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Travel Data, Traffic Generation and Parking Analysis Study Report No. 40: Major Hospitals

for New South Wales Roads and Maritime Services

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1 INTRODUCTION

1.1 BACKGROUND

The former NSW Roads and Traffic Authority (RTA) published its *Guide to Traffic Generating Developments* ("the *Guide"*) in the mid-1990s. This document, which is still used extensively by Councils, consultants and developers, drew on the results of periodic trip generation and parking demand surveys first carried out in 1978 covering a wide range of land-use types across Sydney and NSW regional centres. These surveys are known as the *Land Use Traffic Generation and Analysis (LUTGA)* survey series.

These surveys have been periodically updated in response to emerging social and industry trends, and industry needs. In response to increased investment in the health sector and particularly in new or upgraded major hospitals, the LUTGA surveys are focussing on travel data associated with major regional and private hospitals to assist with planning and assessment of such facilities.

The LUTGA series covered trip generation and parking demand of Private Hospitals across greater Sydney in 1994. However, the scale and complexity of private hospitals covered (ranging from 31 to 99 beds) differ markedly from those of major private and public hospitals which in Sydney can reach over 2000 beds and 500 beds in Regional Centres, and serve a variety of teaching, community health and ancillary functions.

Consultants Urban Research and Planning (URaP) was commissioned by Roads and Maritime Services (RMS) to collate contemporary travel data of major health institutions within Metropolitan and Regional NSW. Due to data being available from past assessments held by various approval agencies and public sources, this particular exercise has been a desktop study focussed on:

(a) summarising available travel data of major public and private Hospitals – in particular: staff and visitation levels, mode of travel, parking demand and patterns, and trip generation from a minimum of ten major hospitals in Sydney and Regional NSW; and

(b) compare this data with hospital operational characteristics as a means of deriving key statistical relationships that assist with forecasting travel parameters and trip rates for application to traffic impact assessments; planning of new institutions; and as inputs to traffic modelling.

1.2 PROJECT OVERVIEW

The main tasks involved with the project were to:

i) locate suitable survey-derived travel data (mode, visitation, parking demand and trip generation information) from a minimum of ten major hospitals in Sydney and Regional NSW;

ii) analyse the survey data to determine person and vehicle based statistics, including daily and peak hour vehicle trips in the AM and PM peak periods; and car parking accumulation

iii) analysis of the data to establish mode, traffic generation and parking accumulation rates by comparing visitation to each site and characteristics such as bed numbers, outpatient numbers, public transport accessibility, etc

iv) undertaking simple linear regression analysis and calculation of statistical correlation coefficients to establish the key relationships that may exist to predict trip and parking rates

v) review existing guidelines and interstate and international data to ascertain relevant factors and similarities to the NSW-specific characteristics

1.3 SCOPE OF THE REPORT

This report is divided into the following five sections.

Section 1 is the Introduction.

Section 2 includes study definition and a literature review.

Section 3 covers methodology and study approach with consideration given to required parameters as part of the assessment.

Section 4 reports on study evaluation and analysis of the results.

Section 5 provides a summary of study findings and recommendations.

1.4 LAND USE DEFINITION

Many land uses have uniform characteristics. This means that their trip generation and parking demand has a direct relation to the area of the place or its population. For example, trip generation and parking demand of offices have a direct relation to the gross floor of the area, or a child-care centre to the number of its staff and children. However, such notion is not easily applicable in assessment of the Hospitals, as their function and activity levels generally fluctuates to the type of Hospital, its location, it size in terms of activity levels and public transport accessibility.

On this basis, some of the planning agencies utilise various parameters in the assessment of parking and trip generation of Hospitals. The main parameters that generally are considered are:

- No of Staff (during a shift, Equivalent Full Time – EFT, or headcounts)
- No of Staff by each category (medical, nursing, admin, students, domestic, etc.)
- No of visitors, volunteers, etc.
- No of beds
- No of outpatients
- No of admissions in different departments
- Special uses

The following Sections provides an overview of the above parameters with their possible usage in assessment of traffic and parking generation for the Hospitals - with illustrative examples and current practices as part of planning codes/guide.

2 LITERATURE REVIEW

2.1 REVIEW OF SOURCES

A review of various sources in relation to estimating trip and parking generation of Hospitals have been carried out and a summary of these are discussed below:

Guide to Traffic Generating Developments (RTA, 2002) – Private Hospitals

Definition
For the purposes of the 1994 surveys, the term *private hospital* referred to those developments alluded to in the Private Hospitals and Day Procedures Centre Act, 1988, No. 123 as "premises at which patients are provided with medical, surgical or other treatment, and with ancillary nursing care, for fee, gain or reward". The size of hospitals surveyed was between 30 and 99 beds. Surveys were undertaken in 1994 of 19 private hospitals in the Sydney region.

Trip Generation
Private hospitals are usually identified through the provision of services i.e. general, surgical, obstetric, rehabilitation and psychiatric. Special services (such as paediatric, accident and emergency and cardiac catheterisation) may also be provided by private hospitals with Department of Health approval.

The best indicator of peak traffic generation or peak vehicle trips (PVT) was found to be a combination of the number of beds (B) and the number of staff per weekday day shift (ASDS). If the average number of staff per weekday day shift (ASDS) is unknown or unavailable the number of beds (B) alone was found to be a good indicator of peak traffic generation or peak vehicle trips (PVT).

The time at which traffic activity was at a peak varied between hospitals, with the most common time being 3.00 pm - 4.00 pm. This time incorporates a staff shift change which involves staff arriving and departing in a relatively short space of time.

The vehicle trip generation in the morning commuter peak hour (MVT), i.e. 8 am - 9 am, and the vehicle trip generation in the evening commuter peak hour (EVT), i.e. 5 pm - 6 pm, were best modelled by a combination of the number of beds (B) provided and the average number of staff per weekday day shift (ASDS).

Peak Period Traffic Generation Models
PVT = -14.69 + 0.69 B + 0.31 ASDS (R^2 = 0.74)
MVT = -10.21 + 0.47 B + 0.06 ASDS (R^2 = 0.64)
EVT = -2.84 + 0.25 B + 0.40 ASDS (R^2 = 0.69)
PVT = -22.07 + 1.04 B (R^2 = 0.63)
MVT = -12.41 + 0.57 B (R^2 = 0.55)
EVT = -11.96 + 0.69 B (R^2 = 0.44)

Size and Mode Share

The hospitals surveyed had between 30 - 99 beds (B), and between 10 - 102 average staff per weekday day shift (ASDS). The mean proportion of people who travelled to the site by vehicle was 87.4%, with a range of 67.3% - 98.2%. Average vehicle occupancy was found to be 1.3 persons per car.

Parking Demand

The peak parking accumulation (PPA) at a private hospital may be estimated by

PPA = -19.56 + 0.85 B + 0.27 ASDS (R2 = 0.74)

When the average number of staff per weekday day shift (ASDS) is unknown, the peak parking accumulation (PPA) may be estimated by
PPA = -26.52 + 1.18 B (R^2 = 0.63)

The average length of stay at a private hospital varies according to the purpose of the trip. The average length of stay for a member of staff, i.e. nurses, doctors, etc. is 5.1 hours. The average length of stay for visitors to the hospital is 1.1 hours.

NZ Transport Agency Research Report 453 (2011)

Survey information for hospitals in Auckland, Wellington and Christchurch shows design parking demand from 1 to 1.5 spaces per bed with an average of 1.3 spaces per bed. Clearly, the range and nature of activities performed on-site will be essential to understanding the total parking demand. Staff and doctor parking needs vary from 30% to 60% of the total, depending on the type of hospital. Outpatient numbers and consultant specialists are significant indicators of overall parking activity.

Trip generation in the peak morning and afternoon hours is from 0.9 to 1.7 trips per bed per hour and 10 to 16 trips per bed per day. As a rule, the area for hospitals is around 100m² per bed. As a resut bed spaces and GFA, as a general approximation, yield similar parking ratios.

Table 2.1 NZ Parking and Trip Generation Rates

Hospital Type	Parking Demand	Peak Hour Trips	Daily Trips
Small	2.3/bed	3.0/bed	13.5/bed
Large	2.1/bed	0.4/bed	3.1/bed

Table 2.2 Summary Parking and Trip Generation Rates

Country	Parking Demand	Peak Hour Trips	Daily Trips
Australia	1.2/bed	1/bed	7.5/bed
NZ	2.2/bed	3/bed	13.5/bed
UK	3.28/bed	1.53/bed	15.03/bed
USA	5.91/bed	1.45/bed	11.8/bed

Australian Authorities and Councils

The **Victorian** (Department of Human Services, Victoria; 2004) and **Queensland** (Queensland Health, Car Parking Infrastructure Policy; 2011) authorities have similar rates for parking demand of the hospitals and are categorised into two groups as illustrated below:

City conditions:

Pm = 0.8 Cpt Sm + 0.6 Ssm + 0.1 Bp + 0.2 Bm + 0.2 Bd + 1.3 DSo

Pa = 0.8 Cpt Sa + 0.6 Ssa + 0.2 Bp + 0.3 Bm + 0.15 Bd + 1.0 Dso

Suburban and country conditions:

Pm = 0.9 Sm + 0.7 Ssm + 0.2 Bp + 0.3 Bm + 0.4 Bd + 1.5 DSo

Pa = 0.9 Sa + 0.7 Ssa + 0.3 Bp + 0.4 Bm + 0.25 Bd + 1.5 Dso

Explanation of Codes:

Pm - required number of parking spaces during the morning peak

Pa - required number of parking spaces during the afternoon peak

Sm - number of staff during the morning peak (typically between 10.00 am and 11.00 am), including visiting doctors

Sa - number of staff during the afternoon peak (such as during the nursing shift changeover, both morning and afternoon nursing shifts counted), including visiting doctors and medical research staff

Ssm and Ssa - number of medical and nursing students present during the morning and afternoon peaks respectively;

Cpt - coefficient of public transport provision - 0.9 if a public transport node such as a bus/rail interchange is located within 250 m from the facility boundary, otherwise 1.0

Bp - number of beds, all patients except maternity patients and children patients

Bm - number of maternity and children beds

Bd - number of beds or recliners for day patients

Dso - number of effective full time doctors and specialists treating Outpatients including Community and Allied Health, Physiotherapy and Imaging.

In addition to the above requirements, a time restricted set down / pick-up area is to be provided near the facility entry. The recommended number of spaces is:

Psp = 0.01 (Bp+Bm)*+ 0.5 Bd

* (Bp+Bm) rounded up to the nearest hundred of beds

Parking provision rates for hospitals are specified in the **ACT** Parking and Vehicular Access Guidelines (2012) as follows:

- 0.8 spaces per peak shift employees plus 0.5 spaces per bed (Town Centre)
- 0.8 spaces per peak shift employees plus 1.3 spaces per bed

The **Wollongong Council** Development Control Plan (DCP) identifies the following parking provisions for the hospitals:

- 1 car parking space per medical practitioner plus 1 car parking space per 2 employees plus 1 car parking space per 2 beds.
- Provision of 1% accessible parking for the Hospital's non outpatients parking
- Provision of 2% accessible parking for the first 1000 spaces of outpatients area (and 1 per 100 for in excess of 1000)

The Council's DCP also states that it has the discretion to waive or reduce the minimum number of car spaces required for a particular site if the reduced provision can be justified in the accompanying Car Parking and Traffic Impact Assessment study, in terms of:

(a) The amount of public car spaces in the locality;
(b) Proximity to public transport nodes;
(c) Opportunity for cross utilisation with another use; and
(d) An empirical assessment of car parking

The car parking rates for hospitals per various Councils' DCPs are summarised below:

Canterbury DCP requires a parking assessment with survey of similar development or provision of 1 space per doctor, 1 space per 2 staff, excluding doctors with taking into account overlapping between shifts for staff parking and 1 space per 3 beds for visitors.

Ku ring gai:

- 1 space per 3 beds + 1 space per 2 day-shift staff or practitioners + 1 ambulance space
- 1 space per 1 full time night-shift employee

Maitland:

- 1 space per 10 beds (visitors) *plus*1 space per 2 employees *plus* 1 space per ambulance

North Sydney:

- 1 space / 6 beds + 1 space / 4 staff

Penrith:

- 1 per 3 beds plus 1 per 3 employees

Randwick:

- 1/3 bed for visitors + 1 per 2 employees + 1 per doctor

Ashfield:

- 1 space per 3 beds plus 1 space per 2 day shift staff or practitioners, plus 1 ambulance space plus 1space per 1 full time night-shift employee.

2.2 OVERVIEW

The overview of the readily available sources indicate that most trip and parking generation rates for hospitals are generally rely on the number of beds and the number of staff during a shift period. In practice, it is often difficult to ascertain the number of staff in different categories such as nursing, medical, domestic, admin, technical due to administration and staff allocation of departments.

The parking demand and trip generation of hospitals differs significantly on the basis of their location, size and types of activities. For example, hospitals in urban areas have a lower rate of vehicular trips and parking generation when compared with regional hospitals or the hospitals that are located where there is limited public transport accessibility. Therefore, it is more appropriate to categorise hospitals in terms of their locations and accessibility (particularly by public transport) and then to assess their traffic and parking generation rates.

3 METHODOLOGY

3.1 OVERVIEW

As discussed earlier, the assessment of traffic generation and parking demand for hospitals is based on a number of location and operational factors which need to be identified as part of a detailed evaluation of a site. Notwithstanding such evaluation, the following variables are generally known and can be used to approximately estimate traffic and parking generation at hospitals:

- No of Staff: based on number of staff (all categories) during the main day shift at the hospital;

- No of Outpatients: total number of outpatients that visit the site during a day with an estimated length of stay of 1.5 – 2 hours to allow for any overlap; and

- No of Beds: acts as an indicator to the number of visitors per bed during a peak parking demand and arrival/departure time with average length of stay of 1.5 hrs. Note: a higher parking demand for visitors occurs during after-hours when a higher level of parking supply would be available.

The rates of parking and traffic demand are highly related to the level of accessibility of the hospital. Hospitals that are located within a highly urbanised environment with good access to public transport show travel mode of typically 50% car use whereas hospitals with limited public transport show a use of car amongst its patrons between 80 – 90%.

A useful technique to estimate parking and trip generation for hospitals involves the development of a spread-sheet model. The model would be based on various categories of staff and their time of arrival and departure as well as outpatients and visitors. The level of car use as a travel mode and car occupancy for each group would be included. The estimated model would ideally be calibrated based on surveys of parking accumulation and vehicular movements prior to extrapolation to emulate the proposal.

3.2 STUDY APPROACH

The approach used in this study to determine parking demand and trip generation for the hospitals is based on linear regression and the method of least squares. This is a statistical technique to determine the line of best fit for a model to the observed data. Appendix “A” provides a detailed description of the regression analysis and its associated tests.

The analysis in this study included the following process:

- Establishment of database obtained from various traffic and parking reports and studies on hospitals redevelopments. A list of these reports is shown in References.
- Validation and verification of data and their use
- Undertake multiple linear regression with all independent variables
- Analyses/interpretation of the results
- Undertake further multiple regression analysis with various combination of independent variables to fine tune/select suitable models
- Analyse and classify most appropriate models

The assessments were carried out using MINITAB software as well as Excel statistical package.

The database included all related variables for each hospital, including:

Dependent variables:

Parking Demand – number of parking spaces for vehicles: based on assessment of the report and parking survey supporting the findings.

AM Peak Hour Trips – vehicle trip generation: total vehicular trip generation during a one hour peak period associated with the hospital activities was recorded from the relevant report based on survey data and/or estimated figure with verification to available traffic counts.

PM Peak Hour Trips – vehicle trip generation: total vehicular trip generation during a one hour peak period associated with the hospital activities was recorded from the relevant report based on survey data and/or estimated figure with verification to available traffic counts.

Independent variables:

Beds: total number of beds in a hospital as stated in the report.

Staff during a main shift: total number of staff during the main shift at the hospital or interpretation of EFT number; at some instances the number of medical, nursing and technical students were also added to the main shift staff number based on its traffic and parking report.

Outpatient number: total number of outpatients attending the hospital during a day; some data were interpreted from the annual outpatients' number visiting the hospital.

The above parameters have been selected on the basis of most relevance and availability of data. Other detailed variables such as accessibility, number of staff in each group within each department, number of students, etc. could be included as part of the assessment. However, collection of these data and their availability would have been a very difficult task to achieve while their use in a model would also be questionable due to significance of parameters.

3.3 TRAVEL CHARACTERISTICS

A typical traffic generation and parking demand for a hospital could be illustrated as shown in Figures 3.1 and 3.2 (a variation to these could be experienced on exceptional circumstances due to hospital's shift hours or activities).

It should be noted that the level of activities and magnitude of vehicular trip generation and parking activities of hospitals also is directly related with travel modes among its users and accessibility of the site.

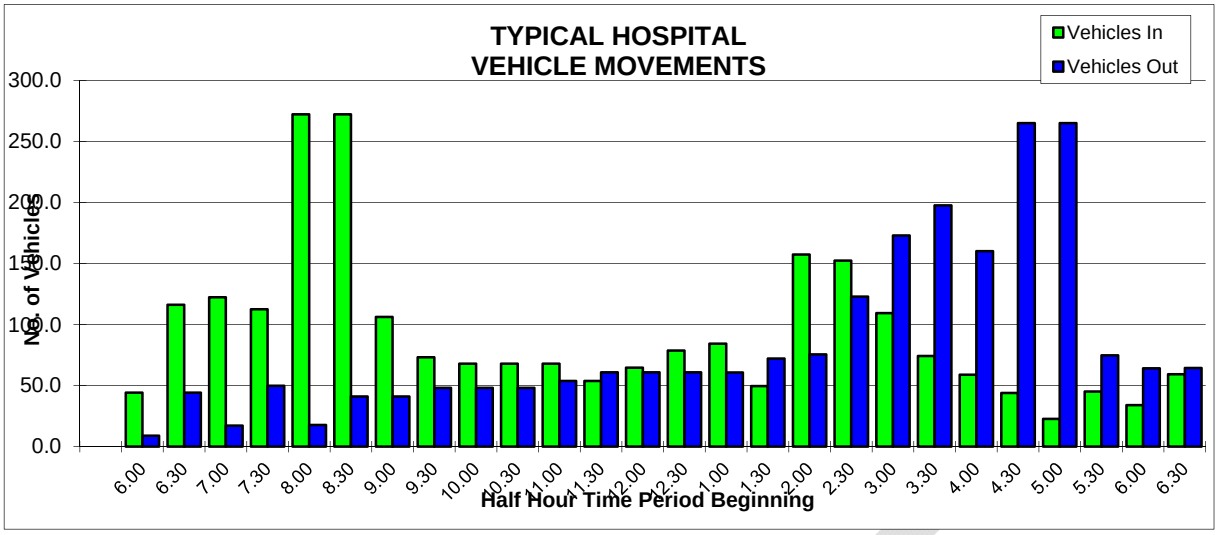


Figure 3.1 **Typical Vehicular Trip Generation for a Hospital**

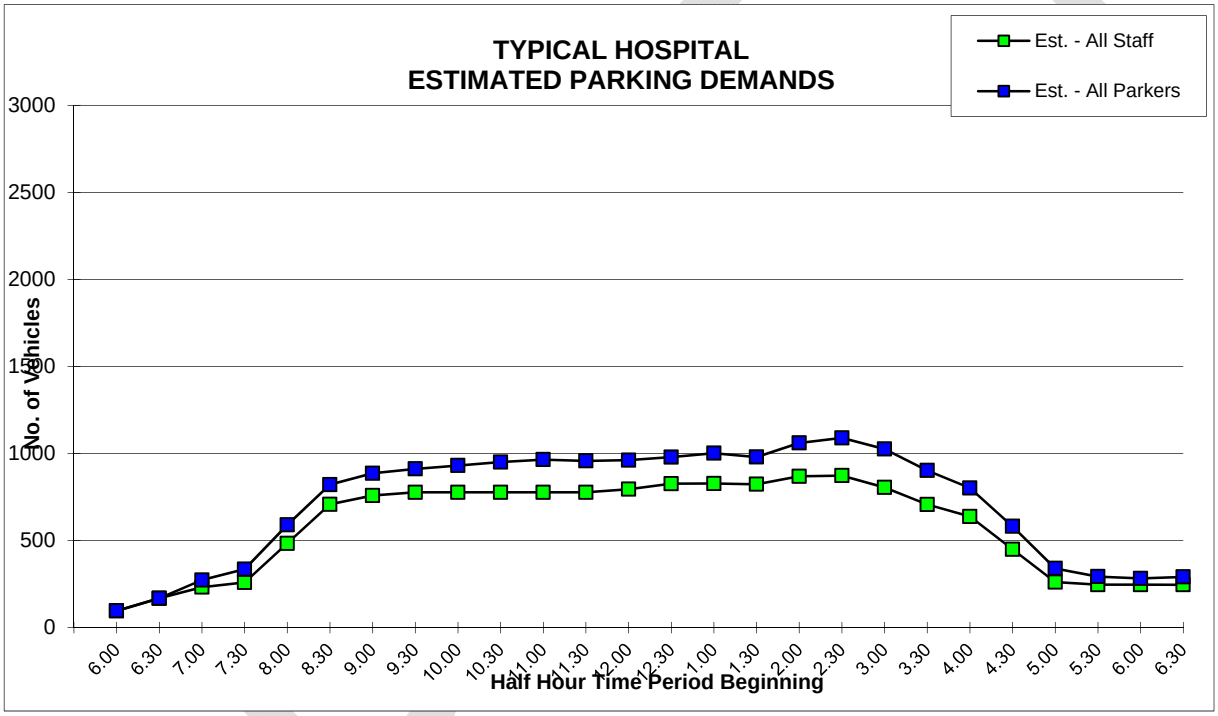


Figure 3.2 **Typical Vehicular Parking Demand for a Hospital**

There are number of factors that would influence the parking demand and vehicular trip generations of the hospitals. In general, hospitals have certain characteristics in terms travel and parking activities of their patrons, these could include:

- Travel mode share generally differs among hospital's patrons. For example, medical staff and VMOs having a higher level of car use at over 90% while other staff members (such as admin, nursing, domestic) fluctuates between 50% and over 80%, subject to the location and level of public transport accessibility. Similarly, outpatients and visitors to the hospitals demonstrate comparable patterns.

- The peak parking demands generally occurs around 11.00AM to 3.00PM. Due to shift change of employees particularly nursing staff, a higher parking demand is experienced during these times - but lasting for a short period only.

- Initiatives on promotion of active and public transport plans (e.g. Green Travel Plan) particularly among staff would have an influence on parking and travel patterns of users.

- Accessibility of the hospital's site to public transport plays an important role in level of parking provision and access strategy for the hospital.

- It is evident that hospitals where located near public transport hubs have a much lower trip generation and less demand on car parking provision. This indicates that there is no absolute need for everyone even a day patient to drive.

- Personal safety of carpark users particularly during night time is an issue of concerns and could be addressed as part of the hospital's parking management plan.

- Way finding signs are helpful tools to direct parkers and users of the hospitals to access the site and within the hospital campus.

4 ANALYSIS

4.1 GENERAL

The method used in analysis of data for estimation of dependent variables, Parking Demand and Trip Generations during morning and afternoon commuter peak hours is multiple linear regressions, as discussed in Section 3.2 and Appendix A.

It should be noted that neither regression nor correlation analyses can be interpreted as establishing cause-and-effect relationships. They can indicate only how or to what extent variables are associated with each other. The correlation coefficient measures only the degree of linear association between two variables. Any conclusions about a cause-and-effect relationship must be based on the judgment of the analyst.

Accordingly, iteration of numerous multiple regression runs have indicated that the use of RTO multiple regression would lead in a better and robust models in comparison to ordinary least square method (OLS). Appendix "A" provides further explanation and the results of test runs for various scenarios. For the analysis purposes, the equations take the following forms:

Parking Demand (spaces) = b_1 x **staff** + b_2 x **Outpatients** + b_3 **Bed**

Peak Hour Trips (veh/hr) = z_1 x **staff** + z_2 x **Outpatients** + z_3 **Bed**

where:

Parking Demand: number of parking spaces (observed and predicted)

Peak Hour Trips: number of vehicular trips during a commuter peak hour (AM or PM)

Staff: number of staff during the hospital's main shift on a weekday

Outpatients: number of outpatients visiting the hospital during a weekday

Bed: total number of beds

b, z: coefficients of independent variables

4.2 STUDY SITES

The study included an investigation and review of numerous traffic and parking reports related to various hospitals redevelopment projects years. In addition to this, car parking occupancy surveys were designed and traffic volume counts (to assess peak hour counts) for six hospitals were also carried out to verify and update the data.

A review of data revealed that travel mode among hospital patrons in hospitals with high level of accessibility (i.e. active and public transport) ranges between 50 – 65% car use, hence, generating a lower parking demand and vehicular trip rates. The level of car use in hospitals with low public transport connectivity reaches to 80-90% of all the travel modes. These findings are further discussed in Section 4.2.

Accordingly, as discussed in Section 2, and considering that travel modes of staff, outpatients and visitors play an important role in level of parking demand and traffic

generation of the hospital, the available data has been divided into two groups for evaluation purposes. Overall the assessment included the following 21 hospitals.

Group 1: Urban Hospitals located near public transport with high level of accessibility to surrounding suburbs:

1. Westmead
2. Royal North Shore
3. Concord Repatriation
4. Wollongong
5. Randwick (Prince of Wales)
6. Nepean
7. Liverpool
8. Royal Prince Alfred Hospital (parking demand only – comparative assessment only)

Group 2: Regional or metropolitan hospitals with limited public transport access:

1. Campbelltown
2. Wagga Wagga
3. Lismore
4. Blacktown
5. Hornsby
6. Sydney Adventist
7. Auburn
8. John Hunter
9. Mater, Waratah – Newcastle
10. Belmont
11. Port Macquarie
12. Bega
13. Tamworth

4.3 DATA REVIEW

As discussed in Section 2.1, a literature review of various traffic and parking reports for hospitals provided relevant information on transport aspects at various hospitals. The majority of the reports were prepared during 2009-2012 but a few reports dated back to 2007. A list of all of these reports is detailed in Reference Section of this report.

The results of this research are shown in Table 4.1, indicating the main descriptive features for each hospital. These included:

Staff EFT (Equivalent Full Time): These are generally available for each hospital through area health services or as part of the hospital redevelopment program and includes all people employed at the hospital including medical, nursing, technical, domestic, admin, engineering, etc.

Staff Shift Number: represents total number of employees in hospital during the main working shift, during a day. This information is supplied as part of the hospital redevelopment or at some instances was derived from EFT number. The number of students has been added at some instances where a high number of students were reported.

Number of Beds: total number of beds available at the hospital. Generally 85-90% occupancy occurs in hospitals, however for study purposes the full number of beds have been recorded per research materials.

No of outpatients: Total daily attendances of outpatients in each hospital were provided by the hospital management (as stated in the reports) or on some occasions were translated from annual outpatients' number for the related hospital.

Travel Mode: most reports identified travel modes of hospital's patrons. These have been considered to categorise hospital's accessibility level in terms of active and public transport use. Table 4.1 provides a summary, overall % of car use or alternative modes as travel modes could be marginally different among various users. For example, staff in a regional hospital might tend to have a higher level of car use than visitors to the hospitals.

AM Peak Hour – vehicle trip generation: total vehicular volumes (in and out of hospital or its peripheral) the during a one hour morning peak period associated with the hospital activities was recorded from the relevant report based on survey data and/or estimated figure with verification to available traffic counts.

PM Peak Hour – vehicle trip generation: total vehicular volumes (in and out of hospital or its peripheral) during a one hour peak period in afternoon associated with the hospital activities was recorded from the relevant report based on survey data and/or estimated figure with verification to available traffic counts.

An overview of data indicates that Group 1 Hospitals have the following general features:

- they are located within an urban area with close proximity to a train station or/and high frequency bus services.
- they have much higher level of activities in terms of service provision and number of admissions.
- the EFT staff number is higher than 2100.
- the outpatients number per day exceeds 1300 with number of beds over 400.
- they show travel mode from 55% – 70% among staff and 50% – 65% among outpatients and visitors.

The Group 2 Hospitals share the following characteristics:

- they are situated in isolated locations with limited access to public transport or have surrounding hilly terrains where walk or cycle could be difficult.
- they are located in regional country towns with exception of Hornsby, Campbelltown, Blacktown and Sydney Adventist Hospitals which are part of Sydney metropolitan have a limited to moderate level of accessibility.
- they have EFT staff number of less than 1500, with exception of John Hunter Hospital.
- they have a moderate level of outpatients number around/below 1000 per day with exception of John Hunter Hospital.
- they have a lower number of beds (in comparison to Group 1) at below 400 with the exceptions of John Hunter and the Sydney Adventist Hospitals.
- They have a high level of car use among its patrons - as high as 80% - 90%.

Table 4.1 Hospitals Data Summary

Hospital	EFT-Staff	Shift Staff	No of Bed	Outpt's /Day	Car Use % Staff– Op/Vist	Parking Demand	AM Veh/hr	PM Veh/hr
Group 1: Urban Hospitals with High Public Transport Accessibility								
RNS	5000	3500	586	2500	75	2500	1360	1460
Randwick	4900	2900	550	2100	52 – 77*	2880	930	1020
Wollongong	2200	1725	444	1870	71	1450	660	877
Westmead	4704	3674	707	1670	75 - 85	2959	1675	1939
Nepean	2510	1450	420	2580	76	1700	857	770
Liverpool	3030	1818	607	2867	83	1650	800	750
Concord	2165	1456	530	1312	85 - 74	1609	568	778
Group 2: Regional & Metropolitan Hospitals with Low Public Transport Accessibility								
Wagga Wagga	732	435	220	650	85	450	170	184
Tamworth	1238	790	270	700	93	1035	410	437
Sydney Adventist	1387	971	548	1095	79*	1308	667	452
Port Macquarie	690	483	161	300	80-85	576	382	365
Mater Newcastle	735	515	192	1090	93-90	660	270	270
John Hunter	2180	1350	600	1470	90-95	1650	1045	1005
Hornsby	777	544	254	680	83 -80	620	441	378
Blacktown	1354	948	328	1153	90 – 80	1100	545	433
Belmont	228	130	82	160		245	115	115
Bega	564	345	136	220	89	485	205	180
Auburn	574	459	132	600	75 - 88	446	282	320
Lismore	1014	850	267	550	92 - 85	820	500	500
Campbelltown	1150	805	406	1000	79	1220	617	586

Key:

PD: Parking Demand (spaces); Staff: Number staff during a main shift; Bed: number of beds

AM: Morning peak hour vehicular trips - in/out (vehicles/hour)

PM: Afternoon peak hour vehicular trips - in/out (vehicles/hour)

EFT: Equivalent Full Time OP: Outpatients; Vist: Visitors

- Census data for the area

A comparative evaluation of data has been carried out and the results are shown in Table 4.2. The analysis provides the following main findings:

- In Group 1 Hospitals, parking demand varies from a minimum of 0.7 to a maximum of 1.2 spaces per staff. This also translates to 3.0 to 5.0 car parking spaces per bed.

- In Group 2 Hospitals parking demand varies from a minimum of 1.0 to a maximum of 1.9 spaces per staff. This is also equivalent to 2.0 to 3.8 car parking spaces per bed.

- The vehicular trip generation rate during AM and PM peak period for Group 1 Hospitals is equivalent to 0.3 to 0.5 vehicle trip per staff per hour while in Group 2 Hospitals, this rates varies between 0.4 to 0.9 vehicle trips/staff/hr. (Note: these figures reflect for all users of the hospital while in fact, staff produce a lower rate.)

- The overall vehicular trip generation during a peak hour period for the Group 1 hospitals with respect to their bed numbers varies from 1.1 to 2.7 vehicle trips per bed. These figures for Group 2 Hospitals are in range from 0.80 to 2.3.

- The above results highlight that transport indicatives are mostly related to the hospitals activities such as outpatients' attendance with less influence from the number of beds. This could be deduced from the lower vehicular trip generation rates per bed in Group 2 in comparison to Group 1. This contrasts with the trip and parking rates for staff as shown in Table 4.2. It should be noted that the length of stay for outpatients and visitors to hospitals are limited with much higher car parking turnover and vehicular trips during the day.

- Caution should be made in the interpretation of data. For example, in Table 4.2, the average number of parking demand per bed for Group 1 is 3.8 spaces while for Group 2 is shown at 3.1. This however mainly represents an aggregate parking demand for overall hospital's activities while in fact there is a lower parking demand rate for each parameter (staff, bed, outpatients) in Hospitals in Group 1 in comparison to the ones in Group 2. This is demonstrated in vehicular trips and parking rates per "staff" for two different hospital groups.

Table 4.2 Comparative Data Summary

Hospital	PD/Staff	AM/Staff	PM/ Staff	PD/Bed	AM/Bed	PM/Bed	AM/PM
RNS	0.7	0.4	0.4	4.3	2.3	2.5	0.93
Randwick	1.0	0.3	0.4	5.2	1.7	1.9	0.91
Wollongong	0.8	0.4	0.5	3.3	1.5	2.0	0.75
Westmead	0.8	0.5	0.5	4.2	2.4	2.7	0.86
Nepean	1.2	0.6	0.5	4.0	2.0	1.8	1.11
Liverpool	0.9	0.4	0.4	2.7	1.3	1.2	1.07
Concord	1.1	0.4	0.5	3.0	1.1	1.5	0.73
Average	***0.9***	***0.4***	***0.5***	***3.8***	***1.8***	***1.9***	***0.9***
Wagga Wagga	1.0	0.4	0.4	2.0	0.8	0.8	0.92
Tamworth	1.3	0.5	0.6	3.8	1.5	1.6	0.94
Sydney Adventist	1.3	0.7	0.5	2.4	1.2	0.8	1.48
Port Macquarie	1.2	0.8	0.8	3.6	2.4	2.3	1.05
Mater Newcastle	1.3	0.5	0.5	3.4	1.4	1.4	1.00
John Hunter	1.2	0.8	0.7	2.8	1.7	1.7	1.04
Hornsby	1.1	0.8	0.7	2.4	1.7	1.5	1.17
Blacktown	1.2	0.6	0.5	3.4	1.7	1.3	1.26
Belmont	1.9	0.9	0.9	3.0	1.4	1.4	1.00
Bega	1.4	0.6	0.5	3.6	1.5	1.3	1.14
Auburn	1.0	0.6	0.7	3.4	2.1	2.4	0.88
Lismore	1.0	0.6	0.6	3.1	1.9	1.9	1.00
Campbelltown	1.5	0.8	0.7	3.0	1.5	1.4	1.05
Average	***1.3***	***0.7***	***0.6***	***3.1***	***1.6***	***1.5***	***1.1***

Key:

PD: Parking Demand (spaces); Staff: Number staff during a main shift; Bed: number of beds

AM: Morning peak hour vehicular trips - in/out (vehicles/hour)

PM: Afternoon peak hour vehicular trips - in/out (vehicles/hour)

4.4 PARKING RATES

4.4.1 Urban Hospitals – Group 1

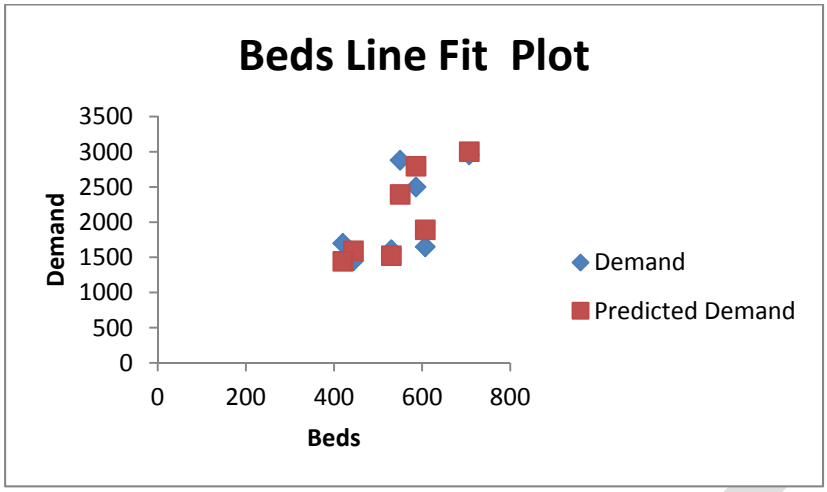
The regression analyses to estimate parking demand for Group 1 have resulted in the following equations (as shown in Table 4.3):

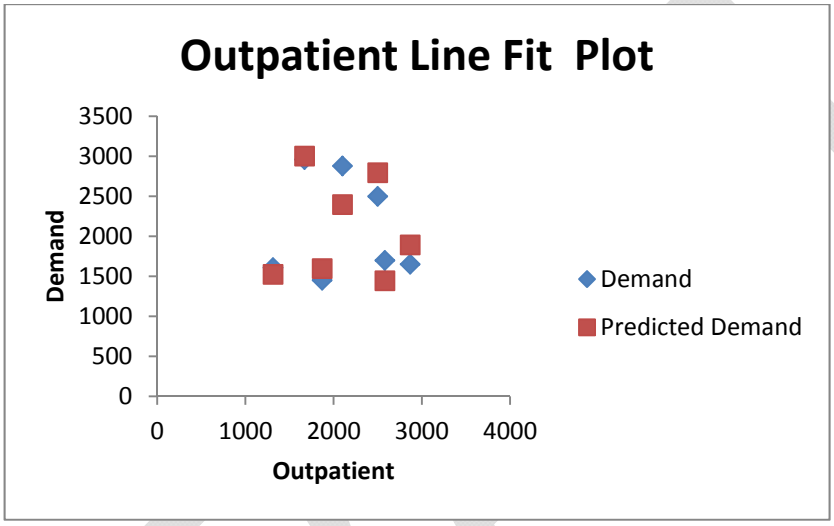
(1) Parking Demand = 0.56 Staff + 0.05 Outpatients + 1.22 Bed
(2) Parking Demand = 0.71 Staff + 0.18 Outpatients
(3) Parking Demand = 0.55 Staff + 1.43 Bed
(4) Parking Demand = 0.86 Staff
(5) Parking Demand = 3.85 Bed

Table 4.3 Parking Rates Hospitals Urban Centres (Group 1)

Model	Coefficient Staff	Coefficient. Outpatients	Coefficient Bed	R^2	Adjusted R
1	**0.56**	**0.05**	**1.22**	***0.98***	***0.73***
t	*2.80*	*0.22*	*0.94*		
p value	0.04	0.48	0.04		
2	**0.71**	**0.18**	**-**	**0.98**	**0.78**
t	5.90	1.34	-		
p value	0.002	0.23	-		
3	**0.55**	**-**	**1.43**	**0.98**	**0.78**
t	3.14	-	1.80		
p value	0.05	-	0.13		
4	**0.86**	**-**	**-**	**0.97**	**0.80**
t	15.20	-	-		
p value	4.1E-06	-	-		
5	**-**	**-**	**3.85**	**0.96**	**0.79**
t	-	-	11.6		
p value	-	-	2.5E-05		

Considering the characteristics of the models and statistical significance models 1 and 3 could be adopted for estimation of parking demand.





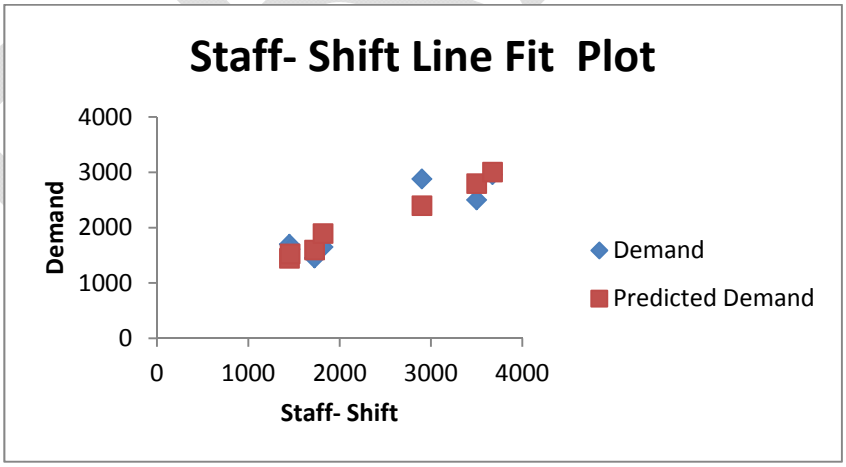


Figure 4.1 Line Fit Plots Parking Demand (Equation 1) – Group 1

4.4.2 Regional Hospitals

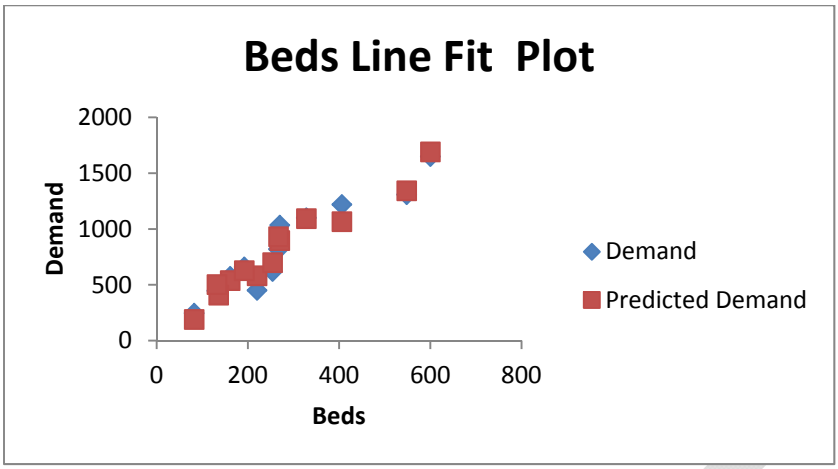
The regression analyses to estimate parking demand for Group 2 hospitals have resulted in the following equations (as shown in Table 4.4):

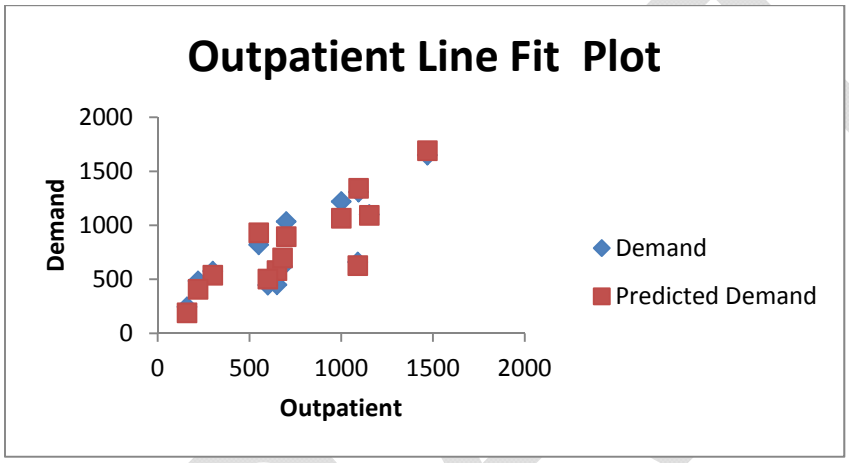
(6) Parking Demand = 0.73 Staff + 0.04 Outpatients + 1.07 Bed
(7) Parking Demand = 1.09 Staff + 0.13 Outpatients
(8) Parking Demand = 0.76 Staff + 1.11 Bed
(9) Parking Demand = 1.23 Staff
(10) Parking Demand = 2.84 Bed

Table 4.4 Parking Rates Hospitals Regional Centres

Model	Coefficient Staff	Coefficient. Outpatients	Coefficient Bed	R^2	Adjusted R
6	**0.73**	**0.04**	**1.07**	***0.98***	***0.89***
t	*3.51*	*0.31*	*2.4*		
p value	0.005	0.58	0.04		
7	**1.09**	**0.13**	**-**	**0.98**	**0.89**
t	6.30	0.87	-		
p value	5.7E-05	0.40	-		
8	**0.76**	**-**	**1.11**	**0.99**	**0.90**
t	4.2	-	2.7		
p value	0.0014	-	0.02		
9	**1.23**	**-**	**-**	**0.98**	**0.90**
t	28.1	-	-		
p value	2.6E-12	-	-		
10	**-**	**-**	**2.84**	**0.97**	**0.89**
t	-	-	22.1		
p value	-	-	4.2E-11		

Equations 6 and 8 would represent the best fit and appropriateness to estimate a parking demand for Group 2 Hospitals.





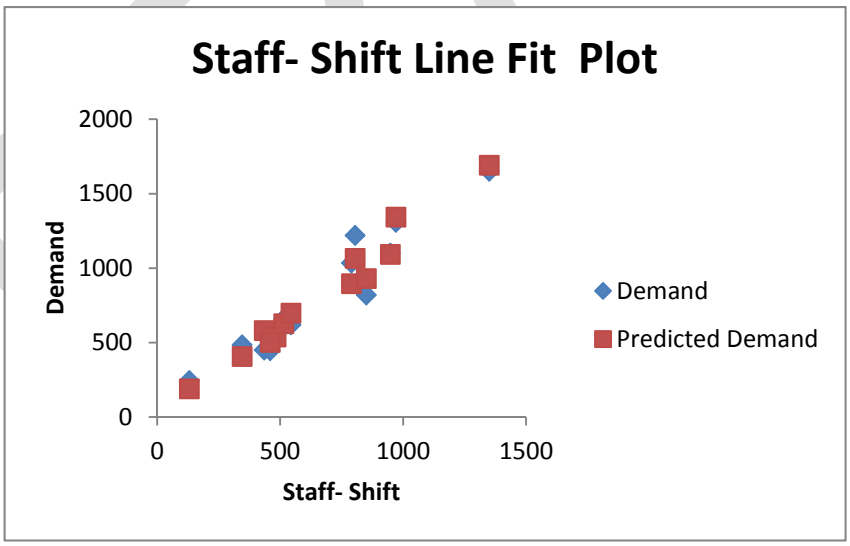


Figure 4.2 Line Fit Plots Parking Demand (Equation 6) – Group 2

4.5 TRIP RATES

4.5.1 Urban Hospitals

The regression analyses to estimate vehicular trips associated with Hospitals in Group 1 during a morning and afternoon commuter peak hour have resulted in the following equations (as shown in Table 4.5):

(11) AM Vehicular Trips = 0.35 Staff + 0.023 Outpatients + 0.21 Bed
(12) AM Vehicular Trips = 0.37 Staff + 0.05 Outpatients
(13) AM Vehicular Trips = 0.34 Staff + 0.32 Bed
(14) PM Vehicular Trips = 0.36 Staff - 0.13 Outpatients + 0.90 Bed
(15) PM Vehicular Trips = 0.47 Staff - 0.02 Outpatients
(16) PM Vehicular Trips = 0.39 Staff + 0.33 Bed

Table 4.5 Trip Rates Hospitals Urban Centres

Model	Coefficient Staff	Coefficient. Outpatients	Coefficient Bed	R^2	Adjusted R
11am	**0.35**	**0.023**	**0.21**	***0.97***	***0.72***
t	*2.99*	*0.22*	*0.28*		
p value	0.04	0.48	0.79		
12am	**0.37**	**0.05**	**-**	**0.97**	**0.77**
t	5.80	0.65	-		
p value	0.003	0.54	-		
13am	**0.34**	**-**	**0.32**	**0.97**	**0.77**
t	3.35	-	0.69		
p value	0.02	-	0.25		
14pm	**0.36**	**- 0.13**	**0.90**	**0.98**	**0.72**
t	3.12	-1.05	1.20		
p value	0.035	0.35	0.29		
15pm	**0.47**	**-0.02**	**-**	**0.96**	**0.79**
t	6.40	+0.24	-		
p value	0.001	0.55	-		
16pm	**0.39**	**-**	**0.33**	**0.97**	**0.77**
t	3.4		0.62		
p value	0.02		0.55		

A review of the results indicates that models 13 and 16 would be best to represent the estimation of vehicular trips during AM and PM commuter hours, respectively.

4.5.2 Regional Hospitals

The regression analyses to estimate vehicular trips associated with Hospitals in Group 1 during a morning and afternoon commuter peak hour have resulted in the following equations (as shown in Table 4.5):

(17) AM Vehicular Trips = 0.45 Staff - 0.07 Outpatients + 0.75 Bed
(18) AM Vehicular Trips = 0.71 Staff - 0.03 Outpatients
(19) AM Vehicular Trips = 0.41 Staff + 0.62 Bed
(20) PM Vehicular Trips = 0.64 Staff - 0.07 Outpatients + 0.12 Bed
(21) PM Vehicular Trips = 0.68 Staff - 0.06 Outpatients
(22) PM Vehicular Trips = 0.59 Staff + 0.05 Bed

Table 4.6 Trip Rates Hospitals Regional

Model	Coefficient Staff	Coefficient. Outpatients	Coefficient Bed	R^2	Adjusted R
17am	**0.47**	**- 0.09**	**0.71**	***0.93***	***0.87***
t	*2. 87*	*-0.90*	*1.97*		
p value	0.017	0.04	0.08		
18am	**0.71**	**- 0.03**	**-**	**0.97**	**0.88**
t	5.50	- 0.32	-		
p value	0.0002	0.76	-		
19am	**0.41**	**-**	**0.62**	**0.97**	**0.88**
t	2.80	-	1.8		
p value	0.018	-	0.09		
20pm	**0.64**	**- 0.07**	**0.12**	**0.96**	**0.85**
t	3.00	- 0.53	+0.25		
p value	0.013	0.61	0.80		
21pm	**0.68**	**- 0.06**	**-**	**0.96**	**0.86**
t	4.80	0.49	-		
p value	0.006	0.68	-		
22pm	**0.59**	**-**	**0.05**	**0.96**	**0.87**
t	3.2		0.11		
p value	0.008		0.19		

Equations 19 and 22 are best to estimate vehicular trips during a morning and afternoon commuter peak hour for Group 2 Hospitals.

4.6 REVIEW OF RESULTS

The following models have been selected for estimation of parking demand and trip generation for the hospitals.

Group 1:

- Parking Demand = 0.56 Staff + 0.05 Outpatients + 1.22 Bed (1)
- Parking Demand = 0.55 Staff + 1.43 Bed (3)
- AM Vehicular Trips = 0.34 Staff + 0.32 Bed (13)
- PM Vehicular Trips = 0.39 Staff + 0.33 Bed (16)

Group 2:

- Parking Demand = 0.73 Staff + 0.04 Outpatients + 1.07 Bed (6)
- Parking Demand = 0.76 Staff + 1.11 Bed (8)
- AM Vehicular Trips = 0.41 Staff + 0.62 Bed (19)
- PM Vehicular Trips = 0.59 Staff + 0.05 Bed (22)

A review of the results indicates that the above models are plausible and aim to provide an indication of vehicular trip generation and required parking demand for the hospitals with respect to their relevant parameters. It should be noted that due to interrelation of data, some level of collinearity is experienced as part of the modelling process. The employment of RTO regression however would have reduced this element to some extent. Nevertheless, the interpretation of regression models reveals their relevancy and validity with a consideration that it could only be taken as a guide as they do not aim to predict an exact estimation.

The equations 1, 3, 6 and 8 demonstrate that parking demand for hospitals are primary dependent on the number of staff with the number of beds as a secondary factor. The coefficient of staff for Group 1 Hospitals is in the order of 0.55 representing a lower car use among patrons of the hospitals in urban areas. Similarly, this coefficient in Group 2 Hospitals is above 0.73, reflecting a high level of car use among patrons in regional hospitals (or in hospitals with limited public transport access). Furthermore, these models are also representing similar features to the ones currently in use for ACT, Victoria and Queensland, as discussed in Section 2.2.

The models for trip generation (i.e. equations 13, 16, 19 and 22) also display a high level of credibility. This is exhibited as part of the coefficients for “staff” showing 0.35 (0.65 - 0.70 arrival or departure x car use say 50-60%) and 0.50 (0.65 - 0.70 arrival or departure x car use say 70-85%) for Group 1 and Group 2, respectively - recognising that during a one hour commuter peak period, generally some 65 -70% of staff arrive or depart (as not all staff arrive or depart at a same time).

The Coefficients of the models also correspond with comparative data assessment as illustrated in Table 4.2.

Accordingly, the models are plausible and should be used within its range of estimation. Some degree of variation should be allowed for estimation of car parking demand and trip generation. A comparison of observed data and its corresponding predicated results indicates a range of + or - 10%.

5 SUMMARY OF FINDINGS

The term *public hospital* refers to those developments referred to in the Public Hospitals and Day Procedures Centre Act, 1988, No. 123 as "premises at which patients are provided with medical, surgical or other treatment, and with ancillary nursing care, for fee, gain or reward".

Public hospitals are usually identified through the provision of services i.e. general, surgical, obstetric, rehabilitation and psychiatric. Special services (such as paediatric, accident and emergency and cardiac catheterisation) may also be provided by private hospitals with Department of Health approval.

The method used in analysis of data for estimation of dependent variables, Parking Demand and Trip Generations during morning and afternoon commuter peak hours is multiple linear regressions.

Review of traffic and parking reports were undertaken for 21 hospitals including 10 in the Sydney region and 11 in regional cities. The hospitals were categorised into two groups, reflecting the level of car use and characteristics of the hospitals.

The Group 1 included those hospitals with high level of public transport accessibility within urban centres. The number of staff in this category exceeded 2100 EFT personnel with number of beds over 400. The use of car as the main mode of travel to and from the hospital accounted for less than 70% among its patrons.

The Group 2 included hospitals in regional cities or suburbia with low level of public transport accessibility. The number of staff in this category was generally lower than 1500 EFT personnel with number of beds less than 400. The use of car as the main mode of travel to and from the hospital accounted for more than 75% among its patrons.

Trip Generation

The best indicator of peak traffic generation or peak vehicle trips (Peak Hour Vehicle Trips) was found to be a combination of the number of beds (Bed) and the number of staff per weekday day shift (Staff).

The vehicle trip generation in the morning commuter peak hour (7.00AM-9.00AM) and the vehicle trip generation in the evening commuter peak hour (4 PM - 6 PM) were both modelled by a combination of the number of beds (B) provided and the average number of staff per weekday day shift (Staff).

Group 1 - Peak Period Traffic Generation Models:

- AM Vehicular Trips = 0.34 Staff + 0.32 Bed
- PM Vehicular Trips = 0.39 Staff + 0.33 Bed

Group 2 - Peak Period Traffic Generation Models:

- AM Vehicular Trips = 0.41 Staff + 0.62 Bed
- PM Vehicular Trips = 0.59 Staff + 0.05 Bed

Parking Demand

The peak parking accumulation in hospitals was modelled by a combination of the number of beds (Bed) provided and the average number of staff per weekday day shift (Staff) and average number of outpatients per day (OP).

If the average number of outpatients per weekday day (OP) is unknown or unavailable, the number of staff per weekday day shift (staff) and the number of beds (B) alone were then found to be good indicators of estimating peak parking demand (Parking Demand). The models based on number of staff during a weekday shift (Staff) and number of beds (B) should only be used when the average number of outpatients per weekday (OP) is unknown.

The peak parking accumulation at a public hospital may be estimated by

Group 1:

- Parking Demand = 0.56 Staff + 0.05 Outpatients + 1.22 Bed
- Parking Demand = 0.55 Staff + 1.43 Bed

Group 2:

- Parking Demand = 0.73 Staff + 0.04 Outpatients + 1.07 Bed
- Parking Demand = 0.76 Staff + 1.11 Bed

Car parking should be provided in accordance with the peak parking accumulation with due consideration being given to reducing the parking required if convenient and safe on-street parking is available provided that the use of such parking does not adversely affect the amenity of the surrounding area.

Factors

The Group 1 hospitals had between 444 - 707 beds (Bed), and between 1450 - 3650 average staff per weekday day shift (Staff). The proportion of people who travelled to the site by vehicle was with a range of 53% - 75%.

The Group 2 hospitals had between 82 - 548 beds (Bed), and between 130 - 948 average staff per weekday day shift (Staff). The proportion of people who travelled to the site by vehicle was with a range of 67 -95%.

The medical staff for both groups of the hospital generally had 100% car use.

The average length of stay at a public hospital varies according to the purpose of the trip. The average length of stay for outpatients was less than 2 hours. The average length of stay for visitors to the hospital during a day time when peak parking occurred was 1 to 1.5 hours.

REFERENCES:

Appendix A

Regression Models

The least squares method is specified by an equation with certain parameters to observed data. In the most common application - linear or ordinary least squares - a straight line is sought to be fitted through a number of points to minimize the sum of the squares of the distances (hence the name "least squares") from the data points to this line of best fit. When we can identify more than one independent variable to influence on the dependent variable, use of multiple regression models are often employed. The multiple regression model allows us to study the relationship between a dependent variable (such as parking demand or trip generation) and several independent variables.

Accordingly, the general model used in this study takes the following form:

$Y= b_0 + b_1X_1 + b_2X_2 + b_3 X_3 + \ldots..+ b_nX_n + e$

Where
Y is a dependent variable such as:
Parking Demand (no of parking spaces), or Peak Hour Trip Generation (vehicles/hour); and
Xs are independent variables such as:
No of staff; No of outpatients, No of beds
b represents the coefficient of variables
e accounts for residuals not explained by the model

The validity of the above model relies on its range of data set that has been utilised while its degree of accuracy in making plausible estimates is determined by the value of R^2. R-squared is a statistical measure of how close the data are to the fitted regression line. It is also known as the coefficient of determination, or the coefficient of multiple determination in the case of multiple regression analysis.

The definition of R-squared is fairly straight-forward; it is the percentage of the response variable variation that is explained by a linear model.

R-squared = Explained variation / Total variation

R-squared is always between 0 and 100%:

- 0% indicates that the model explains none of the variability of the response data around its mean.
- 100% indicates that the model explains all the variability of the response data around its mean.

The higher the R-squared, the better the model is supported by the data. However, generally, an adjusted R- squared is used in regression models that contain different numbers of predictors. The adjusted R-squared is a modified version of R-squared that has been adjusted for the number of predictors in the model. The adjusted R-squared increases only if the new term improves the model more than would be expected by chance. It decreases when a predictor improves the model by less than expected by chance. The adjusted R-squared can be negative, but it's usually not. It is always lower than the R-squared.

Furthermore, the coefficient of each independent variable is also measured by the level of its p-value. The p-value for each term tests the null hypothesis that the coefficient is equal to zero (no effect). A low p-value (< 0.05) indicates that you can reject the null hypothesis. In other words, a predictor that has a low p-value is likely to be a meaningful addition to your model because changes in the predictor's value are related to changes in the response variable. Conversely, a larger (insignificant) p-value suggests that changes in the predictor are not associated with changes in the response.

Study Model

The method used in analysis of data for estimation of dependent variables, Parking Demand and Trip Generations during morning and afternoon commuter peak hours is multiple linear regressions, as discussed in Sections 3.2 and 4.0.

It should be noted that neither regression nor correlation analyses can be interpreted as establishing cause-and-effect relationships. They can indicate only how or to what extent variables are associated with each other. The correlation coefficient measures only the degree of linear association between two variables. Any conclusions about a cause-and-effect relationship must be based on the judgment of the analyst.

One of the basic tests (in addition to statistical tests as described above) to judge the appropriateness of the model is the sign of coefficients. In other words, the equation should be plausible and meet the expected hypothesis. For example in estimation of "Parking Demand", it is expected that as the number of staff, outpatients and beds increase, the parking demand should also increase, meaning that all coefficients for independent variables should have a positive + sign, whilst a negative – sign would not only be counter intuitive, it would neither truly support the nature of the hypothesis.

Similarly to the above, where the value of the constant (in a regression model) is a prediction for the response value when all predictors equal zero and when there is no data in all-zero range, then the value of the constant cannot be valid. In such instances, regression models without intercept (i.e. constant equal zero) could be employed where there is a clear evident that such hypothesis is valid. This type of regression is generally called "Right Through Origin" (RTO) where takes the following form

$$Y= b_1X_1 + b_2X_2 + b_3 X_3 + \ldots.+ b_nX_n + e$$

As the literature review suggests "textbooks rarely discuss RTO other than to caution against dropping the constant term from a regression, on the grounds that imposing any such restriction can only diminish the model's fit to the data. There are, however, circumstances in which RTO is appropriate or even necessary" (Eisenhauer, 2003).

Accordingly, iteration of numerous multiple regression runs have indicated that the use of RTO multiple regression would lead in a better and robust models in comparison to ordinary least square method (OLS). Appendix "A" provides the results of test runs for various scenarios. For the analysis purposes, the equations take the following forms:

Parking Demand (spaces) = b_1 x **staff** + b_2 x **Outpatients** + b_3 **Bed**

Peak Hour Trips (veh/hr) = z_1 x **staff** + z_2 x **Outpatients** + z_3 **Bed**

where:

Parking Demand: number of parking spaces (observed and predicted)

Peak Hour Trips: number of vehicular trips during a commuter peak hour (AM or PM)

Staff: number of staff during the hospital's main shift on a weekday

Outpatients: number of outpatients visiting the hospital during a weekday

Bed: total number of beds

b, z: coefficients of independent variables

Appendix B

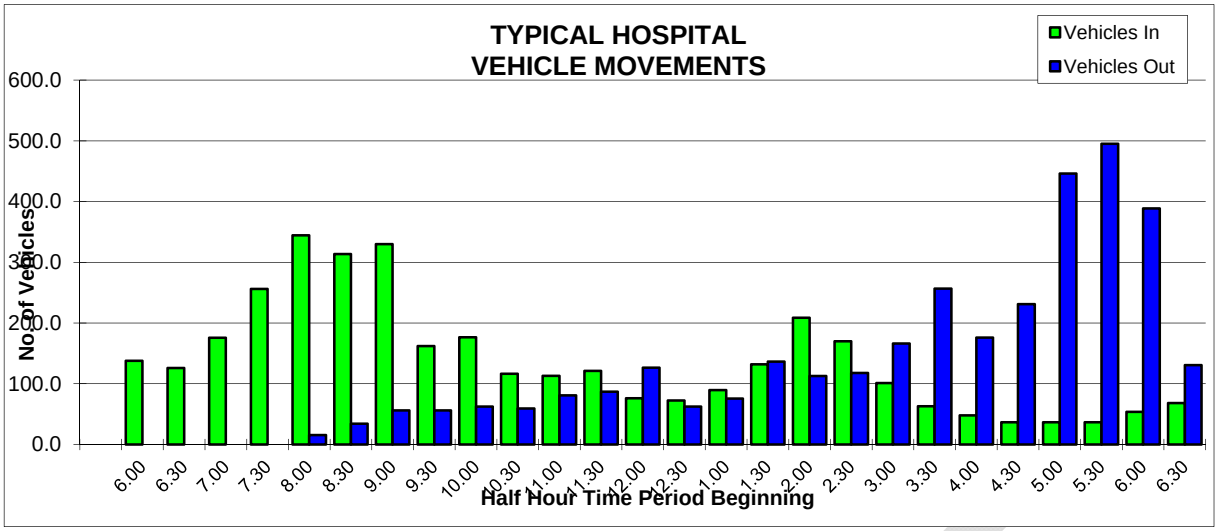
Table B1 Parking Rates Hospitals ($PD = b+bx_1+bx_2+\ldots+bx_n$)

Model	Constant	Coefficient Staff	Coefficient Outpatients	Coefficient Bed	R^2	Adjusted R
Group 1 – PD1U	**914**	**0.63**	**- 0.08**	**- 0.20**	***0.84***	***0.69***
T	*0.8*	*2.80*	*-0.31*	*-0.09*		
p value	0.48	0.07	0.77	0.94		
Group 1 – PD2U	**705**	**0.62**	**-**	**- 0.12**	**0.84**	**0.76**
T	0.88	3.15	-	-0.06		
p value	0.43	0.03	-	-0.95		
Group 2 – PD1R	**22.73**	**0.70**	**0.03**	**1.11**	**0.95**	**0.93**
t	0.33	2.90	0.23	2.28		
p value	0.75	0.015	0.82	0.05		
Group 2 – PD2R	**25.72**	**0.72**	**-**	**1.10**	**0.95**	**0.94**
t	0.40	2.60	-	3.30		
p value	0.70	0.03	-	0.007		

Key: PD = Parking Demand

Table B2 Trip Rates Hospitals ($PVT = b+bx_1+bx_2+\ldots+bx_n$)

Model	Constant	Coefficient Staff	Coefficient Outpatients	Coefficient Bed	R^2	Adjusted R
Group 1 – PV AMU	**- 102.8**	**0.33**	**-**	**0.54**	***0.83***	***0.75***
t	*-0.20*	*2.60*	-	*0.44*		
p value	0.84	0.06	-	0.68		
Group 1 – PV PMU	**- 195**	**0.37**	**-**	**0.76**	**0.84**	**0.76**
t	-0.35	2.66	-	0.55		
p value	0.75	0.06	-	0.61		
Group 2 – PV AMR	**- 39.4**	**0.47**	**-**	**0.58**	***0.91***	***0.90***
t	*-0.76*	*2.70*	-	*1.66*		
p value	0.46	0.02	-	0.13		
Group 2 – PV PMR	**- 20**	**0.62**	**-**	**0.03**	**0.91**	**0.90**
t	-0.33	2.80	-	0.07		
p value	0.77	0.02	-	0.94		
5						
t						
p value		-	-	2.5E-05		


TYPICAL HOSPITAL
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300.0
200.0
100.0
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7.00
7.30
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8.30
9.00
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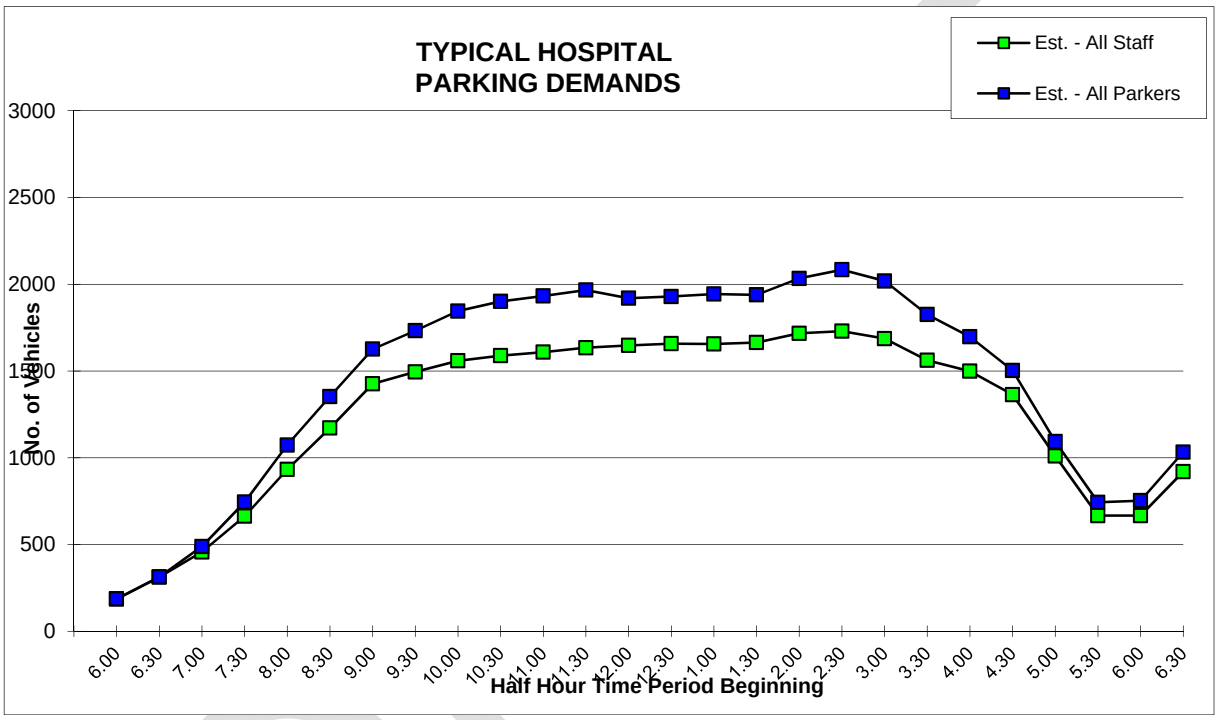
3.30
4.00
4.30
5.00
5.30
6.00
6.30
Half Hour Time Period Beginning


TYPICAL HOSPITAL
PARKING DEMANDS
Est. - All Staff
Est. - All Parkers
3000
2500
2000
1500
1000
500
0
No. of Vehicles
6.00
6.30
7.00
7.30
8.00
8.30
9.00
9.30
10.00
10.30
11.00
11.30
12.00
12.30
1.00
1.30
2.00
2.30
3.00
3.30
4.00
4.30
5.00
5.30
6.00
6.30
Half Hour Time Period Beginning