Rail Links and Sydney's Airports
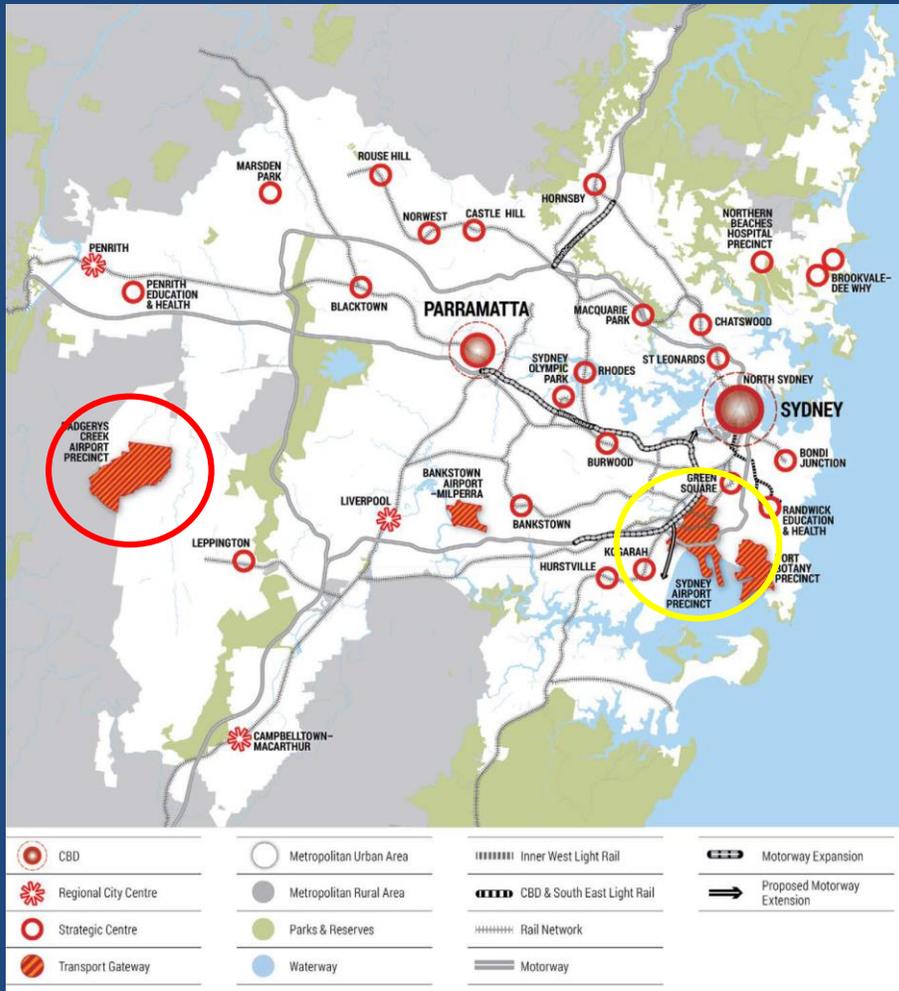
by

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Source: http://www.planning.nsw.gov.au/~/media/Files/DPE/Plans-and-policies/a-plan-for-growing-sydney-2014-12.ashx

- Metro Sydney has a large and diffuse rail system that is focussed on the Sydney CBD - see figure;
- **Sydney Airport (SYD)** is about 8-9 km south of CBD;
- **SYD** Accessible by both major and minor road links in all directions except northwest (being addressed by West Connex)
- **SYD** is accessible by all rail services with not more than one interchange from all the rail network at Wolli Creek or Central;
- Not a dedicated rail link and operates standard double-decker trains;
- Two stations serve the Airport – Domestic and International; and Wolli Creek is an adjacent interchange station;
- **Proposed Western Sydney Airport (WSA)** at Badgerys Creek is 43 kms (As the crow flies = ATCF) west of **SYD;**
- **WSA** is about 11kms (ATCF) from existing railhead at Leppington;
- Sample distances (ATCF) from **WSA** are: CBD 41kms; Penrith 16 kms; Campbelltown 21 kms; Parramatta 24 kms; Norwest 25kms; Bankstown 18.7 kms; Liverpool 16kms; St Leonards 41kms; Blacktown 18 kms;
- Nearest points of connection to rail from **WSA** are Leppington (SWRL); Liverpool (Main South) and St Marys (or Werrington) (Main West)
- <u>Key Question: What market should a rail link to **WSA** seek to serve?</u>

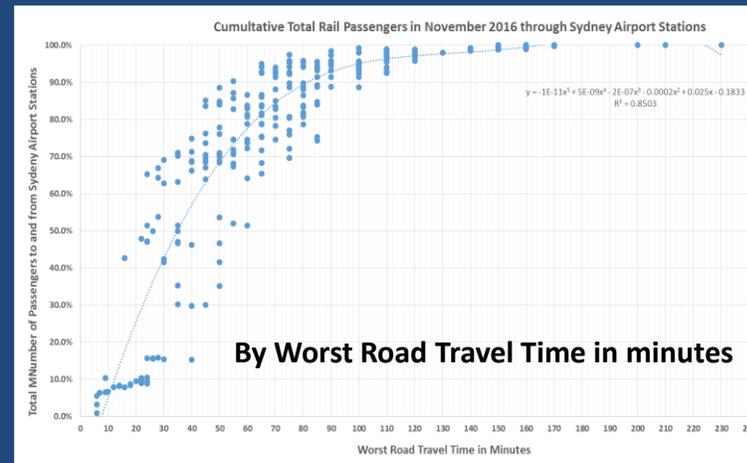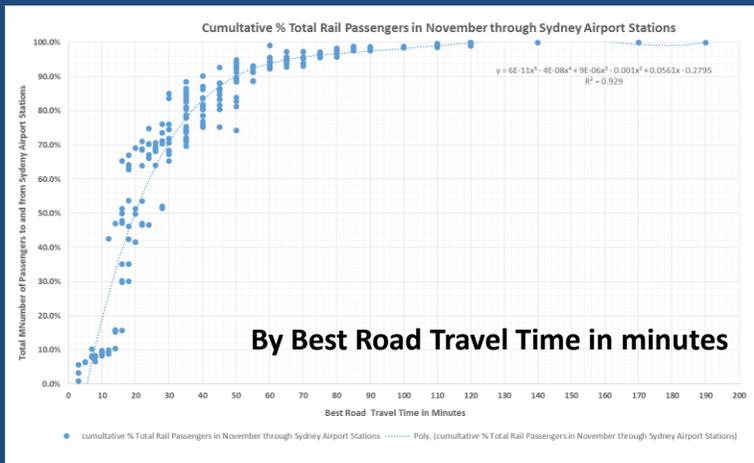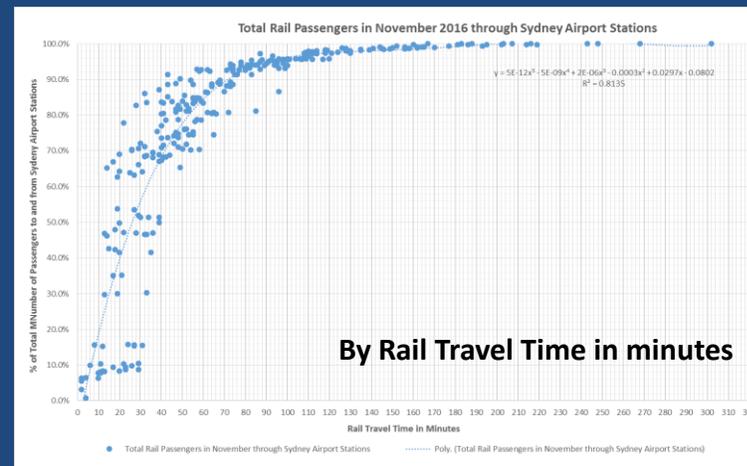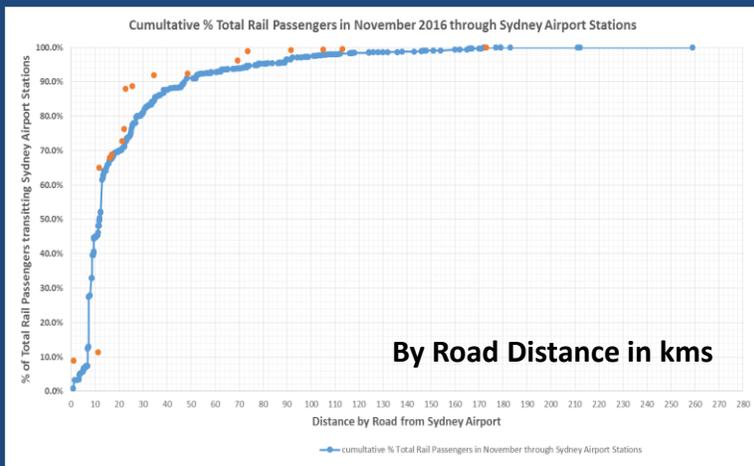# Based on international experience, successful airport railways have:

- Service frequency, efficiency and travel time – clear service dimensions that are superior to alternatives;

- Preferably not a hybrid suburban service but a clearly dedicated Airport service;

- Ease of pedestrian access at both the airport and at their origin or destination – low *"friction"* i.e. no steps, stairs, elevators escalators, tunnels; long walk distances;

- Image and style - dedicated branded rolling stock with seat availability - not crowded suburban rolling stock;

- Good connectivity to other modes and services;

- Good ticket price relative to alternatives;

- Usefulness of origin/destination of the service i.e. how well it addressed an airport terminal and the major destination e.g. CBD station;

- Comfort factors generally and seat availability;

- Understand-ability of what the service does and how much better it is than alternatives;

- Find-ability and Visibility of the service at Airport and at Key destinations;

- Service Profile - Information at the airport, information on the train and generally in the community;

- Accessible to the key sources of OD's for that airport.

Sydney Trains Network

Sydney Airport Stations - International and Domestic

http://www.bouygues-construction.com.au/project/sydney-airport-link/

https://www.airportlink.com.au/trip-information/locations/

- Built as an integral part of the Sydney Rail network; not as stand alone dedicated airport railway;
- Accordingly, it incidentally serves the airport rather than it being the prime / origin destination;
- Built as a PPP in which the private consortium financed and built 4 stations and were paid by Government to build the tunnels and rail systems and a fifth station at Wolli Creek Junction; Consortium was awarded a long term maintenance contract for the entire project.
- Built on time and on budget but issues with the line include: airport stations could not be linked optimally to concourses due to the constraints of the existing airport; rolling stock is not as well suited to travellers with luggage; trains are often crowded with commuters; patronage levels were slow to ramp up and the project failed financially; a single twin track tunnel has caused issues with capacity due to FLS considerations; Some lack of a CBD address; But very successful as an engineering project;
- Has been sold by original Consortium at a loss – but now profitable;
- Probably would attract more patrons if fares lowered – but majority of barrier revenues are now flowing to Govt anyway, patronage is now at around 15 -16 % of passenger movements and is increasing and the railway is increasingly important as road congestion increases around the airport.

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Sydney Airport Rail Link

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Cumulative % Total Rail Passengers in November 2016 through Sydney Airport Stations

By Road Distance in kms

Total Rail Passengers in November 2016 through Sydney Airport Stations

$y = 5E\text{-}12x^5 - 5E\text{-}09x^4 + 2E\text{-}06x^3 - 0.0003x^2 + 0.0297x - 0.0802$
$R^2 = 0.8135$

By Rail Travel Time in minutes

Cumulative % Total Rail Passengers in November through Sydney Airport Stations

$y = 6E\text{-}11x^5 - 4E\text{-}08x^4 + 9E\text{-}06x^3 - 0.001x^2 + 0.0561x - 0.2795$
$R^2 = 0.929$

By Best Road Travel Time in minutes

Cumulative Total Rail Passengers in November 2016 through Sydney Airport Stations

$y = -1E\text{-}11x^5 + 5E\text{-}09x^4 - 2E\text{-}07x^3 - 0.0002x^2 + 0.025x - 0.1833$
$R^2 = 0.8503$

By Worst Road Travel Time in minutes

% of Total Rail Passengers	Best Rail time mins	Best Road time mins	Worst Road time mins	Road Distance kms
~50%	~26	~20	~35	~12
~90%	~72	~50	~80	~48
100%	~180	~120	~170	~180
Average for 287 stations	~75	~52	~77	~57

- TfNSW supplied O-D data from 287 Opal card enabled stations for month of November 2016;
- Total monthly movements of ~700,000;
- Does not differentiate between travellers and workers;
- Excluding internal transfers between International and domestic Stations;
- Road and rail travel times for about 5pm derived from *Google Maps* and *Rome to Rio* websites;

Graphs show % of total rail passengers passing through Airport Stations

- **Top ten stations, generating 52% of movements, are Central; Circular Quay Station; Wynyard; Town Hall; Museum; St James; Kings Cross; Parramatta; North Sydney; and Bondi Jctn. i.e. all <u>CBD employment and hotel district stations</u>, mostly unidirectional from airport and accessible via Airport Rail Link with maximum one interchange i.e. mostly within 12kms of the airport.**

Rail Links and Sydney's Airports © Transportation Associates

Analysis of Opal Card O - D Data for Sydney Airport Stations

Transportation Associates

Sources Transportation Associates analysis based on data originally assembled by IARO (IARO Report 18.13: Forecasting Air-Rail Author: Paul Le Blond), GARA and internet research

Key Points
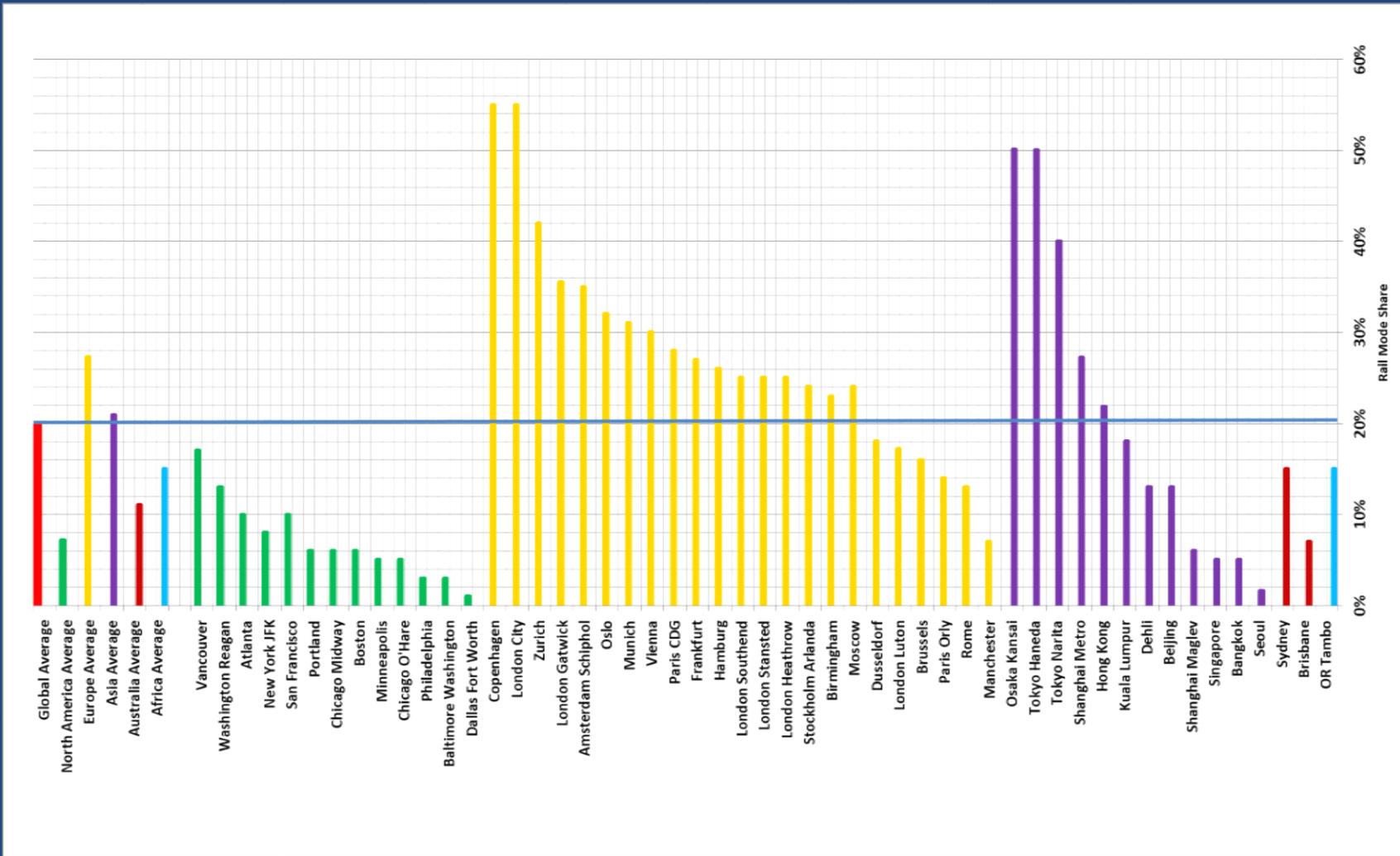
- European Airport Rail links attract both the highest and highest average mode shares;
- Followed by Asia and then Africa and Australia;
- North American Airport Rail links especially US airports attract the lowest average and virtually all the lowest mode shares;
- But within every continent there is major variability in modes share to rail;
- European airports generally lie above the global average of 20% mode share;

Conclusion:

- European travellers generally have a bias towards rail transport. US travellers much less so i.e. culture is important

Rail Links and Sydney's Airports
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International Air Rail Organisation Data Reanalysed
Mode Share to Rail for 51 Airport Rail links on 5 Continents

Transportation
A s s o c i a t e s

Research undertaken by Transportation Associates Pty Ltd

See:http://www.transportationassociates.com.au/files/IARO%20Presentation%20WashingtonV5.pdf

Multi-Factor Linear Regression Factors

Selected as likely to be influential and data available:

- Road distance to Common Downtown location (kms);

- Best Road Time to Common Downtown Location (mins);

- Worst Road Time to Common Downtown Location (mins);

- Rail Time to a Common Downtown location (mins);

- Rail Headway (mins);

- Taxi Fare - Parity Price in 2014 USD;

- Airport Parking (best available price for parking for 24 hours short stay at airport) in USD 2014 parity currency;

- Rail Fare - Parity Cost in 2014 USD.

- Africa - OR Tambo;

- Australia - Brisbane; Sydney

- Asia - Seoul; Bangkok; Singapore; Shanghai Maglev; Beijing; Delhi; Kuala Lumpur; Hong Kong; Shanghai Metro; Tokyo Narita; Tokyo Haneda; Osaka Kansai;

- Europe - Manchester; Rome; Paris Orly; Brussels; London Luton; Dusseldorf; Moscow; Birmingham; Stockholm Arlanda; London Heathrow; London Stansted; London Southend; Hamburg; Frankfurt; Paris CDG; Vienna; Munich; Oslo; Amsterdam Schiphol; London Gatwick; Zurich; London City; Copenhagen;

- North America - Dallas Fort Worth; Baltimore -Washington; Philadelphia; Chicago O'Hare; Minneapolis; Boston; Chicago Midway; Portland; San Francisco; New York JFK; Atlanta; Washington Reagan; Vancouver

- Complex task to acquire reliable and consistent data; any conclusions must be judged in that light;

- Linear regression analysis does not yield highly correlated trends due to the high degree of scatter on almost all dimensions assessed – forecasts from models are interesting, indicative and instructive in the absence of anything better but not investment grade;

- Market share for airport rail links around the world is seemingly most influenced by cultural attitude to use of rail transport – no airport link in North America, Australia or Africa exceeds 20% mode share; some do in Asia and many do in Europe;

- Rail's global average market share of ground transportation is about 20%;

- The top 24 airports in the world which all exceed a mode split of 20%, averaged 30%;

- In summary:

  o a well-connected airport rail link in a country where people are already well used to using public transport ought to be able to achieve at least 20% and possibly up to 30% of market share of the airport's total passengers.

  o In North America, an airport rail link is doing ok if it exceeds 7% - many don't! - and will be doing really well if it achieves the global average of about 20% mode share of total airport passengers.

  o Australia's airport rail links perform better than almost all north American links but not as well as most European or Asian airport rail links. However, as congestion increases around the current airports in Sydney and Brisbane, rail link patronage is slowly increasing;

	Linear Regression Coefficients	
	Intercept	No intercept
Model 1		
Intercept	0.188	0.000
Best Road Time to Common Downtown Location (mins)	0.007	0.011
Worst Road Time to Common Downtown Location (mins)	-0.004	-0.004
Rail Time to a Common Downtown location (mins)	-0.002	-0.003
Headway (mins)	-0.003	0.001
Taxi Fare Parity Price in 2014 USD	0.002	0.001
Airport Parking (best available price for parking for 24 hours short stay at airport) in USD 2014 parity currency	0.001	0.003
Rail Fare Parity Cost in 2014 USD (TfNSW Opal One way Single)	-0.004	-0.005
Model 2		
Intercept	0.146	0.000
Road distance to Common Downtown location (kms)	-0.004	-0.006
Best Road Time to Common Downtown Location (mins)	0.013	0.018
Worst Road Time to Common Downtown Location (mins)	-0.005	-0.005
Rail Time to a Common Downtown location (mins)	-0.001	-0.001
Headway (mins)	-0.001	0.002
Taxi Fare Parity Price in 2014 USD	0.002	0.001
Airport Parking (best available price for parking for 24 hours short stay at airport) in USD 2014 parity currency	0.001	0.002
Rail Fare Parity Cost in 2014 USD	-0.004	-0.005
Model 3		
Taxi Fare Parity Price in 2014 USD	0.002	0.002
Airport Parking (best available price for parking for 24 hours short stay at airport) in USD 2014 parity currency	0.003	0.003
Rail Fare Parity Cost in 2014 USD	-0.002	-0.002

Global Airport Rail Links Analysed

- Regression Model based on 51 airport rail links world wide;
- Assumed a single destination/origin for airport rail users
- All cost converted on a parity price basis to USD2014;
- Three basic models derived – with and without intercept and costs only;
- Models applied to **SYD** to Sydney CBD suggest % of total airport passengers using rail as:

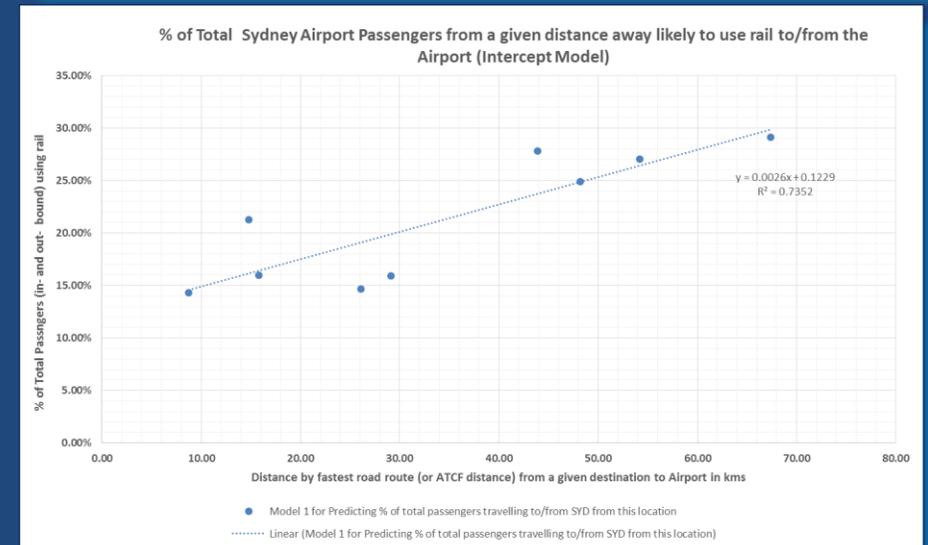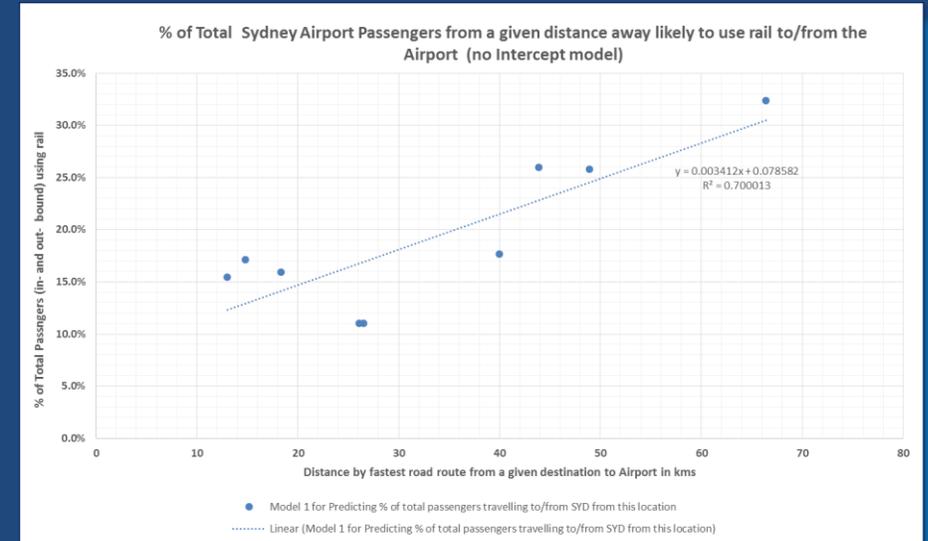| Model	Intercept	No intercept
1	14.29%	15.45%
2	14.58%	19.60%
3	16.05%	16.05%

- I.e. all of a similar order and compare reasonably to actual of about 15% in 2012 and projected 17% in 2017.

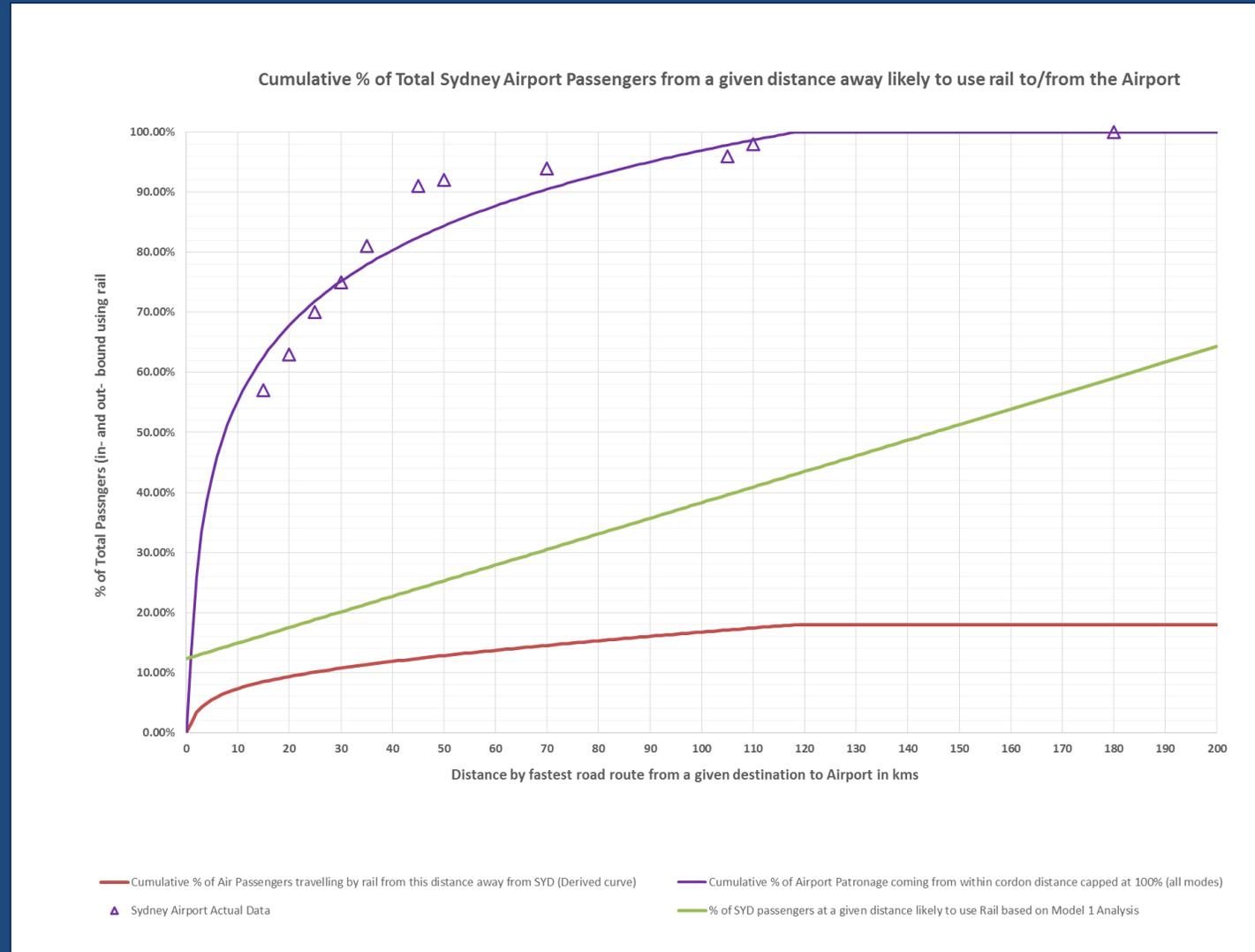| Location	Predicting % of total passengers travelling to/from SYD from this location		
	No intercept - Model 1	Intercept – Model 1	Road Distance in kms
Sydney CBD to SYD	15.45%	14.29%	13.00
Penrith to SYD	32.4%	29.1%	66.40
Campbelltown To SYD	26.00%	27.81%	43.90
Parramatta to SYD	11.0%	15.9%	26.50
St Leonards to SYD	16%	16%	18.30
NorWest Business Park to SYD	25.8%	24.9%	48.90
Bankstown to SYD	17.1%	21.3%	14.80
Liverpool to SYD	11.0%	14.7%	26.10
Blacktown to SYD	17.7%	27.0%	40.00

Key points

- Applying the Global model to Sydney can assist in predicting the usage of rail as surface transport;
- Propensity of passengers to travel by rail to **SYD** is different for locations at different distances from **SYD**;
- Both models are similar – **adopt the intercept model**;
- Accordingly need to understand where **SYD's** passengers come from in order to apply such propensity to use rail to determine % of total passengers likely to use rail;

% of Total Sydney Airport Passengers from a given distance away likely to use rail to/from the Airport (no Intercept model)

$y = 0.003412x + 0.078582$
$R^2 = 0.700013$

% of Total Sydney Airport Passengers from a given distance away likely to use rail to/from the Airport (Intercept Model)
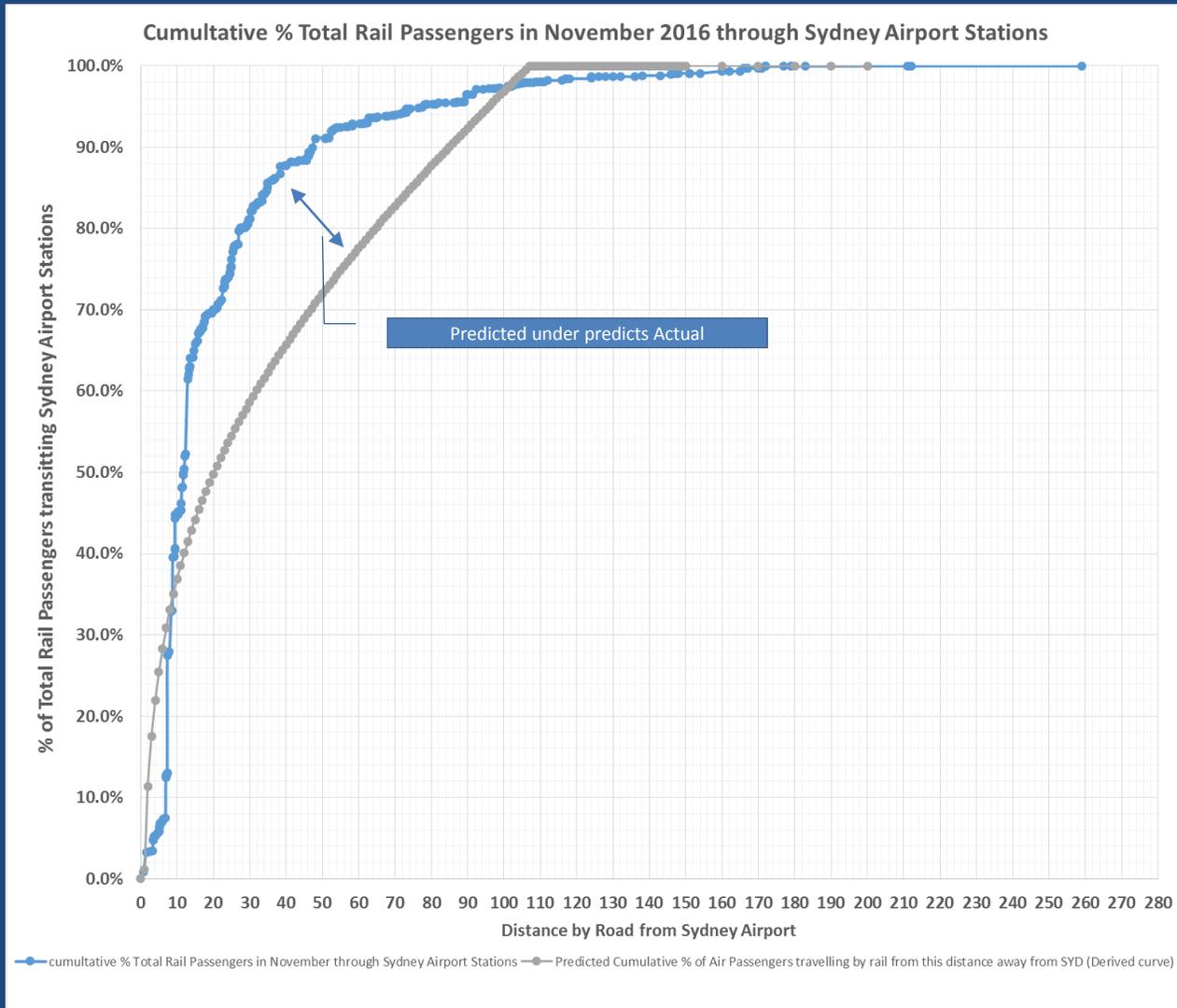
$y = 0.0026x + 0.1229$
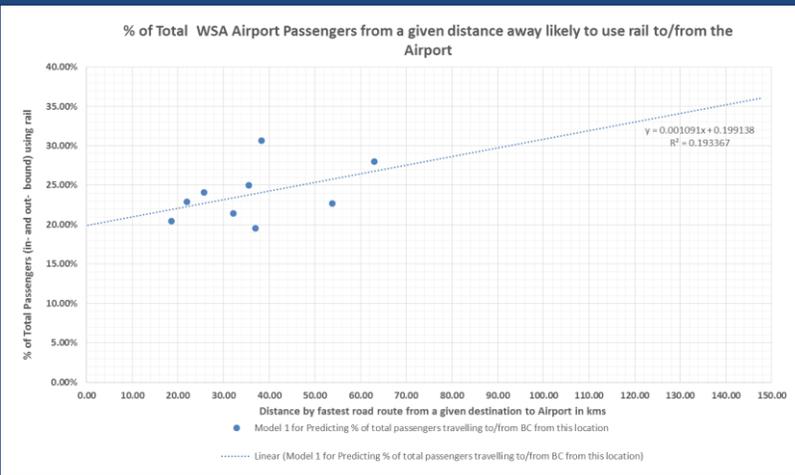$R^2 = 0.7352$

SYD's Rail Link – Predicted

- So can this be used to predict the number of passengers passing through **SYD** that use rail for access and egress?
- The Purple curve shows the actual distribution of **SYD's** passengers and the distances they travel, sourced from the Airport's Masterplan and Ground Travel Plan;
- More than 50% of all passengers are travel only about 10 kms and 90% are with in 70 kms;
- The green curve shows the % propensity of airport passengers to use rail as the mode of access transport based on the global analysis;
- Clearly while the number of people travel reduces there is a higher propensity to use rail;
- The red line of the product of the purple and the green lines and shows the % of air passengers predicted to use rail as their mode of transport to and from the airport and the distances that they are prepared to travel;
- The aggregate % is predicted to be about 18% which compares reasonable with the current actual of around 15%.

Cumulative % of Total Sydney Airport Passengers from a given distance away likely to use rail to/from the Airport

(x-axis) Distance by fastest road route from a given destination to Airport in kms

(y-axis) % of Total Passengers (in- and out- bound using rail)

— Cumulative % of Air Passengers travelling by rail from this distance away from SYD (Derived curve)
— Cumulative % of Airport Patronage coming from within cordon distance capped at 100% (all modes)
△ Sydney Airport Actual Data
— % of SYD passengers at a given distance likely to use Rail based on Model 1 Analysis

Source of Sydney Airport Patrons and Predicted use of Rail

Transportation Associates

Cumulative % Total Rail Passengers in November 2016 through Sydney Airport Stations

Predicted under predicts Actual

cumulative % Total Rail Passengers in November through Sydney Airport Stations ●— Predicted Cumulative % of Air Passengers travelling by rail from this distance away from SYD (Derived curve)

- Comparison of actual rail passenger transiting the two airport stations (blue) with the predicted rail passengers (gray);

- Important note – the actual data <u>does not differentiate</u> between airport passengers and airport workers – purely Opal card tap ons and offs;

- Curves are similar but predicted curve significantly under predicts in the range 12 kms to 90 kms from **SYD** airport;

- 90% of actual rail passengers are within about 50kms;

- Most can access the airport with one rail interchange at Central or Wolli Creek;

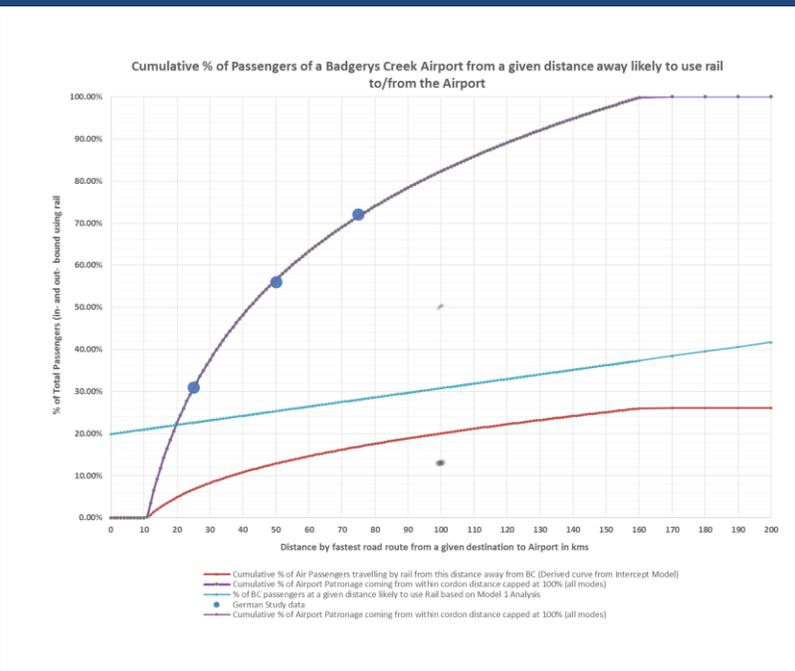- Shows that **SYD**'s market even for rail passengers is tightly drawn around the airport.

% of Total WSA Airport Passengers from a given distance away likely to use rail to/from the Airport

$y = 0.001091x + 0.199138$
$R^2 = 0.193367$

Cumulative % of Passengers of a Badgerys Creek Airport from a given distance away likely to use rail to/from the Airport

Predicting % of total passengers travelling to/from WSA from this location	Intercept – Model 1	Road Distance in kms
Sydney CBD to WSA	22.71%	53.80
Penrith to WSA	22.9%	22.00
Campbelltown To WSA	24.97%	35.50
Parramatta to WSA	21.4%	32.10
St Leonards to WSA	28.0%	63.00
NorWest Business Park to WSA	30.6%	38.30
Bankstown to WSA	19.5%	37.00
Liverpool to WSA	20.5%	18.60
Blacktown to WSA	24.1%	25.70

Sydney Airport Stations - International and Domestic

Western Sydney Airport at Badgerys Creek

WSA's Rail Link (s) – Predicted Patronage

- So can this approach be used to predict the usage of rail at a **WSA** at Badgerys Creek?
- First problem – no historical data about how far passengers are prepared to travel to an airport **where there is a choice**!
- **Very limited data** but one study in Germany provided some insights, having many available airports within driving distances (grey curve extrapolates form this);
- Using the global data, a prediction can be made on the likelihood of passengers to use rail – using a set of relevant points in the metro area as possible sources and being at different distances (light blue line) – but there are many assumptions, especially rail travel times;
- These vary according to whether an extension of the suburban /metro system or new fast rail links
- The product of these gives the % propensity of airport passengers to use rail – and in aggregate this is about 26%; which is significantly higher than for Sydney airport;
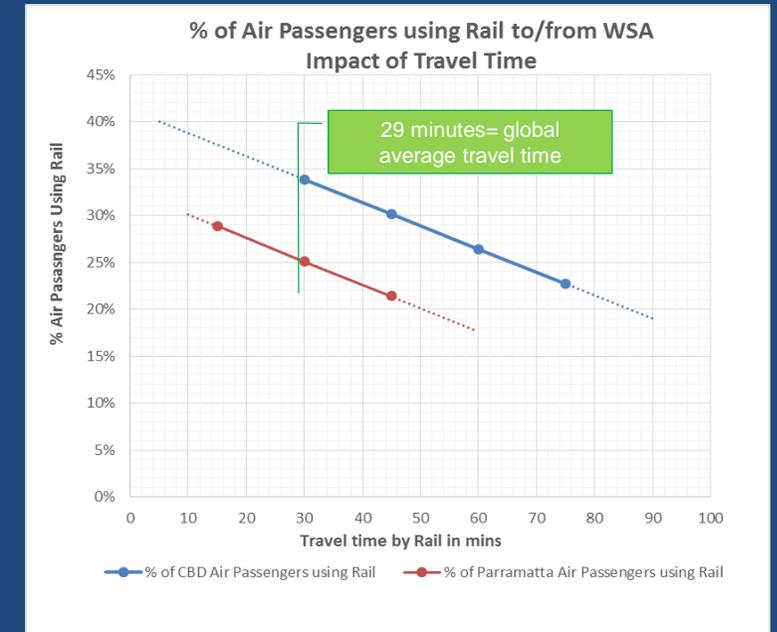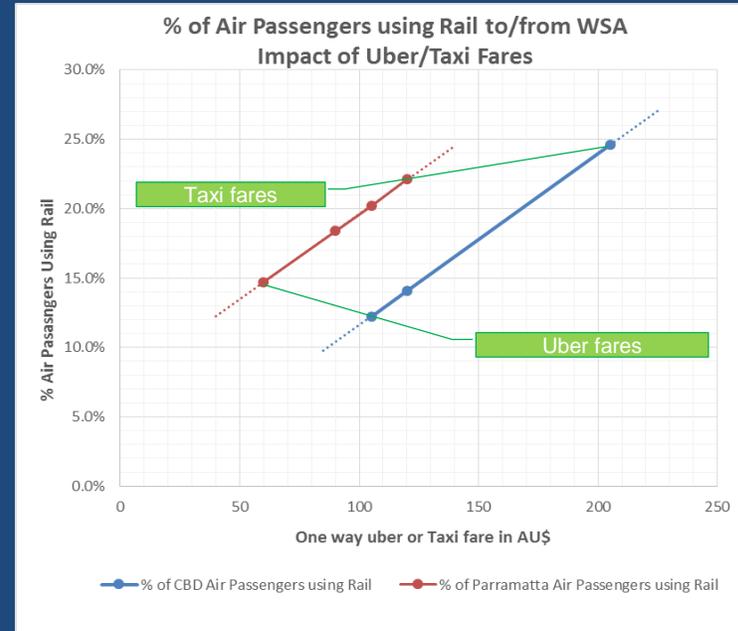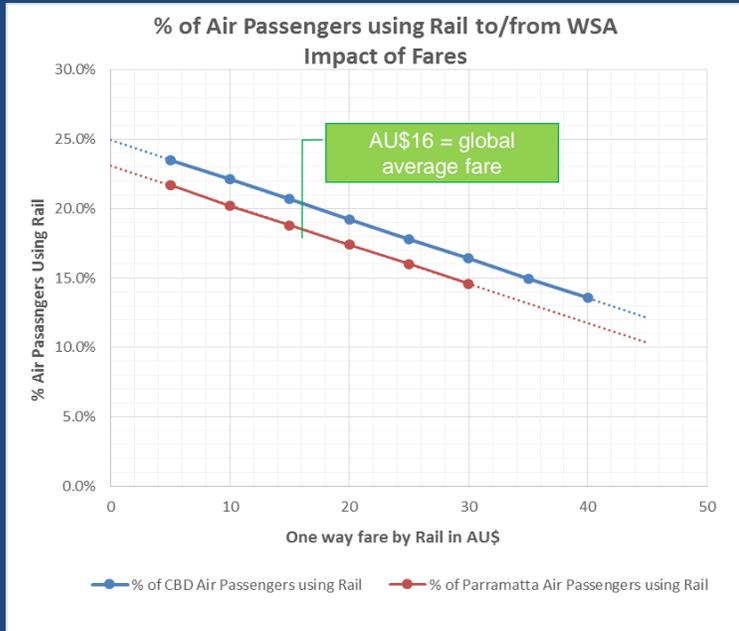
Cumulative Predicted % of those Airport Passengers who will travel by Rail at a Western Sydney Airport at Badgerys Creek Airport to/from a given distance.

60 kms
50 kms **56%**
40 kms **50%**
30 kms **42%**
20 kms **32%**
10 kms **19%**
0%

% of total rail passengers at inside this distance from WSA

- The blue line shows a derived rail demand curve for **WSA** passengers; the red line shows the same for **SYD** as previously presented;
- Driven by principally by the shape of the German data curve, the curve for **WSA** suggests that passengers will travel further by rail to access **WSA** than they would for **SYD** – possibly because of the greater choice that will exist in a two airport system. But more obviously – because they have to!

- But also unlike **SYD** there is no massive population with 12 CBD stations within 10-15 kms – closest is Penrith at 22kms (although about 18 kms ATCF); Liverpool 18.6 kms (ATCF 16.1) – which supports the need to draw from greater distances.
- Note that unlike the rail connections to Sydney Airport, which require at most one transfer, some may require more than one to access **WSA** – a significant constraint on desirability of a rail service.
- Accordingly, the distribution spatially of **WSA** rail passengers may be more distorted to certain corridors in which the most direct rail services lie.

% of Air Passengers using Rail to/from WSA — Impact of Fares

AU$16 = global average fare

% of Air Passengers using Rail to/from WSA — Impact of Uber/Taxi Fares

Taxi fares

Uber fares

% of Air Passengers using Rail to/from WSA — Impact of Travel Time

29 minutes= global average travel time

- If rail fares are simply set at Opal Card rates then for Sydney CBD and Parramatta then rail passengers are around 24%-22% of **all passengers from that location**; if around $16 similar to Sydney Airport, %'s are 18%-20% and if around $30 then the %'s drop to 15%-16%;
- Similarly, if travel times are based on the existing network, %'s are in the low 20%s but if travel times are cut to 30 mins (CBD) and 15 mins (Parramatta) then %'s increase to beyond 30%;
- Cost of alternative modes such as taxi or Uber has a significant impact – Uber level fares reduce rail passengers to 12%-15% from 22%-24% for standard taxi fares. This has a major effect on the usage of rail;
- Clearly combinations of these factors will cause significant differences to the % of passengers attracted to use rail

Ideally to maximize the likelihood of usage of any future rail links to a **Western Sydney Airport** at Badgerys Creek requires that rail have the following service characteristics:

- Because it is **not diffuse**, Rail **cannot** – as can road - address every possible source or sink for airport passengers; So must be targeted on locations which have maximum focussed airport passenger generation capability and growth potential – e.g. Parramatta and Sydney CBDs; Critical to understand the market for whom investment in rail is being made.

- Minimal practical travel time – say CBD to **WSA** 30-35 minutes maximum, especially to compete with Uber level fares; this is likely to require a new line direct to Parramatta and a clear fast path from Parramatta to the CBD if using existing alignments; **Suburban or metro style multi-stop services will not deliver such times;** Note possibilities for layering fast and stopping services**;**

- Critical interchanging locations are for a direct line are Sydney Central; Parramatta and possibly Strathfield;

- For a direct line: Fully seated, not commuter crowded, airport style rolling stock, not more than 15 minute headways;

- Ultimately, probably requires a north-of-harbour link to tap into airport passenger markets in the NE quadrant of the metro area – Epping and Macquarie Park, North Shore and North Sydney and the northern part of Sydney's Golden Employment Arc generally;

- If a more suburban or metro line, must maximize coverage of populace by provide multiple rail to rail interchanging opportunities and /or address multiple parts of the metropolitan area to maximize market attracted to **WSA**; e.g. Glenfield and St Marys for a Leppington to St Marys extension. If at Opal Card prices this may attractive to airport and other workers but less attractive to airport passengers due to slow travel times and effect of peak period crowding.

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A s s o c i a t e s