DESIGN IMPLICATIONS OF INCORPORATING EMPLOYEE PROFILES AND WORKPLACE ACTIVITY LEVELS IN TRAVEL DEMAND MANAGEMENT LED PARKING DEMAND ASSESSMENTS

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ABSTRACT

In the urban areas of South Africa the provision of parking has historically been based on town planning schemes formulated by local authorities. The parking requirements in these town planning schemes were established from the results of numerous surveys that observed the actual use of parking spaces and related the demand to specific attributes of land use, and depending on the land use these could be unit of leasable floor area, availability of seats, availability of beds or the number of employees, in order to derive parking demand rates for design purposes. The fundamental problem with this approach is that the standards are derived from historically observed parking demand and therefore evolutionary socio-economic attributes do not necessarily influence the standards so developed. While these standards are supposed to be continuously updated, it would be difficult to re-demarcate parking spaces for built up areas. Therefore old built up areas remain with the problem of fixed parking spaces when the demand for parking is ever increasing. A more fundamental question, however, is how to better understand travel behaviour to enable the design of sustainable transport services, of which parking form part, in line with policy instruments such as travel demand management. It is the aim of the paper to help contribute towards answering such questions, by providing some empirically derived datasets assimilated within the context of better understanding travel behaviour related to parking demand.

The paper isolates the case of a large firm in the City of Tshwane, employing 3 751 people, and interrogates relationships between work place travel activity patterns, employee profiles and parking demand. South African workplaces, in particular, especially in urban areas, are ever more characterised by increased parking demand and limited capacity to accommodate the demand. In this specific case study, the analysis is reliant on classified occupancy traffic counts at the workplace, employee records and some land use data. The main contribution of the paper is in the publishing of some empirically derived parking demand related datasets, to illustrate usefulness of more in-depth behavioral data in the formulation of designing sustainable transport services. The paper concludes that much insight is gained from understanding travel behaviour in the design of sustainable transport services to serve the workplace.

1. INTRODUCTION

In the urban areas of South Africa, the provision of parking has historically been based on the town planning schemes formulated by planning authorities in the form of parking guidelines. The fundamental problem with this approach is that the standards are derived from historically observed parking demand and therefore evolutionary socio-economic attributes do not necessarily influence the guidelines so developed. While these guidelines are supposed to be continuously updated, this has not been the case in South Africa. Nonetheless, it would become difficult to retrofit built up areas in the future from using the updated guidelines and therefore limited parking capacity will remain eternally problematic, especially with increased per capita car ownership and use.

The study explores the implications of incorporating more in-depth knowledge of workplace activity levels and employee attributes in parking demand assessments at a work place. Such knowledge has the potential of improving parking design standards in a manner that aligns such standards to more contemporary transport planning paradigms (for example that parking is not a right but a good that should be subjected to economic laws of supply and demand). But more fundamentally, the study contributes towards the design of more sustainable workplace related transport services by highlighting some notable dynamics related to parking demand through the interrogation of empirical data at a work place. The study uses a large office park in the City of Tshwane, employing 3 751 people as a case study. The findings of the study are therefore potentially limited to office land use, and in particular, enclosed or gated workplaces.

An interesting feature in the paper is the illustration of some of the value derivable from using readily available every day transaction data (in this case data from the swiping of access control cards in a gated office park), to obtain data that would ordinarily require significant resources from planners. Such low cost transaction data is available in various forms and remains unused, for example, similar data in many gated land uses, cellular phone activity records, sales transactions and more recently publicly available internet-based chat records. It is important that all these datasets be harnessed as much as possible in order to contribute towards the elimination of the dearth of planning data in South Africa, which is actually a secondary purpose of the paper.

2. BACKGROUND

The National Land Transport Transition Act (RSA, 2000), soon to be replaced by a National Land Transport Act (not contrary to the existing Act), empowers planning authorities to use parking charges as one of the tools to manage travel demand. It defines travel demand management as “a system of actions to maximise the capacity of the transport system for the movement of people and goods rather than vehicles, among others, through increasing vehicle occupancy, developing priority measures for, public transport, encourage travel during off-peak periods, shifting demand between modes, restricting the space available for parking, adjusting the price of parking, and other appropriate measures”. In fact the proposed new act goes further to explicitly empower planning authorities to use parking user charges as a revenue generation mechanism (albeit poorly linked to travel demand management). The implementation of travel demand management is in line with the South African transport policy of encouraging the optimum use of existing transport infrastructure in order to maximise the infrastructural throughput of people and goods as opposed to vehicles. With parking being one of the travel demand management instruments, it is imperative that it becomes measurable in legally defendable terms. Nationally, the Department of Transport formulated minimum parking standards (Department of Transport, 1985) for use in urban areas. Basically, the standards

are based on parking use surveys from different land uses in order to establish parking demand rates. Table 1 is an extract from the national minimum parking standards for selected land uses. In the case of general offices, for example, the minimum standard is 2.5 parking spaces per 100 m^2 of gross leasable area (GLA). For universities, the minimum standard for the entire university is 4 spaces for every 10 students. If future revisions of the parking standards were to follow similar parking demand estimation methodology, the minimum rates would inevitably increase given the expected increased per capita car ownership and use in the country (Department of Transport, 1997). The opportunity costs associated with parking space provision (Shoup, 1997), however, render the approach unsustainable. Increased opportunity costs would be further exacerbated by the generally freely available parking in the country. For example, in the City of Johannesburg only 9% of people who drove to work paid for parking (Gautrans, 2002). Cameron and Krynauw (2003) attribute the culture of free parking in South African urban areas to the historical competition between rival municipalities that attempted to attract developers by encouraging the provision of ample parking capacity. Contemporary thinking, however, encourages innovative parking charge schemes as an incentive for commuters to be more aware of other travel options such as switching modes (Ferguson, 2000).

Table 1 Extract from South African minimum parking standards

Land Use	Land Use -subcategory	Standard
Office	General offices	2.5 spaces/100m^2 GLA
	Banks, building societies and other public trading offices	4 spaces/100m^2 GLA
Business	Neighbourhood shopping centre	7 spaces/100m^2 GLA
	Community shopping centre	6 spaces/100m^2 GLA
	Regional shopping centre	5 spaces/100m^2 GLA
Residential	Dwelling unit of 1 habitable room	1 space/unit
	Dwelling unit of 4 or more habitable rooms	1.5 spaces per unit
Medical	General hospitals	1 space/bed
Educational	Universities	0.4 spaces per student

It is argued in the paper that effective implementation of transport policy instruments such as travel demand management, and in particular the use of parking controls as a tool, requires more in-depth understanding of travel behaviour. Investment in empirical research, therefore, becomes imperative. The study attempts to fulfil this objective using some empirical assessment of parking demand dynamics at a relatively large office park. The paper does not aim to dispute the figures provided for in the South African minimum parking standards per se, but seeks to contribute towards the expansion of the scope of the provisions of the standards in line with contemporary transport policy. In fact, it is the current South African transport policy that challenges the foundation of the South African minimum parking standards in that the standards, contrary to the policy, do not seek a sustainable integrated transport solution to address the problem associated with changes (increase) in parking demand, which would certainly be required in its future revisions (if any).

3. METHODOLOGY

The site on which the study is based is located in the City of Tshwane. Its attributes are summarised in Table 2. The site is a knowledge-based professional institution

accommodated in a relatively large office park, and at the time of the survey (May 2007) it catered for a gross employment density of 27 employees/hectare and a net employment density of 2.4 employees/100 m^2 of office space.

Table 2 Attributes of the case study site

Site attribute	Value
Number of employees	3 751
Number of entry points (gates)	4
Office Floor area (m^2)	155 256
Number of parking spaces	3 817
Total site area (hectares)	140
Official working hours	08h00 to 16h30
Site layout	52 separate office blocks
Immediate surrounding land use	Offices
Public transport availability	▪ Dedicated morning and afternoon public transport services ▪ During the day the closest bus and taxi route is 1.2 km from the site
Parking fees	No employee pays for parking

Site data collection entailed the following tasks:

- **Site observations:** In the absence of a parking design plan, parking spaces were manually counted.

- **Traffic counts:** Occupancy traffic counts were collected at all entry/exit points from 6:00 to 18:00, including pedestrians. The 6:00 to 6:15 dataset records were excluded from the analyses due to starting delays at one of the entry/exit points.

- **Access to the firm's human resource data:** Data pertaining to employee salaries were obtained from the human resources department of the firm.

- **Access card data:** Site entry and exit is gained through electronic identity cards swiped at the gates. All the data pertaining to cards are recorded centrally for security purposes. The data were provided under strict confidentiality agreement and the data is low cost.

All the surveys were conducted in May 2007. The electronic access card data as well as the manual traffic counts were also used for mutual validation.

4. RESULTS

The results of the study are presented and summarised in this section of the paper.

Based on the occupancy traffic counts, Figures 1 and 2 present the cumulative changes in the number of people (Figure 1) and vehicles (Figure 2), entering and exiting the site. The

maximum number of people present within the site during the day (maximum cumulative difference between entry and exit) is 3 541 (equivalent to 93% of parking spaces) in contrast to a maximum of 2 395 vehicles (equivalent to 63% of parking spaces). While the site appears to have adequate spare parking capacity, physical observations on the use of parking spaces revealed that parking utilisation differs for different office blocks. Employees working in office blocks where parking demand outstrips the available capacity, were not always able to use parking spaces available elsewhere due to the spatially sparse nature of the site. Ultimately, any available non-demarcated open space in the immediate surrounds is used for parking purposes. Nonetheless, the unused gross parking capacity remains significant (a minimum of 37% at peak demand) and remains, in the least, an opportunity cost ignored by the approaches such as provided for in the South African minimum parking standards, also exacerbated by attitudes that usually regard parking space availability as a right.

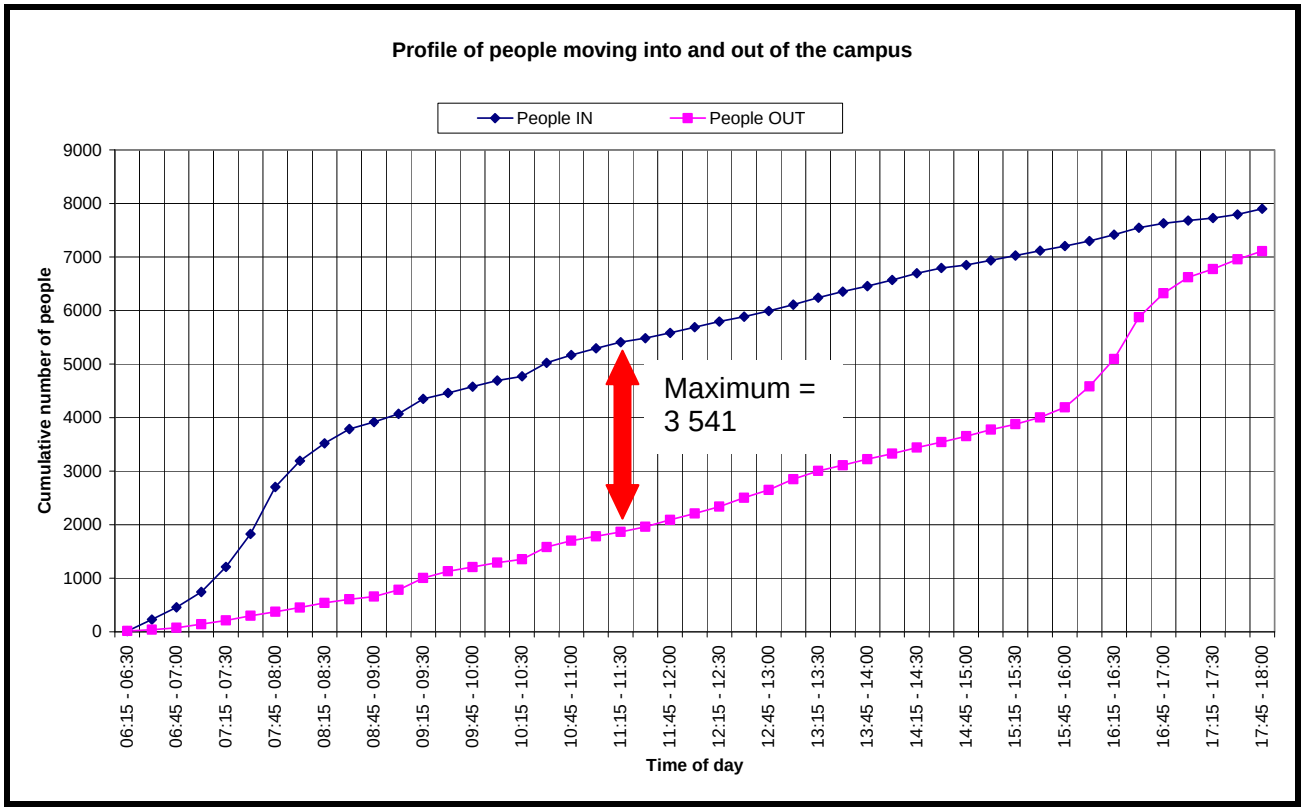

Figure 1 Cumulative number of people entering and exiting the site

The following statistics are worth noting for the observation period:

- The total number of people entry movements into the site is more than twice the number of employees.
- For every employee there were 1.6 vehicles entering the site.

The above statistics illustrate the high levels of travel activity associated with land use, which is often underestimated by transport models relying solely on the number of employees to estimate trip generation rates (as often implemented for simplicity in strategic transport models). The use of such strategic transport models in the design of public transport services at City wide scale, for example, are therefore likely to be inadequate if they are indeed to respond adequately to the levels of activity as suggested in this case study.

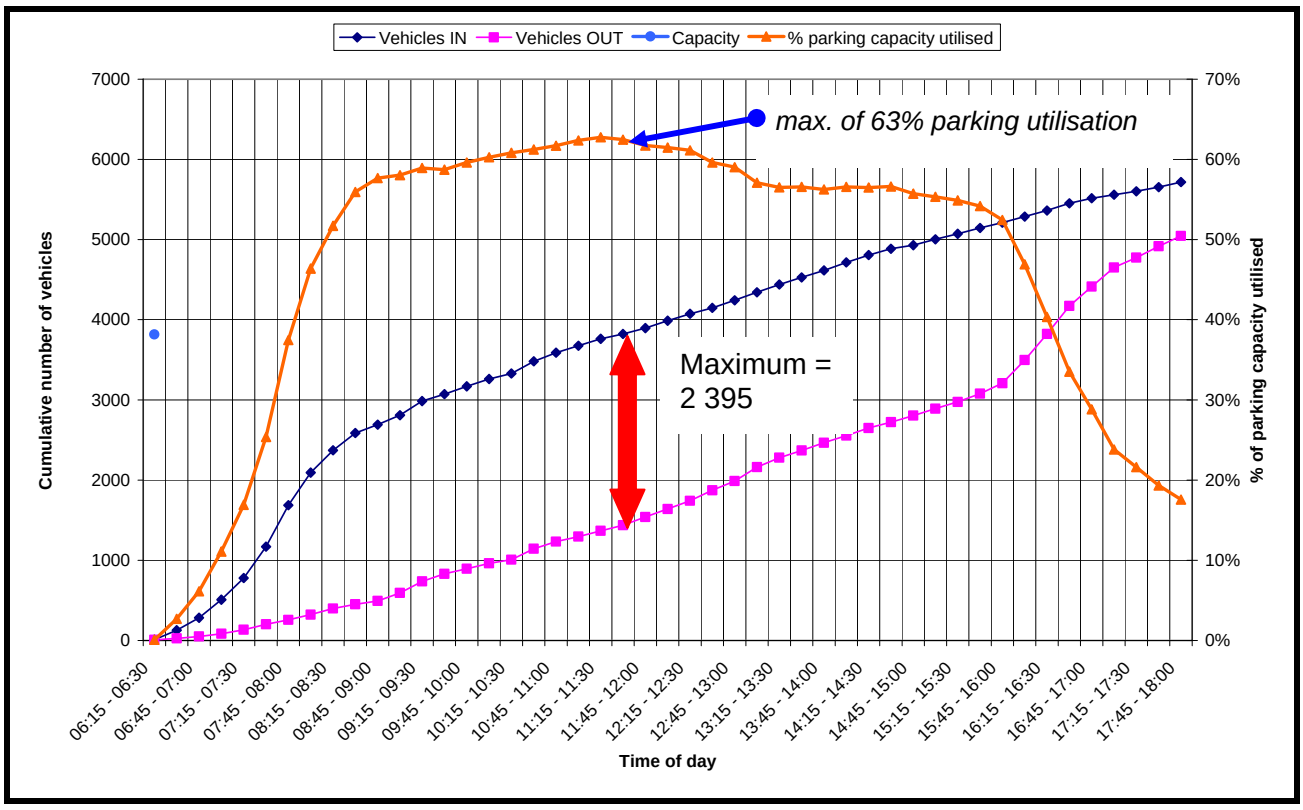

Figure 2 Cumulative number of vehicle entering and exiting the site

Surrogate measures of workplace activity levels are shown in Table 3, where the numbers of site entries and exits per unique individual employee are shown. For example, while 66% and 65% of all the employees respectively enter and leave the site only once, a quarter of the employees make two entries and exits. Overall, about 35% of the employees have more than one entry and exit. About two thirds of the employee parking demand remained statically within the site during official working hours and the other third was elastic. In accordance with the South African White Paper on National Transport Policy 80% of this third should be targeted for public transport use.

Table 3 Number of site entries and exits per employee

Number of entries/exits per person	% of people entering	% of people exiting
1	66%	65%
2	25%	26%
3	6%	6%
4	2%	2%
5+	2%	2%
Total	**100%**	**100%**

Figure 3 shows vehicle occupancies, in terms of average number of people per vehicle, for vehicles (cars and buses) entering and leaving the site (Cars and buses in this case are singled out for illustration purposes). The absence of buses is notable between 8:00 and 16:15, in contrast to periods where their occupancies are as high as 80 persons per bus.

The following observations are worth noting from Figure 3:

- Occupancy levels of cars leaving the site are higher than those entering in almost 60% of the time bands. This suggests that, for more periods, more people leave together in a single car than when entering the site.
- In periods where public transport serving the site is unavailable (from 8:00 to 16:15), the average number of people entering and leaving the site is 597 per hour and 510 per hour, respectively. Such relatively high rates of person movements (in the opinion of authors) should at least warrant investigation into the feasibility of a more frequent public transport service, especially within the context of the design of the City's emission control strategies.

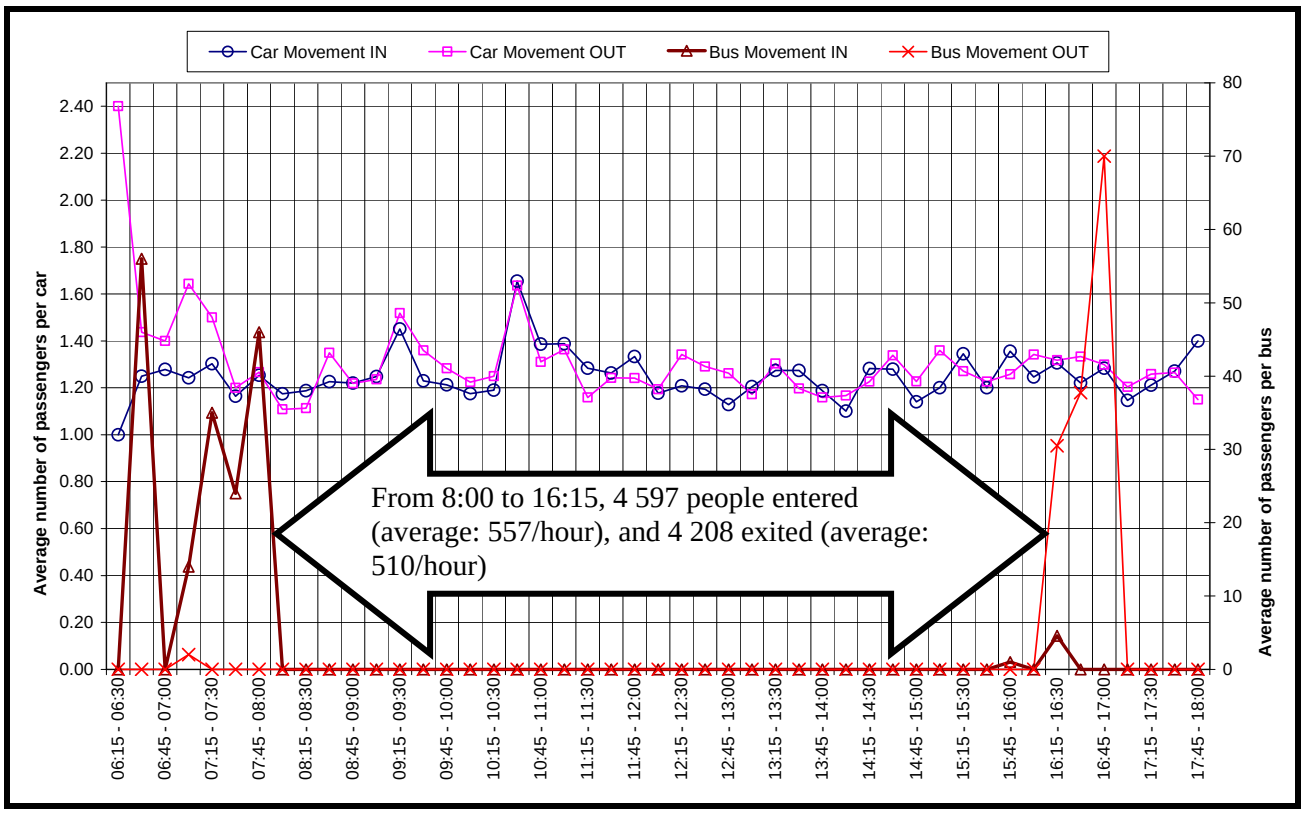

Figure 3 Car and bus occupancies within the survey period

Figure 4 illustrates the model constructed and used to estimate car use by employees. This was used in the predictive mode, based on the recruitment strategies of the firm, to forecast the number of employees likely to drive to work. The probabilities were estimated from the National Household Travel Survey datasets (Department of Transport, 2003), for South Africa, Gauteng Province and the City of Tshwane. A more conservative smoothed curve (design curve) is used for forecasting purposes. Also shown in Figure 4 is the income distribution of the employees, obtained from the human resources department of the firm. Based on the design probability estimate, it would be expected that all the employees earning more than R180 000 per annum (60% in this firm), would drive to work, in addition to the proportion of employees in the lower income bands. Based on the design of car use profile, it is clear that a recruitment strategy that favours higher income employees, would certainly increase the demand for parking. Many firms similar to this one would ordinarily endorse the alternative of increasing the parking capacity for their employees.

It is the seemingly micro issues in isolated workplaces such as these that tend to be ignored in the preparation of transport plans, and ultimately lead to macro issues such as roadway traffic congestion. The design of travel demand management policy instruments

should therefore at least seek to gain a better understanding of such micro issues, if they are to be sustainable.

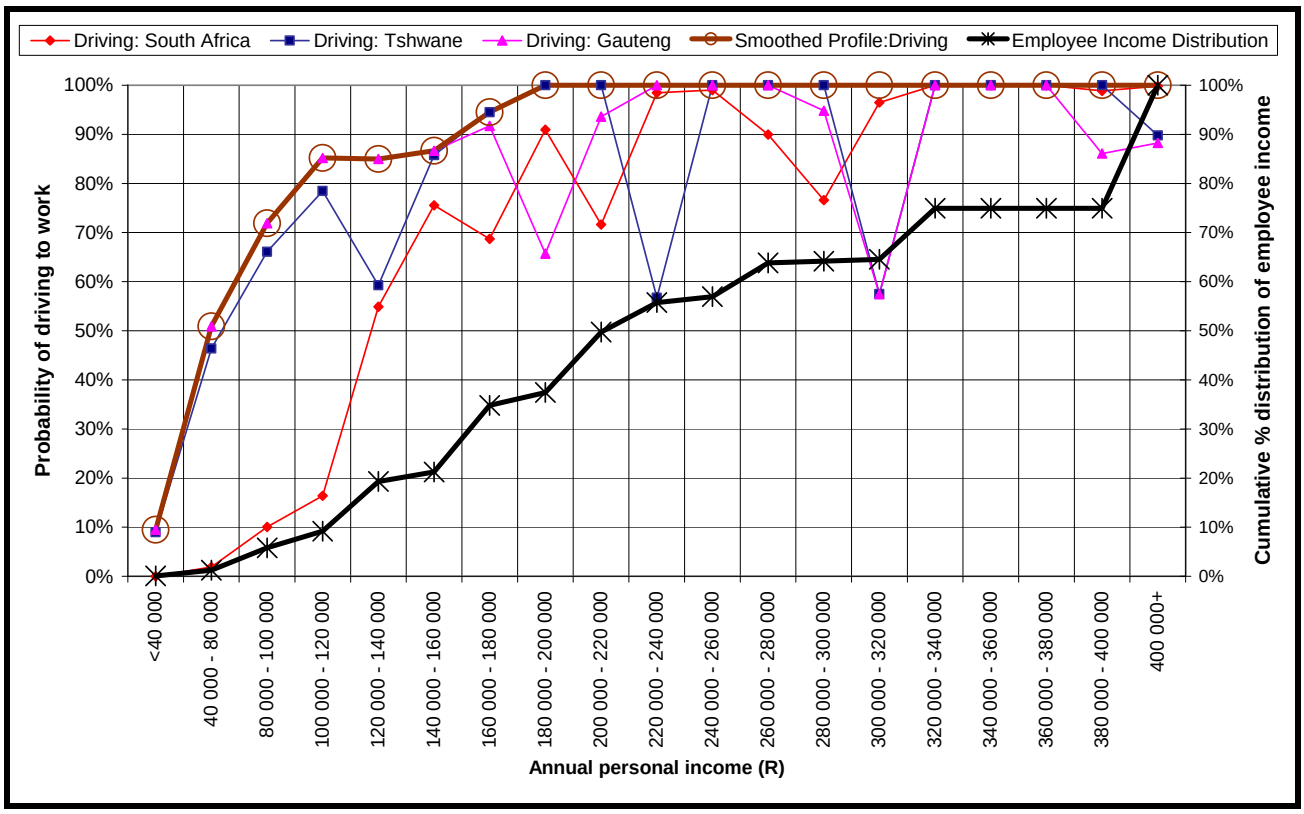

Figure 4 Income based car use probabilities and employee income distribution

5. DISCUSSION

The design of the case study site parking capacity is clearly in line with the minimum parking standards provisions of 2.5 spaces/ 100m^2 GLA. While the study focused on one site in isolation, there are a number of notable lessons that are potentially useful in the design and implementation of transport policies such as travel demand management:

- The understanding of employee activity patterns appears to be a critical for the design of more effective travel demand management instruments. In South Africa the application of activity based analytical techniques has been generally absent. Further research needs to be conducted to illustrate benefits, if any, that could be gained from incorporating such techniques.
- Based on the car occupancy patterns over the survey period, it appears ridesharing is generally practised for trips that originate from the work place. An investigation into existing ridesharing dynamics would add to the understating of conditions under which such a practice could be applied at a larger scale in the work place.
- Without sustainable alternative forms of more efficient transport serving workplaces such as the one investigated in the paper, car use is expected to increase with the implementation of recruitment drives. It is important that the designs of newer developments incorporate plans to minimise total cost to society, including transport related costs. Implementation of this specific intervention is partly provided for in section 29 of the National Land Transport Transition Act (RSA, 2000) and also in section 47 of the National Land Transport Bill.
- Many parts of the study were reliant on access to sensitive information on employees. Such access was granted on the basis of trust established between the firm and the study team. In-depth analysis of travel behaviour is increasingly reliant on such

sensitive information, and it is therefore important that researchers treat such information with absolute respect, in order to maintain the credibility of the transport research profession. This is especially the case for the harnessing of self-generating personal transaction data as a low cost data collection alternative for planning purposes.

6. CONCLUSION

The paper used a large workplace to explore some of the transport services design implications of incorporating more in-depth analysis of employee profiles and workplace activity levels. Based on the data obtained from workplace traffic counts, employee profiles and activity levels, it was shown that much insight is potentially obtainable from understanding travel behaviour in the design of sustainable transport services to serve a workplace (private and public transport). This immediately challenges the entrenched use of minimum parking standards, for example, in designing parking facilities, especially when the South African transport policy empowers planning authorities to use travel demand management tools to better manage the transport system. The role of research becomes critically important when transport policy relies on in-depth understanding of travel behaviour. The Department of Transport, as the custodian of national transport policy, needs to visibly invest in such research.

7. REFERENCES

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