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Commuter response to a high occupancy vehicle lane

Some lessons from the N1/M1 trial

■ Can commuters be expected to form more lift clubs to deal with rising peak hour travel times? ■ How fast will people respond to travel demand management strategies? ■ How effective are high occupancy vehicle lanes in reducing congestion?

THESE ARE SOME OF THE QUESTIONS that need to be answered as South African cities grapple with increasing traffic congestion. One way of addressing the need for using existing road space more efficiently is implementing high occupancy vehicle (HOV) facilities. HOV facilities place restrictions on the use of traffic infrastructure during certain parts of the day, usually through minimum vehicle occupancy requirements. While experience with HOV lanes is extensive elsewhere – notably in the United States, where over 130 projects are in operation – local application of the concept has been limited to pilot projects and bus/taxi lanes on freeways and central city links. Several authorities, including the South African National Roads Agency (Sanral) and some cities, are actively planning for HOV lanes for both private and public transport vehicles.

Experience in the US has been mixed, but there appears to be general agreement that under the right conditions, HOV lanes can provide significant benefits. These can include improving the person moving capacity of a freeway, decreasing travel time and increasing reliability for HOV users, and promoting public transport use, which has wider social benefits.

An opportunity arose to assess the short-term impacts of HOV lanes locally during Public Transport Month in October 2006, when the Department of Transport piloted the HOV concept on the busy N1/M1 corridor between Pretoria and Johannesburg. The five-day pilot was primarily aimed at creating public awareness of the types of measures that might be used to promote higher occupancy modes of travel. It was too short to evaluate any long-term impacts of HOV lanes. However, it did produce some useful insights into the extent to which commuters are willing to respond to interventions that combine penalties for single-occupant car use (in the form of much increased travel times in general lanes) with incentives for shifting behaviour towards higher occupancy modes. The rate at which car users are able (and willing) to adapt their

1 *Location of the HOV trial, 23–27 October 2006*
A *On the first day of the trial high violations of the HOV lane caused congestion even in that lane*

commute behaviour, for instance by changing their departure time or forming lift clubs, is relevant to accurately assess the likely impacts of many travel demand management strategies.

The purpose of the article is to report on some findings around the short-term impacts of the HOV trial, from a transport planning and travel behaviour perspective. Some lessons learned are pointed out, but the intention is not to provide a detailed traffic engineering assessment of the operation of the lane or of the success of the experiment.

THE N1/M1 HOV TRIAL

The HOV lane was introduced for five days between 23 and 27 October 2006 on the N1 and M1 between the Brakfontein Interchange near Pretoria and the Parktown Interchange close to the Johannesburg CBD (figure 1). The corridor carries more than 160 000 vehicles per day and suffers chronic recurrent congestion.

On each day, the lane was in operation in the peak direction during the following times:

- **Morning peak** 06:00 to 09:00 in the southern direction towards Johannesburg
- **Afternoon peak** 15:30 to 18:30 in the northern direction towards Pretoria

When in operation, the right-hand (median) lane was reserved for HOVs with three or more (3+) occupants. Prior studies suggested that 2+ lanes would be swamped by the existing traffic. Temporary road signs were erected upstream and along the length of the HOV lanes, but no lane markings were added (see photographs). Variable message signs also informed motorists of the lane restriction.

To promote the formation of lift clubs and public transport use, the Department of Transport (DOT) provided temporary park and ride services, with dedicated midibuses circulating between dedicated parking facilities in Pretoria and Johannesburg.

Table 1 Level of compliance during morning peak, southbound

Location of surveys	Percentage of vehicles in HOV lane conforming to 3+ rule				
	M 23/10	T 24/10	W 25/10	T 26/10	F 27/10
Nellmapius	43%	No surveys	n/a	43%	Taxi industry protest on M1 and N1 freeways No surveys
Samrand	18%		21%	28%	
New Road	21%		n/a	41%	
Allandale	21%		32%	36%	
Woodmead	7%		17%	24%	
Grayston	6%		n/a	16%	
Glenhove	13%		11%	16%	
Rockridge	6%		n/a	6%	

B *Temporary HOV lane on N1 (southbound) and signage*
2 *Level of compliance at Allandale off-ramp during the morning peak*
3 *Vehicle flow pattern on N1 at New Road*
4 *Vehicle volumes on N1 at New Road (all lanes, Thursday)*
5 *Person throughput, 6:00 to 9:00, N1 at New Road*

ENFORCEMENT, COMPLIANCE AND PUBLIC PERCEPTION

The HOV trial generated public debate and awareness well beyond the ranks of those actually using the corridor. This was at first mostly prompted by frustration at the significant delays experienced by non-HOV drivers during the first few days of the week. Newspaper reports headlined 'N1 rule infuriates drivers' and 'Confusion as N1 project begins' reported motorists initially taking up to two hours longer to get to work. The negative reports seemed to die down later in the week as motorists started to make other plans to avoid these delays. Further criticism was voiced over the inconsistency of law enforcement (especially resentment about the impunity of violators) and insufficient communication around the provision of park and ride alternatives. In fact, utilisation of the park and ride services was very low.

Consequently, public support for the concept of HOV lanes was mixed. A Synovate survey conducted afterwards found that about half of Gauteng motorists surveyed deemed the experiment to have failed. Surprisingly, though, an equal number said HOV strategies should be tried again (but with an improved communication effort). Thirty per cent felt HOV lanes could be effective in actually reducing traffic congestion (perhaps revealing a lack of understanding of the benefits of HOV facilities).

Traffic officers played an important role in promoting awareness of the lanes by visibly stopping violators and informing them how the lane worked. No fines were issued. The levels of violations varied significantly across the corridor and over time. Survey data shown in table 1 indicate that the level of compliance was consistently higher on the northern (N1) section than on the southern (M1) section, and that it improved at most locations over the course of the week. This improvement is perhaps related to the easing of congestion in the general lanes that was observed as the week wore on, thus reducing the incentive to violate the HOV lane.

Compliance over the course of the peak period also varied significantly (figure 2). Compliance at the Allandale off-ramp, for example, was the best during the highest peak hour, from 06:15 to 07:15. Compliance reduced both before and after this hour.

Observations carried out at the Sanral Network Management Centre clearly indicated that this was related to the level of law enforcement. Once law enforcement officers arrived at the section, compliance became significantly higher.

FLOW AND SPEED IMPACTS

It is instructive to consider the impact of the HOV lane on the total throughput of the corridor, both in terms of vehicles and persons. One of the main objectives of HOV lanes is the maintenance or even improvement of a highway's person moving capacity in the face of rising demand.

Figure 3 shows the traffic volumes recorded on a section of the N1 for several weeks prior to, and the week of, the HOV trial. A massive drop in peak volumes is seen on Monday 23 October, the first day of the HOV trial. The vehicle flow rate of the freeway was severely reduced by a combination of underutilised capacity in the HOV lane, increased demand (and severe congestion) in the general lanes, and a reduction in overall capacity caused by partial blocking of the HOV lane by law enforcement officers.

However, as the week wore on the peak flow recovered to levels of around 6 500 vehicles per hour by the end of the week. Looking at figure 4, however, showing vehicle counts in the course of Thursday 26 October, it is apparent that the peak flow occurred at around 5:45 am, before the onset of the HOV lane operation. Once HOV restrictions started at 6:00, flow dropped considerably, and only recovered by 9:00. Over a five-hour time period (between 5:00

and 10:00), total vehicle throughput dropped from the usual 25 170 (average for the previous three weeks) to 22 500 vehicles – an 11% decrease.

The person throughput on the corridor shows a similar pattern. Figure 5 shows a significant drop in person volumes on the Monday, but throughput almost recovered to its previous levels by the end of the week. As can be expected given the reduced vehicle flow in the general lanes, the person throughput was significantly higher in the HOV lane than in the other lanes. Overall, the HOV lane did not improve the person capacity of the corridor within the short time period of its implementation, but might have done so if the HOV lane utilisation allowed to improve over a longer period.

Insufficient travel time information was available to determine if the aggregate travel time for all motorists decreased. Significant speed differentials were observed between the HOV lane and the general lanes, but this varied across the length of the corridor. On the N1 section, motorists in general lanes travelled at an average speed of about 20 km/h as compared to about 65 km/h in the HOV lane. On parts of the M1, speeds were more similar across all lanes, as higher violation levels and more weaving into and out of the HOV lane caused congestion.

The speed differentials imply a time saving of about 2 minutes per kilometre for HOV users on the N1, which is higher than the common guideline stating that effective HOV lanes require savings of about 0,6 minutes per kilometre (1 minute per mile). We do not need congestion quite as bad as that seen on the N1 during the HOV trial week to have successful HOV interventions.

CHANGES TO COMMUTER BEHAVIOUR

Commuters not in high occupancy vehicles may be able to respond to an intervention like the HOV lane in at least four ways:

- Increasing their vehicle occupancy by forming lift clubs, or using public transport, in order to gain access to the HOV lane
- Shifting their departure time to avoid congested periods
- Shifting their travel route to a less congested corridor
- Not making the trip at all

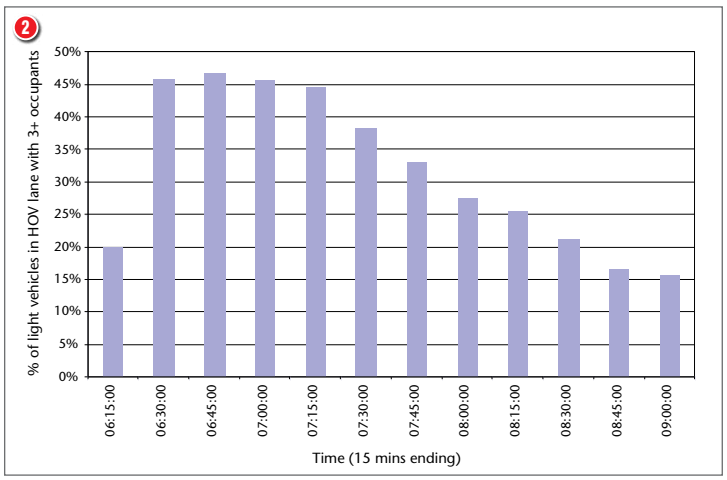
From a transport planning perspective, it is useful to examine the magnitude of each of these shifts observed.

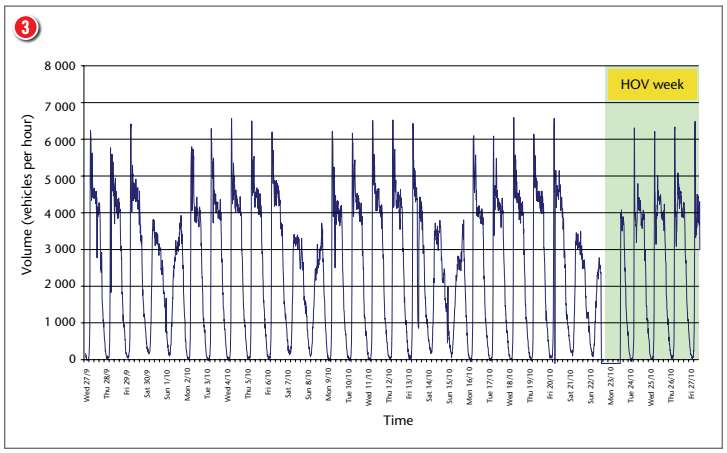
Changes in vehicle occupancy

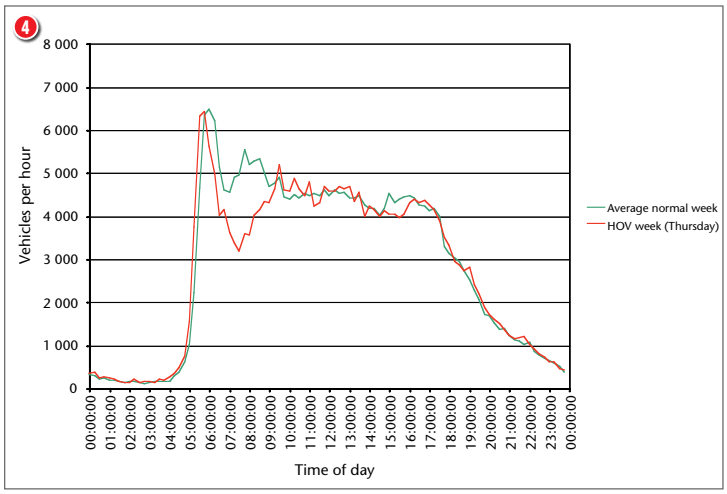
Figure 6 shows the distribution of persons by vehicle occupancy on the Monday and Thursday of the HOV trial, and also for normal conditions before and after the trial, at a typical location. Public transport vehicles constituted less than 5% of all vehicles throughout the period; the shift to public transport modes is considered negligible.

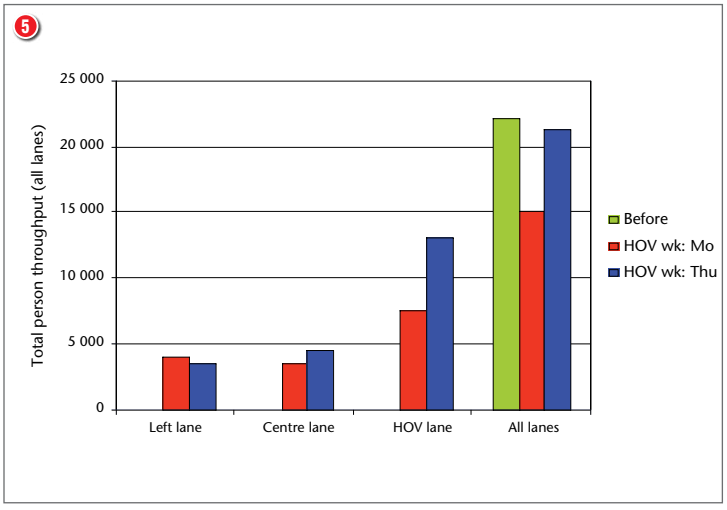
However, a shift in vehicle occupancy among private car users is apparent. During normal operations, about 20% of all passengers are in 3+ vehicles. Occupancy counts on the first day (Monday) of the trial are not representative of any actual shift in occupancies, as the severe flow reduction in general lanes biased the counts towards higher occupancy vehicles in the free-flowing HOV lane. By the Thursday of the trial, when the bias effect was no longer there (as peak period queues abated by 9:00), the percentage of passengers in 3+ vehicles had almost doubled to 38%. A lane-by-lane comparison shows that by far the majority of HOV commuters made use of the HOV lane. The proportion of people in single and double occupancy vehicles had both reduced over this period. By the end of the HOV trial, about 3 200 or approximately 15% of commuters had changed from 1 or 2 to 3+ vehicles. Even within a short period of four days some significant change in occupancy behaviour was thus detectable.

Further occupancy observations were made on the Thursday following the trial. At this time, the proportion of people in 3+ vehicles was still higher than before the HOV trial, at 27%. This suggests that the trial may have had a longer-term impact on occupancies, with some commuters choosing to remain in the lift clubs formed during the previous week. How long these arrangements

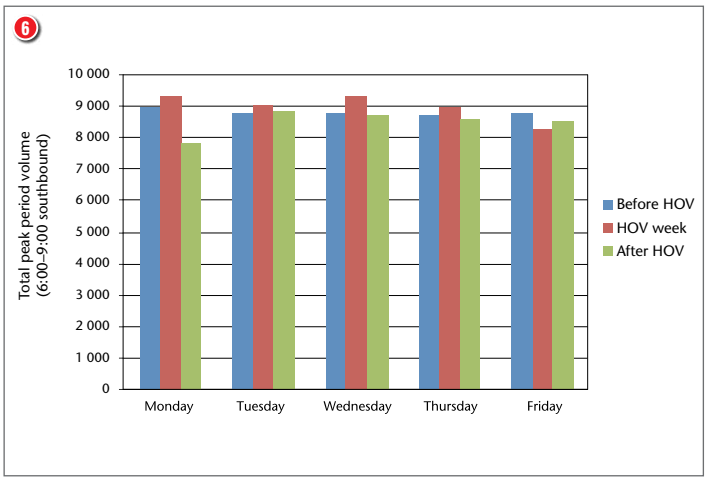








Thirty-six per cent of Gauteng motorists interviewed by Synovate noted an increase in traffic on other roads during the HOV week. To assess the extent of route diversion by N1 commuters trying to avoid the congested freeway, traffic volumes on the R21 was assessed over the same period. The R21/R24 is the only freeway corridor parallel to the N1, and can be expected to have been the main diversion option



C *Enforcement of HOV lane through physical inspection of vehicles*
D *Use of variable message signs to inform motorists of HOV lane restriction*
6 *Occupancy distribution (persons), 6:00 to 9:00, N1 at New Road*
7 *Comparative vehicle volumes on R21 parallel freeway*

persisted we do not know, but there is indeed evidence that short-term 'shocks' such as the five-day HOV trial may cause a lasting behaviour change among car users in congested corridors.

Changes in departure time

From figure 4 it is apparent that the peak flow shifted by about 15 minutes, from 6:00 to 5:45. No information is available on the actual departure times of commuters, but the data support the conclusion that many single-occupant drivers decided to leave home earlier in order to clear the HOV corridor before the lane restriction went into effect.

The average shift in departure time was about 15 minutes. The data indicates that at least 3 800 or 17% of commuters shifted their departure times in response to the HOV intervention.

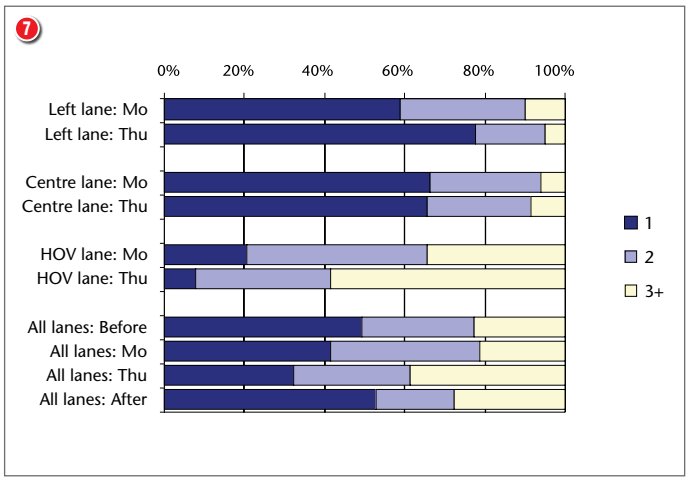
Changes in route choice

Thirty-six per cent of Gauteng motorists interviewed by Synovate noted an increase in traffic on other roads during the HOV week. To assess the extent of route diversion by N1 commuters trying to avoid the congested freeway, traffic volumes on the R21 was assessed over the same period. The R21/R24 is the only freeway corridor parallel to the N1, and can be expected to have been the main diversion option.

Figure 7 shows the peak period volumes on the R21 near Pretoria for the week before, during, and after the HOV trial. There is evidence of an increase in vehicle flows on all days of the HOV week except Friday. (On the Friday traffic volumes on most Gauteng highways were irregular as a result of the impact of a strike by the taxi industry.) The additional traffic varied between about 200 and 500 vehicles, as compared to both the weeks before and after the trial. This amounts to around 6% of normal flows, which is within the typical day-to-day variation observed in three-hour flows. It is therefore not possible to conclusively state that flows increased on the R21, but the pattern would tend to suggest that some small amount of route diversion did occur. Assuming conservatively that all diverting motorists were single occupant drivers, it follows that around 2% of regular N1 users had responded to the HOV trial by changing routes. This is a low estimate, however, as it ignores those diverting to other alternative routes, especially on the M1 section.

Suppression of trips

The best way to assess trip suppression as a result of the HOV intervention would have been to do individual surveys, but as these were not done, one can make a rough estimate of the level of trip suppression from the difference between the before-period travel-



lers and the sum of motorists on the N1, and those who diverted to other routes. For the Thursday of the HOV trial week, the number of motorists travelling on the N1 past New Road (for example) was about 800 below pre-trial levels. This corresponded roughly to the estimated rise of users on the parallel R21, suggesting that there is no evidence of any significant reduction in overall trips.

CONCLUSIONS

The analysis of the behavioural adjustment of commuters in the N1/M1 corridor showed a discernable ability amongst some motorists to adapt to HOV interventions. Approximately 15% of commuters switched from low occupancy to high occupancy vehicles – a surprisingly high number, given the almost negligible utilisation of park and ride and public transport options. At least an estimated 17% changed their departure time by about 15 minutes on average to avoid the congestion caused by the HOV lane restriction. At least 2% switched to parallel routes. While in no way indicative of the long-term behavioural change that HOV lanes (or other TDM-type strategies) can induce, these results do suggest that South African commuters are both willing and able to respond to such interventions if both the stick (in this case severely increased travel times for non-HOVs) and the carrot (faster than usual travel for HOVs) are applied. Of further interest is the speed of adaptation – it took merely three to four commute days for some travellers to adjust, and for the peak to return to its normal magnitude and duration.

Useful lessons can also be learned from the operation and marketing of the trial. It appears that the choice of a 3+ (as opposed to a 2+) occupancy limit was appropriate, given the occupancy distribution on the corridor and the arguably higher than expected shift towards HOVs. Not surprisingly, enforcement of the lane was crucial, not only in terms of lowering violations and ensuring effectiveness, but also generating a positive public response. The lane itself seemed to work better on the northern side of corridor. On the M1 section more closely spaced ramps caused more weaving and reduced speeds on the HOV lane, while restricted shoulder space on the median hampered enforcement efforts, ultimately reducing the lane's effectiveness. Commuters seem to easily disregard HOV restrictions if (a) enforcement lacks, (b) frustration is high, or (c) the legitimacy of the lane is questioned when it is obviously not working. Effective marketing, and good planning and design can presumably avoid these problems in the future.

Acknowledgment

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References are available on request

Source:
http://www.saice.org.za/downloads/monthly_publications/2007/CivilEngSept2007/#/0