Forecasting the Use of Passenger Lifts at Rail Stations

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The authors would like to acknowledge the help of Andrew Ogden and Trevor Puckering of RailCorp for assistance in data collection; Ray Stokmanis of RailCorp for lift statistics; Michael Doggett for rail patronage data; Michael Green of Liftronics and Manuel Diaz of Schindler Lifts for obtaining the automatic lift counts; and all the eagle eyed fieldworkers who undertook the lift occupancy surveys.

The views expressed in this paper are those of the authors and are not necessarily supported by RailCorp.

Abstract

The first passenger lift in the NSW rail network was introduced in 1991 at Lithgow station. By May 2010, 268 passenger lifts have been installed at one hundred stations in the CityRail network. In most cases, lifts have been introduced to provide 'easy access' for disabled or passengers with mobility problems.

This paper presents a four step methodology to forecast the usage of passenger lifts by passengers of different observed mobility such as passengers in wheelchairs or passengers with strollers or heavy luggage. The first step uses automatic lift 'travel' count data that records the number of times lifts move up or down. A forecasting model was developed that explained the number of times the lifts 'travelled' (moved) in terms of station entry and exit counts. The lift travel model also took into account the effect of the height of the lift and location of the lift defined as whether the lift connected the concourse and the platform or the station and the street.

The second step involved fieldworker observation surveys to determine average lift occupancy - the number of passengers carried per lift travel. A model was developed that expressed lift occupancy in relation to the number of lift travels per hour. The third step combined the travel and occupancy forecasts to calculate the number of passenger using lifts.

The fieldworkers also observed the profile of lift users which is used in the fourth step of the forecasting model. Lift users were categorised according to their observed mobility status such as: wheelchair passengers; passengers with strollers; passengers with heavy luggage; elderly/infirm; RailCorp staff; normal mobility etc. This data enabled lift patronage to be forecast by mobility category.

1. Introduction

The installation of passenger lifts at rail stations can be capital expensive. An average lift costs about $500,000 to buy and install which gives an indicative current cost book value of $134 million for the 268 lifts in service. Lifts also require ongoing operational, cleaning and maintenance support over an estimated economic life of 20 years. The introduction of lifts can also reduce the space available for passenger movement in the concourse and for waiting on platforms. RailCorp has developed a methodology to assess the net economic benefit of the introduction of lifts.

This paper presents a four step methodology to forecast the lift usage. A flow diagram of the approach is presented in section 3.

The first step uses automatic lift 'travel' count data that records the number of times lifts move up or down. RailCorp undertakes counts of the number of passengers entering and exiting stations and compiles the data on an annual basis. This 'count' data was used to develop a forecasting model. The model also takes into account lift height and lift location. Section 4 presents the lift travel model.

The second step involved fieldworker observation surveys to determine average lift occupancy - the number of passengers carried per lift travel. A model summarised in section 5 was developed that expressed lift occupancy in relation to the number of lift travels per hour.

The third step described in section 6 combined the travel and occupancy forecasts to calculate the number of passenger using lifts.

The fieldworkers also observed the profile of lift users which is used in the fourth step of the forecasting model. Lift users were categorised according to their observed mobility status such as: wheelchair passengers; passengers with strollers; passengers with heavy luggage; elderly/infirm; RailCorp staff; normal mobility etc. This data enabled lift patronage to be forecast by mobility category. Section 7 presents the profile of lift users.

2. Background

The first passenger lift in the CityRail network was introduced at Lithgow station in the Blue Mountains in 1991. By May 2010, 268 passenger lifts were operating at 100 stations, Table 1.[1] In most cases, lifts have been introduced to provide 'easy access' for disabled or passengers with mobility problems.

In May 2010, there were 307 stations in the CityRail network implying that 1 in 3 stations have lifts. Lifts have tended to be introduced at the more heavily patronised stations. Indeed, in May 2010, three quarters of CityRail passengers are estimated to use stations where lifts are available. Figure 1 shows the growth in the availability of lifts at stations and the divergence in availability measured in terms of patronage versus number of stations.

Most stations require more than one lift to provide easy access. Of the 100 stations where lifts have been installed, only 17 have a one lift which usually connects the concourse with a single or island platform. The other 83 stations have more than one lift. At these stations, lifts provide

[1] The figures include the four Airport Rail Link stations.

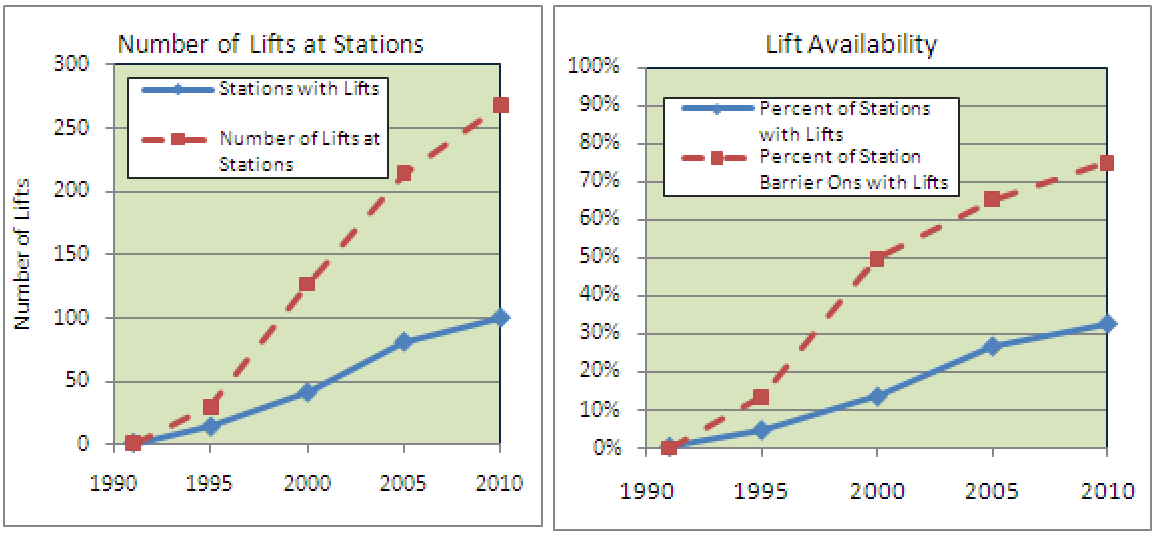
access between the concourse and the platform(s) and between the unpaid area 'street' and either the concourse or platform(s).

Table 1: Passenger Lifts at CityRail NSW Stations

Year End	Number of Stations with Lifts	Total Number of Lifts	Average number of Lifts per Station	Stations with Lifts - Percent of Total Stations	Station Barrier Entries with Lifts as Percentage of Total
1991	1	1	1.0	0%	0%
1995	14	30	2.1	5%	14%
2000	41	127	3.1	13%	50%
2005	81	214	2.6	27%	65%
2010	100	268	2.7	33%	75%

Stations and barrier entries include Airport Rail Link; Stations as at year end; Barrier entries = 2009
Source: RailCorp, Douglas Economics

Figure 1: Trend in Lift Provision at CityRail NSW Stations



Source: RailCorp, Douglas Economics Analysis

The typical CityRail station lift carries up to 17 passengers. Lifts of different capacities are in service however ranging from 8 to 40 passenger capacities. Larger lifts tend to be used in busier situations such as at Town Hall.

Until 2002, all passenger lifts installed at CityRail stations were hydraulic lifts operating at maximum speeds of 0.6 metres per second (m/sec). Hydraulic lifts require a machine room to house the hydraulic oil pump located usually above the lift shaft but sometimes below.

Since 2002, all lifts installed have been traction lifts. Traction lifts use a cable to pull the lift car up or down and can operate at higher maximum speeds than hydraulic lifts. Like hydraulic lifts, traction lifts usually require a machine room. In the mid 1990s however, Machine Room Less (MRL) traction lifts were developed for low-rise situations such as rail stations and it is for this reason rather than speed (largely negated by short travel heights), MRL lifts have become the preferred lift type for installation at CityRail stations.

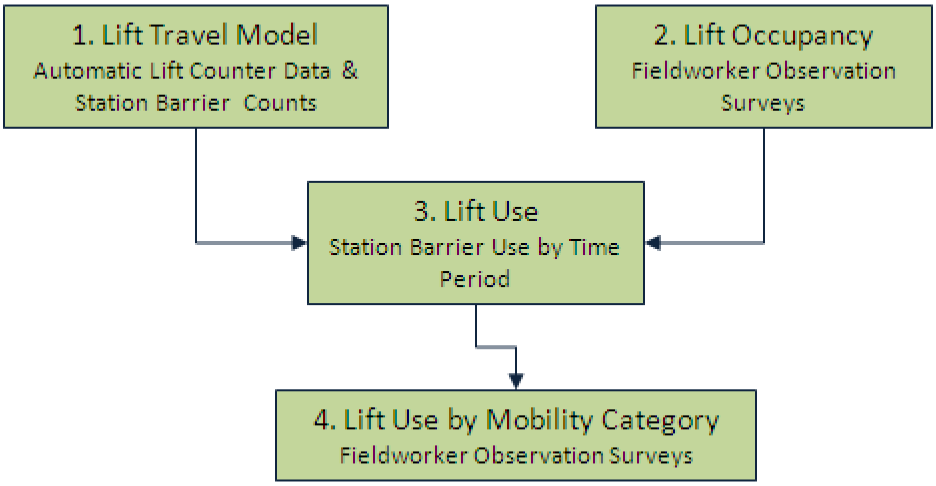
3. Forecasting Lift Use

Demand and economic studies relating to rail station passenger lifts have tended to focus on establishing the 'willingness to pay' for lifts by rail passengers and the incremental rail patronage that may result from the introduction of lifts. Attitudinal market research usually involving 'stated preference' questionnaires have been undertaken to elicit the relative importance of lifts and other station facilities such as seating, weather protection and information. The British Rail Passenger Demand Forecasting Handbook, BRB (1990) presents some example studies. The monetary values established have then usually been compared to fares paid and fare elasticities applied to forecast the likely patronage increase from introducing or improving facilities. In Australia, Douglas and Karpouzis (2006) used a rating approach to forecast the benefit and demand impact of easier lift and escalator provision at rail stations.

However, no published reports were was found on forecasting the patronage of rail station lifts and describing the profile of lift users.

This forecasting approach presented in this paper attempts to fill the gap in published research. The approach combines lift count data recorded automatically by lifts as they travel up and down with observation surveys undertaken at a sample of stations by fieldworkers on the number of passengers using lifts by mobility category. Figure 2 presents the four step approach.

Figure 2: Forecasting Approach



4 Step 1 Forecasting Lift Travels

Most lifts have inbuilt counters which automatically record the number of times the lift travels up or down. It is important to note that lifts may travel unoccupied either in response to a passenger outside the lift pressing the lift button or returning empty to its pre-determined 'home' position.

Count data was obtained for 43 lifts at 17 different stations. For 31 lifts, the data related to 2009 or 2010. The data for the remaining 12 lifts dated back to early December 2002. The count period varied from 3 days to 14 days, the average count period being ten days with the total count duration lasting 430 days, Table 2.

38 lifts had a travel height of less than six metres with all but one lift having a travel height of around 5 metres (the exception was a 2.1 metre lift). 23 lifts connected the concourse and platform. 15 lifts connected the street and either the concourse (12) or the platform (3). Five lifts served underground stations covering taller vertical distances of over 20 metres. The tallest lift in the sample was 26.2 metres in height. These five tall lifts connected the concourse and street. All five had alternative escalator access/egress.

The count data was converted into the number of travels per average day. Table 3 presents statistics on the number of lift travels per average day of the week. The average number of lift travels per day was 658 with a range from 130 to 1,687.

Table 2: Sample Descriptors of Automatic Lift Count Sample

Sample Descriptor	Estimate
Number of Lifts	43
Number of Stations	17
Average Count Period (Days)	10
Max Count Period (Days)	14
Minimum Count Period (Days)	3
Total Count Duration(Days)	430
Average Lift Height (metres)	7.3
Maximum Lift Height (metres)	26.2
Minimum Lift Height (metres)	2.1
Number of Conc-Plat Lifts < 6 metres	23
Number of Street-Conc/Plat Lifts < 6 metres	15
Number of Street - Conc/Plat Lifts > 20 metres	5

Source: RailCorp, Douglas Economics Analysis

RailCorp undertakes weekday counts of the number of passengers entering and exiting stations (referred to as barrier counts). Average system-wide factors for Saturday and Sundays usage as a percentage of weekday use have also been developed. The barrier count data was factored to take account of the number of entry points for street lifts or the number of platform groups served for platform lifts. Thus barrier throughput (entries + exits) for stations with two street entry points would be halved. Likewise the barrier throughput a station with two island platforms would be halved. It should be noted that some stations provide transfer points for passenger changing trains with eight lifts likely to carry transfer passengers. Unfortunately, there was no data to factor the barrier count for these lifts.

Inspection of Table 3 shows the average factored daily barrier throughput was 5,201 ranging from 1,305 to 16,596.

Dividing lift travels by factored throughput provided a measure of the share of passengers using lifts. The average share was 16% and ranged between 3% and 53%.

Mathematical models were developed to explain the variability in lift use. Figure 2 presents a scattergram of the data and the fitted models. Two models were estimated: for travel heights of around 5 metres: one for concourse – platform lifts and one for street lifts. A multiplicative factor was then developed to account for lift height.

Table 3: Sample Descriptors of Automatic Lift Count Sample

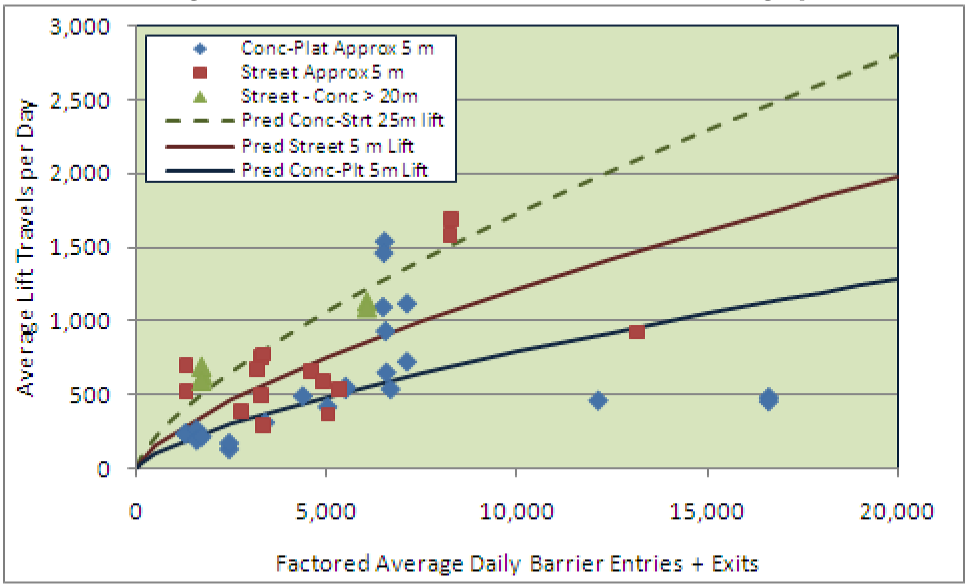
Statistic	Estimate
Average Lift Travels per Day	658
Maximum Lift Travels per Day	1,687
Minimum Lift Travels per Day	130
Average Factored Barrier Throughput per Day	5,201
Maximum Factored Barrier Throughput per Day	16,596
Minimum Factored Barrier Throughput per Day	1,305
Average Travels per Barrier Throughput (%)	16%
Maximum Travels per Barrier Throughput (%)	53%
Minimum Travels per Barrier Throughput (%)	3%

Source: RailCorp Douglas Economics Analysis

The relationship between lift travels and barrier throughput was expressed as a power function. Different power functions were tested. A value of 0.7 provided the best fit allowing for increasing lift travels as barrier throughput increases but at a declining proportional rate.

Lift height was included as multiplicative factor H. The factor was based on the lift travel ratio. For the five street lifts with heights of over 20 metres, the number of lift travels per barrier throughput was 31 which compared with a rate of 20 for the 15 street lifts of around 5 metres in height. Thus the ratio was 1.42 (30/21).

Figure 3: Lift Travels and Barrier Throughput



Equation 1 shows the model fitted, Table 4 presents the estimated parameters and Table 5 presents a 'look-up' table of lift travels against average station barrier throughput.

$$Lday = \beta Tday^{0.7}.H \quad .....(1)$$

Where:

$Lday$ = lift travels per day

$Tday$ = average factored barrier throughput per day

H =Lift height factor $=1.42^{\frac{H-5}{5}}$

β = estimated parameter

Figure 3 shows concourse – platform lifts to tend to be used less than street lifts in proportion to their respective barrier throughputs. This difference manifests itself in a lower parameter (β) of 1.25 for concourse-platform lifts the parameter of 1.93 for street lifts. Thus for a daily barrier throughput of 1,000, Table 5 predicts that a 5 metre concourse-platform lift would travel 157 times per day compared to 243 times for a 5 metre street lift. By comparison a 25 metre street lift would travel 345 times. It is recommended that the height adjustment should only be made for lifts with a travel distance in excess of 8 metres.

Table 4: Predicted Models of Lift Travels

	Conc-Plat	Street
Parameter β	1.25	1.93
Standard Error	0.18	0.22
|t| value	6.99	8.68
Observations	23	15

Source: RailCorp; Douglas Economics analysis

Table 5: Predicted Lift Travels with Barrier Throughput

Factored Daily	Predicted Lift Travels per Day			Lift Travels / T'Put		
Barrier T'Put	Conc-Plt 5m	Street 5m	Street 25m	Conc-Plt 5m	Street 5m	Street 25m
0	0	0	0	na	na	na
100	31	48	69	31%	48%	69%
500	97	150	212	19%	30%	42%
1,000	157	243	345	16%	24%	35%
2,500	299	461	655	12%	18%	26%
5,000	485	750	1,065	10%	15%	21%
7,500	645	996	1,414	9%	13%	19%
10,000	789	1,218	1,730	8%	12%	17%
12,500	922	1,424	2,022	7%	11%	16%
15,000	1,048	1,617	2,298	7%	11%	15%
17,000	1,143	1,766	2,508	7%	10%	15%
18,000	1,190	1,838	2,610	7%	10%	15%
19,000	1,236	1,908	2,711	7%	10%	14%
20,000	1,281	1,978	2,810	6%	10%	14%

5. Step 2 Forecasting Average Lift Occupancy

The second step used the results of observations undertaken by surveyors at a sample of lifts. The surveyors recorded the number of passengers entering or exiting the lift. Empty lift movements were also recorded. The time was also recorded at intervals enabling the number of lift travels per hour to be estimated.

The fieldworkers also categorised the lift occupants into different mobility categories. The resultant profile of lift users is presented in section 7.

Surveys were undertaken at twelve stations in May 2009 and April 2010. 35 different lifts were surveyed. Of these 22 were concourse to platform lifts and 13 were street to concourse or street to platform lifts.

A total of 3,345 lift travels were observed. The travels were aggregated by lift and time period. Observations undertaken during the AM and PM peaks (6am-9.30am and 3:00pm-6.30pm) were distinguished from observations made in the off-peak. Most peak observations were made in the morning peak and most off-peak observations were made between 9.30 am and 3pm.

Table 6 summarises the grouped samples. In total 59 samples were obtained; 41 samples were obtained for platform concourse lifts and 18 for street-concourse/platform lifts. Roughly even numbers of peak and off-peak samples were made.

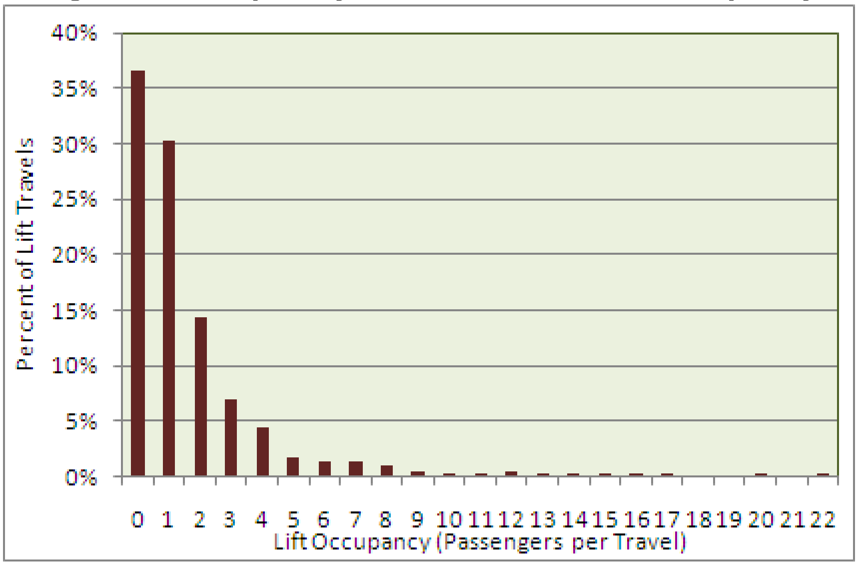
Altogether, lifts were observed for 85 hours with each lift sample typically lasting 86 minutes. The average number of lift travels observed per hour was 39 and was higher at 42 per hour for platform – concourse lifts than for street-concourse lifts (35). More travels per hour were made during the off-peak than the peak especially for platform-concourse lifts although it should be noted that this statistic reflects the particular lifts surveyed. Around 5,400 passengers were observed over the entire survey at a rate of 64 passengers per hour. The average lift occupancy was 1.62 passengers per lift travel and ranged from 1.29 for street-concourse lifts during the off-peak to 1.74 for platform-concourse lifts surveyed during the peak.

Table 6: Lift Occupancy Sample Details

	Platform - Concourse			Street - Concourse/Platform			
Statistic	Peak	Off-Peak	Total	Peak	Off-Peak	Total	TOTAL
Lift Samples	19	22	41	9	9	18	59
Observation Period (hrs)	34	20	54	15	15	31	85
Av Survey Duration (mins)	109	54	79	101	103	102	86
Lift Travels Observed	1,187	1,094	2,281	491	573	1,064	3,345
Lift Travels per Hour	34	55	42	32	37	35	39
Lift Travels per Sample	62	50	56	55	64	59	57
Passengers Observed	2,062	1,771	3,833	835	739	1,574	5,407
Passengers per Hour	60	90	71	55	48	51	64
Passengers per Sample	109	81	93	93	82	87	92
Av Lift Occupancy	1.74	1.62	1.68	1.70	1.29	1.48	1.62

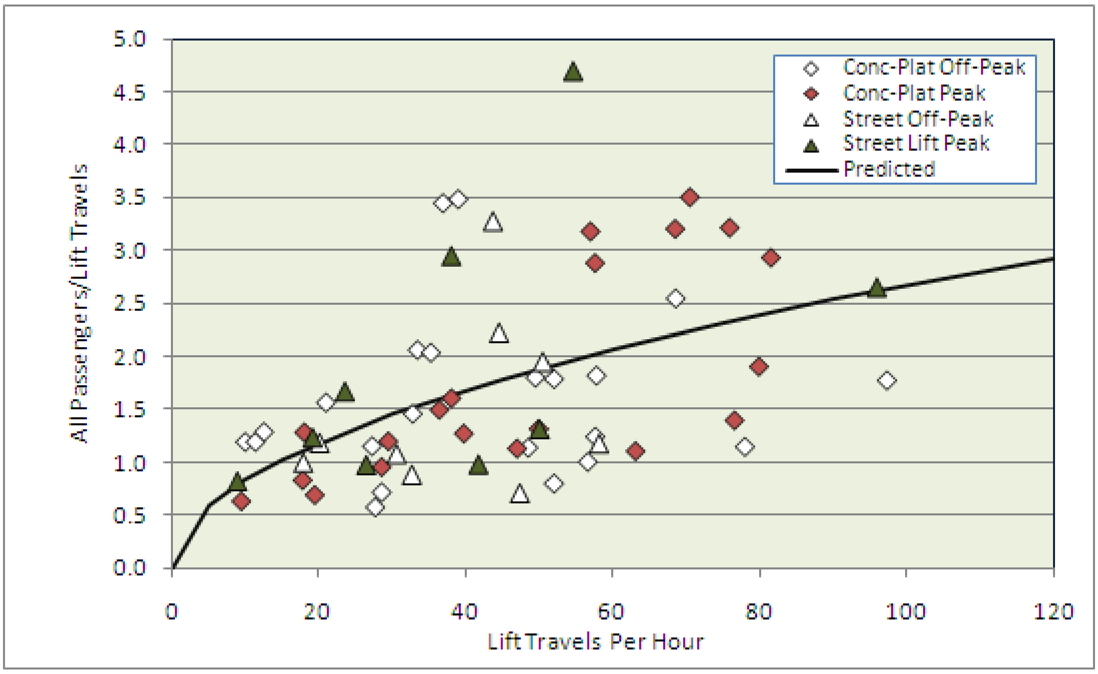
Figure 4 presents a frequency distribution of lift occupancy which shows 37% of the 3,345 lift travels observed were empty, 30% had a single passenger and 14% had two passengers; 19% of travels therefore had an occupancy of three or more passengers with only 2% having ten or more occupants. The highest occupancy was 22.

Figure 4: Frequency Distribution of Lift Occupancy



Average lift occupancy per lift tended to increase with the number of lift travels per hour. The more frequent the lift travelled, the more passengers carried. The relationship was similar for the two lift types and did not vary markedly for peak and off-peak. Figure 5 plots the observations and distinguishes lift type and travel period.

Figure 5: Lift Occupancy with Lift Travels per Hour



As with the lift travel model (equation 1), the prediction model was expressed as a power function with the best fit power found to be 0.5. Thus lift occupancy increases as lifts are more frequently used but at a declining proportional rate. Equation 2 presents the lift occupancy model. Table 7 presents the estimated parameters. Although four models are presented for each lift location – period combination, the overall model is considered sufficiently accurate for forecasting purposes. Table 8 presents the predicted average occupancies and shows lift occupancy to increase from 1.03 at 15 lift travels per hour to 1.85 at 45 lift travels per hour and reach 2.92 at 120 lift travels per hour which is around the maximum number of travels possible.

$$AvOcc = \alpha Lhr^{0.5} \qquad .....(2)$$

Where:
$AvOcc$ = average lift occupancy
Lhr = number of lift travels per hour
α = estimated parameter

Table 7: Predicted Lift Occupancy Models

	Peak		Off-Peak		ALL
	Conc-Plat	Street	Conc-Plat	Street	
Parameter α	0.278	0.322	0.243	0.246	0.267
Standard Error	0.024	0.057	0.027	0.042	0.016
|t| value	11.6	5.6	9.1	5.9	16.7
Observations	19	9	22	9	59

Source: RailCorp, Douglas Economics

Table 8: Predicted Lift Occupancy with Lift Travels per Hour

Lift Travels per Hour	Average Lift Occupancy	Lift Travels per Hour	Average Lift Occupancy
0	0.00	40	1.65
5	0.47	60	2.10
10	0.72	80	2.50
15	0.91	90	2.68
20	1.09	100	2.85
30	1.39	120	3.18

6. Step 3 Forecasting Lift Patronage

Steps 1 and 2 were produced for different time periods. Step 1 forecast lift travels for an average annual day whereas step 2 forecast lift occupancy per hour.

In step 3, station entry and exit counts is presented which can be used to convert the lift travels forecast (step 1) to an average weekday.

Table 9 presents the profile of rail patronage for different days of the week based on RailCorp station entry and exit counts. Saturday and Sunday counts are undertaken less often than weekday and are not reported for each station. Standard factors taken from the CityRail Compendium were used to calculate weekend patronage. From the table it can be seen that weekdays account for 88.1% of week patronage. Saturday accounts for 6.8% and Sunday 5.1%.

Table 9: Patronage Factors by Day of Week

Period	Percent	Notes
Average Day (%)	14.29	100 divided by 7 days
Saturday (%)	6.80	RailCorp Compendium
Sunday (%)	5.10	RailCorp Compendium
Weekday (%)	88.10	100-(Sat + Sun %)
Av Weekday (%)	17.62	Weekday % divided by 5 days
Weekday Factor	1.233	Average Weekday / Average Day
Average Day Factor	0.811	1/Weekday factor
Saturday Factor	0.476	Saturday % / Average Day %
Sunday Factor	0.357	Sunday % / Average Day %

Thus to convert an average annual day to an average weekday, the average day count would be multiplied by 1.233. Conversely, an average weekday count would be multiplied by 0.811 to get the average number of entry and exits on an annual average day.

So if a station has a throughput of 5,000 (entries + exits) per weekday, the average annual weekday throughput would be 4,055.

If there were two platform groups at the station, the annual average throughput per platform group would halved to 2,028.

For a 5 metre concourse-platform lift, the forecast number of lift travels using equation 1 (β of 1.25) would be 258 per average annual day per platform group. To convert this figure to a weekday, the estimate of 258 would be multiplied by the weekday factor of 1.233 to give a forecast of 318 travels per weekday for each of the two concourse - platform lifts.

The weekday total needs to be converted into hourly totals to determine the number of lift passenger trips. RailCorp divides the weekday into five periods as listed in Table 10. Two thirds of trips are made in the peak, split evenly between the AM 06:00-09:30 and the PM peak 15:00-18:30; 21% of trips are made in the off-peak 09:30-15:00 with 11% made in the evening 18:30-02:00 and 2% in the early AM. Also presented in Table 10 are the hours for each time period. The figures are 'effective' hours after deduction for station closure or negligible use before 4am and after 11pm.

Table 10: Rail Patronage Share by Period

RailCorp 2009 Weekday Data

	Early AM 02:00 to 06:00	AM Peak 06:00 to 09:30	Off-Peak 09:30 to 15:00	PM Peak 15:00 to 18:30	Evening 18:30 to 02:00	Total
Mean %	2%	33%	21%	33%	11%	100%
Hours	2	3.5	5.5	3.5	4.5	19

Source: RailCorp, Douglas Economics Analysis, (293 stations T'put>0)

Table 11 applies the patronage share and hour data to the example lift forecast to make 318 travels per weekday. The daily lift travels are allocated to each period based on the patronage share. Thus 6 lift travels are forecast to be made in the early AM period (0.02 x 318). The total lift travels per period are then converted into hourly figures. Thus there are 3 lift trips per hour in the early AM peak (6 / 2 hours).

The lift occupancy model (equation 2) is then applied to the hourly lift travels forecast using a parameter of 0.267 in Table 7 (the parameter for the 'all' observation model). For the early AM, the average lift occupancy is forecast at 0.348 which results in 2 lift trips (0.348 x 6 lift travels).

The lift patronage forecasts over all five individual time periods are then summed to give a weekday lift use of 370 trips.

Table 11: Lift Patronage Forecast

For a lift making 318 Travels per Weekday

	Forecast Lift Travels		Forecast Lift Patronage	
Weekday Period	Per Period	Per Hour	Pax/Lift	Lift Trips
Early AM 02:00 to 06:00	6	3.0	0.348	2
AM Peak 06:00 to 09:30	107	30.5	1.398	149
Off-Peak 09:30 to 15:00	67	12.1	0.803	53
PM Peak 15:00 to 18:30	105	29.9	1.381	144
Evening 18:30 to 02:00	35	7.7	0.613	21
Weekday	318	16.8	1.163	370

It should be noted that the average weekday lift occupancy of 1.163 was not produced using the average of 16.8 lift travels per hour. Instead, it was calculated by dividing total lift patronage (370) by total lift travels (318). Had the average lift travels per hour been used, lift occupancy (0.977) and lift patronage (311) would have been under forecast.

7. Step 4 - Lift Patronage by Mobility Category

The main aim of installing lifts at rail stations is provide ‘easy access’ for passengers with mobility problems especially wheelchair passengers.

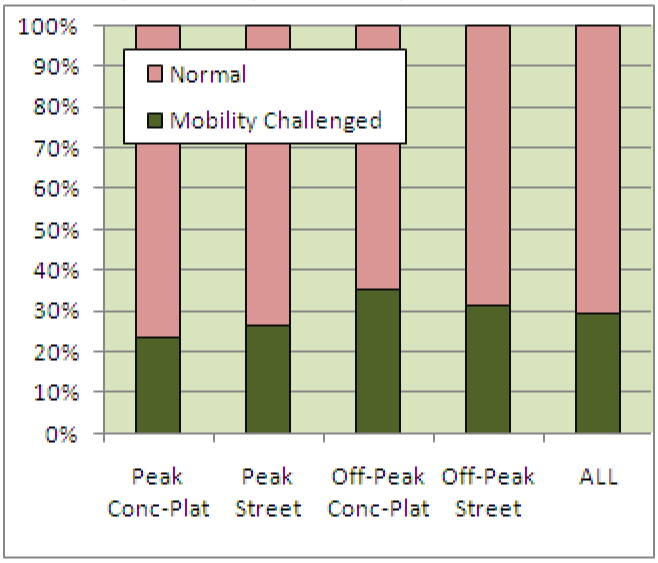
As well as counting the total number of passenger using lifts, the observation survey classified users into mobility categories. Table 12 presents the percentage by mobility category and Figure 6 presents a histogram of the mobility challenged percentage by lift location and time period. The percentages in Table 12 were calculated as the mean of the unweighted sample percentages.

Table 12: Profile of Lift Usage

Percentage of Lift Patronage by Mobility Category

	Peak		Off-Peak		
Mobility Category	Conc-Plat	Street	Conc-Plat	Street	ALL
Wheelchair Passenger	0.8	0.3	0.3	0.4	0.5
Passenger with Strollers	4.7	4.3	7.4	10.1	6.5
Passenger with Baby in Arms	0.4	1.1	0.7	0.9	0.7
Passenger with Bicycle	0.8	1.2	1.2	1.5	1.1
Passenger with Heavy Luggage	6.0	3.5	7.9	1.9	5.7
Blind	0.1	0.1	0.0	0.1	0.1
Old/Infirm	9.4	14.2	15.3	14.5	13.1
Staff with Luggage	1.5	1.7	2.0	1.8	1.8
Total Mobility Challenged Passengers	23.6	26.4	35.0	31.2	29.4
Normal Mobility Passengers	76.4	73.6	65.0	68.8	70.6
Passengers Counted	2,062	835	1,678	739	5,314
Lift Travels Observed	1,187	491	1,044	573	3,295
Empty Lift Travels	428	188	360	210	1,186

Figure 6: Lift Use by Mobility Challenged and ‘Normal’ Passengers



The percentage of lift users who were classified as mobility challenged (MC) ranged from 22.6% to 35%. The lowest percentage was for concourse – platform lifts used during the AM or PM peaks. The highest percentage was for concourse – platform lifts used during the off-peak. Lift users classified as old or infirm were the dominant MC category accounting for 9.4% to 15.3% of lift usage. Passengers with strollers (or prams) and passengers with heavy luggage were the next biggest users groups. Staff with luggage were included in the survey but it should be noted that these lift users are not rail passengers as such and will also not be included in barrier counts.

Few wheelchair passengers were counted; only 23 over the 85 hours of surveys. As a percentage of all lift patronage, wheelchair passengers averaged 0.5% with the highest percentage of 0.8% obtained for peak use of concourse – platform lifts.

Regression models were tested to see whether lift use by mobility category could be explained in terms of the lift travels per hour. However, the models were judged not to provide improve the predictive power over the average profiles presented in Table 12.

To produce a forecast of lift use by mobility category, the percentages in Table 12 need to be multiplied by total lift use as forecast in Table 11. The AM and PM Peak periods use the peak mobility category percentages and the other periods use the off-peak percentages. The resultant forecast for the example concourse – platform lift described in section 7 is presented in Table 12. Of the 370 lift trips, 269 (72.6%) were forecast to be made by passengers with normal mobility. 101 lift trips were forecast to be made by mobility challenged passengers. Of these lift trips, 53 would be made by old or infirm passengers, 20 by passengers with strollers and 12 with passengers with heavy luggage. One trip by a passenger in a wheelchair is forecast.

Table 13: Forecast Lift Usage by Mobility Category for an Example lift

Concourse-platform lift Weekday Use at a Station
with 2 platform groups & 5,000 Weekday Entries & Exits

Mobility Category	Trips per Weekday	Trip Percentage
Wheelchair Passenger	1	0.3%
Passenger with Strollers	20	5.5%
Passenger with Baby in Arms	4	1.1%
Passenger with Bicycle	5	1.2%
Passenger with Heavy Luggage	12	3.2%
Blind	0	0.1%
Old/Infirm	53	14.2%
Staff with Luggage	6	1.7%
Total Mobility Challenged Passengers	101	27.4%
Normal Mobility Passengers	269	72.6%
Total Lift Patronage	370	100.0%

8. Conclusions

Over the last two decades 1990-2010, passenger lifts have been introduced into a third of rail stations in the greater Sydney metropolitan rail network to provide ‘easy access’ for disabled passengers and passengers with mobility problems. Published research has focussed on the monetary benefit of lifts. No published work was found on forecasting the use of lifts by mobility category.

A four step method using automatic lift counts supplemented by observation surveys has been developed to produce ‘rule of thumb’ forecasts for passenger lifts. The first step used automatic lift ‘travel’ count data for 43 lifts (16% of the total number of lifts in service) that record the number of times lifts move up or down. The advantage of this approach was that data for long time periods (430 days over the total sample of lifts) was obtained at minimal cost by ‘piggy

backing' on lift maintenance activities. The drawbacks were that lift travels and not lift patronage was recorded. Also lift travels were not recorded by time period (e.g. such as peak / off-peak). Future work could explore the use of longer data periods and the disaggregation of count data by time period.
Station entry and exit counts compiled annually by RailCorp were used to explain the number of lift travels. The model took into account lift height and lift location (platform-concourse or street-station). Street-station lifts tended to be used more frequently than concourse-platform lifts. For a barrier throughput of 1,000 passengers, a 5 metre concourse-platform lift was forecast to travel 157 times per day compared to 243 times for a concourse - street lift of similar height.

Step 2 was based on 3,345 lift occupancy observations covering 35 lifts. Lift occupancy increased with the number of lift travels per hour: the more frequent the lift travelled, the more passengers carried. The fitted model predicted average lift occupancy to increase from 1.03 at 15 lift travels per hour to 1.85 at 45 lift travels per hour and reach 2.92 at 120 lift travels per hour which is around the maximum number of travels possible.

Step 3 used barrier count data to disaggregate the lift travel model (step 1) which produced average day forecasts into hourly forecasts; this enabled the lift occupancy model (step 2) to be applied.

Step 4 disaggregated lift use by mobility category. A total of 3,295 lift users were observed and classified into one of nine mobility categories. Categories included wheelchair passengers; passengers with strollers; passengers with heavy luggage; elderly/infirm passengers; RailCorp staff with equipment or luggage; and, passengers who were considered to have normal mobility.

Most lift users (71%) were classified as 'normal mobility' with 29% classified as 'mobility challenged' (MC). Proportionately less MC passengers used lifts during the peak with no marked difference between concourse and street lifts. Old or infirm passengers were the dominant MC category accounting for 9% to 15% of lift usage. Passengers with strollers (or prams) and passengers with heavy luggage were the next biggest users groups. 23 wheelchair passengers were counted representing 0.5% of total lift users.

The model has been used as a guide to assess the likely patronage of proposed new lifts at rail stations in Sydney and as a basis of forecasting the economic benefit of lifts. The attraction of the model is its simple data requirement. Only station entry and exit figures are required and for Sydney this data is readily available. As the paper has shown however, actual use varies around the estimated functions reflecting patronage mix and the individual characteristics of the stations involved. Applying the model to other rail systems could provide a benchmark although usage is likely to be affected further by additional factors such as the availability of lifts over the network as a whole and the 'ease of access' over the whole journey experience.

References

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