Development of Modal Share Targets for Ottawa's Transportation Master Plan

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ABSTRACT

The City of Ottawa updated its Transportation Master Plan (TMP) in 2003. The new TMP plans for the management and reduction the long-term demand for single-occupant vehicle trips through a combination of investment in rapid transit infrastructure and the promotion of TDM and other complementary measures. These plans respond to a series of modal share targets that were developed as part of the TMP. In contrast to the traditional method of developing the target shares at screenlines, a new process was introduced. This process took into account the entire trip from origin to destination, as well as the trip purpose. The resultant targets thus allowed TMP actions and policies to be related directly to the intended travel 'market,' as opposed to an arbitrary point on the transportation network.

This paper describes the new process for developing modal share targets. The paper includes a review of the different steps and how the results were applied to the Ottawa TMP, and a comparison with the previous process. It concludes with a review of the benefits to the development of transportation policies and plans, and possible next steps to elaborate further the process.

1. INTRODUCTION

1.1 Context

Similar to many urban centres in Canada, the City of Ottawa is experiencing continued and accelerated growth. Over the next two decades, population and employment are expected to increase by 50%, to 1,192,000 residents and 750,000 jobs by 2021. Suburban communities are projected to accommodate about 75% of the new residents and about 50% of the new jobs. As a result, the overall demand for travel will grow by about 60%, with peak directional demands diffused throughout the City.

In 2003, the City of Ottawa adopted a new Transportation Master Plan (TMP). The TMP was prepared within the broader context of the "Ottawa 20/20" initiatives, a two-year process to form a comprehensive blueprint for the future of Ottawa.

Traditionally, the transportation system had been developed with an emphasis on mobility - to provide transportation facilities to accommodate expected travel demand. In contrast, the City is planning a system that emphasizes accessibility - to increase the range of options open to people who need to travel within the city. The City is striving to minimize the future need for new and widened roads. Therefore, the TMP sets an ambitious transit modal split objective of 30% in the PM peak hour, a rate nearly double the current level of 17%. This target is based in large part upon a proposed comprehensive expansion of the City's bus and rail rapid transit networks. It is complemented by the promotion of TDM and other complementary measures that are aimed at reducing the single occupant vehicle (SOV) trip.

This direction is compatible with the City's desire to protect and improve the environment, reduce the amount of land used for new road infrastructure and decrease air pollution and Greenhouse gas emissions from private automobile use.

1.2 Purpose of This Paper

This paper describes the process that was used to develop modal share targets for Ottawa's new TMP. Historically, transportation plans in Ottawa and other Canadian cities expressed transit targets at screenlines across key corridors.[1] These were based upon travel demand model forecasts of auto and transit trips, which were then factored to identify desired transit targets. The resultant auto trips were used to identify forecast deficiencies in road capacity (i.e., the requirements for new road infrastructure). The previous transportation plan, the (former) Region of Ottawa-Carleton's 1997 TMP, developed its targets this way.[2]

However, the use of screenlines as the basis for the targets is problematic, for several reasons. The most important of these is that it is difficult to tie a link-based target (i.e., which the screenline factors represent) to actual travel patterns (purposes or origins/destinations). As a result, the impact of proposed actions or policy measures on specific segments of the travel 'market' cannot be measured directly against the targets set along key travel corridors.

Accordingly, the 2003 TMP introduced a new process for identifying targets and deficiencies, based upon trip purpose. An analysis of Ottawa's origin-destination survey found that transit modal split for the home-work commute could be categorized according to the density of employment (jobs / km^2) and the proximity of the workplace to the existing rapid transit network. Different transit targets (representing the impact on 2021 demand of the expanded rapid transit network coupled with workplace measures such as reduced parking supply and TDM programmes) then were developed for each category. Similar transit targets were developed for non-work trip purposes. In addition, for the first time, explicit ridesharing, walking and cycling targets were identified.

The new process required interventions at different points within the City's TRANS EMME/2 forecasting model, according to a transparent process.[3] The model outputs were again expressed at screenlines, but this time they could be used as-is to identify road deficiencies. Overall, the new process resulted in more holistic transit target that could be tied directly to TMP policies and actions, thus fostering a greater understanding of the potential 'market' for them. In addition, the new process also made possible the inclusion of specific targets for other (non-SOV) modes.

The remainder of this paper is structured as follows. Section 2 provides a context, by describing the process of developing the TMP. Section 3 reviews the traditional method of developing target modal shares. Section 4 explains why a new method was needed; the new method, and its application to the TMP, are described in Section 5. Section 6

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1 Screenlines are imaginary lines that cut across roads, transit facilities, bicycle paths and footpaths, at which the total numbers of vehicles and persons, by type, can be counted. From these counts, which in Ottawa are typically conducted for a 12-hour period, modal shares during different times of the day are determined.

2 The Region of Ottawa-Carleton and its 11 constituent municipalities, including the former City of Ottawa, were amalgamated to form the 'new' City of Ottawa in January 2001.

3 TRANS is an intergovernmental committee that oversees transportation model development and travel surveys for the National Capital Region. It is comprised of the Cities of Ottawa and Gatineau (Québec), the Ministries of Transportation of Ontario and Québec, the two transit operators (OC Transpo and the Société de transport de l'Outaouais [STO]) and the National Capital Commission.

assesses the new method, identifies possible refinements for the future and concludes the paper with a review of possible applications to the development of long-range transportation plans elsewhere.

It should be noted that although this paper focuses on the process of developing modal share (i.e., demand) targets, the underlying research also examined supply-side factors, which are not discussed in this paper. These factors were applied to the analysis of capacity deficiencies at the screenlines. The factors accounted for heavy trucks and buses, light trucks, passenger-car equivalency factors, transportation system management factors and level of service standards. In addition, the individual lane capacities of different road types were reviewed. Many of these capacities were increased in light of actual observed throughput.

2. CURRENT AND ANTICIPATED CONDITIONS

Key points to note are:

- **Rapid growth is projected for the City of Ottawa**. As noted, the City's population is set to increase by 50% to 2021, to 1,192,000 persons. Employment is projected to grow even faster, to 750,000 jobs by 2021. The number of households (dwelling units) also is expected to increase faster than the population, to 502,000 by 2021.

- **More people in more households will be working**. The rate of jobs per person increases, by 17% in Ottawa as a whole. By 2021, the average number of jobs per dwelling unit (1.5) will exceed the 1997 Regional target of 1.1 – 1.3 jobs per unit.

- **Most of the growth will take place in three urban communities** (Kanata-Stittsville, Orléans and Barrhaven-Riverside South / Leitrim). As shown in Figure 1, the three urban communities are located outside the Greenbelt that surrounds the inner suburbs. (The figure divides the City of Ottawa [and the adjoining City of Gatineau] into 20 analytical zones.[4]) Three-quarters of the growth in population, over half the new dwelling units (58%) and just over half the new jobs (52%) are expected to be located in the three urban communities.

The rapid growth in population and jobs translates into two key implications for travel:

1. **There will a substantial increase in travel during the PM peak hour.** Total person-trips are projected to increase roughly according to growth in dwelling units (81%). Over half the projected increases in PM peak hour travel will start or end in the three urban communities.

2. **Peak travel demand will spread**; notably, with more trips taking place in the off-peak (inbound) direction and more suburb-to-suburb travel. In particular, the three urban communities will have 30% of the City's jobs in 2021, almost as many as the Inner Area's 33% (although the Inner Area will continue to have the City's dominant

[4] The 20 districts are aggregations of the TRANS EMME/2 transportation model's 258 zone system (see Section 5.2.2 below).

concentration of jobs). By 2021, almost as many people will live in the three urban communities as inside the Greenbelt, with 44% of the population (compared with 47% inside the Greenbelt).

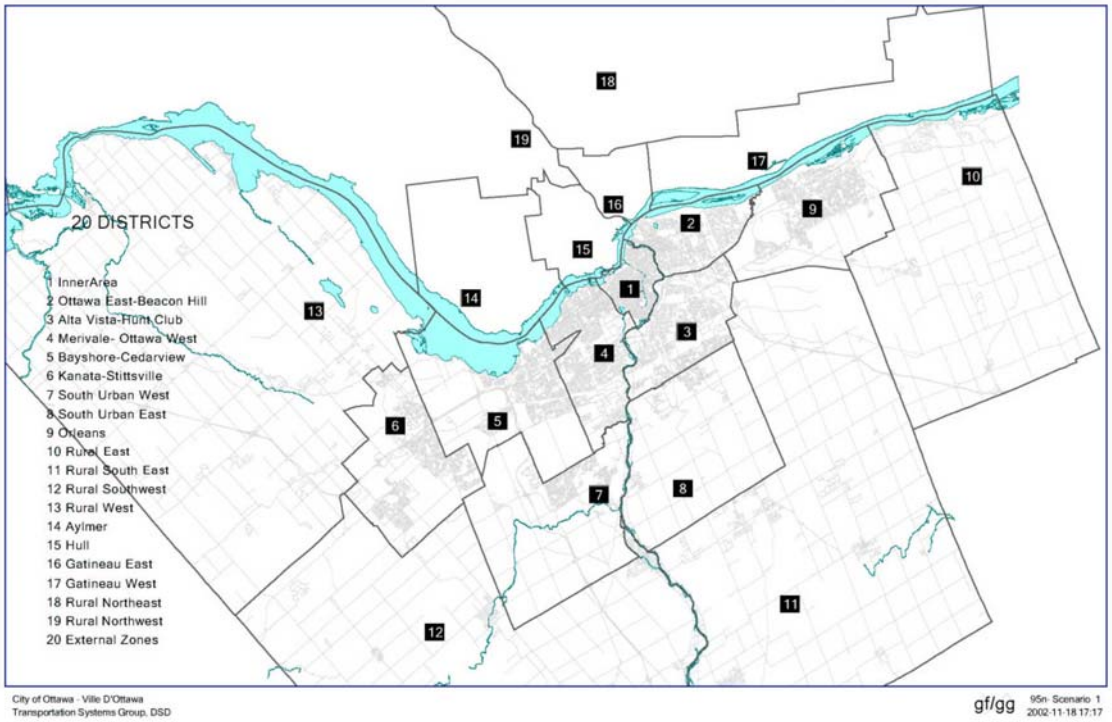

Figure 1. City of Ottawa Analytical Districts

Finally, a review of recent trends provided some insight into the potential markets for non-SOV modes:

- **Growth in Peak Vehicular Traffic**. Observed traffic counts at four groups of screenlines[5] (shown in Figure 2) indicate that between 1989 and 2001, AM and PM peak hour and peak period volumes have increased in (at least) the peak directions. The overall *annual* increases have been of the order of 1% or less. By comparison, PM peak hour traffic on the same screenlines is projected to increase by a *minimum* of 1.5% per year between 2001 and 2021. Traffic volumes are expected to grow faster in the future than they have in recent years.

- **Vehicle Occupancy Trends**. The same screenline data indicate that average auto occupancy (number of people in individual vehicles)continues to fall over time, for both peak periods. For example, in 1989, at the Central Business District screenline, the auto occupancy was 1.46 persons per vehicles during the PM peak hour outbound (i.e., the peak direction, travelling away from the downtown). In 2001, the average at this screenline was 1.38 persons per vehicle. Taken together with the aforementioned growth in traffic, the results means that more vehicles are carrying fewer people.

[5] The screenlines were: Ottawa River, Rideau River, a cordon around the Central Area (Central Business District) and a cordon around the Greenbelt.

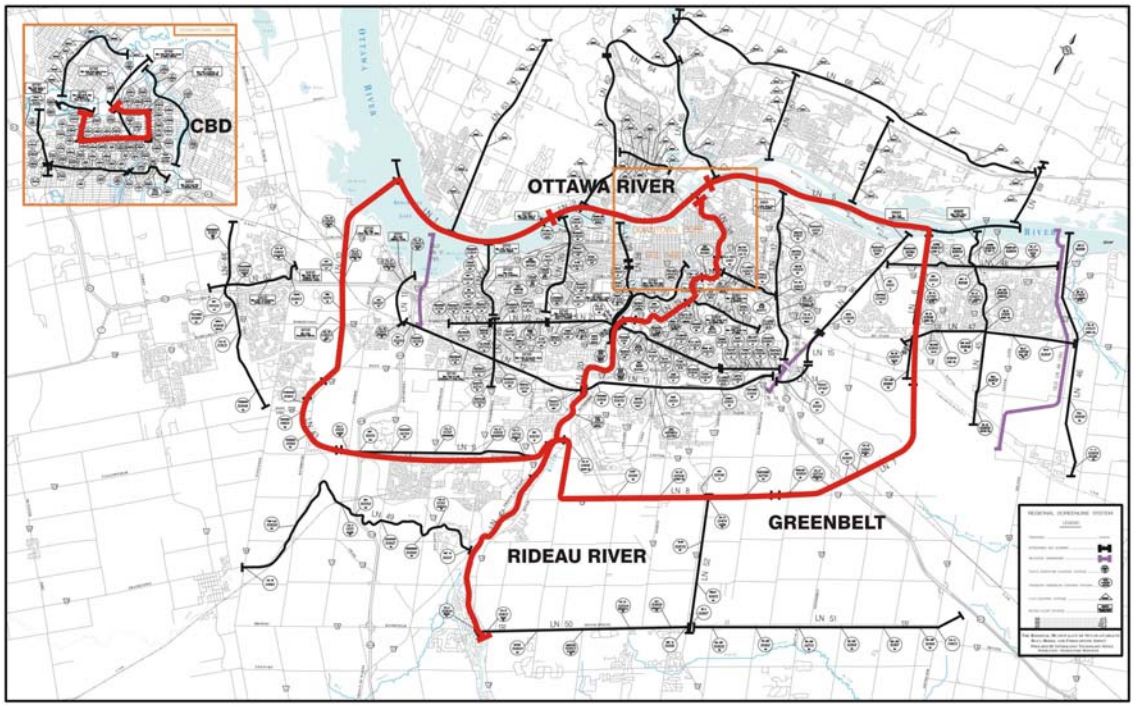

Figure 2. Screenlines Used in Trends Analysis

- **Peak Spreading Trends**. An important indicator of congestion is how peak hour travel has spread into the adjoining times. The peak spreading phenomenon occurs when peak hour *drivers* divert their trips to the 'shoulders' of the peak (before or after), thereby avoiding the peak. Since the peak hour represents 40% of the 2½ peak period, a peak hour ratio (the ratio of peak hour- to peak period-*vehicle* volumes) approaching 40% means that sustained congested conditions would occur. (i.e., 100% of the peak period traffic divided by 2½ hours = 40% of the traffic in each hour). This also indicates the extent to which individuals are able and prepared to adjust their travel times to avoid the severe congestion that would otherwise result. Finally, it is an efficiency indicator of the proportion of the day that the full capacity of the transportation system can be utilized.

  The evidence indicates that peak spreading is occurring - slowly - in Ottawa. Table 1 compares the aggregate screenline PM peak hour factors in the peak (outbound) direction for 1989 and 2001 for *vehicles*. The data indicate that peak spreading is occurring, although at a relatively slow rate (with annual changes generally of 0.5% per year or less).

Screenline	Period (peak direction)	1989	2001
Ottawa River	PM outbound	46%	44%
Rideau River	PM outbound	45%	43%
Central Business District	PM outbound	46%	45%
Greenbelt	PM outbound	46%	44%

Table 1. Screenline Peak Spreading (vehicles) – 1989-2001*

* Source: Screenline data provided by the City of Ottawa.

The data suggest that the achievement of the '40%' threshold appears to be some years away – at current trends, this would occur after 2021. Ottawa's congestion is not as pervasive, say, as that of Toronto; but the situation cannot be ignored. At the same time, however, there are currently sharp 15-minute peaks, which like will continue to exist even as the peak flattens across the 2½ hour peak period (to speak nothing of non-recurrent congestion that is caused by incidents, which also impact peaking).

Another reason the situation cannot be ignored is suggested by the following indicator: The peak hour ratio for *person*-trips by all modes across the National Capital Region is approaching this threshold: dropping from 43% in 1986 to 41% in 1995.[6] This suggests that the demand for travel – by all modes – is largely pervasive throughout the peak period.

- **Markets for Different Modes**. Current data indicate that the longer the trip, the more likely it is to be made by auto. An analysis of the distribution of 1995 TRANS Origin-Destination survey by mode and by purpose yielded several important findings. The analysis reflected PM peak period conditions, but its trends generally were considered applicable to the PM peak hour. The findings included:

    - Shorter trips are more conducive to alternatives to the auto. The analysis indicated that almost half of trips up to 1 km. in length were made on foot (47%) and bicycle, as were about one-third (34%) of trips between 1 and 2 km. long. Cycling captured at most 3% of trips, at distances up to 5 km.

      On a daily basis, trips by auto hadthe highest average distance, at 9.7 km., with transit trips slightly shorter at 9.5 km. Cycling trips averaged 4.2 km. in length, and walking trips had an average distance of 1.4 km.

    - Walking and cycling shares were highest for the home-school commute. This reflected both the proximity of many schools to students' homes, and the lack of an alternative for many students (notably, because they are too young to drive).

    - Transit shares are highest at moderate to longer distance trips; notably, almost one-quarter (24%) of all trips between 15 and 20 km. In this range, transit captured almost 30% of the home-work commute and two-third (67%) of the home-school commute.

    - The highest auto shares over all distances generally were for the home-shopping, home-other and non-home-based trips, as well as for the home-work commute over 2 km. This reflects in part the convenience of the auto for shopping, for 'other' purposes such as medical appointments

[6] Source: TRANS Committee, *1995 NCR OD Survey, Highlights of Demographic and Travel Patterns*, May 1997; Exhibit 3.18 (Distribution of Trips by Time of Day), p. 28.

and for such non-home-based trips such as a job-related meeting outside the normal workplace.

Other City tabulations from the same data indicate that:

- The large majority of daily cycling trips were less than 5 km. long, except for the home-work trip, for which half (50%) were greater than 5 km.

- Virtually all daily walking trips were within 5 km., with upwards of 2/3 being within 2 km.

These tabulations help to identify appropriate markets for alternatives to driving alone and, it follows, appropriate targets for these alternatives. For example, although mixed used development may promote the localization of the home-based trip to the dentist (a trip in which the auto could be left at home), the reality is that many trips are linked to other purposes over longer distances, which may mandate the use of the auto.

3. TRADITIONAL METHOD OF DEVELOPING TARGET SHARES

As noted, earlier *TMP*s applied target transit modal splits to strategic screenlines (i.e., to the forecast volumes at these screenlines). Thus, transit targets were expressed in the (former) Region of Ottawa-Carleton's *Official Plans* at individual screenlines: for example, the 1997 regional TMP cites a transit target of 30% of PM peak hour outbound (northbound) trips across the Ottawa River screenline by 2021.

The screenline reference has been used for several years, locally and in cities around the world: Screenlines provide a readily identifiable marker to monitor progress towards the achievement of the targets. Annual screenline classification and occupancy (C&O) counts can be compared, over time, with the targeted volumes.

The primary purpose of any transportation analysis undertaken as part of a master planning exercise is to identify the future transportation system requirements necessary to accommodate the growth in travel associated with the increase in population and employment opportunities for the study area over a finite planning period. In the 1997 regional TMP, as with previous plans, the transportation analysis included the application of the TRANS EMME/2 transportation model. The TRANS transportation model is jointly maintained and updated by area planning agencies that have a history of collaboration on transportation modeling and joint data collection efforts in the National Capital Region. The TRANS model is a traditional four stage planning model (trip generation, trip distribution, mode split and trip assignment) and future travel forecasts are predominately influenced by the location and scale of future land use projections for the region.

The TRANS model was used to provide a baseline forecast of travel (auto and transit) based on an understanding of key growth assumptions associated with future urban development patterns. However the travel forecast used as a basis for the 1997 Regional Master Plan included adjustments to the baseline forecast of the travel model, particularly for the private auto travel. These adjustments to the demand model results were conducted outside the model and were undertaken to account for several changes

in travel behaviour. Primary changes in travel behaviour not considered to be adequately reflected by the modelling framework were:

- Increased walking and cycling trips resulting from intensified land use patterns and expansion of the cycling network (the TRANS model predicts travel based predominately on travel characteristics associated with auto and transit demands).

- Reduced overall PM peak hour travel demand resulting from the application of transportation demand management (TDM) measures.

- Increased utilization of transit due to increased marketing efforts, improved intermodal connections and other indirect efforts.

The approach used to include these changes in travel behaviour noted above has been in the past referred to as a screenline approach. This approach and methodology included detailing the travel demand (person trip travel) across each of the strategic screenlines based on the results obtained from the planning model. A comprehensive analysis of the demand (walking, cycle, transit and private auto) across each of the strategic screenlines was then undertaken to determine and assess the impact of the changes in travel behaviour noted above and consequently the level of adjustment to the travel demand. These post-modelling adjustments were carried out on a spreadsheet to ensure the various adjustments were documented in a systematic manner. The adjustments to travel demand were carried out on a screenline by screenline basis with the net result being a reduced level of auto travel demand across each of the strategic travel corridors. The remaining steps in the transportation analysis were then to develop the necessary infrastructure improvements to accommodate the associated level of auto travel demand within each of the travel corridors.

Infrastructure requirements were consequently identified to service the adjusted auto demand along key travel corridors.

4. WHY IS A NEW APPROACH NEEDED?

The screenline basis for modal share targets reflected an era in which the main levers available to planning agencies to manage travel demand was through construction, either of new roads or of transit services (e.g., the Transitway). Thus, achievement of the target related directly to the supply of transportation at that screenline.

Today, the paucity of resources for transportation investments means that other ways are needed to reduce or manage the number of drive-alone auto trips; notably, measures that rely upon influencing driver behaviour at the origin or destination end of a trip (e.g., through a work place ridesharing programme). It is recognized that these measures may be applicable only to certain segments, or must vary among different segments, of the travel market.

As a result, it is now recognized that a more encompassing approach is to develop modal share targets that apply to the trip itself; i.e., to the origin- or destination-end of a trip. The targets can vary by origin or destination, by mode or by trip purpose. A notable example (detailed below) is the development of transit targets for the afternoon work-to-

home, with different targets applied according to different densities of employment concentrations. These targets are applied to the model-generated origin-destination trip tables (matrix), which then are re-assigned to the road and transit networks in the model.

In this way, the strategic screenlines express the impacts of a target, rather than the target itself. The O-D based targets also can be translated more meaningfully into policies and actions that the public can understand directly: e.g., the transit share of employees at low density suburban workplaces will be increased to *n* % by reducing the supply of parking, subsidization of employer-supplied transit passes, etc.[7] In other words, the targets can be related directly to the actions and policies that would be used to implement them; something that cannot be done through the existing, screenline-based reference. The screenline reference continues to serve as a monitoring point, against changes in the observed C&O counts over time. The screenlines also identify the arterial road capacity that is required to serve the travelling public.

In sum, the basis for establishing targets was broadened to a trip-based approach, which replaced the screenline-based approach that was used in previous TMPs. The screenlines are retained as reference points, to illustrate the manifestation of the trip-based targets and to identify future capacity requirements for infrastructure.

The new, trip-based approach is elaborated below.

5. DERIVATION OF FACTORS AND TARGETS

5.1 Approach

The approach was based upon the selection of factors for which target shares were to be developed. These factors – all intended to be alternatives to the SOV - comprised:

- Transit
- Trip elimination (including telecommuting as well as trip avoidance)
- Time shifting (a deliberate shifting of trips from the peak hour to the peak shoulders)
- Walking
- Cycling
- Ridesharing

These factors also had been considered in the (former) Region of Ottawa-Carleton's 1997 TMP, with the key difference being that a single combined target for TDM and trip elimination was assumed in lieu of explicit targets for trip elimination, time shifting, walking, cycling and ridesharing.

In addition to providing an explicit application of targets for each individual factor, the breakdown used in the 2003 TMP allows the development of targets for specific trip lengths (i.e., origin-destination pairs) and by trip purpose (i.e., differentiating between

[7] This is a hypothetical example, used here for illustration only. The derivation of policies and actions is (and properly should be) conducted separately from and subsequent to this analysis, and is beyond the scope of this analysis.

work and non-work trips). The distinction by trip length takes into account the distances over which alternatives to the SOV trip were competitive, as derived from Table 2 above. The breakdown by work and non-work purposes reflects the fact that alternatives to driving alone are more attractive for the regular work commute whereas reasonable alternatives to auto travel tend to be significantly less attractive for non-work trips.

Accordingly, the following discussion is presented along these lines. The discussion begins with the development of transit targets, since transit is the primary alternative to the SOV trip. Transit targets for the work (commute) trip are described first, followed by the non-work transit targets. Finally, the development of the targets for the other factors is described.

As noted, these factors all represent alternatives to driving alone. It is important to note that they complement each other: they must work in tandem in order to achieve the desired result of reducing the number of automobiles on the roads. Distinguishing them in this analysis provided a more complete, and necessary, understanding of their dynamics.

5.2 Derivation of Transit Targets

5.2.1 Proportion of Work Trips

The City's base 2021 forecasts projected that 33% of PM peak hour trips were for the work-to-home commute, known as "home-based-work" (HBW) trips in the EMME/2 model. The comparative proportion of HBW trips in the 1995 TRANS Origin-Destination Survey was 32%, indicating that the proportion is projected to be stable over time.

The proportion of work trips is actually larger, since linked trips also occur; i.e., HBW trips describe only the direct work-to-home trip. Many commutes also have an intermediate stop between work and home (for example, to shop, for personal business [banking, doctor's appointment, etc.] and so on). Each leg is modelled as a separate trip purpose, and cannot easily be combined to show the linkages. For example, an intermediate stop at a store would be recorded as non-home-based or NHB trip (work-to-store), then home-based-shopping (store-to-home).

The 1995 TRANS Origin-Destination Survey indicated that about half the PM peak hour NHB trips were part of the home-to-work chain. The City's base 2021 forecast projected that NHB trips represented 27% of the PM peak hour trips, yielding a total proportion of 47% (33% + ½ * 27%) of trips related to the work-to-home commute. These trips – i.e., the combination of HBW and half the NHB trips – are defined as "work" trips. The remaining 53% represent "non-work" trips.

5.2.2 Categorization of HBW Transit Modal Splits by Employment Zone

The next step was to identify transit targets from the work-based origin; that is, reflecting the most likely end of the trip at which commuters could be influenced to use transit. Previous work demonstrated that proximity of the workplace to the Transitway (i.e., to rapid transit) is a significant indicator of transit use: i.e., commuters wanted to be able to take a bus within steps of their work place.[8]

[8] Source: *TRANS EMME/2 Model Development Study*, TRANS Committee, 1992.

Next, a review of the observed (surveyed) 1995 trip origins and the forecast (2021) trip origins indicated that the transit modal split varied according to the density of employment (jobs / km^2). Five categories were developed:

1. 0 to 2,500 jobs / km^2 (low density; in primarily residential areas).
2. 2,500 to 5,000 jobs / km^2 (medium density; mainly mature industrial and business parks).
3. 5,000 to 20,000 jobs / km^2 (high density, such as new town centres, shopping centres and business parks).
4. 20,000+ jobs / km^2 (single use special generators such as hospitals, outside the Central Business District [CBD]).
5. 20,000+ jobs / km^2 (the Central Business District).

Figure 3 graphically illustrates the various employment densities that were assumed to be achievable throughout the City by 2021. The figure is based upon the TRANS EMME/2 model's 258 zone system.[9] However, it should be noted that densities were calculated only according to the actual area occupied by the employment development (i.e., if only 30% of a zone's area contained office buildings, then the zone's density was based upon that area alone).

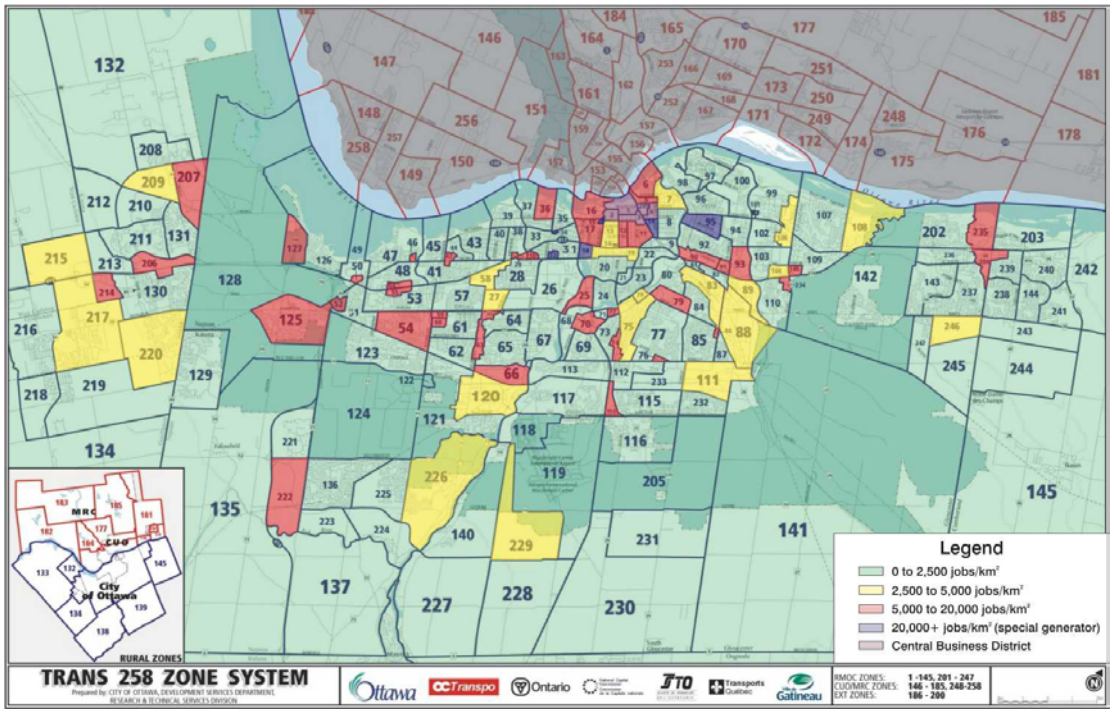

Figure 3. 2021 Employment Densities by Traffic Zone

Table 2 summarizes the observed 1995 transit modal splits (PM peak hour trips originating) from all traffic zones in the City of Ottawa. The table summarizes the transit splits for all trips (all trip purposes combined) and for HBW trips, assigning each zone by

[9] The TRANS model covers the entire National Capital Region, including the City of Gatineau, Québec. However, this analysis considered only the 192 zones that are in the City of Ottawa.

five categories of employment density and whether or not the zone's employment "massing" is oriented to rapid transit (i.e., is "within a 400 metre walking distance of a station, as designated by "on RT [rapid transit]).

Categories of Zones by Employment Density	1995 Total Trips		1995 HBW Trips	
	Off RT	On RT	Off RT	On RT
1. Low density	5%	9%	10%	16%
2. Medium density	7%	10%	13%	23%
3. High density	13%	18%	18%	29%
4. Special generator	13%	32%	0%	24%
5. Central Business District	N/A	38%	N/A	52%
Total, all City of Ottawa zones	17%		23%	

Table 2. Transit Modal Splits by Employment Density – 1995
Source: 1995 TRANS O-D Survey

Figure 4 plots these modal splits, along with those projected for the 2021 base conditions (i.e., forecast travel behaviour, without factors or targets being applied). For both the observed 1995 and forecast 2021 conditions, the figure demonstrates a general increase in transit modal splits:

- From low density (category 1) to CBD (category 5).
- From "off" rapid transit to "on" rapid transit.
- From 1995 to 2021 (with the RTES network in place).
- For work trips (work-to-home) versus all trips.

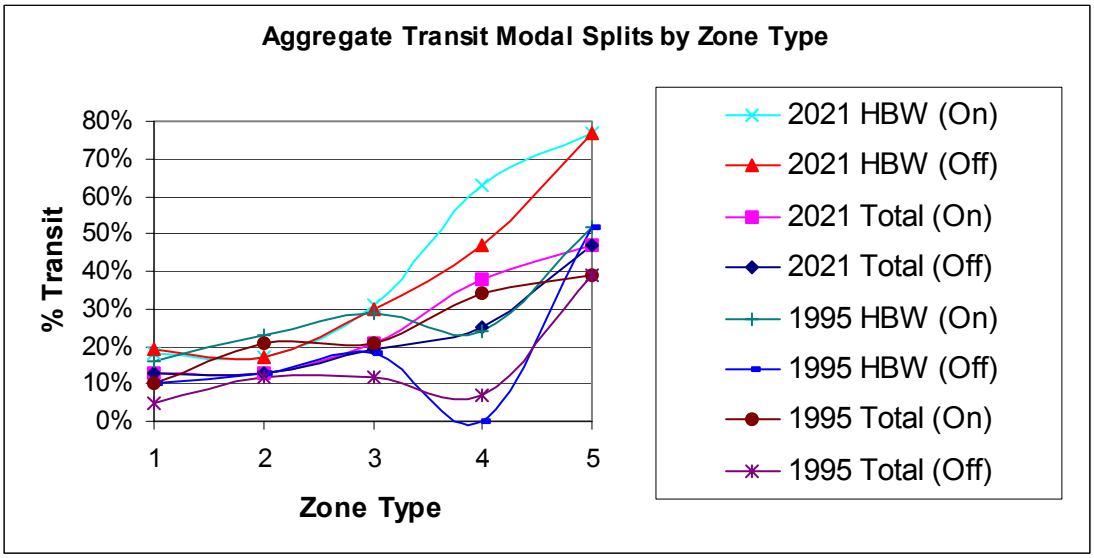

Figure 4. Trends in Transit Modal Splits by Employment Density – 1995 Observed and 2021 Base Forecast

5.2.3 Development of "Work" and "Non-Work" Transit Targets

Application of "ambitious but realistic" transit targets to all 2021 "work" trips (HBW plus half the NHB trips) resulted in the "work" trip transit modal splits for the different categories that are summarized in Table 3.[10] The table lists the base transit modal splits and the modal splits that were achieved with the targets (i.e., what was actually achieved over *individual* zones when the City applied the *average* targets to its forecasting model). The consultant and the City worked together to derive the average targets, using the aforementioned 1995 and 2021 bases as a guide. It should be noted that the transit modal splits for any given origin-destination pair were limited to an assumed practical maximum of 85%.

Categories of Zones by Employment Density	2021 base "Work" trips		2021 "Work" trips achieved with target	
	Off RT	On RT	Off RT	On RT
1. Low density	16%	16%	28%	33%
2. Medium density	16%	16%	32%	39%
3. High density	27%	29%	37%	47%
4. Special generator	45%	62%	57%	68%
5. CBD	N/A	75%	N/A	77%

Table 3. 2021 "Work" Transit Modal Splits by Employment Density
Source: City of Ottawa, TRANS model forecasts

A similar process was applied to the non-work trips. The resultant base transit modal splits and the splits achieved with the targets are summarized in Table 4. Overall, the application of the targets yielded a transit modal split of 28% during the PM peak hour in 2021.

Categories of Zones by Employment Density	2021 base "Non-work" trips		2021 "Non-work" trips achieved with target	
	Off RT	On RT	Off RT	On RT
1. Low density	13%	12%	15%	25%
2. Medium density	12%	11%	15%	25%
3. High density	22%	16%	15%	24%
4. Special generator	12%	30%	15%	25%
5. CBD	N/A	12%	N/A	24%

Table 4. 2021 "Non-Work" Transit Modal Splits by Employment Density
Source: City of Ottawa, TRANS model forecasts

[10] The targets were derived through several iterative refinements. The targets were "ambitious" since they correspond with the ambitious overall target of effectively doubling the current 17% transit share to 30%; and they are "realistic" in that the targets could be differentiated according to the different work trip market segments (i.e., the employment density categories and the proximity to rapid transit).

5.3 Non-Transit Targets

Table 5 summarizes the values and targets for the factors that were used in this analysis. It includes a description of how the factors were applied, the selected factor values, a discussion of their derivation and background information and data. For comparison, the table also describes how (and if) the factor was used in the 1997 Region of Ottawa-Carleton TMP.

As noted, the 1997 TMP used a single factor to account for such TDM initiatives as ridesharing, flexible working hours and so on. However, the term "TDM" has been used in the literature to represent different measures, depending upon the perspective. As a result, the impact on travel varies. Also, although several measures frequently are brought together as part of a TDM package, the individual impacts of each constituent measure often cannot be isolated.

Given these variances, and given the definitional problems with the available information, for the purposes of this analysis it was agreed to identify and isolate specific "non-transit" factors: the broader term gets around definitional issues that are associated with TDM. This also allowed greater precision in estimating the impacts, to account for origin-destination, purpose, mode and trip length. Accordingly, as summarized in Table 6, factors were estimated for trip elimination, walking, cycling, ridesharing and time shifting.

5.4 Accounting for Changes in Economic Conditions

It is important to note another adjustment that was made to the base horizon year forecasts. The TRANS model was calibrated according to 1995 socio-economic conditions. City staff determined that the forecasts of PM peak hour travel may be under-estimated, for three reasons:

- The TRANS model was calibrated to 1995 travel conditions, which reflected recessionary economic conditions. (This is partially supported by an observed dip in peak hour traffic volumes despite significant population growth during the same period across the four strategic screenlines in 1994, 1995 and 1996 [i.e., compared with previous years]; however, this trend was not pervasive.)

- The ratio of jobs-per-person (for the age groups 20-64 years) is expected to grow by about16% between 1996 and 2021 (from 0.77 to 0.89). This suggests a commensurate increase in work-related travel. However, the base forecasts did not account for these increases (i.e., this must be considered exogenously to the model structure).

- Related to the jobs-per-person ratio, the labour force participation rate also is projected to increase. However, the base forecasts do not account for these increases (again, this must be considered exogenously to the model structure).

Factor	Description / Target	Equivalent in 1997 Region of Ottawa-Carleton TMP
TDM	Not used. Targets for specific TDM components used instead (time shifting, walking, cycling and PPV [ridesharing]).	Single target (4%) applied to all screenlines. Target included trip elimination and TDM (combined).
Trip elimination	• Represents trips eliminated through teleworking or home-based work. • Target: 8% (represents increase of 3% over 5% existing [estimate]). • Assumed to apply equally to all modes for work-based trips. • Source: Available data are sparse (meaning forecasting is difficult), but observations from the *Census of Canada* "worked at home" data, opinion surveys, and telecommuting data from local industries and from the US Census provide some indication. • Note: available definitions of what constitutes 'trip elimination' are ambiguous.	Not used explicitly. Included with TDM target.
Time shifting	• Represents peak hour auto driver trips shifted to the peak shoulders, through outreach (education / awareness) programmes and additional promotion of flexible work hours. This is over and above the current trend to peak spreading. • Target: 1% (assumed; no conclusive data regarding a specific rate). • Applies to all O-Ds and all trip purposes.	Not used.
Walking	• Represents measures to encourage walking (e.g., more sidewalks, suitable lighting, etc.), as well as auto disincentives (e.g., parking measures). • Target: 50% reduction in auto driver trips for distances equivalent to the average walking trip – i.e., ≤ 1.5 km. in 1995 (see Table 2). • Applies to all trip purposes.	Walking considered in the 1997 TMP, but no region-wide target specified.
Cycling	• Represents measures to encourage bicycling (e.g., more bicycle paths, safe delineation of bicycle lanes on roads, etc.). • Target: 10% reduction in auto driver trips for distances equivalent to the average cycling trip – i.e., ≤ 4.5 km. in 1995 (see Table 2). • Applies to all trip purposes.	Cycling considered in the 1997 TMP, but no region-wide target specified.
Ridesharing	• Represents measures at the work place and other supportive measures to encourage ridesharing, over and above transit, walking, cycling and related measures. • Target: 1.5% reduction in auto driver trips, for all trip lengths (all O-Ds). • Derived from the 3% observed maximum attained at medium-density, single employer sites in Ottawa; discounted by half to allow for the likely smaller participation at low-density, multi-employer sites. • Applies to all work sites, i.e. to all work-to-home trips.	Single target (1.27 persons per vehicle) applied to all screenlines, based upon observed screenline count data.

Table 5. List of Non-Transit Factors

The implication is that the forecast demands could represent the lower end of the range, assuming that the projected population and employment materialize.

Accordingly, a correction factor of +12% (three-quarters of the expected 16% increase in the jobs-per-person ratio[11]) was applied to better reflect the activity of employed persons in the work force and to ensure, in turn, that trip generation rates could be applied to the planning horizon. There was a corresponding increase of 12% in the number of work trips.

6. DISCUSSION AND CONCLUSIONS

Several points can be made concerning the new approach:

- The new approach, with its focus on the trip (origin-destination and purpose), provides an explicit and direct link between the analysis of future demand and the resultant actions, plans and policies in the TMP.

- It thus makes more apparent the existing link between the forecasting process (the technical input to the TMP) and the content of the TMP (the public output of the TMP). In turn, this can only benefit the public and political debate that is an integral part in the development and adaptation of a transportation master plan and, it follows, further help residents and businesses understand the importance of 'doing their part' to achieve the TMP's goals (e.g., to use transit more often, to walk, cycle or rideshare more often, etc.).

- The new approach also allows the tailoring of TMP actions, policies and plans to specific 'markets,' expressed both in terms of trip distance and purpose (work and non-work). This is an important consideration in maximizing the cost-efficiency of proposed actions, policies and plans. The explicit treatment of work trips by employment density provides a direct linkage to land use policy and to future site development decisions and policies within the framework of the City's Official Plan (of which the TMP is part).

- Finally, the new approach, with its inclusion of several alternatives to the SOV trip, provides a framework for considering systematically and explicitly both 'hard' capital-intensive solutions (road and transit infrastructure) and 'soft' inexpensive solutions (such as walking, cycling, telecommuting, etc.).

- The reader may find the transit work and non-work targets to be ambitious. However, it is important to note that:

    - the targets were aimed at achieving the 30% overall share that City Council had already designated as an objective;

    - the process (the subject of this paper) is independent of the overall targets, in any event; and

[11] That is, the full 16% value was not applied, because some home-to-work trips occur outside the PM peak hour.

- using the old screenline method would have resulted in the development of non-transparent factors to achieve the 30% overall share.

In conclusion, the new process described in this paper for developing modal share targets provides a more holistic, multi-modal and systematic framework for responding to today's transportation planning needs. It makes the best use of available tools (notably, the travel demand forecasting model), with selected interventions. By using existing observations (O-D survey) to differentiate existing and potential markets, especially through the categorization of work trip modal shares by employment density, the new process provides improved input to the public and political deliberation of a city's transportation master plan.

Further refinements to the approach are both possible and desirable. Potential improvements include:

- The incorporation of more up-to-date data for a future TMP would be helpful, to bring the available information up-to-date, fill in gaps and provide a more complete understanding of how travellers will behave in certain situations. A new TRANS origin-destination survey is proposed for 2005. Better data on experiences elsewhere regarding telecommuting, trip shifting, ridesharing, walking and cycling rates also would provide further insight; as would before-and-after observations of modal shifts for these non-transit alternatives to the SOV trip as the TMP is implemented over time. These data would provide improved estimates of the individual and complementary impacts of specific measures.

- These data also could be used to calibrate new multi-modal models, expanding the existing auto driver, auto passenger and transit logit modal split model (i.e., in order to estimate the shares of the other modes directly within the model).

- In the meantime, further analysis of existing data sources (the 1995 TRANS OD survey, traffic count trends and demographic and socio-economic trends) would greatly improve the basic understanding of different travel market segments.

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The views expressed in this paper are those of the authors, and do not necessarily reflect those of the City of Ottawa or its consultants.