INVESTIGATION INTO THE PHENOMENON OF REDUCED HOUSEHOLD TRAVEL SURVEY DERIVED TRIP GENERATION RATES IN GAUTENG PROVINCE

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ABSTRACT

Gauteng Province has carried out two household travel surveys (HTS) – the first was carried out in 2000 and the recent one was completed in 2014. HTSs are the mainstay of transport planning and modelling, being used by the province to update the Gauteng Provincial Strategic Transport Model, among other things. The household AM peak trip generation rates according to this recent survey are indicated to be lower than that found in the 2000 HTS. A similar trend has been reported in South Africa, albeit with moderate changes.

The paper investigates the statistical significance of the lower trip generation rates for the current HTS and further interrogates the results to determine plausible causes for the lower trip generation rates. While factors such as reduced household size, increased unemployment and peak spreading are found to be present, it is the design of the survey instrument resulting in respondent fatigue that is found to be the main cause. In response, the paper provides some recommendations for improved design of survey instruments for cases where whole day travel is being measured.

Key Words:

Gauteng Province, household travel survey, transport planning and modelling, trip generation rates, respondent fatigue

1. INTRODUCTION

The existing road infrastructure in South Africa is insufficient to cater for the existing and future travel demand. Continual upgrade of the existing road infrastructure to accommodate the increase in travel demand is unsustainable both on the environment and economy. More sustainable ways are thus required to cater for existing and future demand using available resources.

Household travel surveys are carried out at regular intervals to understand travel demand. In general, socioeconomic information captured from the household travel survey is used to calibrate various travel demand models, which are then used to inform transport planning and influence policy. Deficiencies in the data captured will have negative impacts on every stage associated with transport planning (Ortuzar & Willumsen, 2005). Much research has been carried to identify problems associated with household travel surveys as evidenced by outputs of long-standing conferences such as the "International Conference on Travel Survey Methods". However, many of the problems are context specific and should therefore be evaluated on a case by case basis.

Gauteng Province has carried out two household travel surveys (HTS) – the first was carried out in 2000 and the recent one was completed in 2014. The mean peak period trip generation rate for the recent household survey travel survey was found to be significantly lower when compared to the earlier study.

The objectives of the paper are to:

- Determine statistical significance of the lower trip generation rate for the current study when compared to the study carried out in 2000
- Interrogate the results to determine plausible causes for the lower trip generation rate, and
- Give recommendations to improve the design of the survey instrument.

2. BACKGROUND

2.1. Study Area

The study area in this paper is limited to the province of Gauteng in South Africa. The province has the highest density of all South Africa's nine provinces. The province also contributes about 35% to the country GDP, which is more than double the second highest province (Statistics South Africa, 2013). Therefore, transport planning and management are of critical importance to the province given that transport is an essential component of any large economy. The province also has three metropolitan municipalities, namely Ekurhuleni, Johannesburg and Tshwane and also two district municipalities, namely Sedibeng and West Rand.

2.2. Sample Size

Table 1 below shows the distribution of the sample sizes and the weighted number of households by municipality. The two surveys, Gauteng Travel Survey 2000 (GTS 2000) and the Gauteng Household Travel Survey 2014 (GHTS 2014) had sample sizes of 22 944 and 29 779 respectively. Ekurhuleni had the highest sample size whilst West Rand had the lowest. The number of households in Gauteng has almost doubled in between the survey periods.

Table 1: Sample size by municipality

Municipality	Household sample	Percentage sample households	Weighted number of households	Percentage of weighted households
Ekurhuleni	10 467	35.1%	1 017 965	26.0%
Johannesburg	6 390	21.5%	1 434 856	36.7%
Sedibeng	2 128	7.1%	302 712	7.7%
Tshwane	8 891	29.9%	900 736	23.0%
West Rand	1 903	6.4%	254 485	6.5%
Total GHTS2014	**29 779**	**100.0%**	**3 910 754**	**100.0%**
GTS2000	**22 944**		**2 182 285**	

3. METHODOLOGY

Error! Reference source not found. below shows at a high level the methodology used. The methodology for analysis is broken down into two phases. The first phase aims to draw statistical conclusions whilst the second phase will interrogate the travel surveys as follows:

- Dataset validation against other pre-existing datasets i.e. National Household Travel Survey 2013 (NHTS2013), Census, etc. where possible, and
- On the basis of the gaps identified above, carry out detailed analysis toward the reported lower peak period trip generation.

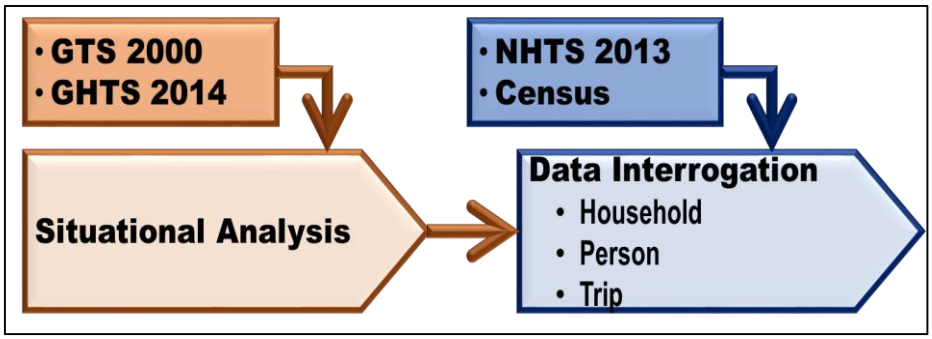

Figure 1: Schematic representation of the methodology

3.1. Statistical Analysis

This stage of the methodology will establish whether or not the reported trip generation rate was a result of sampling error, chance or inadequate sample size. Using Anderson–Darling test and normal probability plots, the datasets would be tested whether or not there are normally distributed. Inferential statistics tools will then be used to determine the statistical significance of reported lower peak period trip generation rate for each municipality at household level. Minitab® 30 days trail version 17.2.1 software package was used to perform the above mentioned statistical tests.

3.2. Data Validation and Analysis

Each household survey dataset is typically grouped into four distinct subsections i.e. household attributes, person attributes, trip making attributes and public transport attitudinal attributes. For the purpose of this paper the discussion will be limited to household attributes and trip making attributes.

Data validation will first be carried out where possible against other datasets to ensure consistency and to highlight red flags which might be responsible for the reported lower trip generation rate i.e. the weighted sample values must be relatively close to Census data.

4. RESULTS AND DISCUSSIONS

Figure 2 below shows average peak period trip generation per household for the different municipalities. The reported household peak period trip generation rates for the GHTS 2014 are lower by almost 50% when compared to GTS2000. The GHTS 2014 peak period trip generation rates are significantly lower when compared to the trip generates in the South African trip data manual (2013).

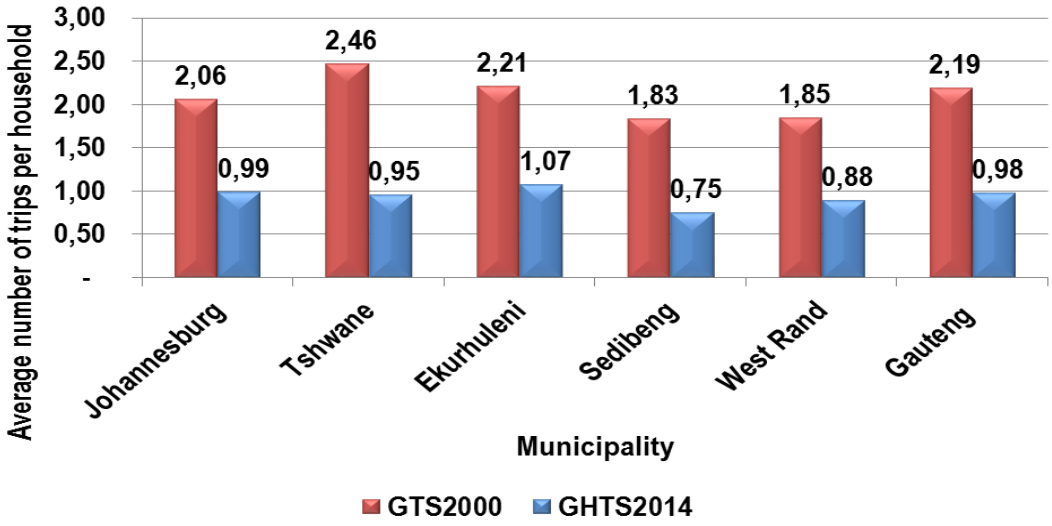

Figure 2: Peak period (06:00 – 09:00) Trip generation rates per household

Lower trip generation rates have been reported in previous studies however the difference was not this significant. Trip generation surveys were carried out in the late 2000s at 55 locations in and around the City of Johannesburg and Ekurhuleni. The study found that the average trip generation rates obtained when compared to the rates published by the South African Trip Generation Rates (1995) and other relevant sources, were lower (Veska & Venter, 2009).

4.1. Statistical Significance

Error! Reference source not found. and **Error! Reference source not found.** show the probability plot for peak period trips generation rates in the City of Johannesburg for both GTS (2000) and GHTS (2014) datasets. From the figure it is evident that datasets are not normally distributed and this result of non-normality is consistent across all municipalities. The peak period trip generation rates per household for each municipality were then tested for normality using Anderson–Darling test for normality and the result of non-normal was obtained as already obtained using the graphically method.

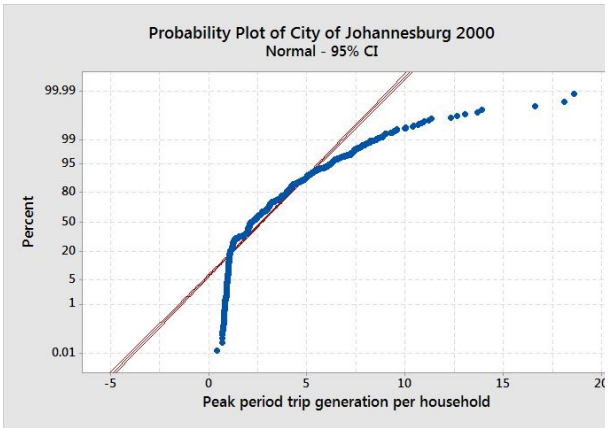

Figure 2: Probability plots for peak periods trip generation per household in GTS2000 (CoJ)

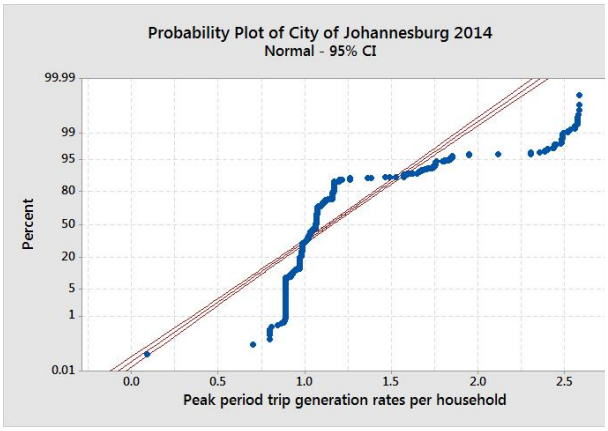

Figure 3: Probability plots for peak periods trip generation per household in GHTS2014 (CoJ)

Table 2 shows results from the two statistical tests which were carried out i.e. t-test and the nonparametric mann-whitney test. Both tests confirm that the lower peak period trip generation rates are statistically significant. This implies that the significant lower trip generation rate for the current study were not a result of sampling error, chance or inadequate sample size.

Table 2: 95% confidence interval test results

	T-test (two sample test)		Nonparametric (mann – whitney)	
	t-value	P-value	U-value	P-value
City of Johannesburg	-59.32	0.00*	2 268 622	0.00*
City of Ekurhuleni	-51.48	0.00*	6 444 787	0.00*
City of Tshwane	-70.62	0.00*	5 640 313	0.00*
Sedibeng LDM	-32.07	0.00*	255 724	0.00*

West Rand LDM	-28.07	0.00*	202 515	0.00*

4.2. Data Validation and Analysis of the Data

4.2.1. Household Attributes

4.2.1.1. Household Income

The mean household income for the two datasets GTS2000 and GHTS2014 are R3 247 and R5 767 respectively, this is excluding just below 20% of the sample who did not provide information with regard to their income in the current study. On the bases of provided data, Income has not significantly changed in real terms.

The level of distortion the high refusal rate to reveal income has on the results, makes difficult to extract concrete evidence to prove that mean household income had an influence on the reported lower trip generation rates. Census (2011) places the mean monthly household income in Gauteng at just below R10 000. At this Census value, the implication is the mean household income in real terms has significantly improved in the Gauteng Province.

4.2.1.2. Household Size

The mean household size has decreased in the province over the years as depicted in Table 3. Depending on the socio-economic factors which are unique to each household, the effects of a lower mean household size might result in lower or high trip generation rates.

Table 3: Household size over the time

Year	1985	GTS 2000	GHTS 2014
Mean household size	3.90	3.56	2.94

Table 4 shows the R-squared value for a plot of household trip generation rate versus household size. From the table the lower R-square value for the GHTS 2014 dataset is evidence that the household size might result in higher or lower reported trip generation rate per household.

Table 4: R-squared value for the relationship between household size and peak period trip generation rate

	R-square value	
	GTS 2000	**GHTS 2014**
City of Johannesburg	0.1980	0.0033
Ekurhuleni	0.2419	0.0020
City of Tshwane	0.3204	0.0018
Sedibeng LDM	0.3342	0.0003
West Rand LDM	0.3513	0.0111

4.2.2. Person Attributes

4.2.2.1. Missing / Unreported Trips

The total peak period trips reported in the two HTSs were 4.7 million trips GTS (2000) and 3.8 million trips GHTS (2014). This implies the total peak period trips reported in the GHTS 2014 had dropped by just under a million trips. During the same period, the number of households in the Gauteng Province has doubled and the population has increased by 3 million people.

A vast majority of the schools in the Gauteng Province have their classes starting before or around 8 o'clock in the morning, this would imply that vast majority of the trip which are for the purpose of education would take place during the peak period. For GHTS (2014), the number of people who reported their occupational status as being related to some form related to education was 2 68 million i.e. primary school learner(50.9%), high school learner(35.3%) and student at a university/college/post matric(13.8%).

Extracting from the GHTS 2014, only Educational purpose trips during the peak period and for the whole day only 1 810 337 trips were reported and just under 2 million trip were reported respectively. Both peak and whole day travel values are way below the reported value of 2.68 million, which is the occupational status related to education.

Educational trips undertaken by individuals 6 years and older, during peak period, reported in the NHTS (2013) are at 2.5 million trips, within the Gauteng Province. This reported value is relative close to the 2.68 million occupational status related to education value. When compared to the national household survey the current survey has underreported peak period trips for education purposes.

According to the Census (2011), homebased education only accounts for 0.5% as a form of studying within the Gauteng Province. As a result homebased schooling has little effect on the justifying the unreported Educational trips. The unreported deficit for educational trips is almost 6.8 hundred thousand trips. Most of which are expected to take place within the peak period. Response burden (response fatigue) was the only plausible reason which could have resulted in the reported educational trips.

4.2.2.2. Peak Hour Spreading

Figure 4 shows the distribution of the peak period trips. Proportionally there is an increase in the number of trips taking place before 6 o'clock am. On the basis of the of the evidence presented in the Figure 4 the lower peak period trip generation rates might have been as a result of peak spreading.

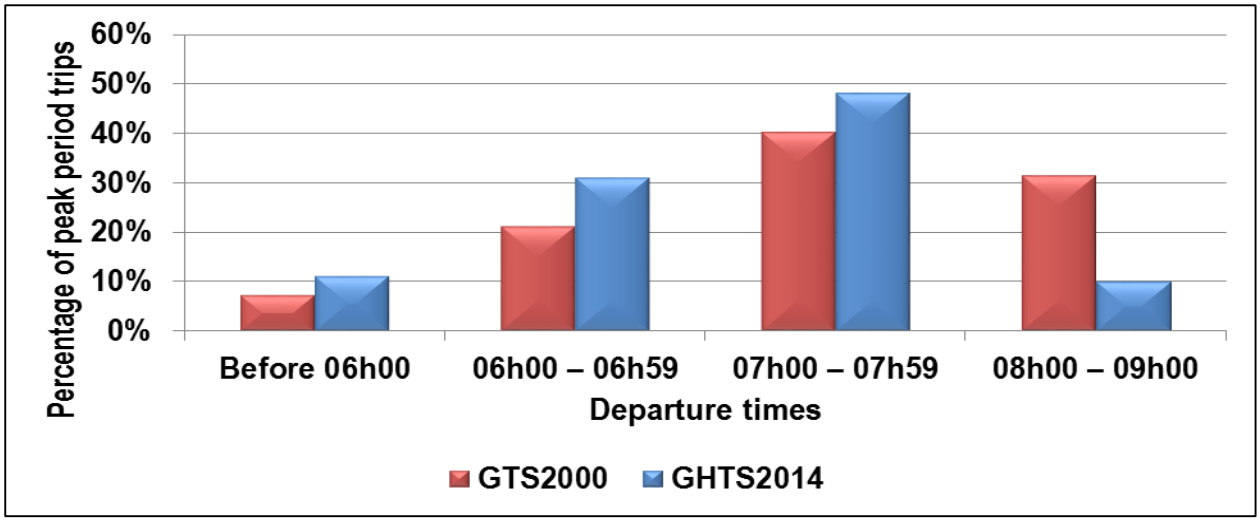

Figure 4: Peak period departure times

5. RECOMMENDATIONS AND CONCLUSIONS

There is evidence to suggest that the mean household size is decreasing over time in the Gauteng Province. Further investigations would have to be conducted to determine effects of this decrease in household size given unique the South African conditions on the trip generation rates.

The current survey detected high levels refusals to disclose household income as a result the influence of household income on the reported lower trip generation could not be fully investigated.

Respondent burden (response fatigue) was found to be the main contributing cause to the reported lower trip generation rates. This is because the respondent had to report trip making for every member of the household for the whole day.

The current study has revealed that there is an increase in the number of trip taking place before 6 o'clock. This increase of trips before 6 o'clock might be responsible for the lower peak period trip generation rate.

It is recommended that in future the effect of respondent fatigue be explicitly tested before the survey instrument is used.

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