TRIP PATTERNS AT PRIMARY SCHOOLS

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ABSTRACT

In the town of Stellenbosch, vehicular trips to and from schools are major contributors to traffic congestion during peak times. The congestion that is observed at individual schools within Stellenbosch, varies significantly, suggesting that the trip patterns of learners are different depending on the school they attend.

The number of trips generated by a school is estimated using trip generation rates as proposed in documents such as the Institute of Transportation Engineers Trip Generation Manual, the South African Trip Data Manual (TMH17) and Department of Transport Traffic Manual. This research, however, found variation in vehicular trip generation potential among different schools according to quintile, which is not taken into account by the standard trip generation rates. Further to this the vehicular trip generation rate of schools has changed over time due to modal shift towards motorised transport, specifically private vehicle. It is therefore possible that the number of trips to/from a given school is over or under estimated when the traffic impact of a school is evaluated.

Although the travel behaviour of learners has been intensely researched in the past, very few studies compare the travel behaviour of primary school learners attending schools with different socio-economic characteristics. This study aims to understand learners' travel behaviour by investigating and comparing the trip generation rate and modal split of learners aged 9 to 13 attending five primary schools in Stellenbosch.

1. INTRODUCTION

1.1 Background

The increase in vehicle dependence is a problem in cities throughout the world, causing problems such as pollution, congestion, high travel cost, longer travel distance due to urban sprawl, increasing fuel prices and poor health. Congestion spreads across all tracts of the urban network and is a matter of considerable social concern as the cost thereof is high: loss of productivity, economic inefficiency, poor service delivery, increase in accidents, increased fuel consumption, increased vehicle emissions, etc.

In the town of Stellenbosch, experience has shown that congestion is much worse during school term time than other times. This suggests that trips to and from schools are major contributors to congestion.

School-related traffic congestion is defined as the overcrowding and blocking of streets on or near school property that is typically associated with the transport of children to and from school by private vehicle (PV) (La Vigne, 2007). High volumes of traffic at schools during arrival and pick-up times can lead to poor traffic circulation and often unsafe conditions for cyclists and pedestrians (Institute of Transportation Engineers, 2018). The congestion observed in the vicinity of individual schools in Stellenbosch varies significantly, suggesting that the trip patterns of learners are different depending on the school which they attend.

The number of motor vehicles increases annually, resulting in a decrease in active transport (US Department of Transportation, 2016). Vehicle ownership in the Western Cape has increased from 1 433 659 registered vehicles in 2010 to 1 812 466 registered vehicles in 2018 (National Traffic Information System, 2018) representing a 3% per annum increase. Globally the number of children using non-motorise transport (NMT) have declined significantly over the last 50 years (Schlossberg, et al., 2006). Results from the National Household Travel Survey, conducted in 2003, show that 71% of all trips to educational centres in urban areas in South Africa were walking trips, 10% were trips made by private cars and 12% of the trips were made by taxis. The 2013 NHTS results show that 65.8% of scholars walk to educational centres (5.2% less than in 2003), 13 % travel by cars and 15% using taxis (Statistics South Africa, 2013). Walking to school has decreased by 5.2% between 2003 and 2013, implying a modal shift to motorised transport among learners and an increase in congestion around schools.

This study aims to understand learners' travel behaviour by investigating and comparing the trip patterns of learners attending five primary schools in Stellenbosch. The relationship between travel mode and the factors that may influence mode choice are also examined. Further to this, the actual trip generation rate of four primary schools will be determined and compared with the trip generation rates recommended in policy documents. Comparing the trip generation rates will provide valuable information as to how trips vary between primary schools within the same urban area but with different socio-economic characteristics.

1.2 Trip generation

The number of trips generated by a school can be estimated as the product of the trip generation rate and the independent variable quantified for the specific land-use as shown in Equation 1 (Montgomery & Runger, 2007):

$$\boldsymbol{Trip\ Generation\ Rate} = \frac{\boldsymbol{Number\ of\ Trips\ Generated}}{\boldsymbol{Independent\ Variable}} \qquad \text{(Equation 1)}$$

The trip generation rate of primary schools, as given in documents such as the Institute of Transportation Engineers Trip Generation Manual (Institute of Transportation Engineers, 2003), the South African Trip Data Manual (TMH17) (Committee of Transport Officials, 2013) and the South African Trip Generation Rates Manual (Stander, et al., 1995) are shown in Table 1 below.

1.3 Understanding school travel patterns

The school going population increases annually and it therefore becomes increasingly important to understand school travel patterns. In 2000, 11 600 365 learners (Grade 1-12) were enrolled at South African government schools, in 2013 this number increased to 11 657 346. In the Western Cape the number of Grade 1-12 learners were 901 218 in the year 2000, this number rose to 987 003 in 2013 (Department of Basic Education, 2015) (Department fo Basic Education, 2002).

Children start travelling independently around the age of 9, and it is at this stage in their lives where the opportunity lies in changing trip making behaviour. The current chauffeuring practice may establish a pattern of automobile dependence that could likely carry over to adolescence and adulthood (Sirard & Slater, 2008).

Table 1: Trip generation rates for schools

Institute of Transportation Engineers (Institute of Transportation Engineers, 2003)		
Trip Generation per Learner	**Average Rate**	**Range**
Elementary school (Grades 1,2,3,4,5 / 6):	AM: 0.42	0.11 – 0.92
Middle school (Grades 6,7, 8):	AM: 0.53	0.14 – 1.29
Trip Generation Rate per Employee	**Average Rate**	**Range**
Elementary school (Grades 1,2,3,4,5 / 6):	AM: 5.19	01.22 – 9.5
South African Trip Data Manual (TMH17) (Committee of Transport Officials, 2013)		
Trip Generation per Learner	**Average Rate**	**Range**
Public Primary School (Grades 1 – 7)	AM: 0.85	N/A
Trip Generation Rate per Employee	**Average Rate**	**Range**
Public Primary School (Grades 1 – 7)	N/A	N/A
South African Trip Generation Rates (Stander, et al., 1995)		
Trip Generation per Learner	**Average Rate**	**Range**
Primary School (Grades 1 – 7)	AM: 0.9	0.82 – 0.95
Trip Generation Rate per Employee	**Average Rate**	**Range**
Primary School (Grades 1 – 7)	AM: 20.4	18.4 – 22.4

2. RESEARCH DESIGN

2.1 Study schools

The National Department of Basic Education groups all government schools into one of five categories: Quintile 1, 2, 3, 4, or 5. With Quintile 1 (Q1) schools designating the poorest institutions and Quintile 5 (Q5) the wealthiest. The quintile to which a school is assigned is based on the rates of income, unemployment and illiteracy within the school's catchment area (Collingridge, 2013). School fees also usually increase with quintile. This research considered trip patterns at Q3, Q4 and Q5 primary schools and learners between the ages of 9 and 13.

The following schools participated in this study:

1. A.F. Louw Primary (Q4);
2. Brückner de Villiers Primary (Q3);
3. Eikestad Primary (Q5);
4. Idas Valley Primary (Q4); and
5. Stellenbosch Primary (Q5).

The town of Stellenbosch and the study schools are shown in Figure 1.

Figure 1: Study area schools

2.2 Data collection

Personal interviews, classified traffic counts and self-completion questionnaires were used to investigate the trip patterns at the participating schools.

2.2.1 Personal interviews

Personal interviews were conducted with a representative from each school to gather general information relating to the school such as the number of learners, number of employees, vehicular and pedestrian entrances to the school and parking availability.

2.2.2 Classified traffic counts

In order to calculate the vehicular trip generation rate of each school, it was necessary to conduct a classified traffic count at the participating schools. Only vehicles were counted, separating vehicles into two classes: 1) private vehicle and 2) buses and minibus taxis and bakkies used as taxis.

The traffic counts were only conducted at four of the five studied primary schools due to the proximity of one of these schools close to other schools which could have resulted in an overestimation of traffic generation.

The traffic counts were conducted in the morning for one full hour before the start of the school day. The traffic counting took place over several days, allowing one day per school. The day chosen for each school was a normal school day, outside the school holiday period.

2.2.3 Self-completion questionnaire

Printed and internet based self-completion questionnaires were distributed and completed by parents of children aged 9 to 13 attending the five studied Primary Schools in Stellenbosch. The questionnaire collected information to understand the trip making patters of primary school learners and the factors that influence modal choice.

3. TRIP PATTERNS

The modal split of trips made by learners from Q3, Q4 and Q5 schools were compared by considering household characteristics such as distance to school, vehicle ownership, number of learners in the household, etc. and the influence of learners' specific characteristics such as age, gender, etc..

Table 2 indicates the number of respondents from each set of schools per quintile. As the number of respondents from the Q3 school is very low, conclusions about the trips made by learners from Q3 schools may not be representative. Additionally, the return rate for Q5 schools was low. The results presented in this research are therefore indicative, but not conclusive of the various quintile schools in Stellenbosch, and more research is required, especially for Quintile 1 and 2 schools and schools in the rest of South Africa.

Table 2: Survey responses

Qunitile	Number of Learners between age 9-13 (Grade 4 – 7)	Number of Completed Surveys Returned	% Return
Q3 (1 school)	152	15	9.9
Q4 (2 schools)	841	172	20.5
Q5 (2 schools	960	63	6.6

3.1 Quintile of school

The modal split of trips to and from Q3, Q4 and Q5 schools are shown in Figure 2 and Figure 3.

It appears that as the school quintile increases from 3 to 4 and 5 the usage of non-motorised transport (NMT) and public transport (PT) modes decrease while the private vehicle (PV) mode share increases. Virtually none of the learners attending Q5 schools use PT as a mode of transport to and from school. While respondents from Quintile 3 and Q4 schools, the majority of trips to and from school are NMT trips or PT trips in both the morning and afternoon. In the afternoon (NMT) and public transport (PT) usage increases and private vehicle (PV) usage decreases among learners attending Q4 schools. The opposite is true for Q5 schools: in the afternoon the NMT usage decreases and PV usage increases.

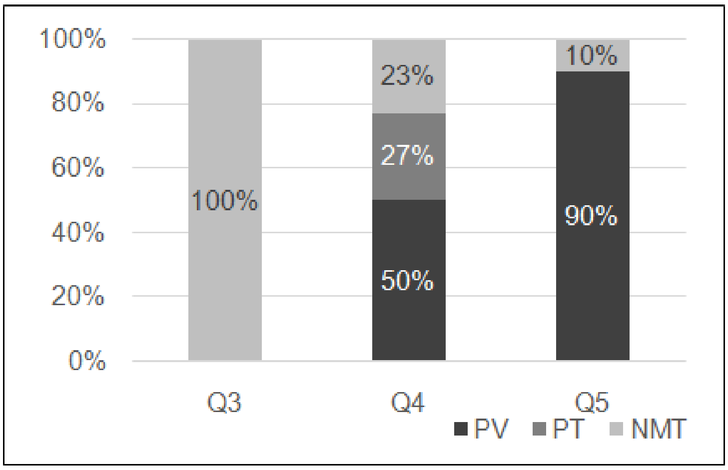

Figure 2: Quintile and Travel to School

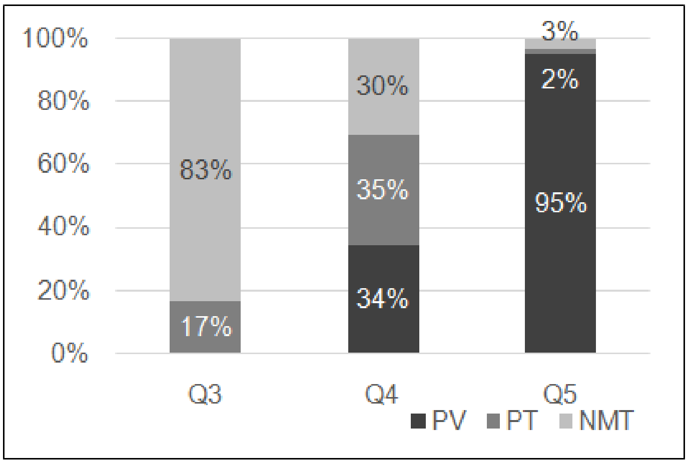

Figure 3: Quintile and Travel from School

3.2 Distance to school

Figure 4 shows the percentage learners living 0-1km, 1-2km, 2-5km, 5-10km and more than 10km from the studied Quintile 3, 4 and 5 schools.

Comparing the distance Q3, Q4 and Q5 learners travel to and from school shows that as the quintile classification of the school increases the travel distance of learners to school increases. As previously discussed, the mode share of PV is the highest amongst learners attending Q5 schools, who live further from the school compared to learners attending the Q3 school (predominantly living within 1-2km from the school). This may be due in part to the distance travelled to school.

It can be deduced that the mode share of NMT decreases as the distance to school increases and the mode share of motorised transport (MT) increases as the distance increases.

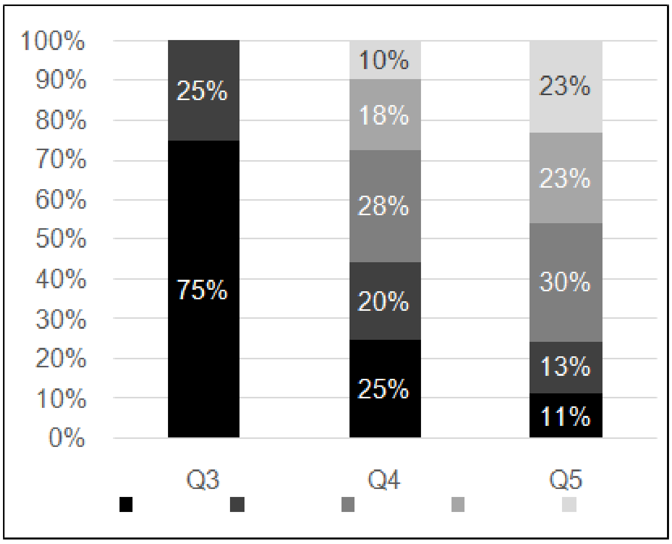

Figure 4: Comparing the distance Q3, Q4 and Q5 learners travel to and from school

3.3 Number of parents or guardians employed

The number of parents or guardians employed increases with school quintile (shown in Figure 5). Most respondents are from households with at least one parent/guardian employed and employment increases as the school quintile increases.

From the survey results is may be deduced that higher employment rates result in increased household income, (which likely influences the choice of school that parents send their children to) and higher income affects mode choice. The findings indicate that learners from households with two parents or guardians employed are more likely to use MT to travel to or from school.

Across all quintile schools surveyed, the majority of NMT users are from households with either none or a single parent or guardian being employed. This may possibly be due to the fact that lower employment means that a parent or guardian is available to make sure learners travel safely to and from school and are therefore more likely to let leaners use NMT modes. It may also influence the number of vehicles per household, as is investigated in the next section.

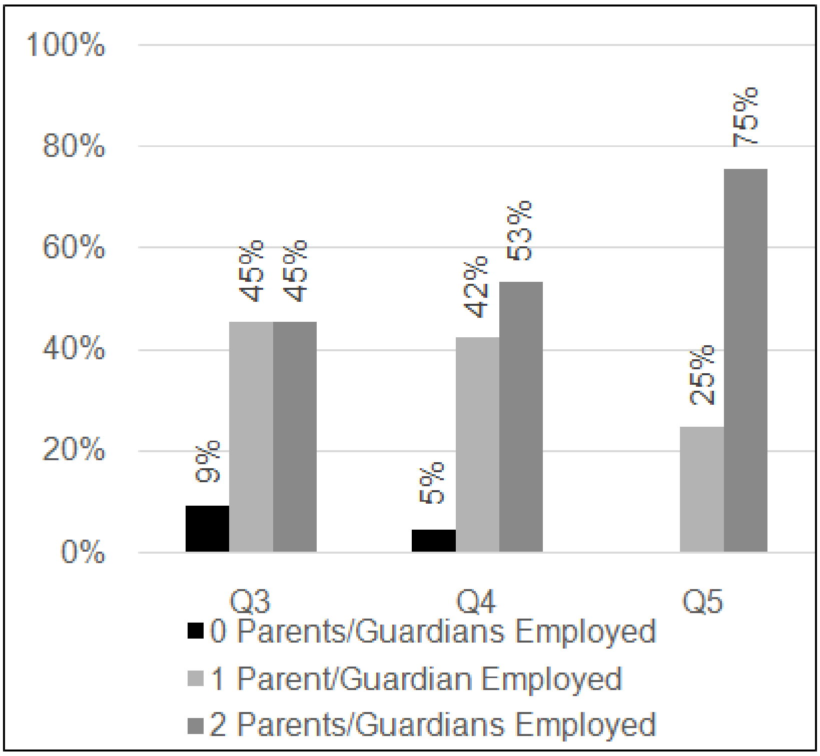

Figure 5: Comparing employment amongst Q3, Q4, and Q5 Schools

<u>3.4 Number of vehicles in household</u>

From Figure 6 it appears that vehicle ownership per household increase as the quintile classification of the school increases.

The survey results indicate that households with at least one vehicle available are more likely to use PV for trips to and from school than NMT and PT. As the number of vehicles owned by a household increases the mode share of PV increases.

Learners from households with only one vehicle will often be taken to school on the parent/guardian’s way to work (trip chaining), but in the afternoon these leaners make use of alternative modes of transport as parents or guardians may not be available when the school day finishes.

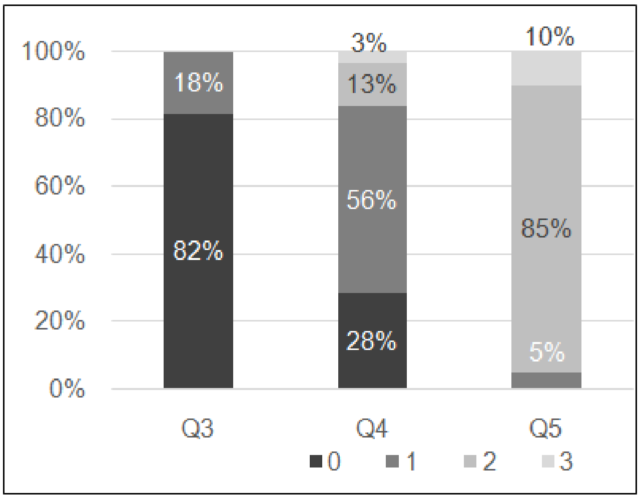

Figure 6: Vehicle ownership and school quintile

3.5 Extra mural activity

EMA participation is the highest among Q5 learners and lowest among Q4 learners. This could be related to the cost associated with these activities or the availability of EMAs at the particular school. As shown in Figure 7, the modal split of trips to and from EMAs vary significantly among learners from Q3, Q4 and Q5 schools.

The majority of Q5 learners use PV to get to and from EMAs while the majority of Q3 learners use NMT modes. Similar to the trips to and from school, NMT modes has the largest mode share amongst Q3 schools while PV remains the preferred mode amongst learners from Q5 schools. Interestingly, the proportion of PV used to reach EMAs is substantially higher than the proportion of PV trips from school in the afternoons for both Q3 and Q4 schools. This may indicate that there is limited PT from the schools to the EMAs. PV usage to reach EMAs is slightly lower for Quintile 5 schools.

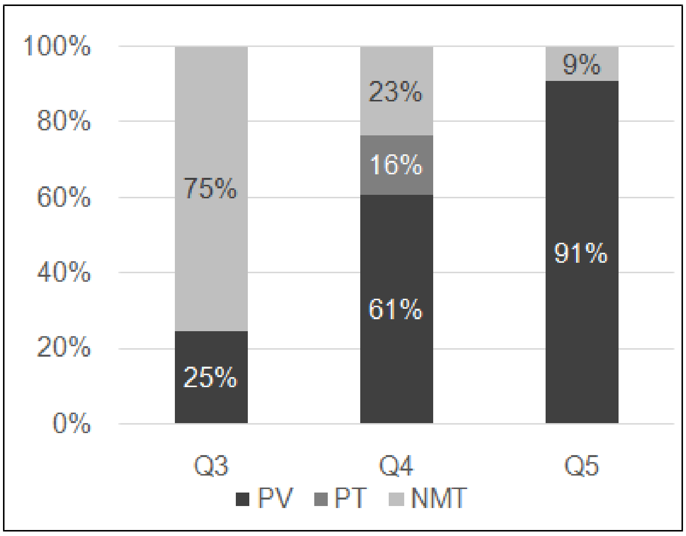

Figure 7: Comparing modal split of learners to/from EMA (Q3, Q4 and Q5)

Participation in EMA was found to only affect the modal split of trips from school in the afternoon. The modal split of trips to school made by learners participating in EMA and learners not participating in EMA is similar in the morning. However, the modal split of trips made by learners participating and learners not participating in EMA are different in the afternoon. There could be many reasons for the observed modal shift amongst learners participating in EMA in the afternoon: time at which the EMA takes place, the location thereof, the time available between activities, the physical intensity of the EMA, etc.

3.6 Gender

The degree of parental control exercised over girls is higher than that of boys. Boys are allowed to travel independently while girls are more likely to be accompanied by an adult. The percentage of NMT users that is accompanied by an adult, split according to gender are shown in Figure 8, Figure 9 and Figure 10.

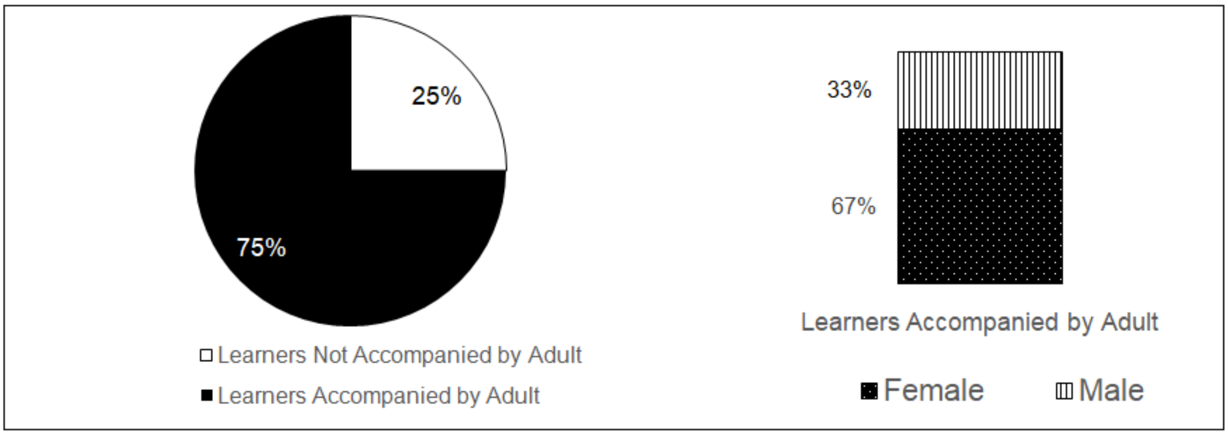

Figure 8: Q3 - Percentage NMT users accompanied by adult and gender

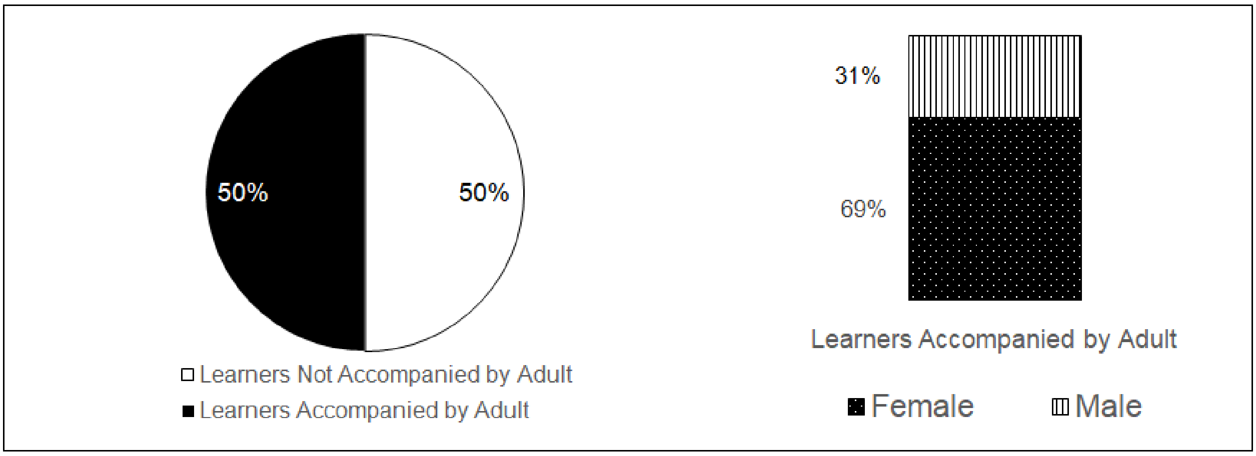

Figure 9: Q4 - Percentage NMT users accompanied by adult and gender

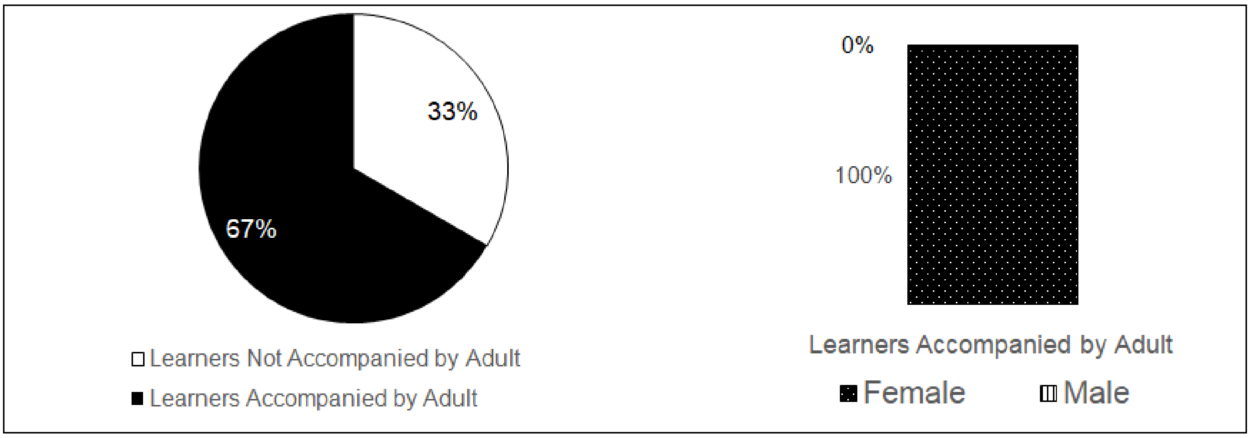

Figure 10: Q5 - Percentage NMT users accompanied by adult and gender

3.7 Parents reasoning and adult supervision

Parents face a difficult decision when deciding what mode of transport young children should use to get to and from school. Their perception of their physical and social environment, the resources available to the family and an evaluation of their child's personal ability to manage such a trip safely, will all influence their decision (Sirard & Slater, 2008).

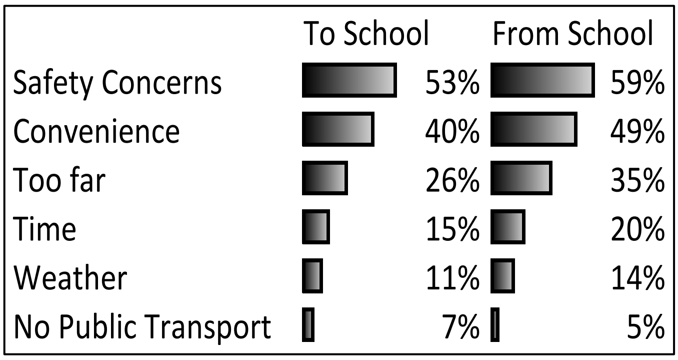

Figure 11: Quintile 4 - parents' reasoning

In an effort to understand parent's reasoning when it comes to modal choice of minors, the self completion household survey asked parents why they do not allow learners to use NMT modes or why they chose to use PV or PT for trips to and from school transport learners.

Figure 11 shows that safety concerns and convenience were the top reasons given when Quintile 4 parents and guardians were asked why they do not allow learners to use NMT modes to travel to and from school.

4. TRIP GENERATION

Using the data collected during the classified traffic counts, the total number of learners and the number of employees per school, Equation 1 were applied to calculate the trip generation rate for four of the five study schools. Table 3 shows the trip generation rate calculated per learner and per employee.

Table 3: Calculated trip generation rates

School	Quintile	Number of Learners	Number of Employees	Number Vehicles Counted	Trip Gen. Rate/Learner	Trip Gen. Rate/Employee
A.F. Louw Primary	4	679	35	216	0.318	6.171
Brückner de Villiers Primary	3	311	18	39	0.125	2.167
Eikestad Primary	5	844	50	N/A	N/A	N/A
Idas Valley Primary	4	911	45	354	0.389	7.867
Stellenbosch Primary	5	950	86	525	0.553	6.105

Comparing the trip generation rate of Q3, Q4 and Q5 schools shows that the trip generation rate of primary schools within the same urban area vary significantly: as the quintile of the school increases the vehicular trip generation rate per learner increase.

Comparing the calculated morning peak hour vehicular trip generation rates per learner and per employee with the trip generation rates of the Transportation Engineers Trip Generation Manual (Institute of Transportation Engineers, 2003), the South African Trip Data Manual (TMH17) (Committee of Transport Officials, 2013) and the South African Trip

Generation Rates (Stander, et al., 1995) in Figure 12 and Figure 13, show that the calculated trip generation rate per learner and employer are significantly lower than that given in the SA Trip Gen manual and TMH 17. The Trip generation rates given in the ITE document are closer to the trip generation rates calculated for Stellenbosch schools.

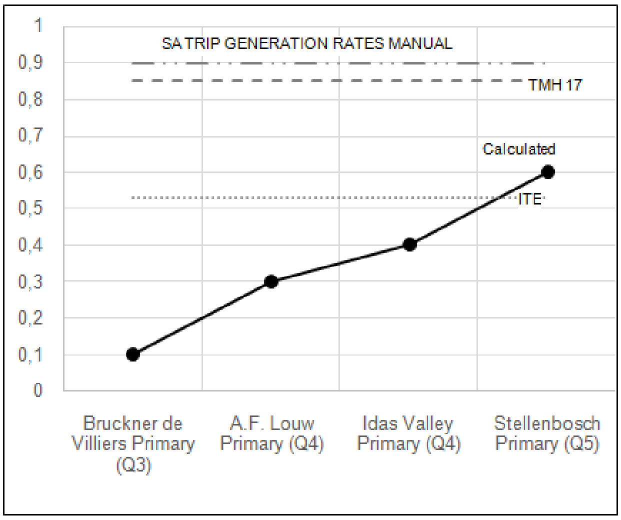

Figure 12: Trip generation rate per Learner

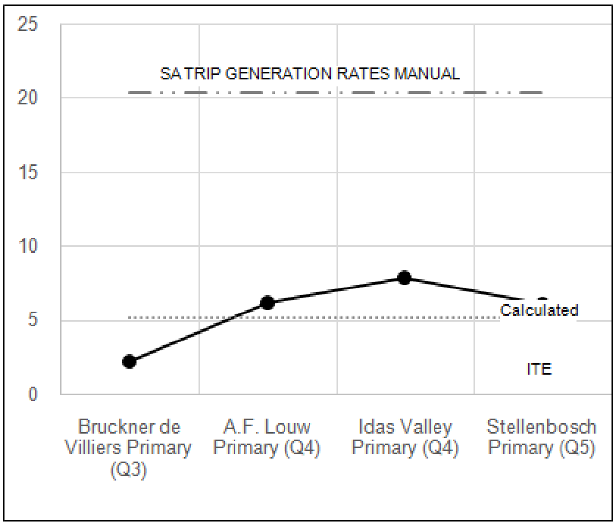

Figure 13: Trip generation rate per Employee

5. CONCLUSIONS

In the town of Stellenbosch, trips to and from schools are major contributors to traffic congestion during peak times. The congestion that is observed in the vicinity of individual schools within Stellenbosch, varies significantly, suggesting that the trip patterns of learners are different depending on the school they attend. With the school going population growing yearly it becomes increasingly important to understand school travel patterns.

Trip Generation estimation is the first step in the *Classic Transport Model*. The number of trips generated by a school is estimated using trip generation rates as proposed in documents such as the Institute of Transportation Engineers Trip Generation Manual, the South African Trip Data Manual (TMH17) and South African Trip Generation Rates. This research, however, found variation in trip generation potential among different schools according to quintile, which is not taken into account by the standard trip generation rates.

Further to this, the trip generation rates of schools vary due to the fact that the modal split of trips to and from primary schools are significantly different depending on factors such as: the age of learners, distance to school, number of parents employed, vehicle ownership, participation in EMA and the gender of learners. Depending on the quintile of the school the relative importance of these factors varies.

When parents were asked why they choose to use PV modes to transport learners to and from school, safety concerns, convenience and distance were among the reasons cited most commonly. In order to improve the usage of NMT modes for trip making to and from school, parents have to be convinced that learners will be safe when travelling to and from school using NMT modes.

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