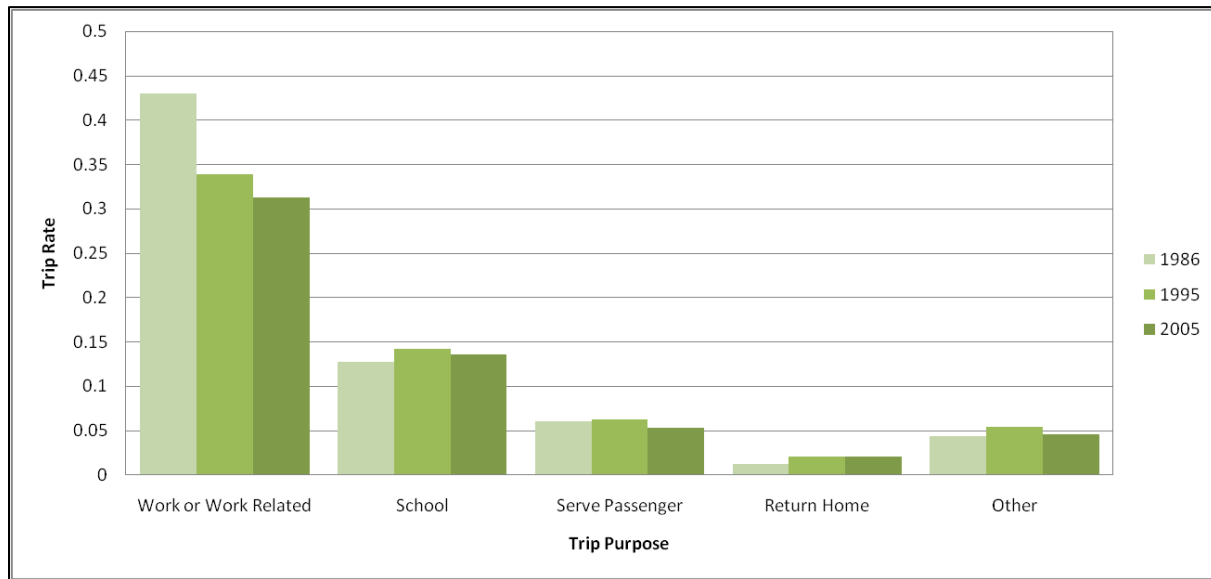


Figure 6: AM peak trip rates per capita by purpose, 1986-2005

2.3.2 Decline in non-work trip rates. From 1986 to 1995 the number of daily trips to a location other than work per NCR resident (including trips *from* work) decreases from 2.20 to 2.12, and from 1995 to 2005 there is a further decline to 1.97.

The short-term trend indicates a more rapid decrease than the long-term trend, the opposite of the situation with work trips. Overall, this is a much more consistent decline than for work trips, with the decline from 1986 to 1995 less than that for work trips despite the inclusion of the return trips from work in this category. This means that were the return component of work trips to be excluded (if it could be identified separately from other homebound trips), non-work-related travel would likely remain the same or even show a slight increase over time.

A continuation of the trends to 2031 would result in a rate of 1.52 non-work trips/capita if the 1986-2005 trend is followed, and 1.58 non-work trips/capita if the 1995-2005 trend is followed. The rate used by the TRANS model is 1.58, matching that from the extrapolation of the 1995-2005 trend.

2.3.3 Variation in trip rates by age and region. Separating daily trip rates into three age groups (student/recent workforce entry, main workforce and retirees) shows that trip rates as a whole are forecast to decline in the pre-retirement period, so the overall decline does not result from an increase in the proportion of retirees as the population ages. However, the recent trend shows a tendency, especially in Gatineau, for people over the age of 65 to make more trips. Thus, if the number of retirees does increase over time, this may increase the overall trip rate, and potentially lead to higher demand for off-peak transit. In Ottawa, both the oldest and youngest age groups increase their share of the overall number of trips by following either the 1986-2005 or the 1995-2005 trends. However, in Gatineau, if the trend since 1995 is followed,

there is a huge increase in the proportion of trips made by retirement-age people, and the trip distribution diverges appreciably from that of Ottawa. If the 1986-2005 trend is followed, Ottawa and Gatineau remain similar in trip distribution by age into the future.

2.4 Transit and Non-Motorized Mode Share

From 1986 to 2005, transit mode share shows an overall decrease from 18% to 15%, although it is important to note that there is an increasing trend from 13% in 1995 to 18% in 2005. There is an indication of increasing transit mode shares in some areas (particularly in Gatineau) and of increasing non-motorized travel in some areas (particularly urban districts and short-distance travel to the CBD). Adjustments may need to be made to the mode share parameters in the model in order to account for these changes.

2.4.1 Reduction in non-auto trips per capita. There is also a drop in transit trips per capita, with a decrease for trips in the AM peak of 0.17 to 0.12 between 1986 and 2005. Decreases are reasonably consistent (percentagewise) across all purposes. However, the transit mode share does not decrease for any individual district type; the drop in overall mode share results instead from a large proportion of trips shifting to district types with lower transit usage. Meanwhile, non-motorized travel has increased (changing from 8% to 12% of all trips) over the whole NCR, but this increase is due to travel patterns in the central districts, which already had a significant non-motorized share. Non-motorized commuting in the four densest (central) districts increases from a 21% mode share to 29%. An illustration of the breakdown in these variations for the most recent trend (1995-2005) is presented in Figure 7 for AM peak trips to destinations within particular district types.

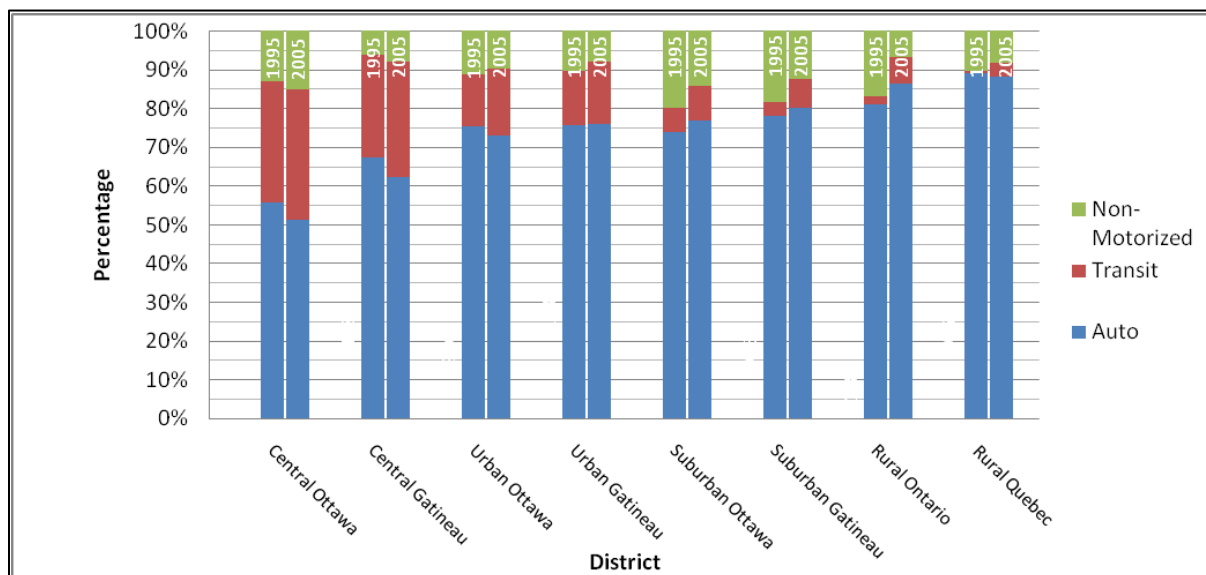


Figure 7: Variation in mode shares by destination district type (AM peak), 1995-2005

2.4.2 Increase in non-motorized share to CBD. The walk and cycle proportion of trips to Ottawa Centre in the AM peak period has increased from 8% to 14% between 1986 and 2005, while the auto drive and transit shares have remained similar (with driving decreasing, then increasing, and transit increasing, then decreasing). If the 1995-2005 trend continues, the non-motorized mode share to the district of Ottawa Centre will increase to 18% by 2031, while the corresponding transit mode share will increase from 43% to 54%. The non-motorized increase is specifically for trips to downtown, as overall in the NCR the non-motorized share in the AM peak period remains almost constant.

The non-motorized share for AM peak trips to the CBD shows an increasing trend since 1995, with Ottawa maintaining a greater share than Gatineau but with both growing at a similar rate.

2.4.3 Adjustment in work trip mode share distribution. Over both the long-term (1986-2005) and the short-term (1995-2005) periods, transit mode share for work trips has either increased or stayed the same for all area types, despite a decline between 1986 and 1995. For each of the six district groupings considered individually (rural Ontario, rural Québec, suburban Gatineau, suburban Ottawa, central/urban Gatineau and central/urban Ottawa), the proportion of transit trips made by residents to work in the AM peak period increases between 1986 and 2005. Therefore, the overall decline in transit mode share during this period comes from purpose and/or geographical adjustments (as rural mode shares remain consistently lower than suburban mode shares, and central/urban are higher than either) rather than shifts away from transit by residents of particular areas. Thus, the transit mode share trend is linked to the demographic shift trend.

Between 1995 and 2005, the proportion of suburban Gatineau residents who took transit to work increases from 9% to 19%; and for central/urban Gatineau residents the increase is from 11% to 21%. By comparison, suburban Ottawa increases from 16% to 21%, and central/urban Ottawa from 18% to 24%. If the 1986-2005 trend is extrapolated, there is a gradual increase in Gatineau transit mode share over time, reaching 25-30% by 2031, while the Ottawa transit share remains almost constant at around 25%. However, it should be noted that the rapid observed increase in Gatineau's transit share since 1995 reflects the significant improvements in the transit level of service, which in turn has led to equalization in transit use characteristics between Gatineau and Ottawa. If the 1995-2005 trend is extrapolated, the increase is greater for both Ottawa and Gatineau, with Gatineau still growing faster—if the 1995-2005 growth in mode share could continue to 2031, transit mode share in Gatineau would exceed 45% in central and urban districts, although in practice this is unlikely to be attainable without higher-order transit.

2.4.4 Reduction in transit share across all trip purposes. All purposes (work, school, return home and other) decrease their transit mode share between 1986 and 2005 by 3.5% to 4.5%. The transit mode share to work decreases from 20% to 15% between 1986 and 1995, but increases to 16% by 2005, as seen in Figure 8.

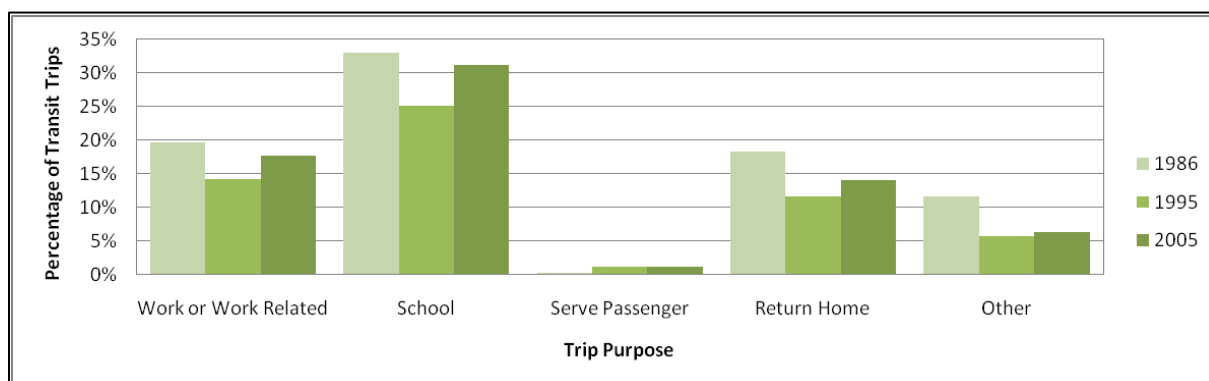


Figure 8: Transit mode share by purpose (1986-2005)

The transit mode share variation by number of household vehicles is consistent across the years.

2.4.5 Urban density influences transit share. There is an increase in transit mode share in suburban areas from 1995 to 2005, in parallel to density growth in those areas, though the correlation is less well defined for urban areas. As the number of jobs (and, the corresponding employment density) has increased in suburban areas such as Orléans, Hull Périphérie, Gatineau Est, Aylmer and South Nepean, so has the percentage of transit trips. The relationship is shown in Figure 9. The disparities in urban density between suburban and urban areas have been decreasing over time.

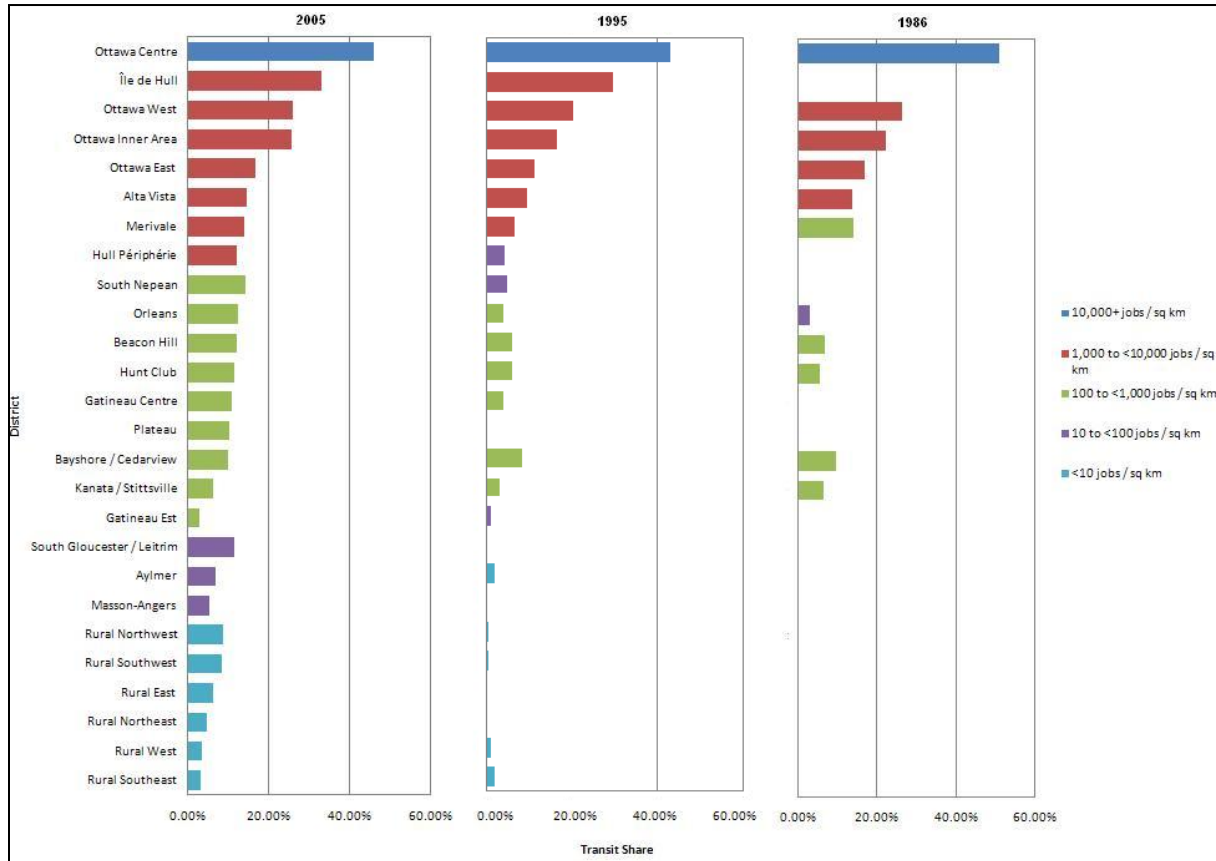


Figure 9: Variation of transit share with employment density, 1986-2005

3. DISCUSSION

Upon considering the trends described in this paper, the most significant issue that comes to light is a demographic and economic shift towards suburbs in both Ottawa and Gatineau that is causing a change in travel patterns as radial travel (to/from central cores) is gradually replaced by localized and circumferential travel. Although the number of jobs in the central districts of the two cities is still increasing, the increase is proportionally low compared with the rate of employment growth in urban and suburban areas.

The long-term estimates resulting from extrapolating these shifts are comparable with the projections produced by the TRANS model.

However, this change has consequences for transit mode share, as trips that do not involve travel to the downtowns use transit less. Accordingly, despite the increase over time in transit mode share in individual districts, with commuting by transit gaining an increased share in rural and suburban as well as urban areas, the overall regional transit share has declined. Extensive transit improvements have helped to stop this decline in recent years, especially in Gatineau – one important trend is that transit behaviour and many other characteristics are starting to resemble each other on both sides of the Ottawa River (as opposed to acting, in travel behavioural terms, like two distinct cities). However, even as the proportion of people living in the central districts decreases, the number of cars per worker is increasing throughout the region (although this trend appears to be very unstable). As both people and jobs move to the suburban areas they will form new travel patterns and create new areas of capacity constraint for which model projections will need to account.

Other trends include a reduction in the differences between male and female travel patterns, and an overall decrease in the number of trips per capita for both work and non-work purposes. The trip rates change by different degrees for different age groups: People of retirement age historically have been making fewer trips on average than those of other ages, but there are indications that this difference is narrowing. This means that, especially in Gatineau (where the older age group is growing faster with respect to the whole population), the number of trips made by people over 65 may come to rival the number made by those people under 25. As these two demographics have very different trip purposes and travel patterns, these changes present another challenge for the model to address.

While it is possible that some of these trends may be linked, analysis of the TRANS survey results does not enable us to identify causal relationships between trends over time as each survey effectively represents a snapshot of a single moment. For investigating these relationships further, it is instructive to look at panel surveys, which monitor the same respondents over time and are thus able to link the development of their demographic and trip-making characteristics, providing for dynamic travel behaviour analysis. In North America, the most comprehensive study has been the Puget Sound Transportation Panel (PSTP) in the Seattle area, which surveyed 20,000 personal travel diaries in 10 “waves” from 1989 to 2002, although eventually it was discontinued due to costs of maintenance and difficulties in replacing people who drop out over time.(2)

The PSTP and other panel surveys indicate that:

- Most changes in mode (i.e., from transit use to driving) occur immediately after a change in occupation or place of employment (which may remove transit as a viable mode). When making relocation decisions, people also are likely to take their estimate of the importance of transit into account as a considering factor. (3)
- People in households that increase car ownership increase the average number of trips made. This leads to the question of whether an increase in ownership causes the increase in trips, or the increase in trips causes the demand for more car purchases. A German mobility panel survey, still ongoing, has shown indications that those who make higher numbers of trips are the most likely category to increase their vehicle ownership. (4) Nonetheless, the trends observed in the NCR are for an overall increase in vehicle ownership rates while at the same time a decline in the number of trips. The shift in job locations towards suburban areas that are less well served by transit may be showing an influence here. Also, the trend of ownership increase in the NCR is unstable, with the trend possibly showing a decrease depending on which survey period is extrapolated.

- It is difficult to determine whether variations in land use characteristics, gender, employment and occupation type are significant in changing trip rates. Findings do not identify any definite correlation between these. However, the PSTP clearly demonstrated a link between change in jobs and change in modes. An analysis of the PSTP in turn found the need for travel demand models to better reflect the growing diversity of travel behaviour and to give more attention to the role of employment, job type and land use as explanatory variables for behaviour.
- The PSTP found that trip rates are gradually decreasing over time although there is some variability in this among household age profiles. The number of trips increases with an increase in the age of children (ages 6-17) in the household, but decreases with an increase in the number of adults (18 and over). This is important to view in light of the situation in the NCR with both an increase in the average age of the population and a declining trip rate. However, there are a variety of other potential causes for declining trip rates, such as economic fluctuations and increase in fuel prices, and, as was noted before, trip rates among over-65s in the NCR are actually increasing, so it is difficult to establish a clear link with age profile and trip rates. Nonetheless, the declining trip rate appears to be a consistent phenomenon, as it is also observed in the Greater Toronto Area from the Transportation Tomorrow Survey.

4. SUMMARY AND POSSIBLE IMPLICATIONS FOR MODELLING

A recent study identified important travel and demographic patterns that have developed in the National Capital Region between 1986 and 2005. Many of these appear to be driven by one or more key region-wide trends: A key trend is the increasing influence of the suburbs for both population and employment growth, which in turn appears to have influenced a variety of changes including a reduction in transit mode share, a lowering of housing density and a decline in the proportion of trips destined to downtown. Traditional travel patterns to and from the central districts are losing ground to trips that involve only suburban and rural areas, whether within suburban areas, circumferentially, or between newly developed localized suburban hubs.

A decline in rates both for work and non-work trips is a second significant trend, and it is noteworthy that trip rates vary by age category over time. It should be noted that the decline in rates is not unique to the NCR—data for Toronto also show the number of work trips per capita and per worker declining between 1986 and 2006.

A comparison of the extrapolations of key trends with TRANS model forecasts showed consistency between the two in most cases. Nonetheless, the exercise is useful for purposes of validation, and to anticipate and monitor changes as they develop over time. It should be noted that, in some cases, the trend from 1986 to 2005 indicates a different extrapolation, if it is continued, than the trend from 1995 to 2005 for the same indicator. For example, overall transit mode shares decrease slightly between 1986 and 2005, but increase substantially between 1995 and 2005 (with an overall pattern resembling a 'V'). Thus, the extrapolations of current trends may vary depending on the starting point. This suggests that extrapolations might best be viewed in terms of ranges and through comparison with other urban areas. This contextual 'reality check' helps further to ground model forecast results.

The aforementioned findings suggest several possibilities for consideration in future model development:

Several activity rate and demographic changes may have to be considered more explicitly in future trip generation models. For example:

- Differences are reduced between male and female travel patterns, with female auto use growing faster in the older age categories.
- The overall decrease in the number of trips per capita suggests a lower overall activity rate.
- Historically, people over 65 travel less than those in younger age groups, but this gap is narrowing, and trips made by over 65s may equal those made by under 25s (especially in Gatineau where the proportion of the population over 65 is growing faster). As these two demographics will have very different trip purposes and travel patterns, these changes present another challenge for the model to address.
- As noted, an analysis of the Puget Sound panel surveys found the need for models to better reflect both the growing diversity of travel behaviour and the influence of demographic and employment changes on this behaviour.

Calibration of each of the steps of a model is necessarily driven by today's patterns (especially transit share, which focuses on the central core). However, with the growing significance of suburb-to-suburb and other non core-focused travel, and multiple activity centres away from the CBD, several possible implications for model development arise:

- The calibration of trip distribution and mode share models may need to differentiate more clearly between radial trips focused on the central core and suburban or circumferential trips. It may not be sufficient to use local demographic or employment inputs to make this differentiation within the same region-wide model: rather, subsets of models may be needed. Activity- or tour-based models in theory should address this concern; nonetheless, these formulations also should be reviewed to ensure that the observed differentiation is reflected appropriately.
- Screenlines and travel times may need to be calibrated in both directions to be able to deal with the increasing influence of counter-peak flows.
- Data may be sparse in currently dormant directions. This might suggest the need for larger survey samples in suburban areas, or for non-home surveys to gain a better sense of the destination-end patterns.

In summary, it is important to note that this study and the above-noted implications are not critiques of TRANS' comprehensive sets of surveys or of its state-of-the-practice model. At the same time, nothing is static; and so ultimately the purpose of this study is to help modellers and transportation planners anticipate changes that influence both their analytical tools and the inputs that drive forecasts of travel. The benefits to practice of this type of analysis arise in ensuring that we understand fully how our 'market' for travel is changing – and why that is happening. Ultimately, as translated through our data and forecasting models, we can gain ensure that proposed transportation investments and policies fully meet the needs of today's – and tomorrow's – travelling public.

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6. REFERENCES

- (1) HDR | iTRANS, National Capital Region Travel Trend Study, Part 1 (90 pages) and National Capital Region Travel Trend Study, Parts 2 and 3 (159 pages). Prepared for the TRANS Committee, January 2011. The material described in this paper is drawn from the 'Parts 2 and 3' report.
- (2) Goulias, K., Blain, L., Kilgren, N., Michalowski T., and Murakami, E., Catching the Next Big Wave: Do Observed Behavioral Dynamics of Baby Boomers Force Rethinking of Regional Travel Demand Models?, Transportation Research Record: Journal of the Transportation Research Board, No. 2014, Transportation Research Board of the National Academies, Washington, DC, 2007, pp. 67-75.
- (3) Perk, V., Flynn, J., and Volinski, J.M., Transit Ridership, Reliability and Retention. Final Report No. BD549-32, prepared by National Center for Transit Research for Florida Department of Transportation, 2008.
- (4) Zumkeller, D., German Mobility Surveys – the German Experience: German Mobility Panel (MOP) and Long Distance Panel Survey (INVERMO), Seminar on methods and approaches for permanent surveys, Paris, October 2007.