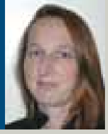

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Determining long-term parking needs **at OR Tambo International Airport**

The economic growth and arrival of low-cost airlines in South Africa has led to a boom in air passenger travel. The OR Tambo International Airport in Johannesburg has seen increased passenger numbers of around 10% per annum. This, combined with FIFA's requirements for the 2010 World Cup, has sparked various investments. During the planning of the investments, a knowledge gap was identified. A research study by the University of Cape Town (UCT) has resulted in the development of a long-term sketch-planning tool that can assist in exploring future scenarios

The original paper by Fatima Adam and Marianne Vanderschuren, of which this article is a summary, was published in the *Journal of Air Transport Management* (Vol 15 (6) 2009), and also received a Commendation (Traffic Engineering) from the SAICE Transportation Division at their Chairman's Luncheon in April this year

INTRODUCTION

Air passenger trips have been increasing over the last decade, partly due to the increase in the number of low-cost airlines. Franke (2004) indicates that in the US, low-cost airlines carry 24% of passengers and account for 9% of industry revenues. In Europe, low-cost airlines accounted for 8% of passengers and 3% of revenues in 2002, and are rapidly expanding. Passenger trips at OR Tambo International Airport (ORTIA) have increased by 10% per year over the last three years.

The sharp increase in travel demand at ORTIA in recent years has led to frequent shortages of parking supply and kerbside pick-up/drop-off bays, particularly during peak periods. This often results in long delays and increased frustration for those using these facilities. To solve these terminal precinct congestion problems, it is necessary to understand parking and kerbside drop-off/pick-up bay demand so that infrastructure investment will correspond to this demand.

The need for the development of a sketch-planning tool was identified to estimate the required kerbside, short-term and long-term parking. UCT's study included a literature review, collection of primary information (traffic counts and questionnaires) and analysis of secondary empirical data. From this a sketch-planning tool was developed, calibrated and validated. Extrapolation of trends was used to identify parking needs. Furthermore, reduced parking requirement scenarios, due to the establishment of the Gautrain high-speed rail link to the airport, and reduced passenger growth, due to oil depletion and oil price increases (Peak Oil), were calculated.

To develop the sketch-planning tool, it was necessary to understand how kerbside, short-term and long-term parking is determined at other airports. The most appropriate method, or a combination of existing methods, could then be used to develop the tool. Once the steps in the tool had been confirmed, the data required to run the tool were identified and collected.

LITERATURE REVIEW

Horonjeff and McKelvey (1994) state that, in general, the most accurate way to calculate kerbside bay requirements is using first principles, i.e. applying turnaround times and vehicle lengths of the various modes to the demand of each mode, to determine bay requirements. Rule-of-thumb methods can also be used, but are less accurate. Planners at the Geneva Intercontinental Airport recommend that total kerb frontage length should be provided at a rate of 0,15 m per departing passenger and 0,24 m per arriving peak hour passenger. Alternatively, foot-minutes (or metre-minutes) can also be used, where one lineal foot (0,3 m) of kerb space can provide 60 foot-minutes of capacity in one hour (Ashford and Wright 1992).

In general, *airport parking* is utilised by passengers, meeters and greeters, staff, service personnel, people visiting offices and rental vehicles. Each type of user has different requirements for parking duration (long- and short-term parking), hence having a unique influence on demand. Ashford and Wright (1992) recommend that a special study of airport access traffic be carried out to determine how the various sectors can be adequately projected.

Based on the literature review, it was decided to use first principles to calculate kerbside and parking demand, with the agreement of the Centre for Transport Studies at UCT and the Senior Airport Planner of the Airports Company South Africa (ACSA).

DEVELOPMENT OF SKETCH-PLANNING TOOL

The four-step model served as the theoretical basis of the sketch-planning tool. Traditionally, this is a sequential model consisting of the following steps, as described by Ortúzar and Willumsen (1994) and cited in Molai and Vanderschuren (2003):

- *Trip generation* – concerned with the number of trips produced by, and attracted to, each zone within a study area
- *Trip distribution* – concerned with where trips will go by matching origins with destinations
- *Modal choice/split* – concerned with the type of mode used to make the trips from a given origin to a given destination
- *Route assignment* – concerned with predicting the routes used by the trips from a given origin to a given destination, by a particular mode.

Instead of these four steps, the sketch-planning tool developed includes only the first three steps in an alternative order:

Trip generation → Modal split → No of kerbside and parking bays required → Trip distribution

The objective of the *trip generation* step is to determine the number of person trips produced and attracted by the airport, and to determine where these trips originate from. This step quantifies the trips created by travellers as a direct result of flight activity, whether they arrive independently or are transported by meeters/greeters. The number of trips created by meeters and greeters who arrive independently to visit travellers is also quantified in this step.

The objective of the *modal-split* step is to determine the modes used by people arriving at, or departing from, the airport. The established modal split is then applied to the total number of person trips calculated in the *trip generation* step to obtain the hourly person trips per mode. The volume of vehicle trips per mode is then determined by applying the average vehicle occupancies of each mode to the number of person trips created by each mode. This effectively determines the *demand* for infrastructure at ORTIA. In the third step, the sketch-planning tool converts the demand created by each mode into the infrastructure required to meet this demand. This is done by applying the observed vehicle turnaround times of each mode to the vehicular demand, to obtain the number of kerbside and parking bays required.

In the final step, the *trip distribution* step, the origin of trips terminating at the airport and the destination of trips originating at the airport were classified into aggregated areas within Gauteng so that simple origin-and-destination maps could be produced.

DATA REQUIREMENTS

It is clear from the description of the sketch-planning tool that large amounts of data were required as inputs to the model. Apart from the literature review, two types of data sources were utilised, namely *primary data sources* and *secondary empirical data sources*.

Traffic surveys and interview-based surveys made up the primary data sources used in the study. Traffic surveys were undertaken along the terminal frontage roads at ORTIA on 7 March 2008 to determine the vehicle occupancies and turnaround times of particularly the kerbside modes, for which the tool calculates infrastructure requirements.

Interview-based surveys were undertaken over a period of one week, between 27 March and 2 April 2008. Apart from determining the occupancies of vehicles that park, the interview-based survey was also used to determine:

- the modes in which passengers arrive at the airport, to determine the infrastructure required for each mode separately
- the extent to which passengers are met by meeters and greeters, who arrive independently at the airport, to determine the additional parking demand created by them
- the potential diversion to the Gautrain link to the airport, once operational, to determine the reduction in parking demand
- the origins of trips to the airport and the expected destination of trips upon passengers' return, to create origin and destination maps.

Due to financial constraints, interviews were undertaken only among departing passengers and, for all types of information obtained, it was assumed that the same information would be applicable to arriving passengers. A total of 2 044 interviews were conducted during the survey week, in which a total of 384 027 actual departing passenger movements occurred, resulting in a confidence interval of 2,16%, at a 95% confidence level. The sample for the interview-based surveys was thus statistically significant.

Empirical data for the study were extracted from ACSA's flight and parking databases. The flight database was used to determine the person trip generation created by flight activity, for the study period, which is essentially the first step of the tool. It was also used to determine the growth in passenger trips over the past few years, to assist in trend extrapolation of parking needs. The parking database was used to determine the turnaround times of long- and short-term parkers as these differ significantly and infrastructure requirements need to be calculated separately for these modes.

INFRASTRUCTURE REQUIREMENTS

Analysis of ACSA's flight database shows that an average daily flight capacity of 76 337 trips and an actual daily trip generation of 54 861 person trips occur at ORTIA. Furthermore, the interview-based survey found that 2,1% of domestic and 13,4% of international departing passengers are accompanied by greeters. Meeters meet a further 4,8% of domestic and 30% of international arriving passengers. Some 4 948 additional daily trips are, therefore, generated at ORTIA (Table 1).

The modal split of passengers and vehicle occupancies was determined from the interview-based survey. Application of surveyed modal splits and corresponding average vehicle occupancies to the 54 861 person trips generated as a result of flight activity results in a daily vehicle trip generation of 19 964 travel-related trips. The number of kerbside pick-up and drop-off bays required for the various public transport modes, as well as for private vehicles, was determined separately in the tool. Calculations were based on the application of typical turnaround times of each mode in a drop-off/pick-up bay. A safety factor of 20% was applied to the number of hourly bays required, per mode, to account for this. The final number of kerbside bays required is illustrated in Table 2. Since the calculations were done for the peak hour, the kerbside bay estimates are high.

The number of private parking bays required in the peak hour at ORTIA was determined in the sketch-planning tool by applying the typical turnaround times of parking bays, according to the ACSA's parking database (parking tickets). The number of bays required for long-term parkers (bays occupied by travellers who park for the duration of their trip) and for short-term parkers (bays occupied by independent meeters and greeters or those accompanying passengers) was calculated separately. The average turnaround times for both long-term and short-term parkers were 35:42:26 and 1:07:52 respectively. Due to the standard deviation

Table 1 Person trip generation

	Weekly arrivals	Weekly departures	Total daily average
Flight capacity	267 232	267 124	76 337
Person trips generated	190 053	193 974	54 861
Independent meeter and greeter trips	23 212	11 422	4 948
Total trips generated	**213 265**	**205 396**	**59 809**

Source: Analysis of ACSA databases

Table 2 Kerbside bays required (turnaround time in minutes)

Flight type	Private vehicle	Minibus-taxi	Metered taxi	Hotel shuttle	Coach
Domestic arrivals	70 (04:00)	4 (05:00)	31 (36:40)	2 (06:28)	1 (06:28)
Domestic departures	34 (03:00)	0 (N/A)	0 (N/A)	1 (06:28)	1 (06:28)
International arrivals	68 (04:00)	6 (05:00)	29 (44:30)	4 (06:28)	2 (06:28)
International departures	30 (03:00)	0 (N/A)	0 (N/A)	2 (06:28)	2 (06:28)
Total bays required	**202**	**10**	**60**	**9**	**6**

Table 3 Turnaround time behaviour for long-term and short-term parkers

Long-term parkers			Short-term parkers			
Days parked	% of parkers	No of parkers on peak day	Hours parked	% of parkers	No of parkers on peak day – greeters	No of parkers on peak day – meeters
0	59,27%	1 113	0	51,07%	1 255	997
1	16,83%	316	1	33,21%	816	649
2	4,45%	84	2	10,54%	259	206
3	10,07%	189	3	3,29%	81	64
4	4,85%	91	4	1,88%	46	37
5	1,09%	20	**Total**	**100%**	**2 457**	**1 953**
6	0,75%	14				
7	0,71%	13				
8	0,32%	6				
9	0,26%	5				
10	0,81%	15				
11	0,24%	4				
12	0,24%	4				
13	0,08%	1				
14	0,04%	1				
Total	**100%**	**1 876**				

Source: Analysis of ACSA parking database of long-term parkers (certain long-term parkers who parked for up to 14 days), the average turnaround time could not be used to calculate parking demand. Instead, the distribution of parking turnaround times, by day, was used for long-term parkers.

A summary of the parking duration is provided in Table 3, which illustrates that, on the identified peak day, 1 113 vehicles parked for less than a day, while 765 vehicles parked for more than a day. In the sketch-planning tool the number of long-term parkers over days was established. A total of 1 877 bays are required to meet the demand created by long-term parking traffic generated on the peak day. Assuming that the turnaround time behaviour of parked vehicles is similar on all days, it stands to reason that vehicles entering on the fourteenth day arrive before occupied bays are vacated (background parkers). The calculation to determine the number of bays occupied on the peak day yields 2 070 bays.

A calculation similar to that described above was undertaken to determine the number of parking bays required for short-term parkers. The results of the calculations are summarised in Table 4.

Table 4 Parking bays required to meet travel-related and meeter and greeter demand

Parking bays	Arrivals	Departures	Total
Travel-related bays required			
Long-term generated	0	1 877	1 877
Long-term background	0	2 070	2 070
Short-term (passengers accompanied by meeters and greeters)	686	863	1 549
Independent meeter and greeter bays required			
Meeter and greeter	607	290	897
Total	1 293	5 100	6393

SCENARIO TESTING

The sketch-planning tool determines the number of parking and kerbside bays required to meet the current demand, during the peak times. By means of trend extrapolation, infrastructure requirements for future years were determined (assuming business as usual).

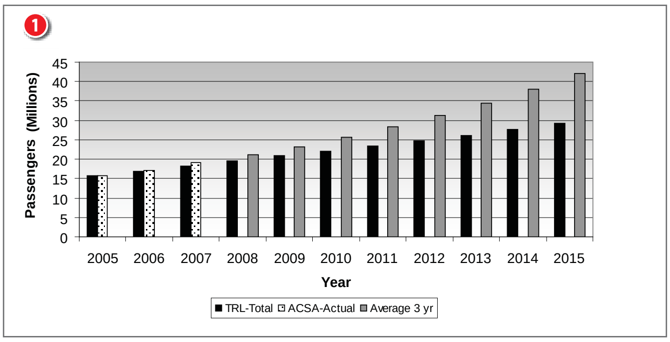
Two external scenarios were tested that could have an effect on future trip generation, namely:

- the effect of the Gautrain station at ORTIA, and the consequent diversion from road-based modes to rail (modal split)
- the effect of the Peak Oil phenomenon (oil depletion and fuel price increases) and the resultant decrease in flight frequency and occupancy (trip generation) on infrastructure requirements.

Figure 1 illustrates the actual annual passenger movements for 2005–2007, and also displays two growth forecasts. The first forecast assumes that traffic will grow at an average of 10% per annum, which is the average growth obtained over the last three years. The second one uses the growth forecast by the TRL (UK) for ACSA. A low-, medium- and high-impact scenario was tested for each of the two scenarios (Gautrain and Peak Oil), as well as for a combination of both scenarios. The effect of the scenarios was investigated in the short term (2013), medium term (2023) and long term (2038).

The low-impact scenario of the diversion from road-based access modes to the Gautrain was put at 15%, as indicated in the ORTIA Masterplan (NACO and Stewart Scott 2006). Based on

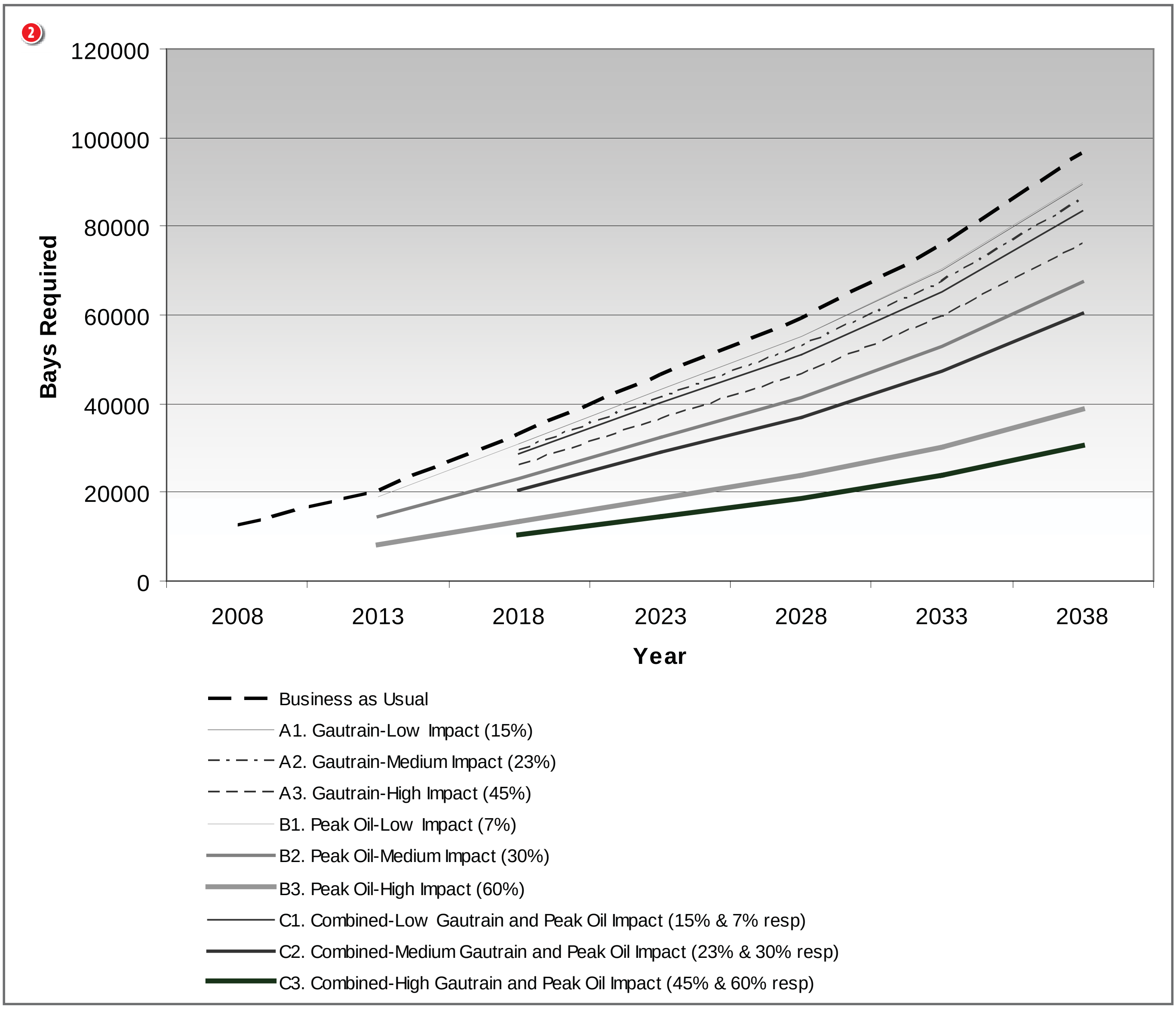
1 Passenger growth forecast at ORTIA
Source: Analysis of ACSA Database and ORTIA Masterplan
2 Total parking bays required



the interviews with passengers, the highest diversion to Gautrain was estimated to be 45%. As not all passengers will actually behave as indicated, the medium-impact scenario was put at 23%.

For the Peak Oil scenario, it was estimated that the low-impact reduction in trip generation would be 7%. According to Parker (2008), experts estimate that this scenario would lead to big cuts in airline capacity of 25%. However, the authors felt that these estimates are low in comparison with what will happen when oil production declines; hence, a 30% reduction in trip generation was used for the medium-impact scenario. For the long term, Kuhlman (2005) predicts that air travel will again be reserved for the wealthy and for government business, as a result of extremely high ticket prices. Hence, a 60% reduction in trip generation was estimated for the high-impact scenario. Low-impact Peak Oil and Gautrain scenarios do not have a significant effect on kerbside infrastructure requirements, when compared with the infrastructure to be provided if traffic flows are as per normal. The combined Peak Oil–Gautrain high-impact scenarios resulted in severe reductions in kerbside demand.

However, Figure 2 illustrates that, with respect to parking, even if low-impact changes occur in person trip generation due to Peak Oil, and changes in modal split occur due to Gautrain, the parking infrastructure demand reduces by approximately



3 000 bays, while a significant decrease of approximately 6 000 bays is estimated for the combined scenario.

Since ACSA has plans to increase the number of parking bays to beyond 14 000 in the short term (2013) to meet expected demand, the scenario testing illustrates that short-term kerbside and parking infrastructure supply would be underutilised in the medium term, should the high-impact combined scenario become reality. The combined scenario is unlikely to occur in the short or medium term, but the calculations illustrate that, although infrastructure should ideally be provided so that it meets the demand at any point in time (peak day), the required supply may be underutilised in future. If trends begin to show that person trips are constantly being reduced, due to Peak Oil, or that diversion to Gautrain is increasing continuously, more consideration should be given to the supply of infrastructure in view of the future utilisation of that infrastructure. Furthermore, ACSA could review the decision that demand has to be met 100% of the time.

CONCLUSIONS

Scenario testing of future kerbside and parking demand to inform infrastructure investment appears to be an extremely useful exercise. Potential reductions in parking demand, due to a reduction in air travel and a move to Gautrain, show that short-term investments might become underutilised in the medium term. It has also been recommended that future trends regarding parking and kerbside infrastructure demand be monitored by ACSA, so that the corresponding supply of infrastructure is optimised, without wasting financial resources. The sketch-planning tool developed has been handed to ACSA to assist in further analysis of changing trends.

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