Traffic Composition during the Morning Peak Period.

Implications for Urban Traffic Management Systems

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Using registration plate analysis, this paper investigates 1) the proportions of 'unique' vehicles, 2) the proportions of vehicles re-appearing from day-to-day and their individual arrival variances and 3) the numbers of locally registered vehicles among those seen during the morning commute period on three roads in Southampton.
During incidents, a traffic controller would hope to divert the more familiar drivers onto less congested parts of the network using VMS and other media. Knowing the proportions of regular and unique drivers which make up the peak commuting periods would help in the timely dissemination of this traffic information.
The proportions of unique vehicles varied significantly with road and time. Vehicles appearing on more than one day formed 80% of the traffic before 08:15 but only 60% between the 08:45 and 09:00 peak period during the 1996 Bassett Avenue survey ($F_{(4,20)}$ = 60.1, p<0.001, Ms_e = 6.2). Although the proportions of vehicles re-appearing from day to day varied significantly with road, ($\chi^2_{(3)}$ = 1501, P<0.001), their arrival variances were found to be very similar. On average, 65% of the returning vehicles re-appeared within +/- 5 minutes of their previous day's time implying that this frequency of arrival could be part of an habitual behaviour pattern.
The results suggest that for occasions where congestion can be anticipated in advance, such as prior to emergency roadworks or special events, warning messages would be most effective before 08:30 a.m. when the largest proportion of regular vehicles would be using the roads. If regular users are more familiar with the local road network than one-off 'unique' vehicles, and would be more likely to divert on receiving incident information relevant to their route, then later in the morning, the proportion of knowledgeable local drivers falls substantially.

1. Introduction

Day-to-day variability in travel behaviour can occur in two ways. Firstly, peoples constantly changing personal requirements influence their travel needs on a daily basis. Secondly, individuals experiences from one day influence their decisions on the next. This could be reflected in the mode of transport chosen, departure time or the route taken.

It has been shown that behaviours which make up the daily travel pattern can be highly repetitious in nature (Huff and Hanson, 1986) but that observing an individuals behaviour on a single day might not be representative of their routine travel. Golledge, (1970) described habitual behaviour as, ‘behaviour that is repetitive and invariant within some set limits’ and in which ‘at successive periods of observation there is no set change in behaviour’. A routine journey to work can show ‘systematic variability’ when observed over a period of time. Spyridakis et al., (1991) found from a sample of 3,893 Seattle commuters that 33.8% decided on their route before leaving home, while 64% made decisions whilst driving, which depended on the conditions encountered on the freeway and city streets. Despite this, work by Golledge (1970), Clarke et al., (1982) and Williams and Ortuzar (1982) suggested that little variability in route choice actually occurs from day-to-day within an habitual pattern of behaviour. Heathington et al., (1971) estimated that commuters had a considerable delay tolerance, being anything up to twenty minutes before they would divert from their first choice route.

A driver’s ability to divert when confronted by traffic congestion, depends on the individual’s level of network familiarity, which is derived from experience in, and exposure to, the local road network (Evans, 1980). An effective urban traffic management system incorporating variable message signs (VMS) and other driver information devices seeks to divert the more ‘familiar’ individuals to other parts of the network when incidents occur. This allows for a more efficient movement of traffic through the available road space.

To help achieve this it would be beneficial to know the proportions of ‘regular’ and ‘unique’ vehicles which make up the morning commuter traffic travelling into and out of an area. Among those vehicles seen using a route on different days, an understanding of the variation in individual arrival times could help indicate optimum times to relay important traffic information to drivers. This paper investigates the proportions of ‘unique’ vehicles, the proportions of vehicles re-appearing from day-to-day and the numbers of locally registered vehicles (and potentially ‘familiar’) among those seen during the morning commute period on three major roads in the city of Southampton.

2. State-of-the-art

2.1 Current knowledge on variability

Trips can vary from day-to-day for a number of reasons:

- Changes in the time the journey has to be made
- Changes in the route taken
- Altering the end destination
- Altering the transport mode used to make the journey

- Changes in job/housing location
- Car sharing or using public transport
- Consolidating trips to reduce the need to travel
- Elimination/suppression of trips

Such day-to-day variation which can be part of a habitual travel pattern has been the subject of several studies. Smeed and Jeffcote (1971) found that the standard deviation around the mean journey speed from 253 logged trips between Bray and Central London was between 22 and 33%. In similar experiments of speed variability for journeys in Central London, Mogridge and Fry (1984) found a standard deviation of between 15 and 20% of the mean and Mohammadi (1987) between 16 and 20%. Reasons for these deviations were down to those listed above and additional factors such as traffic incidents and prevailing weather conditions. The results suggest that if 100 commute journeys were monitored over time, between 10 and 20 would be travelled with an overall door-to-door time more than 20% quicker than average with a similar proportion being travelled 20% slower than average (Cairns et al., 1998).

Commuters who have become accustomed to variation in their habitual journeys would be unlikely to immediately respond to changes in speed since such changes would not be immediately obvious. To be able to detect such changes would require the individual to build up a picture of the typical conditions from experience. Bonsall, Jones and Montgomery (1983) commented that household interview surveys suggested that 98% of workers who drove on a given day would also drive on a second given day, and that 88% claimed to never vary their route from work. A study that they subsequently undertook using registration plate recognition (Bonsall et al., 1984) suggested that 50% of vehicles observed on a given day would not be present on the following day and that estimating reappearance rates depended on the type of survey approach taken (direct interviews, 80%; driver logs, 74%; registration plates, 50%). They concluded that direct interview and driver log techniques seriously over-estimated the constancy of reappearance compared to registration plate observations.

2.2 Measurement techniques

Drivers will pass the same landmarks and junctions on their preferred route at approximately the same time each day, providing that a common home departure time has been established to satisfy a specific work arrival time. Shift workers may display several patterns of travel along the same route over a period of months, depending on their work schedules.

Route and arrival variability data can be obtained using journey diaries or revealed preference questionnaires, asking a subset of the commuting population to record or recall their routes, home departure and work arrival times over a set period. Another technique is to use registration plate analysis to record the day-to-day arrival times of vehicles along the same stretch of road.

Bonsall et al., (1984) used two methods of sampling registration plates on main routes around Leeds to determine the day-on-day reappearance rates of vehicles in comparison with questionnaire and diary techniques. The complete registrations of all red and white cars were noted at some sites whereas the partial plates (digits and year letter) for as many vehicles as possible were collected at others. Correction factors were then applied to estimate the numbers of spurious matches between sites.

The results suggested that the day-on-day reappearance of vehicles was 80% from a direct interview method, 74% from driver logs and 50% from registration plate data. Despite the

possibility of erroneous transcription of the registration plates the authors were convinced that this could not fully account for the differences found between the questionnaire-based and registration-based estimates. They concluded that the former techniques seriously over-estimated the constancy of reappearance.
Various techniques for recording registration plates to assess variability in vehicle arrival times have been documented (Martin and Bell, 1993) including pencil and paper, hand held computers and tape recorders. At rates of flow greater than 700 veh/hr, recording the whole plate for each vehicle, (4 letters and 3 numbers) becomes difficult, and errors made in transcribing the results increase. As the number of registration plate characters recorded is reduced however, the chance of incorrect or spurious matches of pairs of plates increases.
Makinowski & Sinha, (1976) showed that statistically reliable estimates of travel parameters, such as journey time, could be obtained without recording all the characters of the registration plate. Surveys have also shown that a single enumerator can quite comfortably dictate registrations at flows of up to 1200 vehicles per hour (Martin and Bell, 1993; Bonsall et al., 1988).
As part of a series of journey time surveys (Cherrett, 1998), optical character recognition software written by Siemens Traffic Controls Limited (ORION) was used to automatically extract vehicle registrations from VHS video footage of traffic in Southampton. Text files of date and time stamped vehicle registrations were produced by the software which ran in real-time using pre-recorded video footage. Tests on two roads in Southampton showed that the system correctly read 77% and 65% of the registrations presented to it (Cherrett, 1998).

3. Aims

For a number of days during the morning peak period (07:30 and 09:15) and using three major roads accessing Southampton from the North, West and East, this paper sets out to investigate three areas:

1. The proportions of ‘unique’ vehicles appearing only once during the study periods, and whether these proportions vary significantly with time period and road.
   If significant differences were found, would this infer that traffic information (particularly that displayed through VMS) would have varying levels of effectiveness depending on the time of day the information was displayed and the roads on which the signs were located?
2. The proportions of vehicles re-appearing each day and their variations in daily arrival time.
   In incident situations, the traffic control room operator would hope to divert the more familiar drivers onto less congested parts of the network. This would benefit not only their own journeys but those of the remaining drivers still on the incident link who would encounter reduced queuing. Determining the daily re-appearance rate of vehicles could indicate the proportion of locally familiar drivers in the traffic mix.
3. The area of registration of returning vehicles to assess if those that are ‘unique’ are from out-of-town.
   Could the area of registration shown on a licence plate be used to aid the traffic control room operator determine the proportions of familiar drivers using a particular road? If so, then this knowledge might help in the development of pre-planned re-routing strategies to mitigate the negative impacts of incidents on key parts of the network.

4. Experimental design

The data from four separate journey time surveys were used in this study. Two surveys in 1994 collected registrations of vehicles travelling West on the A3035 into the city over Cobden Bridge (an A-class single carriageway road linking the Eastern residential conurbation of Bitterne to the city), and North East on the A35 Winchester Road (an A-class single carriageway road linking the Western side of the City to the M3, Cherrett, 1998). The other two surveys took place in 1996 and involved the same stretch of the A35 Winchester Road and the Southbound section of the A33 Bassett Avenue, a four lane unsegregated dual carriageway linking the M3 motorway to the city centre (Cherrett et al., 1995; Cherrett, 1998).

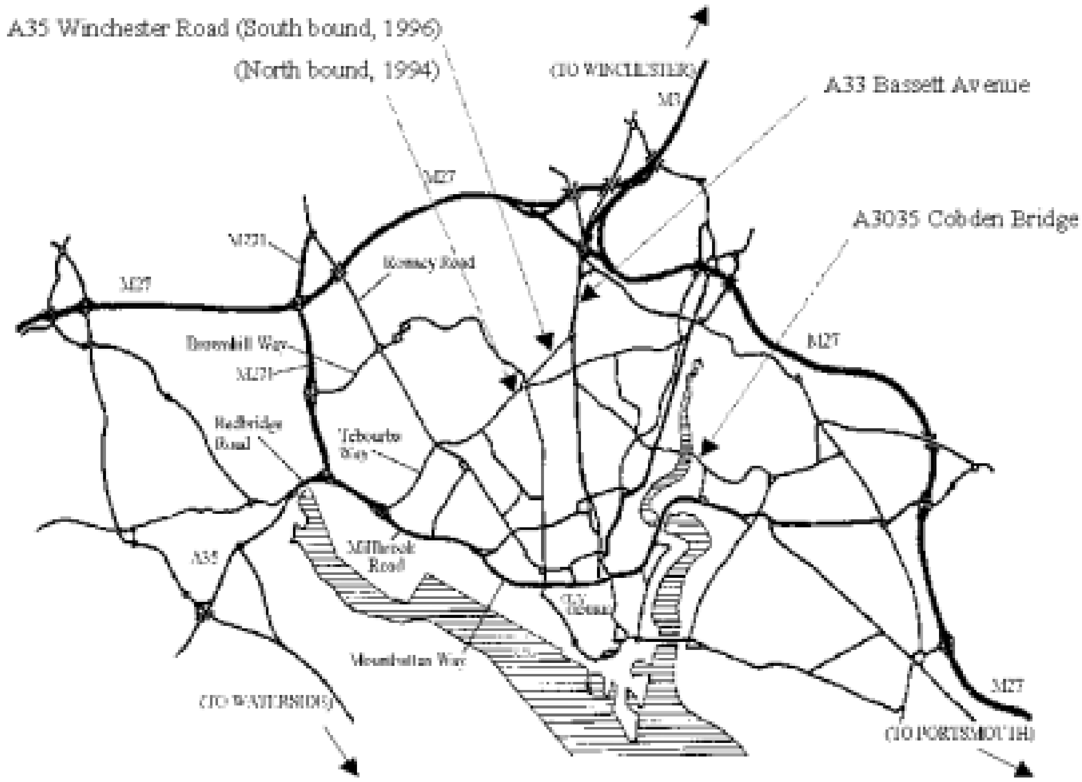

Figure 1. A map showing the key roads in and around the city of Southampton. Marked are the sites of the 1994 (A35 Winchester Road and A3035 Cobden Bridge) and 1996 (A33 Bassett Avenue and A35 Winchester Road) registration plate surveys.

The key characteristics of the data collected are summarised in Table 1.

Table 1. Characteristics of the 1994 and 1996 vehicle registration plate surveys in Southampton.

Survey	Period	Survey Time	Road Name	Road Type	Measurement technique
Cobden Bridge 1994	17/11/94-1/12/94 (10 days)	08:10 – 09:05	A3035	A-class single carriageway	Licence plates of all vehicles recorded using a dictaphone
Winchester Road 1994	19/10/94-15/11/94 (11 days)	08:10 – 09:05	A35	A-class single carriageway	Licence plates of all vehicles recorded using a dictaphone
Bassett Avenue 1996	21/10/96-25/10/96 (5 days)	07:30 – 09:15	A33	Unsegragated four lane carriageway	Automatic registration plate recognition
Winchester Road 1996	7/10/96-11/10/96 (5 days)	07:30-09:15	A35	A-class single carriageway	Automatic registration plate recognition

Figure 1 shows the four roads used to collect the registration plate data. The A33 Bassett Avenue feeds the A35 Winchester Road and for drivers bound for the city centre, a diversion choice is available at the Winchester Road roundabout to allow traffic to travel into town via Hill Lane. The 1996 filming locations on the A33 Bassett Avenue were upstream of this potential diversion point. The Winchester Road locations were situated South of the potential diversion point and the variability in arrival patterns observed during the 1996 surveys could have been affected by drivers diverting from the queues on Bassett Avenue. The congestion on the diversion route is also considerable during the morning peak, due in part to the schools traffic passing through the area. Journey diaries which coincided with the 1994 surveys (Cherrett, 1998) showed that 48% of a sample of commuters stuck to their preferred commute route over an 11-day period. There were no incidents or special events during the 1996 surveys and significant movements of vehicles from the A33 to the A35 were not thought likely.

Table 2. The mean flows, percent of unreadable registrations and the mean number of vehicles appearing more than once during the observation periods in the 1994 and 1996 registration plate surveys.

Survey	Mean total flow	Mean % of unreadable plates	Mean no. of vehicles appearing > once/day
Cobden Bridge 1994	1058	3.3	3.8
Winchester Road 1994	618	1	0.3
Bassett Avenue 1996	3608	1.8	7.8
Winchester Road 1996	1685	2.1	3.8

Table 2 shows the mean flows, percent of unreadable registrations and the mean number of vehicles appearing more than once during the observation periods. The 1996 video based surveys allowed the accuracy of the automatic registration plate recognition software to be assessed. This was achieved by replaying the original VHS tapes and cross checking the registrations with the completed Excel files. This editing process corrected all the miss-reads except those where the front of a vehicle had been completely obscured. Results showed that the automatic registration plate capture software read 77% and 65% of the plates from the A33 Bassett Avenue and A35 Winchester Road footage respectively.

The completed files of registration plates were fed into Microsoft Excel where they were organised into 5-minute intervals by day. The data formed three columns, registration (a maximum of 8 characters), day (1 to 5 or 1 to 11 for the 1994 Winchester Road/Cobden Bridge and the 1996 Winchester Road/A33 Bassett Avenue surveys respectively) and time slice (1 to 11 or 1 to 21, again depending on the surveys).

In both sets of surveys, the collected registrations were checked for errors by replaying the original audio/VHS tapes and cross checking with the completed Excel files. This editing process corrected all the miss-reads except those where the front of a vehicle had been completely obscured.

A programme written in FORTRAN 77 was used to analyse the data. This compared the registrations in one named file with those in another, producing a results file, listing for each plate, the number of times it was seen, the days on which it was seen and the specific arrival time on those days.

5. Results

5.1 The proportions of vehicles appearing once (‘unique’ vehicles)

The aim was to determine the proportions of ‘unique’ vehicles appearing only once during the four survey periods and to assess whether their numbers varied significantly with time period and road.

When a particular time ‘window’ is monitored each day, the likelihood of a vehicle never appearing on any other day depends to some extent on where the vehicle appears in the first window used for comparison. If a vehicle appears in the first time slice of a window, subsequent earlier starts will mean that it may not be recorded at all on further occasions. A similar argument applies to those who first appear at the end of a time window. Those near the middle have the greatest chance of being recorded again.

Accordingly, the vehicles appearing in the mid section of each day’s survey, (08:20 to 08:50 and 07:45 to 09:00 in the 1994 and 1996 surveys respectively) were saved as separate files. These were then compared to one large file containing all the time intervals for the whole survey period. In the case of the 1994 surveys, this process allowed regular drivers from the 08:20 to 08:50 period to arrive on other days 10 minutes earlier to 35 minutes later; 20 minutes earlier to 25 minutes later and 30 minutes earlier to 15 minutes later respectively compared to their normal times and still be recorded as repeat commuters. The results from this exercise are shown in Figures 2 and 3.

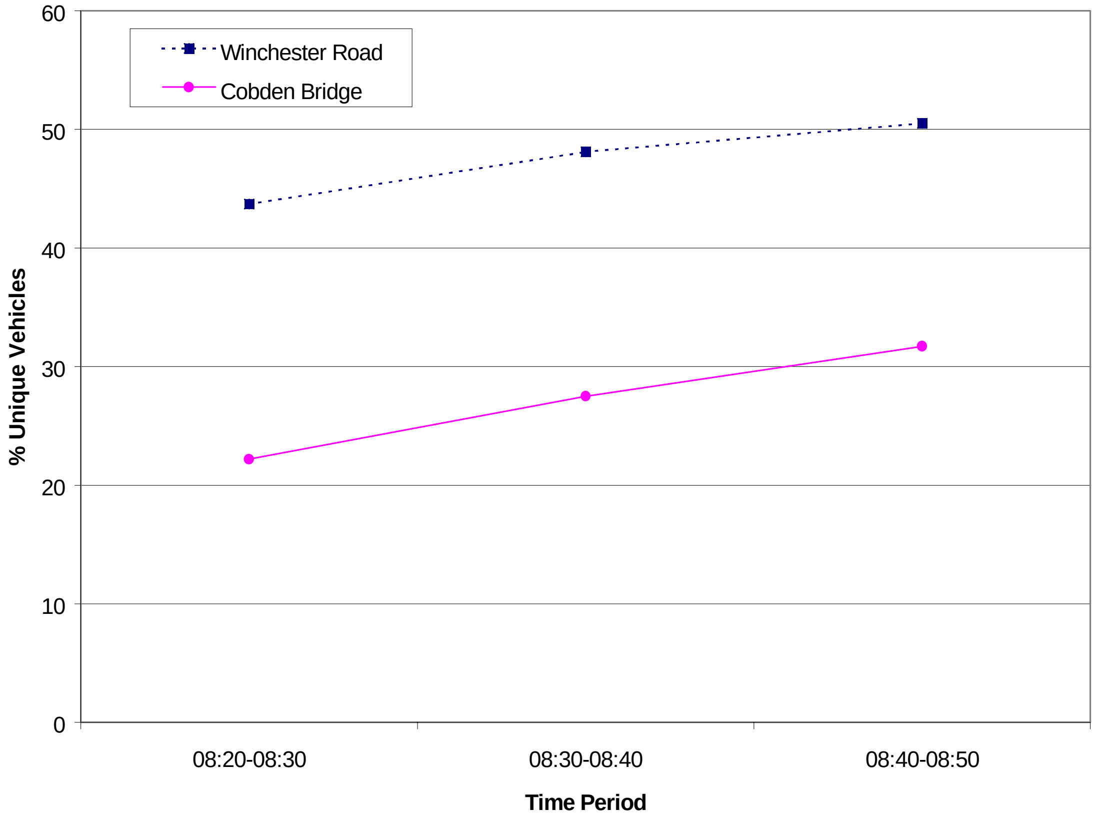

Figure 2. The mean percentage of vehicles from time slices 08:20-08:30, 08:30-08:40 and 08:40-08:50 which were unique to each day in the 1994 Winchester Road and Cobden Bridge surveys (i.e. never re-appearing again at any time during the survey periods).

One-way analysis of variance (ANOVA) tests were carried out on the daily percentage of unique vehicles in the mid section of each days survey to test the null hypothesis that their numbers would be independent of time interval. In both the 1994 and 1996 surveys the proportions of these unique vehicles were found to vary with time interval. Significantly more returning drivers were observed during the 08:20 to 08:30 period, ($F_{(2,24)} = 13.56$, $p<0.001$, $Ms_e = 7.96$ and $F_{(2,27)} = 13.39$, $p<0.001$, $Ms_e = 17.38$) in the 1994 Winchester Road (56% return rate) and Cobden Bridge (78% return rate) surveys respectively. On average, returning vehicles made up 80% of the total flow between 07:45 and 08:15 in the 1996 surveys, whereas their numbers fell to 60% during the peak 08:45 to 09:00 period, ($F_{(4,20)} = 30.3$, $p<0.001$, $Ms_e = 14.39$ and $F_{(4,20)} = 60.1$, $p<0.001$, $Ms_e = 6.2$ for the 1996 Winchester Road and Bassett Avenue surveys respectively). The numbers of irregular travellers during the 08:45 to 09:00 period on the Bassett Avenue proved to be significantly greater than in any of the other intervals.

Two-by-two homogeneity Chi-Squared tests using Yates' correction for continuity, showed that there were significant differences in the proportions of unique vehicles between the 1994 Cobden Bridge and Winchester Road survey sites, ($\chi^2_{(1)} = 360.9$, $P<0.001$ and $\chi^2_{(0.005)}$ (1 df) $= 7.88$). The same test undertaken on the 1996 Bassett Avenue and Winchester Road data showed that there were no significant differences in the proportions of unique vehicles between the two survey sites, ($\chi^2_{(1)} = 2.3$, P>0.05 and $\chi^2_{(0.05)}$ (1 df) = 3.8).

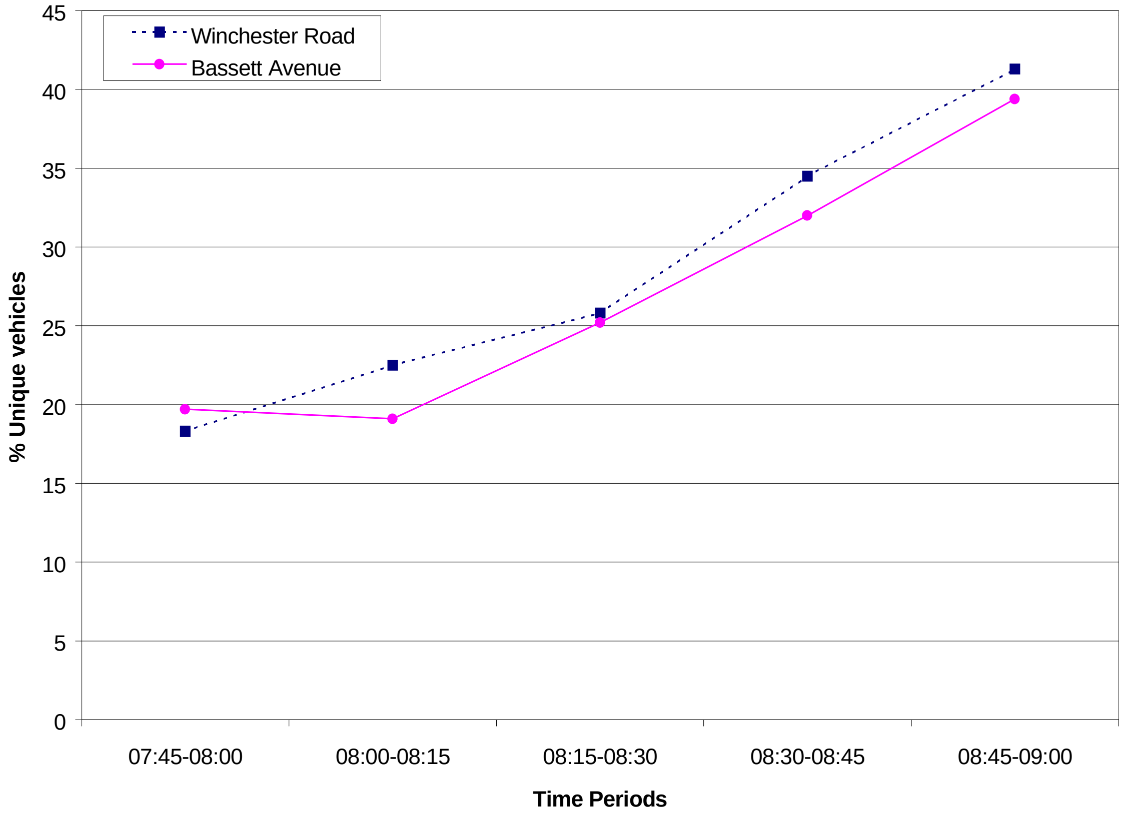

Figure 3. The mean percentage of vehicles from time slices 07:45-08:00, 08:00-08:15, 08:15-08:30, 08:30-08:45 and 08:45-09:00 which were unique to each day in the 1996 Winchester Road and Bassett Avenue surveys (i.e. never re-appearing again at any time during the survey periods).

Greater numbers of unique vehicles were seen among the traffic travelling North along the A35 Winchester Road compared to traffic travelling West over Cobden Bridge in the 1994 surveys. This might be expected as the North bound A35 would be taking traffic out of the city towards Winchester and the M3 whereas Cobden Bridge linked the Eastern residential areas to the central business district. Cobden Bridge would expect to have a certain proportion of regular vehicles using it to access the city, being only one of four crossing points over the River Itchen. The A35 Winchester Road taking traffic out of the city would be carrying more long distance travellers, there being few industrial areas to the North of the city.

The key issue arising from this technique is the proportion of one-off 'unique' vehicles which were in fact regular commuters who were merely using an alternative route on the particular day they were observed. Separate journey diaries taking place on the same days as the 1994 registration plate surveys (Cherrett, 1998) showed that 48% and 41% of two commuter samples using Winchester Road and Cobden Bridge respectively, chose the same route over

11 days. This echoes the findings of Golledge, (1970), Clarke et al., (1982) and Williams and Ortuzar, (1982) that little variability in route choice occurs from day to day within an habitual pattern of behaviour.

Other concerns are the proportion of one-off ‘unique’ vehicles which belong to local households who own more than one vehicle. Also, whether the time windows used in the surveys to allow returning vehicles to re-appear earlier or later on subsequent days were wide enough. Industrial areas employing large numbers of people on rotating shift systems would generate different vehicle movements when compared to traditional office hours.

5.2 Proportions and timings of vehicles repeating the journey from day to day

The object of this analysis was to determine the proportions of vehicles reappearing from one day to the next, together with the variance in their appearance times. For this, one day’s complete registration data were compared to the subsequent days, and the matches obtained saved to a separate results file. Only consecutive survey days were used, comparisons between Fridays and Mondays being omitted.

Table 3. Daily re-appearance rate and timings of vehicles in the 1994 and 1996 surveys.

Survey	% of vehicles returning	% of vehicles which appeared within +/- 0-5 minutes of previous day’s time
Cobden Bridge 1994	36.7	67.1
Winchester Road 1994	24.8	67.6
Bassett Avenue 1996	49	61.9
Winchester Road 1996	48.9	65.7

Table 3 shows the results from the day-to-day registration comparisons. The 1994 Winchester Road survey showed that only 25% of the vehicles on an average working day would also appear on the subsequent one. Of these, 68% re-appeared within +/- 0 to 5 minutes of their previous day’s time. Of the vehicles recorded travelling into the city over Cobden Bridge, 37% on average would appear from one day to the next, 67.1% doing so within +/- 0 to 5 minutes.

Chi Squared tests showed that there were no significant differences in the numbers of returning and non-returning vehicles each day in the Winchester Road ($\chi^2_{(5)} = 4.51$, $P>0.05$ and $\chi^2_{(0.05)}$ (5 df) = 11.07) and Cobden Bridge ($\chi^2_{(6)} = 5.88$, $P>0.05$ and $\chi^2_{(0.05)}$ (6 df) = 12.59) surveys. The numbers of re-appearing vehicles however were found to vary significantly with site ($\chi^2_{(1)} = 154.2$, $P<0.001$ and $\chi^2_{(0.005)}$ (1 df) = 7.88), there being fewer ‘regular’ vehicles travelling out of the city on the A35 Winchester Road.

The 1996 Winchester Road survey, examined the returning habits of vehicles travelling South from the Winchester Road roundabout and showed that on average, 49% of the vehicles seen on one day returned on the next, very different from the 1994 survey of North bound traffic. Of these, 66% re-appeared within +/- 0 to 5 minutes of the previous day’s time. In a similar way, 49% of the vehicles seen on one day returned on the next in the 1996 Bassett Avenue survey with 62% arriving within +/- 0 to 5 minutes of the previous days time.

A 2 by 2 homogeneity Chi Squared test showed that unlike the 1994 surveys, the numbers of returning vehicles did not vary significantly with site, $\chi^2_{(1)} = 0.026$, $P>0.05$ and $\chi^2_{(0.05)}$ (1 df) = 3.84. There were however significantly smaller numbers of vehicles in the Bassett Avenue survey arriving within +/- 5 minutes of their previous days time compared to the Winchester Road, $\chi^2_{(1)} = 13.06$, P<0.001 and $\chi^2_{(0.005)}$ (1 df) = 7.88.

Using the data from the 1994 surveys, analyses of variance tests were carried out to test the null hypothesis that variance in arrival time, (the time slice deviation (+ or -) compared to the previous day), would be independent of day. The differences in arrival times of the repeat drivers in the 1994 Winchester Road and Cobden Bridge surveys were tabulated. The results (Tables 4 and 5) showed that there were very highly significant differences in the mean variation in arrival times between the days during both surveys, ($F_{(8,1295)} = 3.94$, p<0.001, $Ms_e = 4.92$ and $F_{(8,3268)} = 9.37$, p<0.001, $Ms_e = 4.387$ for the Winchester Road and Cobden Bridge surveys respectively).

Table 4. ANOVA on the effect of day on the average deviations in arrival time (number of 5 minute time slot differences) for repeat journeys during the 1994 Winchester Road survey.

Days	No. of repeat drivers	Average deviation (time intervals)	Variance	Sig.diff*
19v20/10	127	0.13	4.1	ab
20v21/10	147	-0.16	3.32	ab
21v24/10	119	-0.55	7.79	a
24v25/10	152	0.63	5.89	b
25v26/10	161	-0.05	4.71	ab
1v2/11	152	-0.07	5.08	ab
2v14/11	135	0.44	4.19	ab
14v15/11	167	-0.28	4.12	ab
15v16/11	144	-0.31	5.57	ab

* Average deviations sharing the same letter, (column 5 'Sig. diff') are not significantly different (p = 0.05) using Scheffe's multiple range test.

Table 5. An ANOVA on the effect of day on the average deviations in arrival time (number of 5-minute time slot differences) for repeat journeys during the 1994 Cobden Bridge survey.

Days	No. of repeat drivers	Average deviation (time intervals)	Variance	Sig.diff*
17v18/11	363	-0.04	5.65	a
18v21/11	308	0.19	6.37	ab
21v22/11	378	0.03	4.72	a
22v23/11	373	0.51	4.12	b
23v24/11	351	-0.78	3.94	
24v28/11	353	0.11	3.8	ab
28v29/11	392	-0.1	3.98	a
29v30/11	370	0.09	3.22	ab
30v1/12	389	0.07	4.03	ab

* Average deviations sharing the same letter, (column 5 'Sig. diff') are not significantly different (p = 0.05) using Tukey's multiple range test.

During the Winchester Road survey the average arrival times of vehicles on Monday 24/10/94 were significantly earlier than the previous Friday (21/10/94) and Tuesday 25/10/94 saw vehicles arriving significantly later. Monday 24/10/94 was the first day of the schools half term period and vehicles appeared 0.55 time slices earlier on average indicating that the journey times had been reduced.

On average, vehicles appeared nearly one time slice earlier, (1 to 10 minutes) on the 24th of November compared to the 23rd during the Cobden Bridge survey. Roadwork's in the area started on the 23/11/94 with the West bound carriageway approaching Cobden Bridge being reduced to half its width by cones. Traffic congestion was considerable from 08:00 onwards. The experience of roadwork induced congestion might have convinced drivers to depart earlier the following day to compensate, but no evidence was found to confirm this from the separate diary surveys.

Over a period of time, commuters will develop a cognitive map of the road network between their home and place of work, and of other areas of importance to them. Different routes will be taken for different reasons and may consist of small variations on a common path, or completely novel routes travelling through separate areas. The collective route options open to the driver are called the 'Route Choice Set'. The rules that govern the use of the choice set vary between individuals (Bovy and Stern, 1990).

Benshoof, (1970) and Stern and Leiser, (1988) concluded that little new network knowledge is acquired by an individual after they have resided in an area for two years. Effective traffic management during incidents hinges on 'familiar' local drivers heeding advice broadcast by the control centre and making route alterations away from affected links. One interesting question is the proportion of commuters who use the same route each day of the week and have little or no knowledge about alternative routes in the network and could therefore be classed as unfamiliar. This issue has not been addressed in this work.

5.3 Proportions of vehicles re-appearing according to area of registration

Collecting whole registration plates during the 1996 surveys allowed a test to determine whether vehicles seen returning from one day to the next were predominantly locally registered. For vehicles registered before August 1st 1983, the first two letters after the initial letter on the registration plate indicate the office of registration. Between 1983 and 2001 plates were identified by the last two letters of the registration. The two registering offices closest to Southampton are situated at Portsmouth and Bournemouth and the letters associated with them are BK, BP, CR, DL, OR, OT, OW, PO, PX, RV, TP, TR and AA, CG, EL, FX, HO, JT, LJ, PR, RU respectively.

Query searches were carried out in Microsoft Access identifying registrations containing the letters described in the appropriate locations. 'Cherished numbers' or 'private plates' as they are sometimes known, cannot easily be traced to a particular registration office. Of the 3573 plates recorded on the first day of the Bassett Avenue survey and the 1684 on day one of the Winchester Road survey 61 (1.7%) and 29 (1.7%) respectively fell into this category.

The results (Figure 4) showed that even amongst vehicles appearing on all 5 days during the Winchester Road and Bassett Avenue surveys, only 51% and 50% respectively were registered locally. Two, 5 by 2 homogeneity Chi-Square tests showed that there were significant differences in the numbers of locally registered vehicles re-appearing at different frequencies over the periods on Winchester Road ($\chi^2_{(4)} = 12.7$, $P<0.025$ and $\chi^2_{(0.025)}$ (4 df) = 11.14) and Bassett Avenue ($\chi^2_{(4)} = 53.1$, $P<0.001$ and $\chi^2_{(0.005)}$ (4 df) = 14.86). As might be expected fewer local registrations were seen among the one-off vehicles. The Winchester

Road survey had a greater overall percentage of local registrations (48%) compared to the Bassett Avenue (44%), $\chi^2_{(1)} = 9.1$, $P<0.001$ and $\chi^2_{(0.005)}$ (1 df) = 7.88.

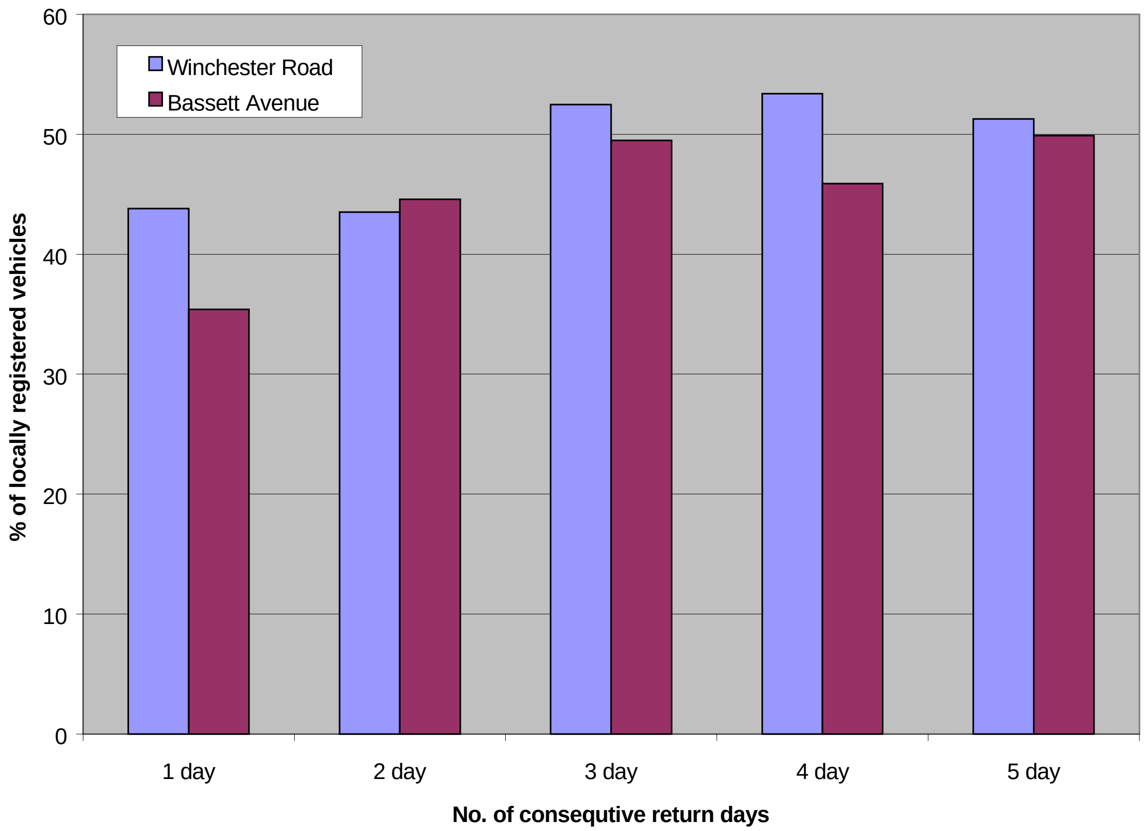

Figure 4. The percentage of locally registered vehicles observed returning over the five-day survey periods in the 1996 Winchester Road and Bassett Avenue surveys.

The results show that regularly returning vehicles were equally likely to be registered outside the County, suggesting that the area of registration can no longer be relied upon to give an indication of a local owner. The car leasing market could be one of the causes as large numbers of vehicles are centrally registered in one location before being distributed to nationwide points of sale.

6. Conclusions

This paper describes an experiment to assess the numbers of ‘unique’ vehicles, the numbers of locally registered vehicles and the arrival variances of vehicles re-appearing from day-to-day during the morning commute period along four major carriageways within the city of Southampton.

The results showed that the proportions of unique vehicles (vehicles appearing on one day only during the whole survey period) varied significantly with road and time interval. Vehicles appearing on more than one day formed 80% of the traffic before 08:15 but only

60% between the 08:45 and 09:00 peak period during the 1996 Bassett Avenue survey. An effective urban traffic management system would hope to cope with incidents by re-distributing traffic onto other parts of the network. This would be achieved using a range of information media such as VMS and local radio broadcasts. Unless diversions were forced upon drivers, individuals divert according to the nature and urgency of their trip, their familiarity with alternative routes and their immediate proximity to their destination.

The results suggest that for occasions where congestion can be anticipated in advance, such as prior to emergency roadworks or special events, warning messages might be most effective before 08:30 a.m. when the largest proportion of regular vehicles would be using the roads. This theory assumes that regular users are more familiar with the local road network than one-off ‘unique’ vehicles.

Although the proportions of vehicles re-appearing from day to day varied significantly with road, ($\chi^2_{(3)}$ = 1501, P<0.001 and $\chi^2_{(0.005)}$ (3 df) = 12.84, Table 13) their arrival variances were found to be very similar. Of the daily returning vehicles seen during the 1994 Winchester Road and Cobden Bridge surveys and the 1996 Winchester Road and Bassett Avenue surveys, 66%, 67%, 66% and 62% respectively re-appeared within +/- 5 minutes of their previous day’s time implying that this frequency of arrival could be part of a habitual behaviour pattern.

Estimating the numbers of local drivers by using licence plate registration marks proved unreliable. Of the vehicles appearing on all 5 days during the 1996 Winchester Road and Bassett Avenue surveys, 50% had been registered outside the county perhaps indicating the influence of the fleet and car leasing companies whose vehicles become distributed nationwide.

The results suggest that valuable information on road usage and peak demand can be obtained from registration plate surveys. This work could be taken further by contacting the owners of the unique vehicles to determine their individual characteristics but this was not possible due to the data protection laws currently existing.

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