Commuting mode choice and work from home in the later stages of COVID-19: Consolidating a future focussed prediction tool to inform transport and land use planning

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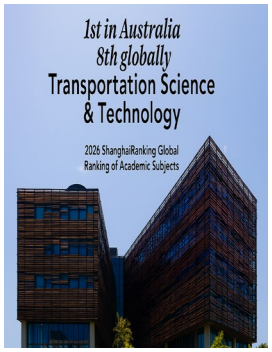
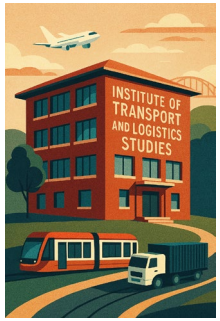
https://www.sydney.edu.au/business/about/our-people/academic-staff/david-hensher.html



ITLS

iMOVECRC

BRT+ CENTRE OF EXCELLENCE



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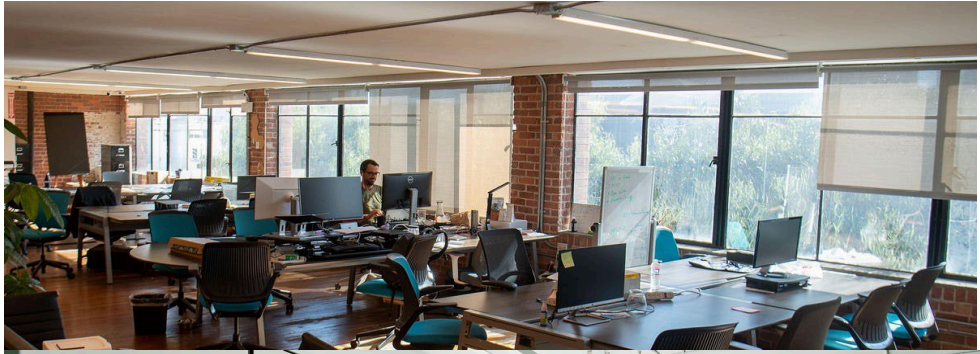
NSW GOVERNMENT Transport for NSW

Department of Transport

Queensland Government



WFH and Hybrid Work Location Still Very Relevant: Hybrid: Coordination – office benefits are being with co-workers

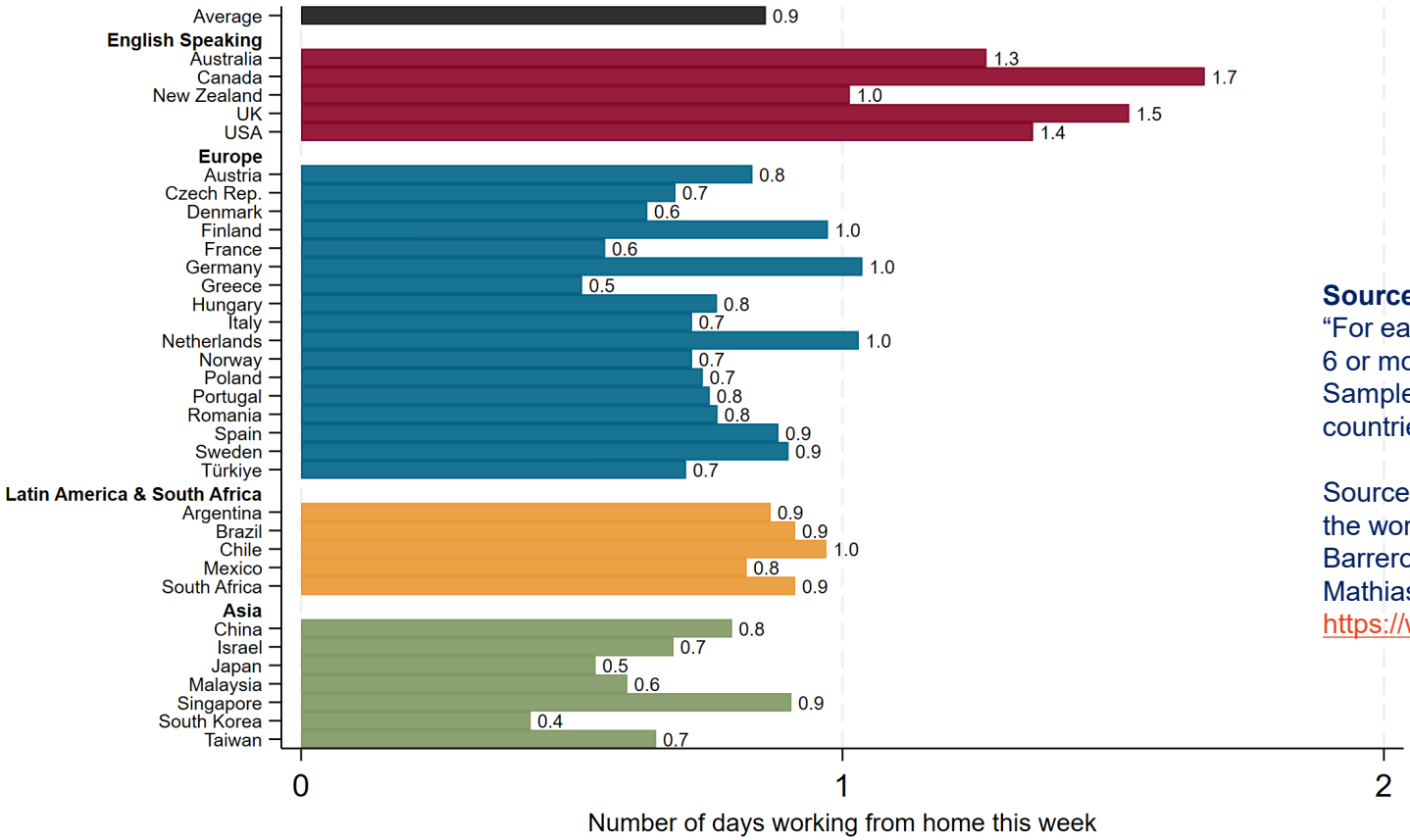
WFH/Remote working possibly the greatest transport policy lever we have had for many years

WFH is no longer stigmatised

We must continue to recognise this post-COVID-19

'Flexibility is here to stay' and 'employers who offer a balance of WFH and in office will attract more high-quality employees' (The Future of Office Space Summit, 17 Feb 2021)

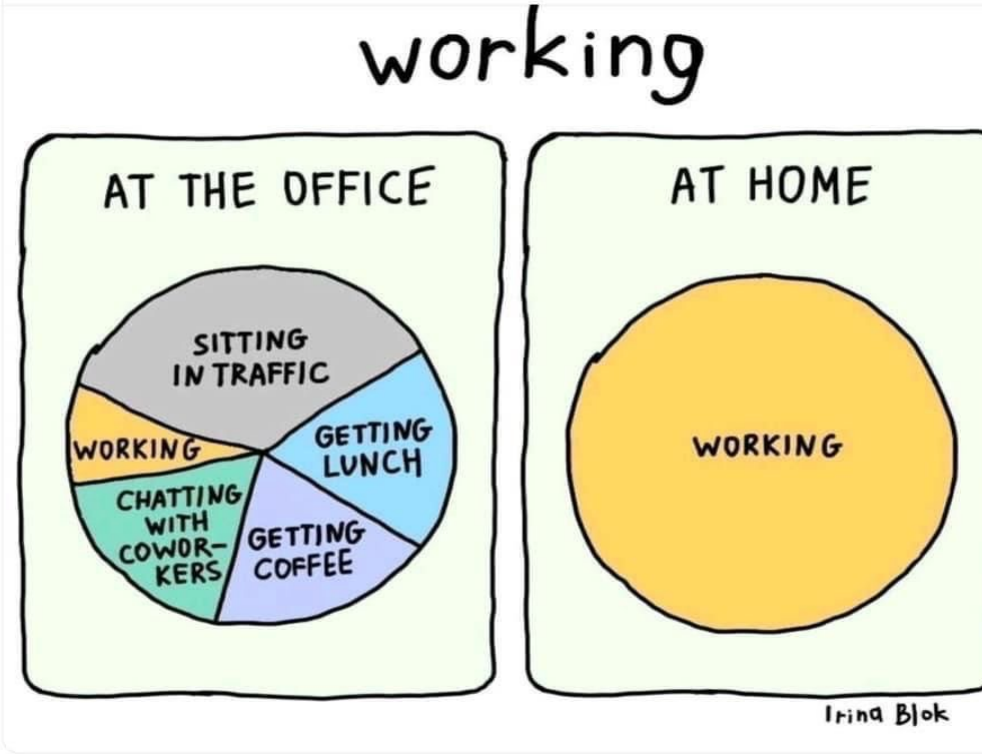
Globally: Highest in North America, UK and Australasia, then Europe, Latin America and South Africa, and then Asia (April-May 2023)



Source: Responses to the question "For each day last week, did you work 6 or more hours, and if so, where?". Sample of N=42,426 workers in 34 countries surveyed in April-June 2023.

Source: "Working from home around the world" by Cevat Aksoy, Jose Barrero, Nick Bloom, Steve Davis, Mathias Dolls and Pablo Zarate. https://wfhresearch.com/gswadata/

From early 2020 to end of 2022



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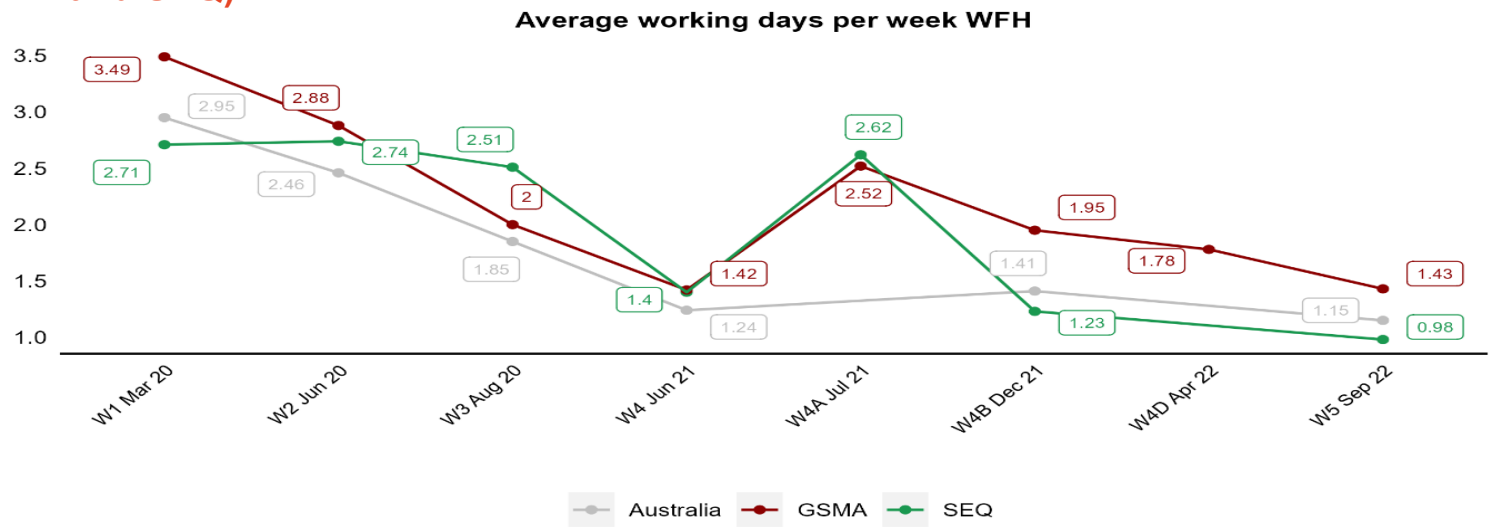
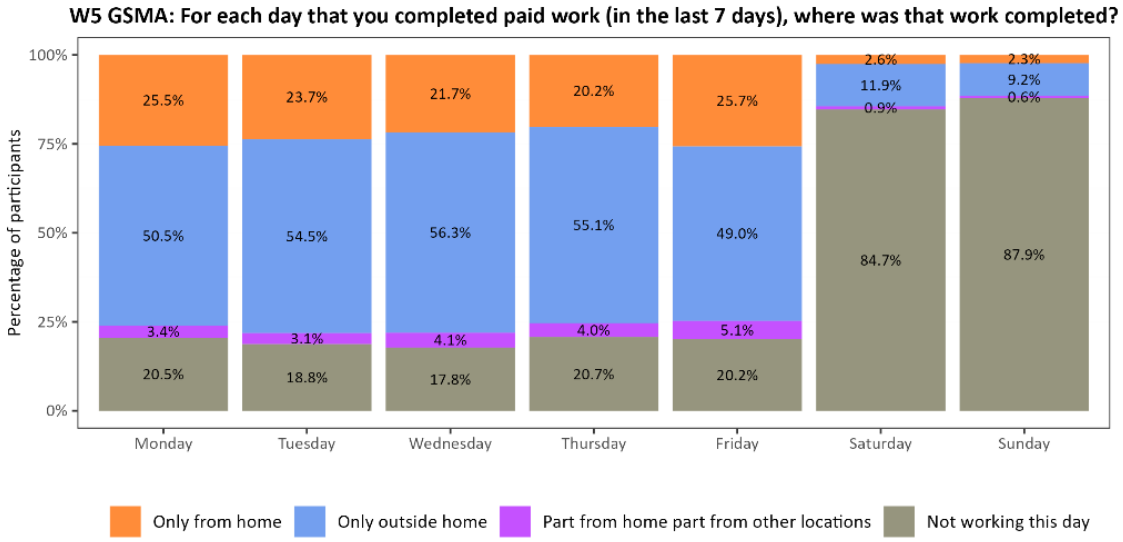
The number and proportion of working days that are working from home at some point (Mainly GSMA and SEQ)

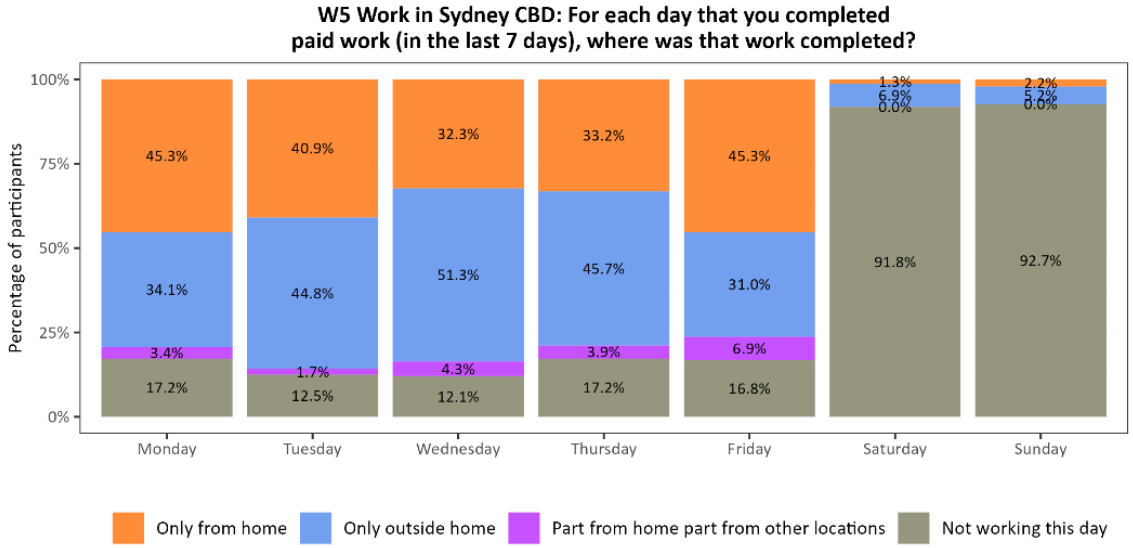


GSMA over 7 days as a weighted average is 1.04

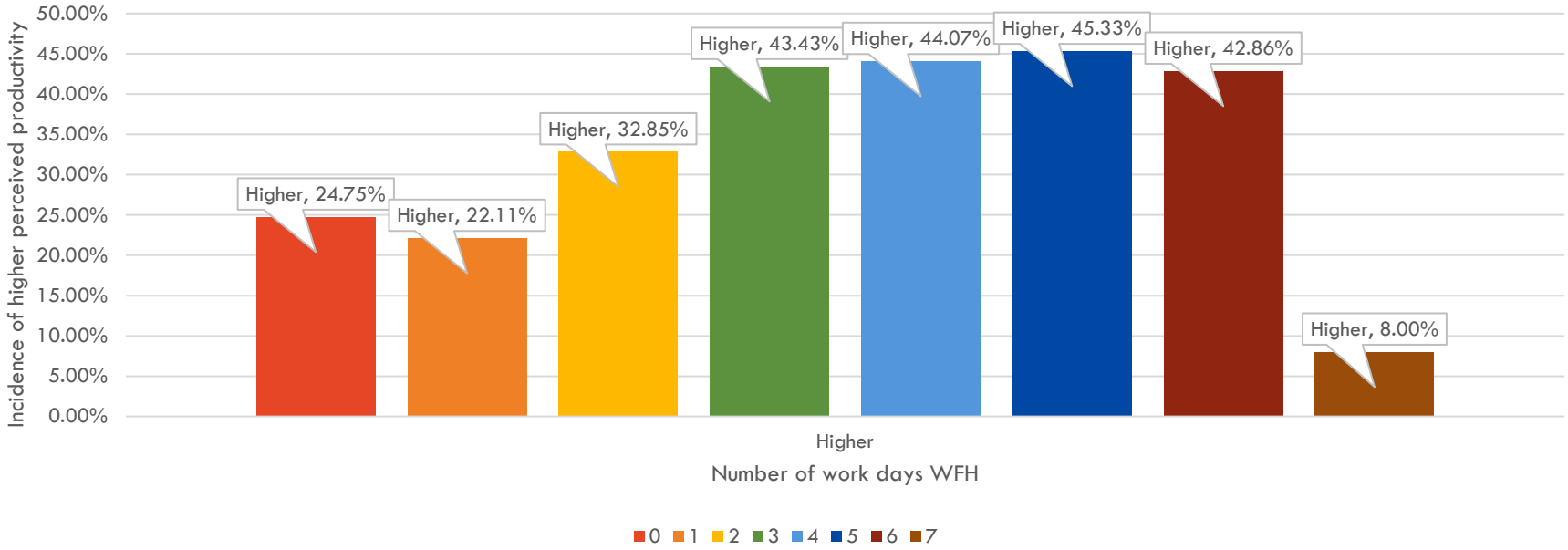
Aug-Sept 2022	GSMA	Rural NSW	Sydney CBD	SEQ	Rural QLD	BNE CBD
Average days worked	4.30 (1.34)	4.45 (1.53)	4.39 (1.32)	4.44 (1.23)	4.69 (1.24)	4.55 (1.30)
Weekdays	4.02 (1.42)	3.94 (1.43)	4.24 (1.37)	4.07 (1.31)	4.29 (1.19)	4.27 (1.29)
Weekends	0.27 (0.60)	0.50 (0.81)	0.16 (0.50)	0.37 (0.69)	0.40 (0.70)	0.28 (0.61)
Average days WFH at some point:	1.43 (1.86)	0.82 (1.65)	2.20 (1.91)	0.98 (1.66)	0.86 (1.70)	1.62 (1.90)
Weekdays WFH	**1.43 (1.82)**	**0.73 (1.47)**	**2.16 (1.87)**	**0.98 (1.57)**	**0.80 (1.57)**	**1.55 (1.84)**
Weekends WFH	0.06 (0.32)	0.09 (0.37)	0.03 (0.23)	0.06 (0.31)	0.06 (0.32)	0.07 (0.32)
Average days WFH only:	1.21 (1.76)	0.62 (1.49)	2.00 (1.90)	0.77 (1.44)	0.66 (1.54)	1.40 (1.75)
Weekdays	1.17 (1.72)	0.55 (1.33)	1.96 (1.86)	0.72 (1.39)	0.62 (1.41)	1.35 (1.73)
Weekends	0.05 (0.28)	0.06 (0.32)	0.03 (0.23)	0.05 (0.27)	0.04 (0.28)	0.06 (0.28)
Proportion of days WFH only:	0.27 (0.38)	0.14 (0.31)	0.43 (0.39)	0.18 (0.32)	0.14 (0.31)	0.32 (0.38)
Weekdays	0.27 (0.38)	0.14 (0.31)	0.43 (0.39)	0.17 (0.32)	0.14 (0.31)	0.31 (0.38)
Weekends	0.03 (0.17)	0.04 (0.19)	0.02 (0.15)	0.03 (0.17)	0.03 (0.16)	0.04 (0.19)
Sample size	1135	232	231	874	270	163

Profile of Location of worked hours by DoW for GSMA & GSMA-CBD Wave 5 (Aug-Sep 2022)

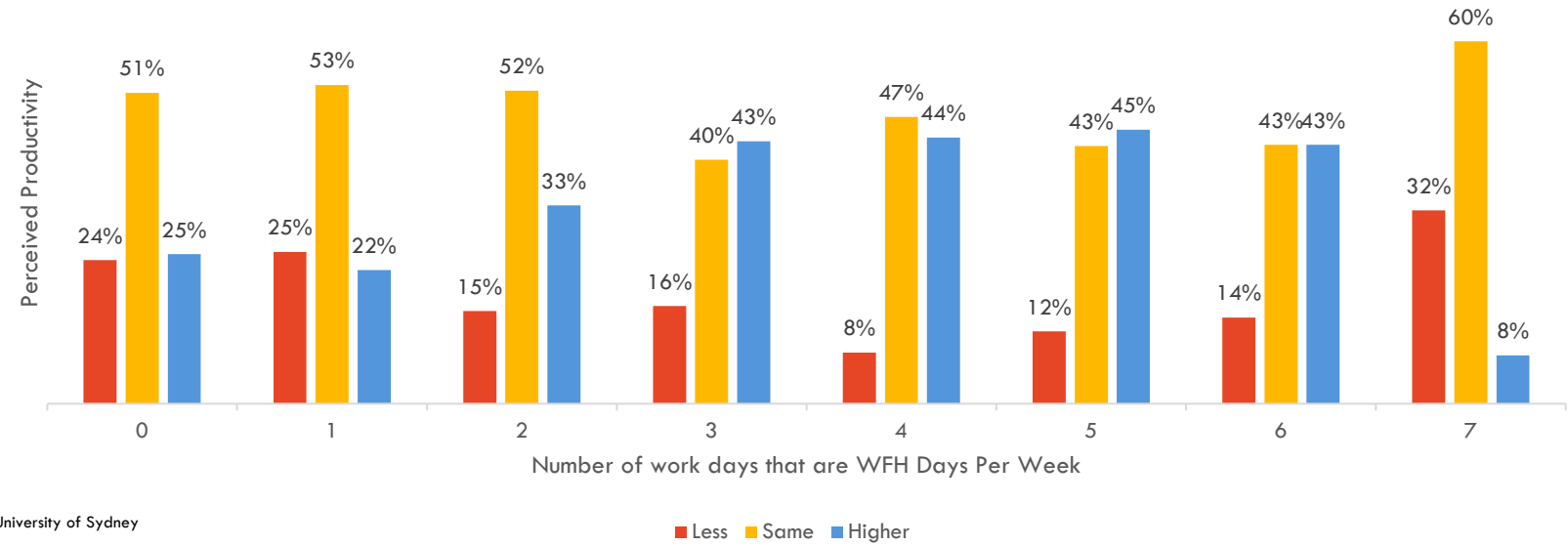




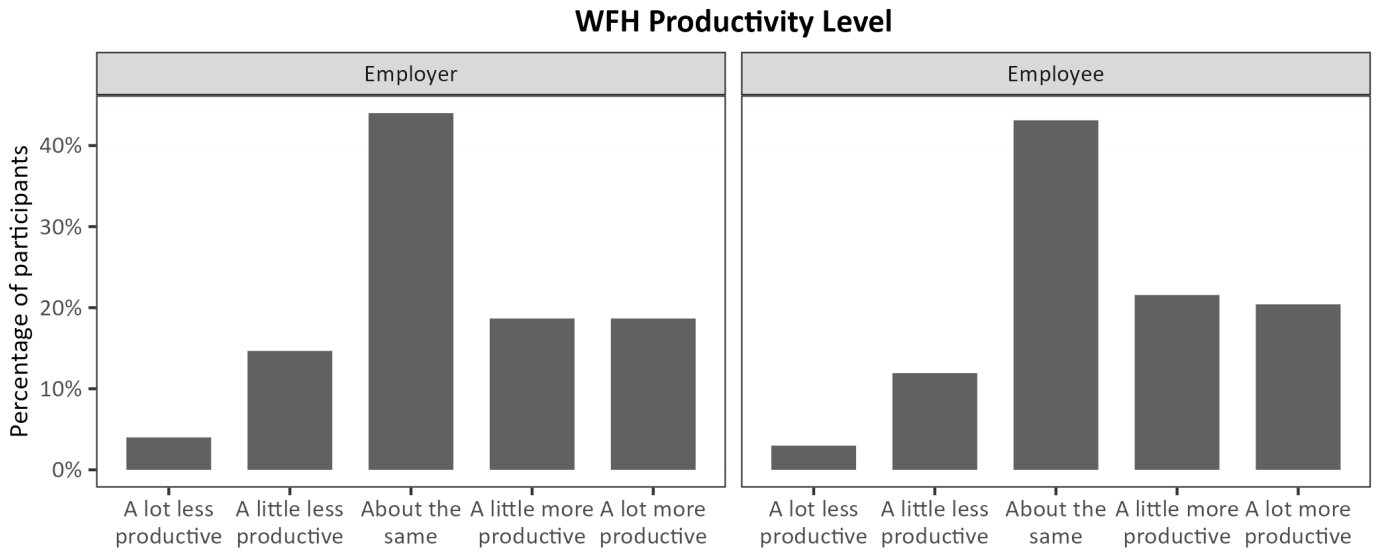
WFH Days by Higher Perceived Productivity by Employees - GSMA Sept 2022



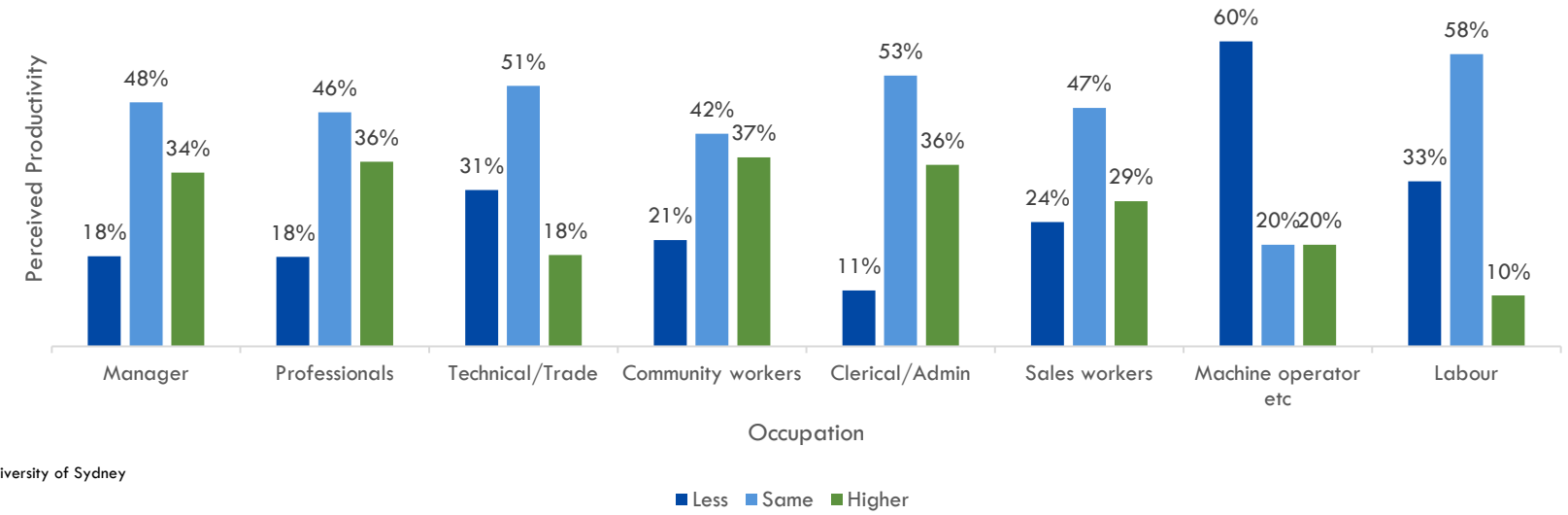
WFH Days by Employee Perceived Productivity - GSMA Sept 2022



Productivity WFH – Employer and Employee Perceptions Wave 5 (Aug-Sep 2022)



Occupation by Employee Perceived Productivity - GSMA Sept 2022: Green higher than Dark Blue 5 out of 8 occupations

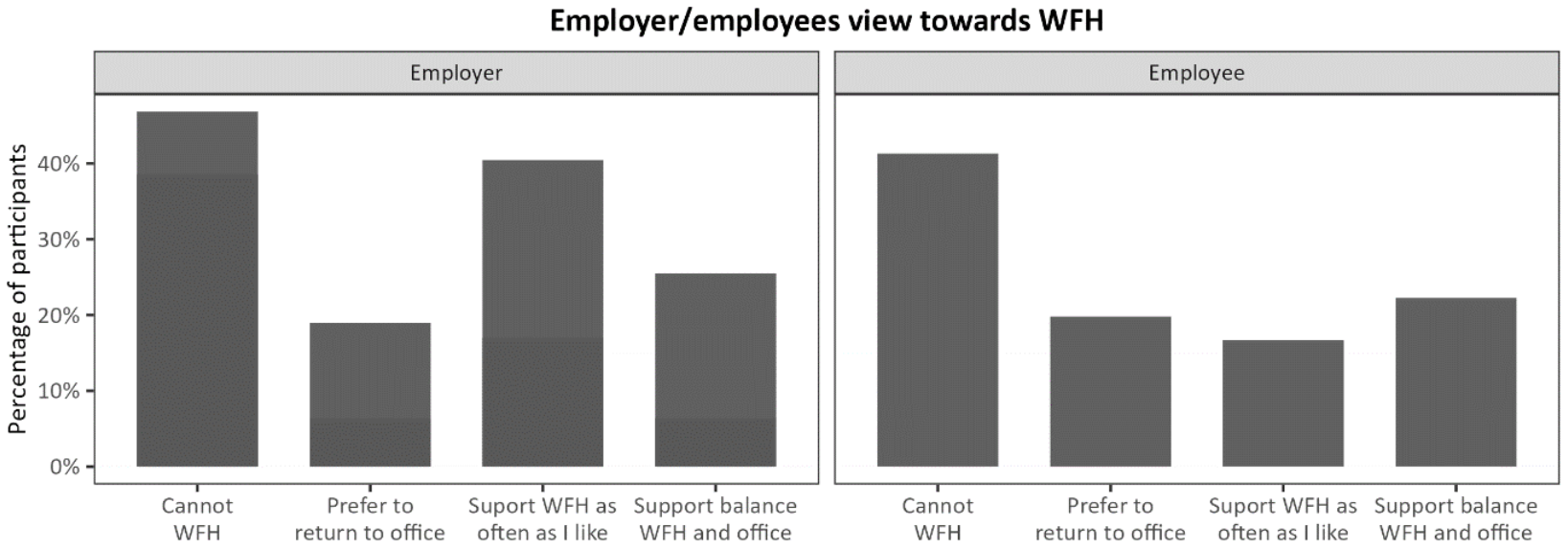


Productivity Boost - USA

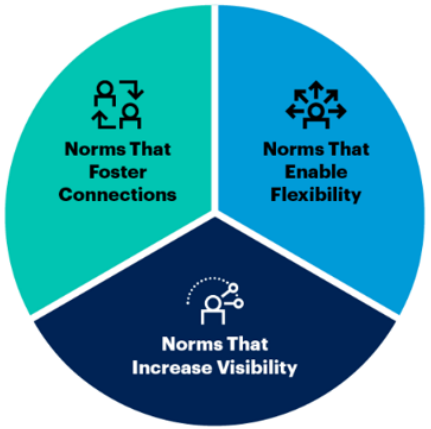
- The productivity boost came from two sources (USA evidence).
  - First, remote employees worked 9 percent more in minutes per day. They were rarely late to work, spent less time gossiping and chatting with colleagues, and took shorter lunch breaks and fewer sick days.
  - Remote employees also had 4 percent more output per minute. They told us it's quieter at home. The office was so noisy many of them struggled to concentrate.
- The macro evidence also suggests, or at least is consistent with, work from home working:
- In the five years before the pandemic, U.S. labor productivity growth was 1.2 percent; since 2020, this picked up to 1.5 percent. Given the state of the world, that acceleration was miraculous.
- Ref: Working from Home Around the Globe: 2023 Report, Cevat Giray Aksoy, Jose Maria Barrero, Nicholas Bloom, Steven J. Davis, Mathias Dolls and Pablo Zarate
- Update:

  https://www.businessinsider.com/remote-work-from-home-surviving-return-to-office-mandates-era-2026-1

Wave 5: GSMA September 2022 Employer and employee views on WFH
(Support WFH as often as like big difference ER and EE)



Frequent remote workdays and meeting-free days have emerged as hybrid work norms that contribute to improved employee productivity and performance.

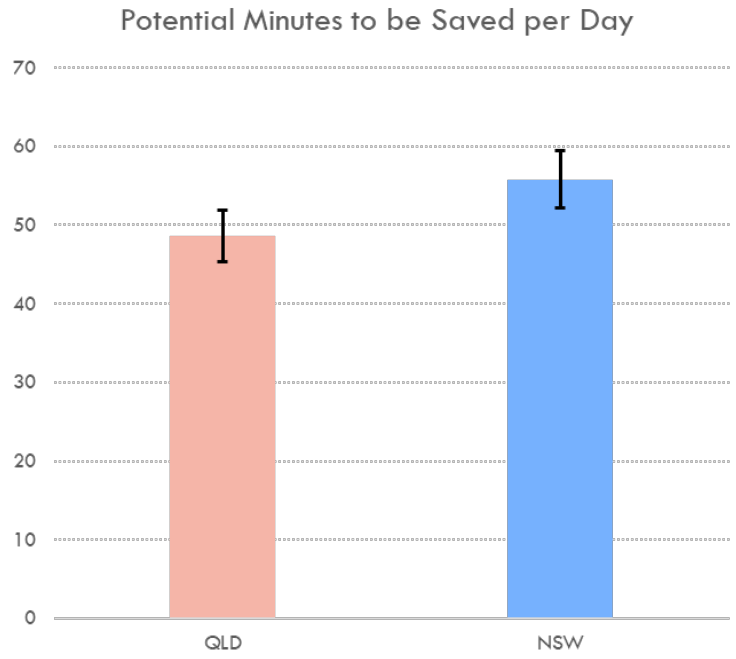


https://www.gartner.com/en/newsroom/press-releases/04-17-23-gartner-says-employees-are-twelve-percent-more-likely-to-leave-their-workplaces-if-employers-dont-establish-explicit-hybrid-work-norms

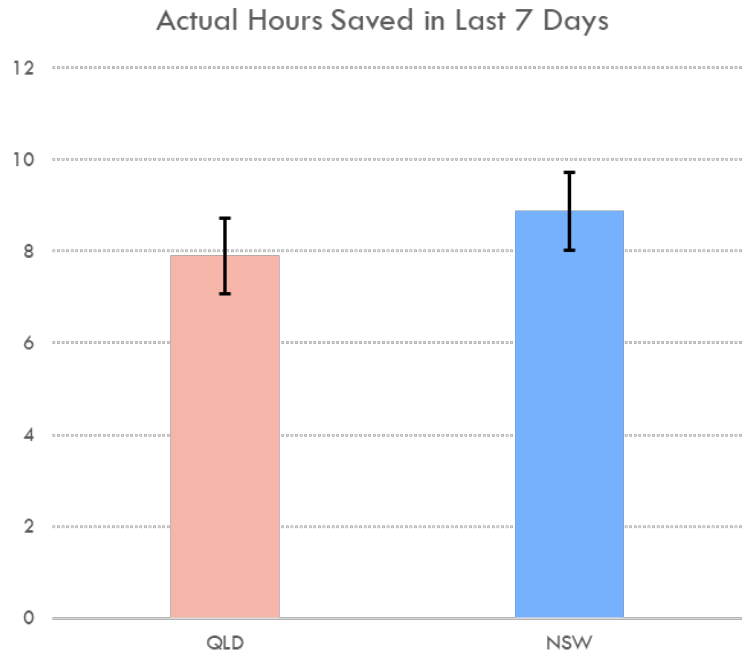
Time Saving and Reallocation due to WFH in Australia

In QLD respondents saved an average of 7.9 hours in the last week by not commuting, those in NSW saved an average of 8.9 hours. In QLD there is an average of 100 extra minutes per week being spent on additional unpaid work, 120 minutes on household tasks, and 100 minutes reallocated to home-based leisure activities. It is roughly the same in NSW.

- **Potential minutes** saved per day by not commuting and WFH

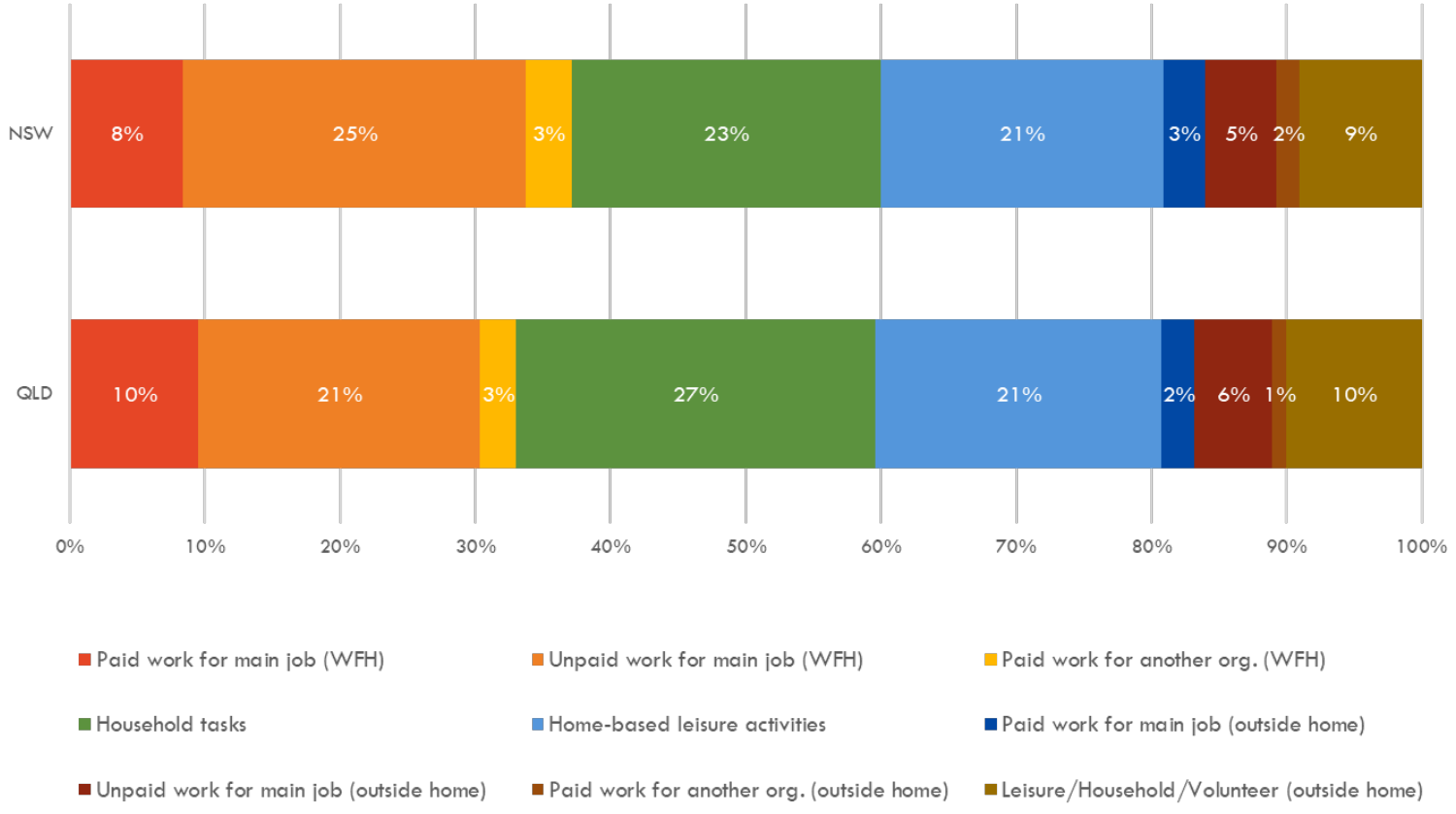


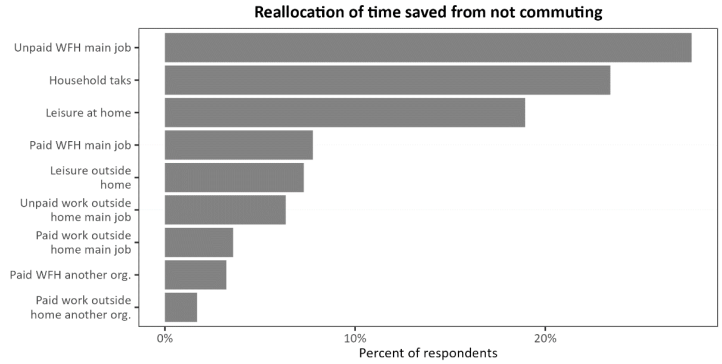
- **Actual hours** saved in the last 7 days by WFH and not commuting



Hensher, D.A., Beck, M. and Balbontin, C. (2022) Time allocation of reduced commuting time during COVID-19 under working from home, *Journal of Transport Economics and Policy (#4013)*, 56 (4), October, 399-428.

Reallocation of Saved Time NSW and QLD (~20% is outside home) Reallocation of Saved Time NSW and QLD (~20% is outside home): September 2022





Update as of September 2025 in Australia

https://www.sydney.edu.au/business/our-research/institute-of-transport-and-logistics-studies/transport-opinion-survey.html

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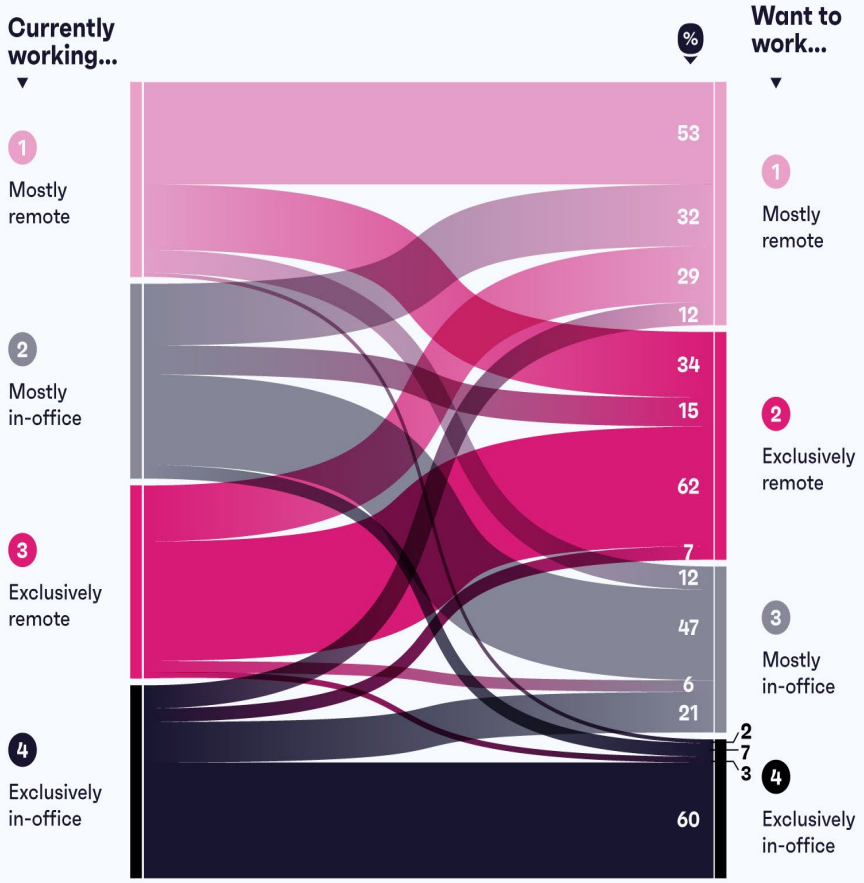
Workers prefer the status quo, but if given a choice, more lean towards remote work

% of business professionals who currently have these workplace policies and say the following would be their preference



Which of the following best describes your team's current office attendance? • Which of the following would you personally prefer, in terms of office attendance?

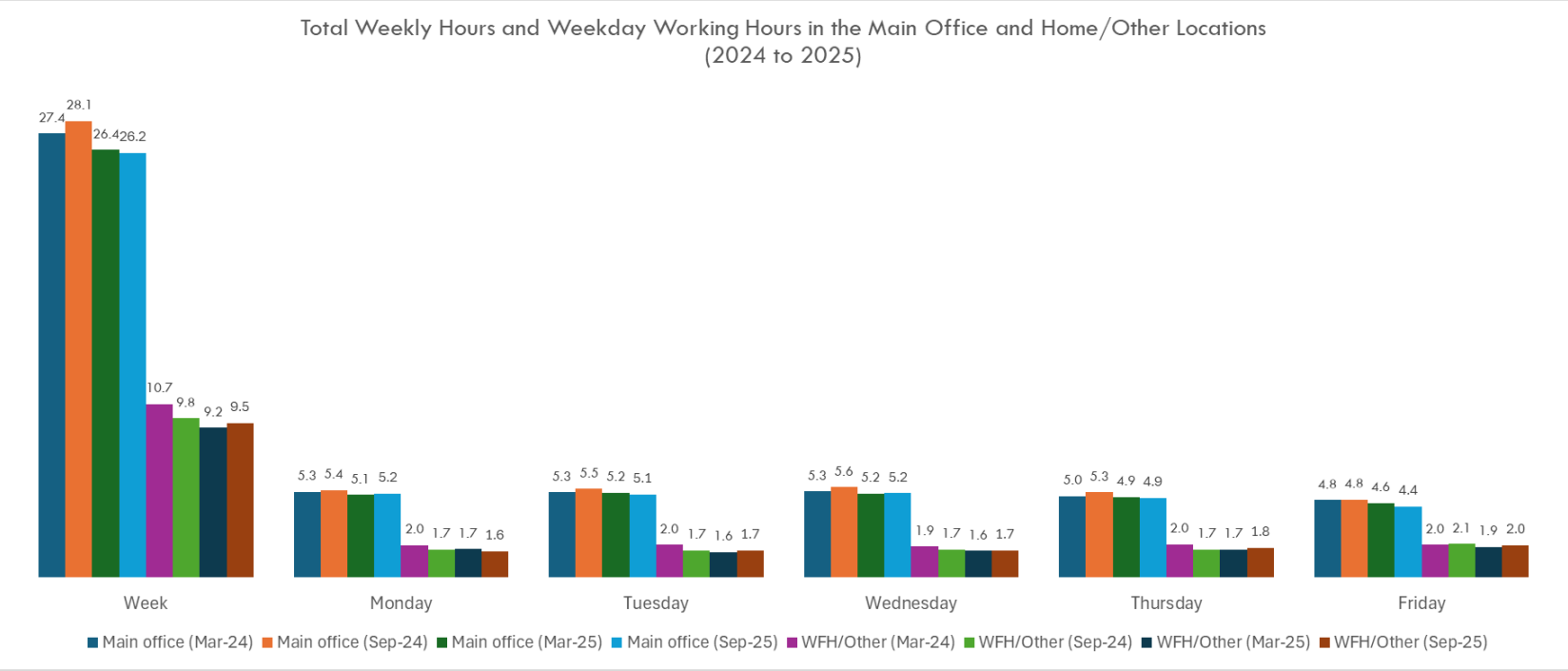
GWI Work Q3 2024

27,612 business professionals who work at a company with at least 2 employees and 1 office in 19 markets

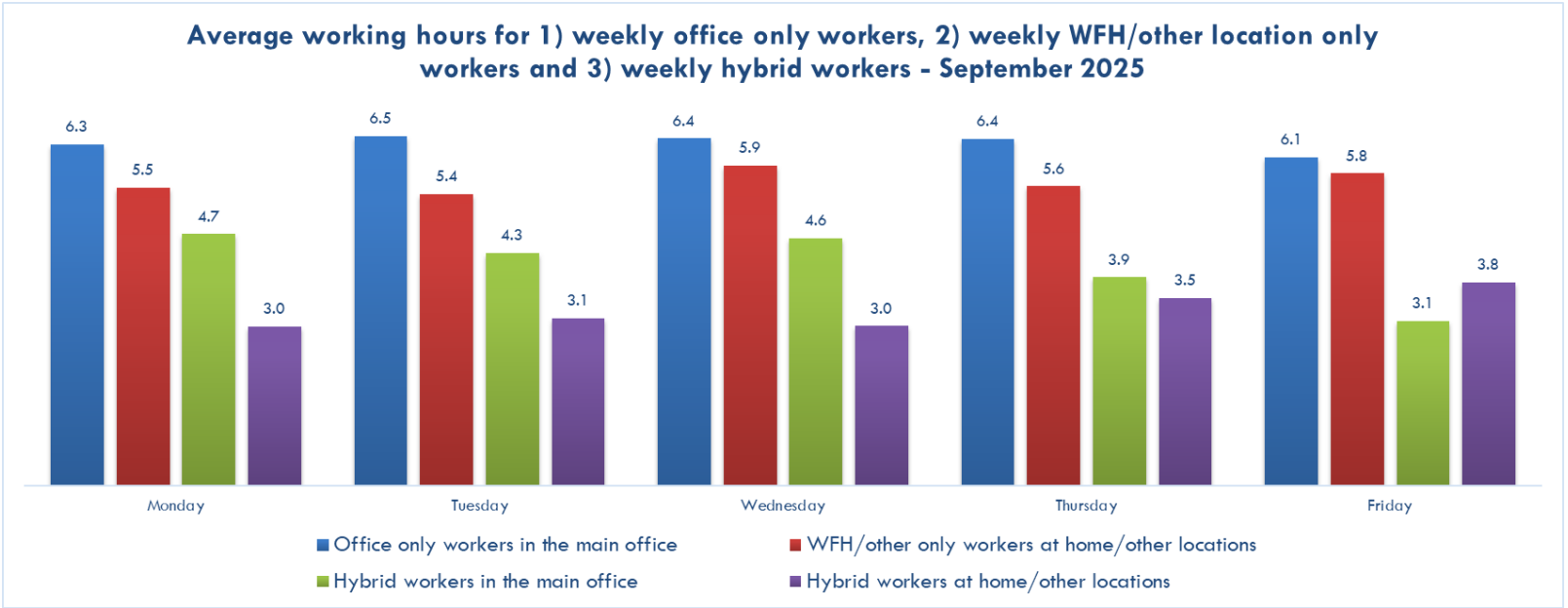
Update as of September 2025 in Australia

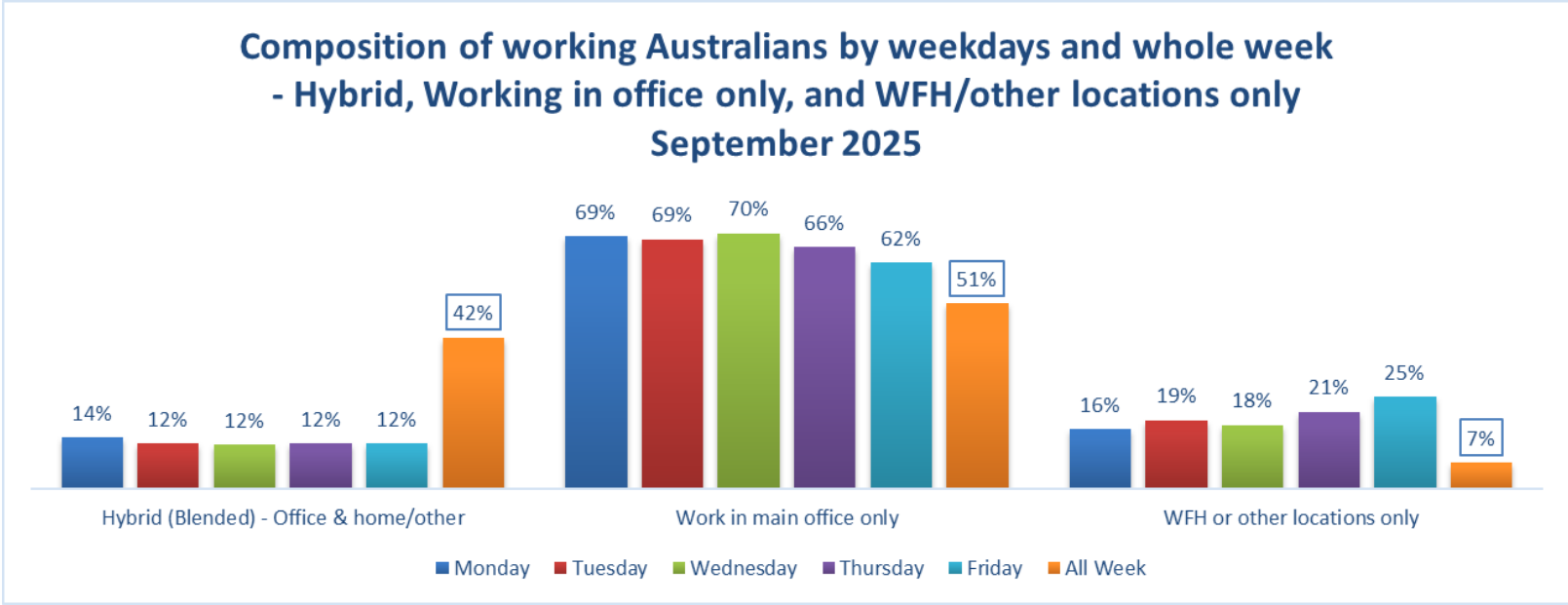
- In a typical week, working people have an average of 27% of working hours working from home (WFH) or from locations other than their main workplaces.
  - The percentage of WFH hours is, on average 20%. These levels have remained stable since 2023. Professionals, clerical workers and managers are the three occupations with the highest percentages of working hours spent at home or elsewhere.
- For each weekday, on average, about 67% of workers work in the main workplaces, 20% work from home or other locations, and 12% work at both locations.
- However, people change their working patterns during the week.
  - Weekly, 51% of workers work from the main office and never from other locations.
  - Only 7% of workers work from home or other places and never work in the main offices.
  - The remaining 42% of workers work from both main offices and other locations, such as home, defined as weekly hybrid workers.
- **The percentage of weekly working hours remains consistent to, at**
  - **73.4% from the office, 20.4% from home, and**
  - **6.2% from other locations,** out of an average of 35.6 working hours in a typical week.
- **About 38% of commuting travel begins outside the traditional peak periods.**
  - Approximately 89% of workers believe that productivity has either increased or remained the same under flexible working arrangements.
- About 72% of workers also believe their employers think their productivity has improved or has not been influenced by the arrangements.

All Locations Working Hours (Stabilising): Look at blocks of 4 cols each day re Main office and WFH: Australia

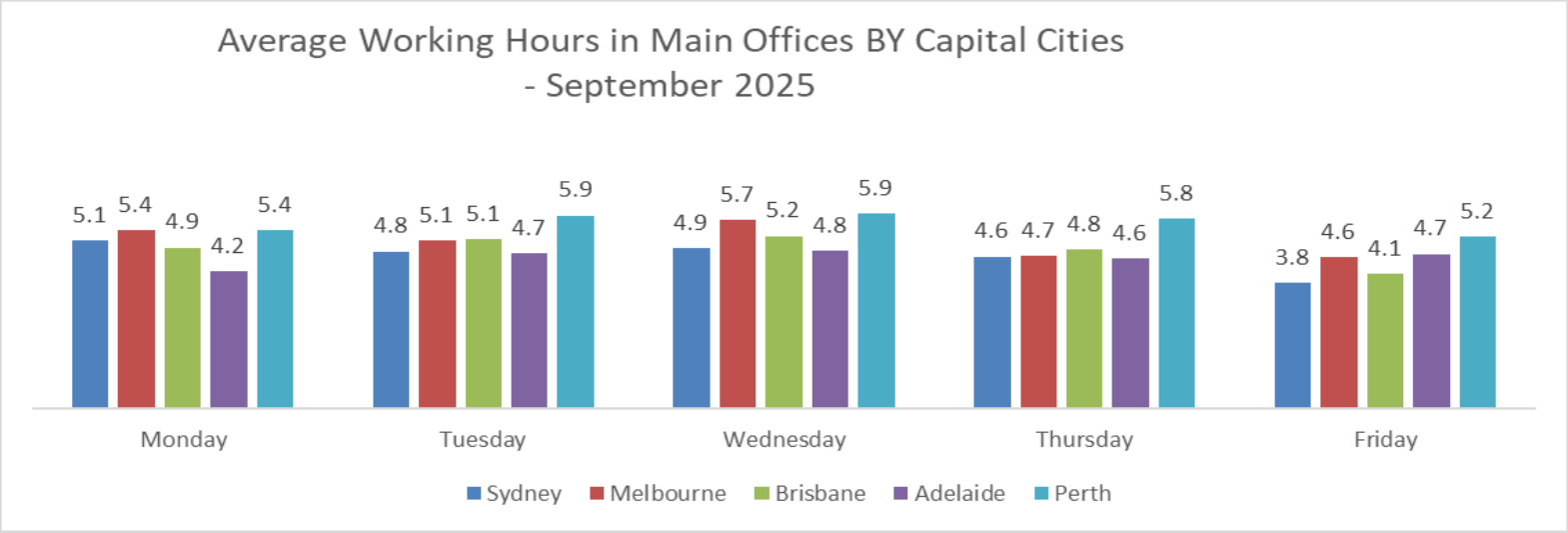


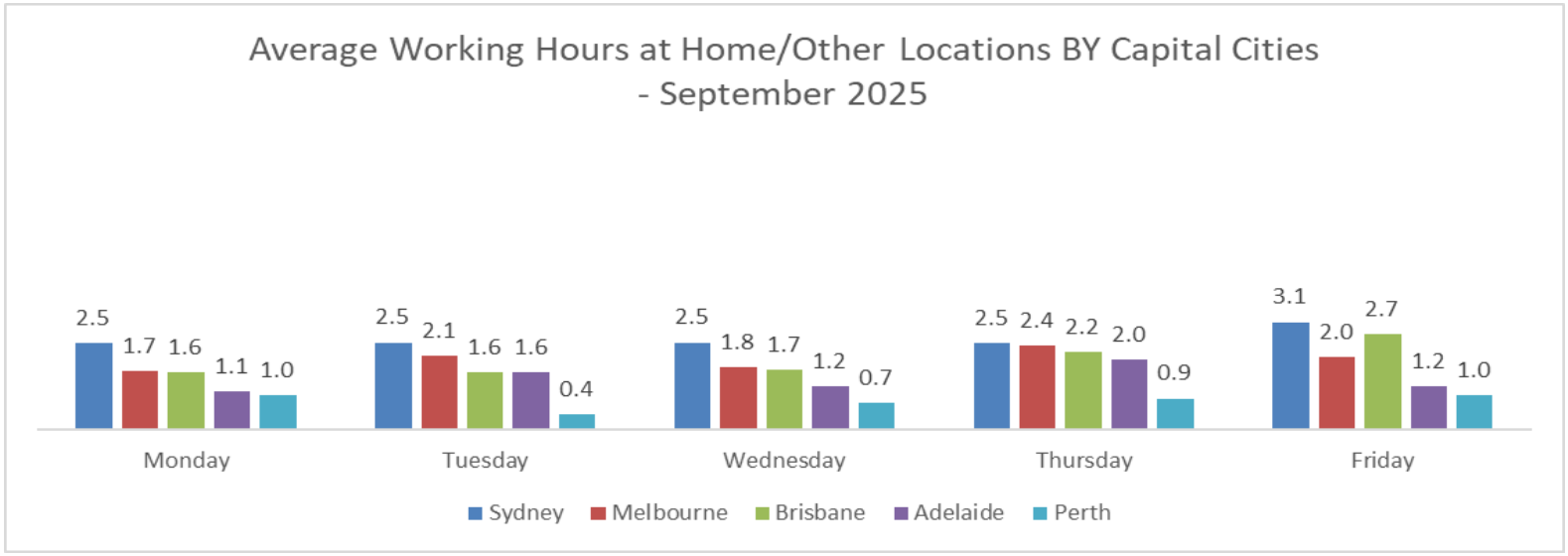
All Locations (Stabilising) decomposing each day: office only, WFH only, blended or hybrid day: Hours and worker incidence: Australia



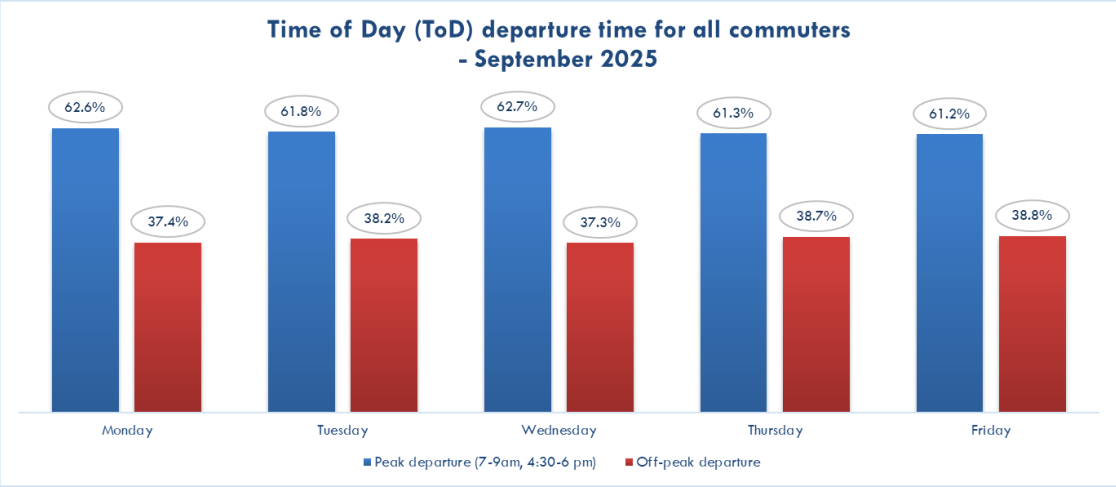


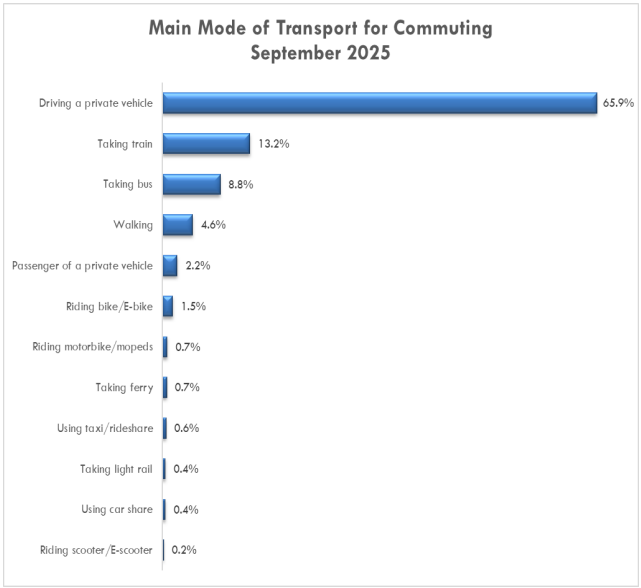
Capital Cities working hours by location

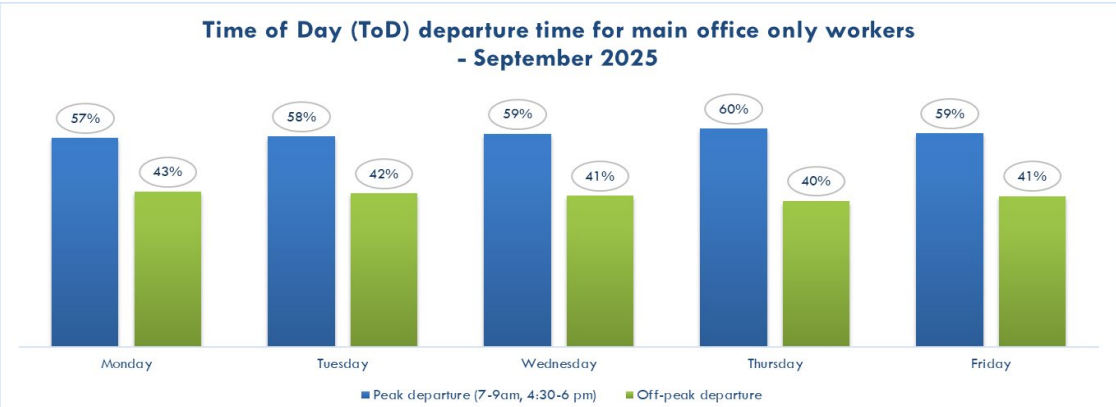


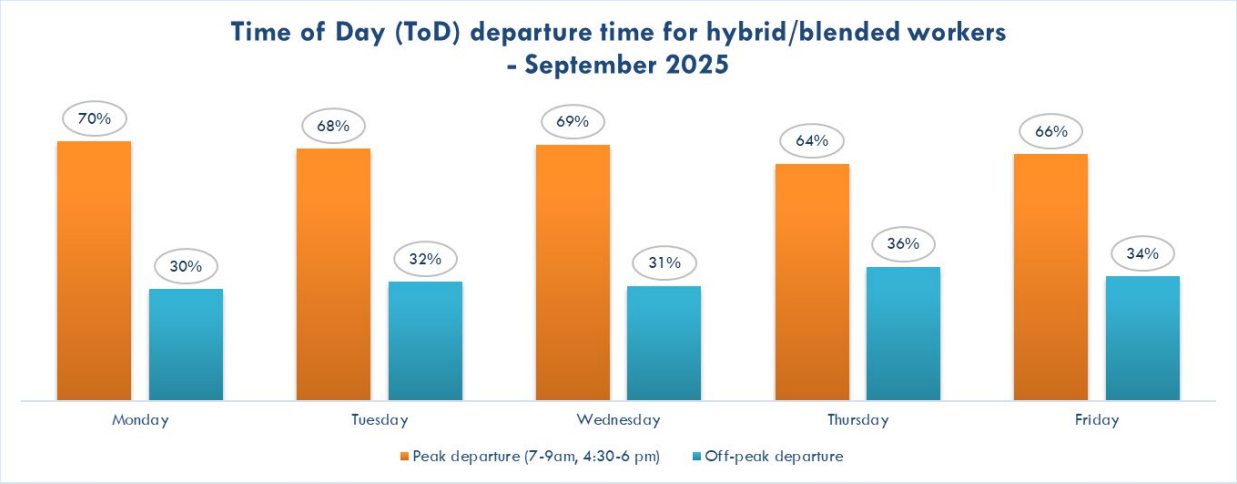


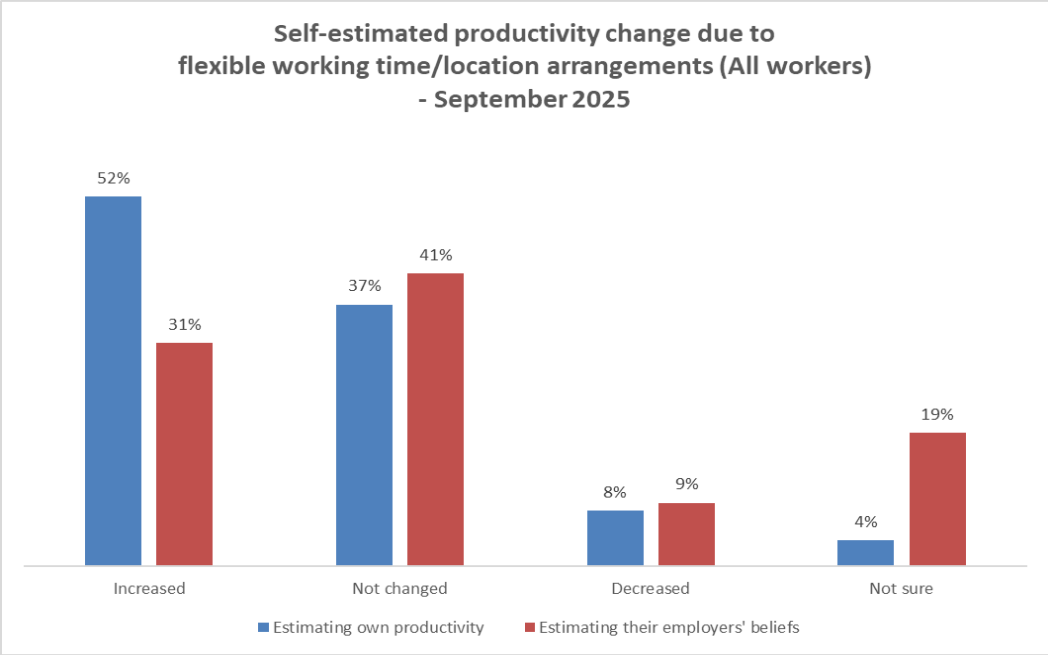
Australia


Time of Day (ToD) departure time for all commuters - September 2025
62.6%
37.4%
61.8%
38.2%
62.7%
37.3%
61.3%
38.7%
61.2%
38.8%
Monday
Tuesday
Wednesday
Thursday
Friday
Peak departure (7-9am, 4:30-6 pm)
Off-peak departure

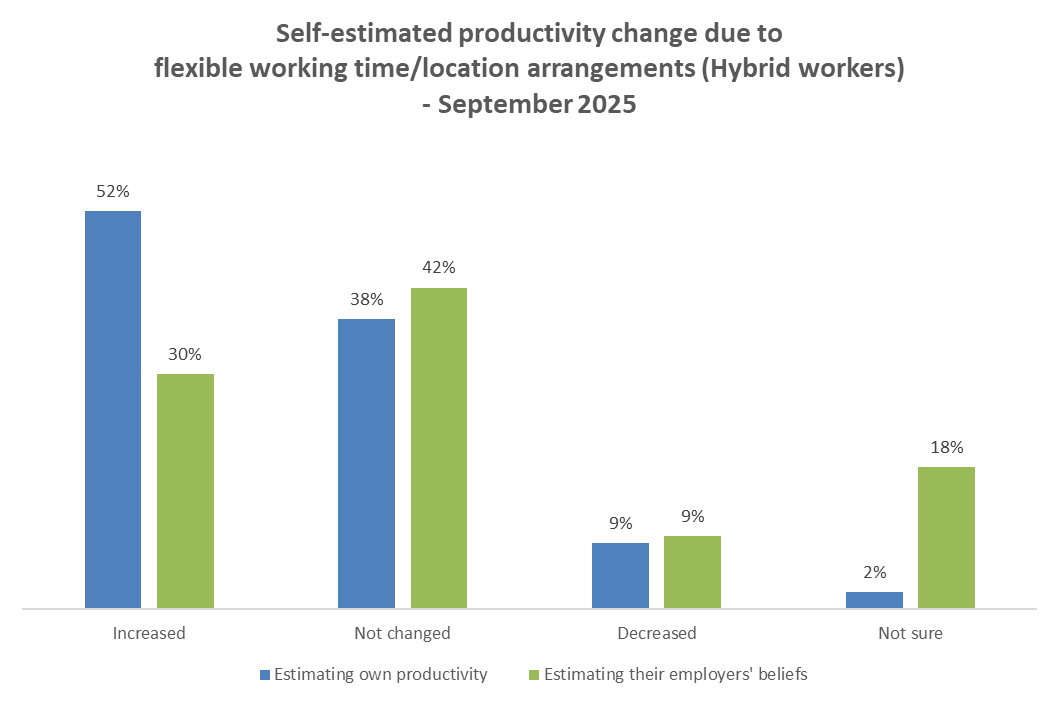

Main Mode of Transport for Commuting September 2025
Driving a private vehicle 65.9%
Taking train 13.2%
Taking bus 8.8%
Walking 4.6%
Passenger of a private vehicle 2.2%
Riding bike/E-bike 1.5%
Riding motorbike/mopeds 0.7%
Taking ferry 0.7%
Using taxi/rideshare 0.6%
Taking light rail 0.4%
Using car share 0.4%
Riding scooter/E-scooter 0.2%


Time of Day (ToD) departure time for main office only workers - September 2025
57%
43%
58%
42%
59%
41%
60%
40%
59%
41%
Monday
Tuesday
Wednesday
Thursday
Friday
Peak departure (7-9am, 4:30-6 pm)
Off-peak departure


Time of Day (ToD) departure time for hybrid/blended workers - September 2025
70%
30%
68%
32%
69%
31%
64%
36%
66%
34%
Monday
Tuesday
Wednesday
Thursday
Friday
Peak departure (7-9am, 4:30-6 pm)
Off-peak departure


Self-estimated productivity change due to flexible working time/location arrangements (All workers) - September 2025
52%
31%
37%
41%
8%
9%
4%
19%
Increased
Not changed
Decreased
Not sure
Estimating own productivity
Estimating their employers' beliefs

Australia


Self-estimated productivity change due to flexible working time/location arrangements (Hybrid workers) - September 2025
52%
30%
38%
42%
9%
9%
2%
18%
Increased
Not changed
Decreased
Not sure
Estimating own productivity
Estimating their employers' beliefs

The Modelling Approach Australia March 2024

Hensher, D.A., Wei, E,. and Pellegrini, A. (2025) Accounting for the location and allocation of working hours throughout the working week: a discrete-continuous choice model, *Transportation Research Part A*, 104484. https://doi.org/10.1016/j.tra.2025.104484

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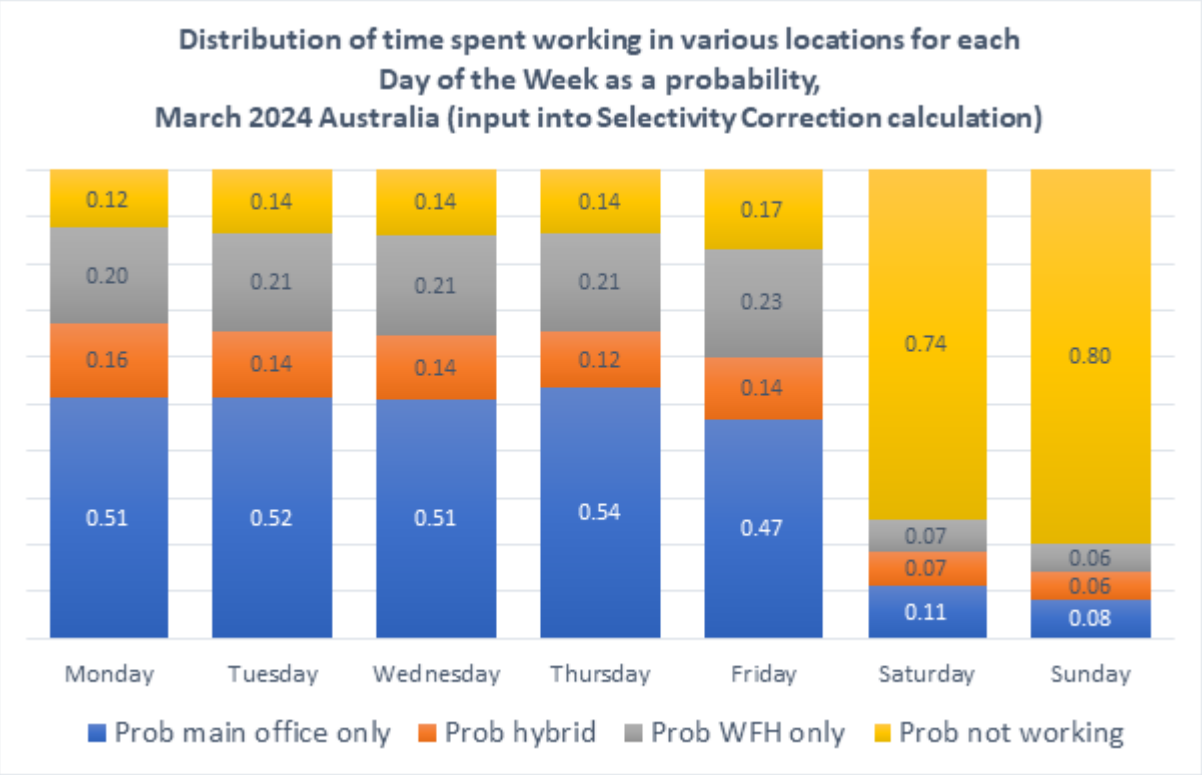
Accounting for the Location and Allocation of Working Hours throughout the Working Week: A Discrete-Continuous Choice model March 2024

Random Parameters: Mean	*Alternative*	*Parameter estimate*	*t-value*
Professional occupation (1,0)	WFH only	1.0369	11.0
Time saved by not commuting (mins)	WFH only	0.0080	2.0
Random Parameters: Standard deviation			
Professional occupation (1,0)	WFH only	1.0369	11.0
Time saved by not commuting (mins)	WFH only	0.0040	2.0
Non-Random parameters:			
Peak main office constant	Main Office peak	0.3409	3.07
Age 18 o 34 years (1,0)	Main Office peak	0.5943	4.51
Age 35 to 55 years (1,0)	Main Office peak	0.6672	5.02
Friday dummy variable (1,0)	Main Office peak	-0.3422	-2.26
Commute by public transport (1,0)	Main Office peak	0.1608	2.93
Off-peak main office constant	Main Office off-peak	0.2593	2.38
Age 18 o 34 years (1,0)	Main Office off-peak	0.5266	4.06
Age 35 to 55 years (1,0)	Main Office off-peak	0.6824	5.22
Friday dummy variable (1,0)	Main Office off-peak	-0.3087	-1.97
Peak hybrid work location constant	Hybrid location peak	-2.8699	-11.5
Friday dummy variable (1,0)	Hybrid location peak	-0.4166	-1.97
Commute by car as driver (1,0)	Hybrid location peak	-0.6066	5.56
Off-peak hybrid work location constant	Hybrid location off-peak	-3.3602	-12.9
Male (1.0)	Hybrid location off-peak	0.4262	4.09
Work from Home constant	WFH only	-1.5556	-7.93
Live in Victoria (1,0)	WFH only	0.7274	4.13
Live in Western Australia (1,0)	WFH only	-1.2542	-4.43
Clerical and Admin occupation (1,0)	WFH only	0.9209	4.58
Saturday dummy variable (1,0)	No work all day	3.9332	22.1
Sunday dummy variable (1,00	No work all day	4.3301	33.2
Error components:			
Main Office -peak and off-peak		-1.2268	-19.9
Hybrid main office and other location peak and off-peak		4.0119	20.3
Work from home only		2.8491	23.4
AIC/N	2.337		
Log-likelihood at zero	-8604.03		
Log-likelihood at convergence	-5585.73		
McFadden Pseudo R^2	0.351		
Number of observations	4802		
Panel data groups	686		

Hensher, D.A., Wei, E,. and Pellegrini, A. (2025) Accounting for the location and allocation of working hours throughout the working week: a discrete-continuous choice model, *Transportation Research Part A*, 104484. https://doi.org/10.1016/j.tra.2025.104484

Probability of working at various locations for each day of the week, summed to 1.0 for each DoW



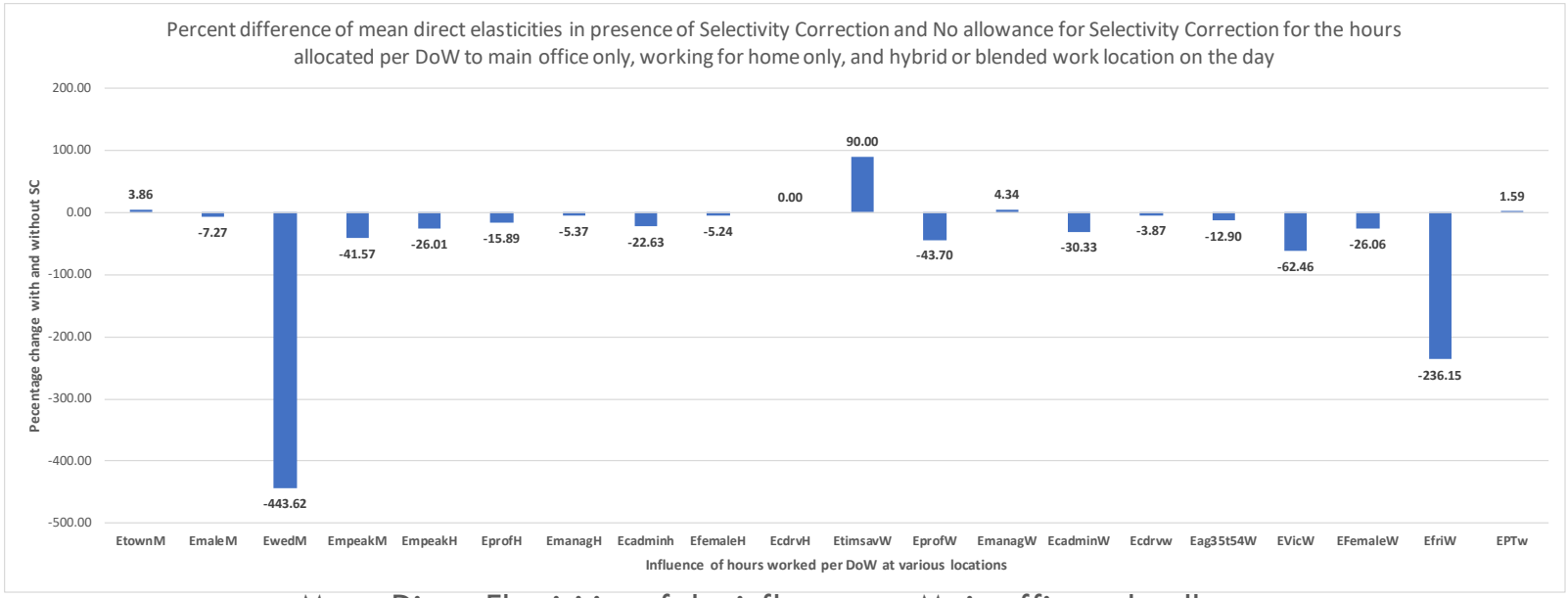
Mean Direct and Cross-Elasticities associated with the MMNL model March 2024

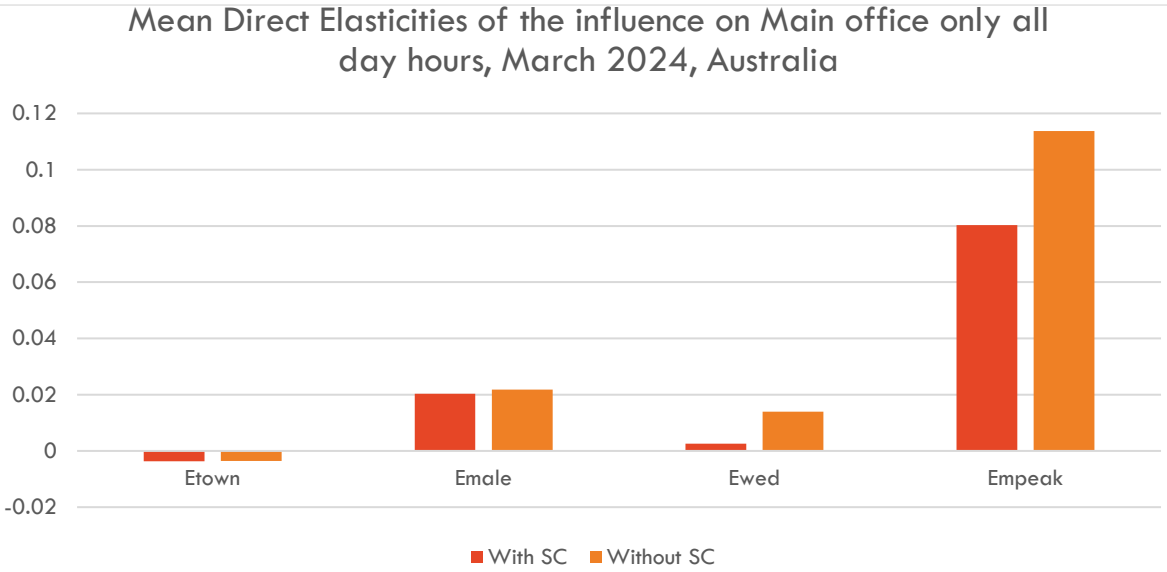
Influence	Main Office peak	Main Office off-peak	Hybrid location peak	Hybrid location off-peak	WFH only	Not work all day
Professional occupation (1,0)	-0.038	-0.036	-0.026	-0.025	**0.156**	-0.2028
Commuting time (mins)	-0.048	-0.046	-0.032	-0.029	**0.171**	-0.022
Age 18 o 34 years (1,0)	**0.177**	-0.099	-0.026	-0.026	-0.032	-0.032
Age 35 to 55 years (1,0)	**0.245**	-0.144	-0.035	-0.034	-0.042	0.041
Friday (1,0)	**-0.035**	0.199	0.006	0.006	0.007	0.006
Commute by public transport (1,0)	**0.028**	-0.015	-0.005	-0.003	-0.006	-0.005
Age 18 o 34 years (1,0)	-0.079	**0.168**	-0.020	-0.019	-0.024	0.024
Age 35 to 55 years (1,0)	-0.129	**0.271**	-0.032	-0.032	-.038	-0.037
Friday (1,0)	0.016	**-0.034**	0.005	0.005	0.006	0.005
Friday (1,0)	0.002	0.002	**-0.046**	0.019	0.002	0.001
Saturday (1,0)	-0.116	-0.115	-0.124	-0.112	-0.091	**0.244**
Sunday (1,0)	-0.103	-0.102	-0.121	-0.120	-0.096	**0.227**
Commute by car as driver (1,0)	0.011	0.012	**-0.309**	0.139	0.009	0011
Male (1.0)	-0.008	-0.008	-0.084	**0.169**	-0.006	0.007
Victoria (1,0)	-0.013	-.0.013	-0.008	-0.008	**0.052**	-0.009
Western Australia (1,0)	0.009	0.009	0.005	0.005	**-0.034**	0.006
Clerical and Admin occupation (1,0)	-0.022	-0.022	-0.016	-0.013	**0.090**	-0.016

SURE models with and without Selectivity Correction March 2024

Influence	Location	With Selectivity Correction		Without Selectivity Correction	
	Alternative	*Parameter estimate*	*t-value*	*Parameter estimate*	*t-value*
Constant	Main Office	4.9057	37.4	1.8739	23.4
Town (1,0)	Main Office	-0.5887	-4.09	-0.5661	-3.61
Male (1,0)	Main Office	0.5490	5.88	0.5888	6.03
Wednesday (1,0)	Main Office	0.2008	1.98	1.0915	8.55
Commute in peak (1,0)	Main Office	2.3454	22.9	3.3204	31.6
Constant	Hybrid Location	0.8393	5.91	0.4238	7.00
Commute in peak (1,0)	Hybrid Location	0.2221	3.91	0.2793	5.05
Professional occupation (1,0)	Hybrid Location	-0.2494	-4.19	-0.2890	-4.83
Management occupation (1,0)	Hybrid Location	-0.1872	-2.62	-0.1971	-2.75
Clerical and admin (1,0)	Hybrid Location	-0.1713	-2.42	-0.2101	-2.94
Female (1,0)	Hybrid Location	-0.1862	-3.67	-0.1956	-3.87
Car driver commute (1,0)	Hybrid Location	0.1879	3.66	0.1686	3.27
Constant	WFH only	0.6420	2.58	-0.8087	-5.45
Commuting time (mins)	WFH only	0.0270	11.12	0.0360	16.3
Professional occupation (1,0)	WFH only	0.4370	4.58	0.6280	6.80
Management occupation (1,0)	WFH only	0.6395	6.02	0.6118	5.52
Clerical and admin (1,0)	WFH only	0.4883	4.47	0.6336	5.76
Car driver commute (1,0)	WFH only	0.4226	3.48	0.4389	3.45
Victoria (1,0)	WFH only	0.2817	3.30	0.4576	5.40
Age 35 to 54 years (1,0)	WFH only	0.2668	3.76	0.3012	4.07
Female (1,0)	WFH only	0.1371	1.97	0.1728	2.16
Friday (1,0)	WFH only	0.1657	1.92	0.5569	5.29
Commute by public transport (1,0)	WFH only	0.3875	2.88	0.3814	2.70
Constant	No work	0.0083	3.19	0.0072	5.95
Clerical and admin (1,0)	No work	-0.0078	-2.65	-0.076	-2.70
Selectivity correction	Main Office	2.1122	27.5		
Selectivity correction	Hybrid Location	0.2029	3.30		
Selectivity correction	WFH only	0.5364	6.71		
Selectivity correction	No work	0.0007	0.45		
Log-likelihood		-26831.9		-27405.2	

The percentage difference in elasticity impacts of including and excluding the selectivity correction variable March 2024





Final comments on the DC-CC Model accommodating Blended Locations within the one day

- This paper has integrated two behaviourally important changes in the nature of work, namely
  - where it is undertaken, and the
  - quantity of hours allocated to each work location.
- The location and allocation of hours varies by day of the week with a notable increase in working from home only on a Friday, suggesting that
  - we should be cautious in using an average day of the 5-day week as the basis of predicting commuting patterns throughout the week.
  - In addition, some work activity has moved to the weekend days as a result of increased flexibility in the working task, devoid of any stigma that may have prevailed pre-COVID-19.
- The discrete-continuous model system developed herein, when built into strategic transport model systems will allow the analyst to investigate the extent of travel behaviour change when the profile of flexi-time and flexi-place varies, as we continue to monitor the adjustments that are still occurring the in the work and commuting market.
- An extension worth considering is simultaneous estimation (Pellegrini and Scagnolari, 2021), although we do not anticipate significantly different results (except maybe for standard errors), but this would complicate the ability to embed a DC-CC mode into a strategic transport model system.

The Modelling Approach and Waves 4 & 5: GSMA Strategic Model System

"What Modelling does is give you good direction and good vision."
Premier of NSW, 6 September 2021

Hensher, D.A., Balbontin, C., Beck, M.J., and Wei, E. (2024) Commuting mode choice and work from home in the later stages of COVID-19: Consolidating a future focussed prediction tool to inform transport and land use planning,.**WFH Paper #34,** Presented at *ICMC Conference* Chile (April1-3 2024), *Transportation Research Part A*, 187, 104194 https://doi.org/10.1016/j.tra.2024.104194

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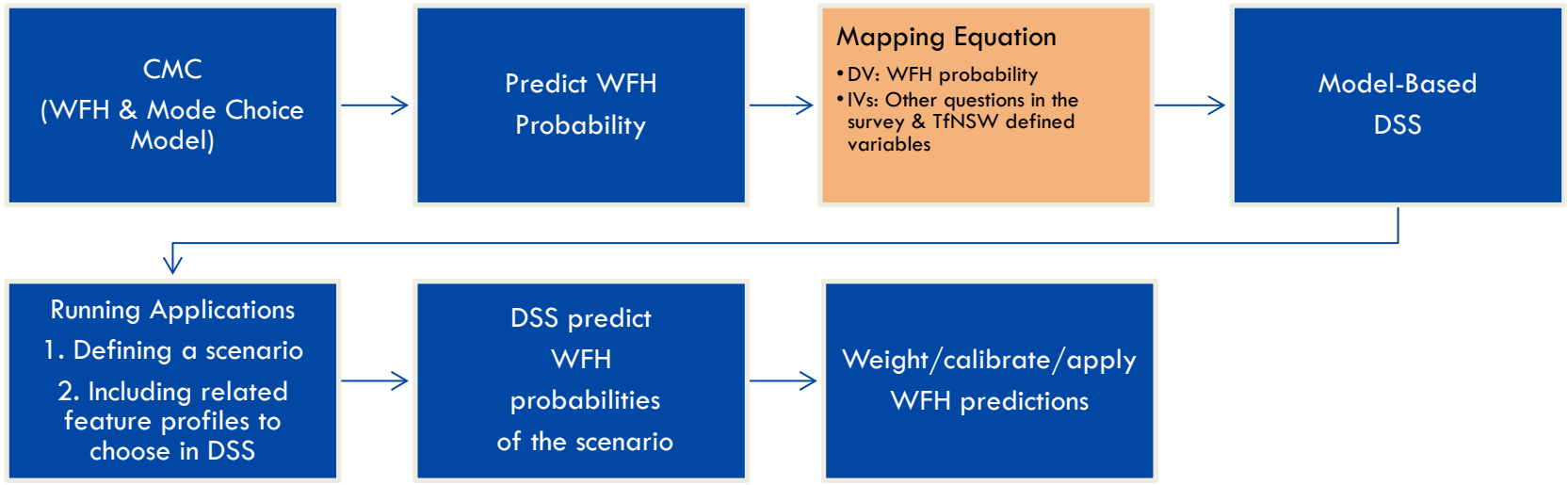
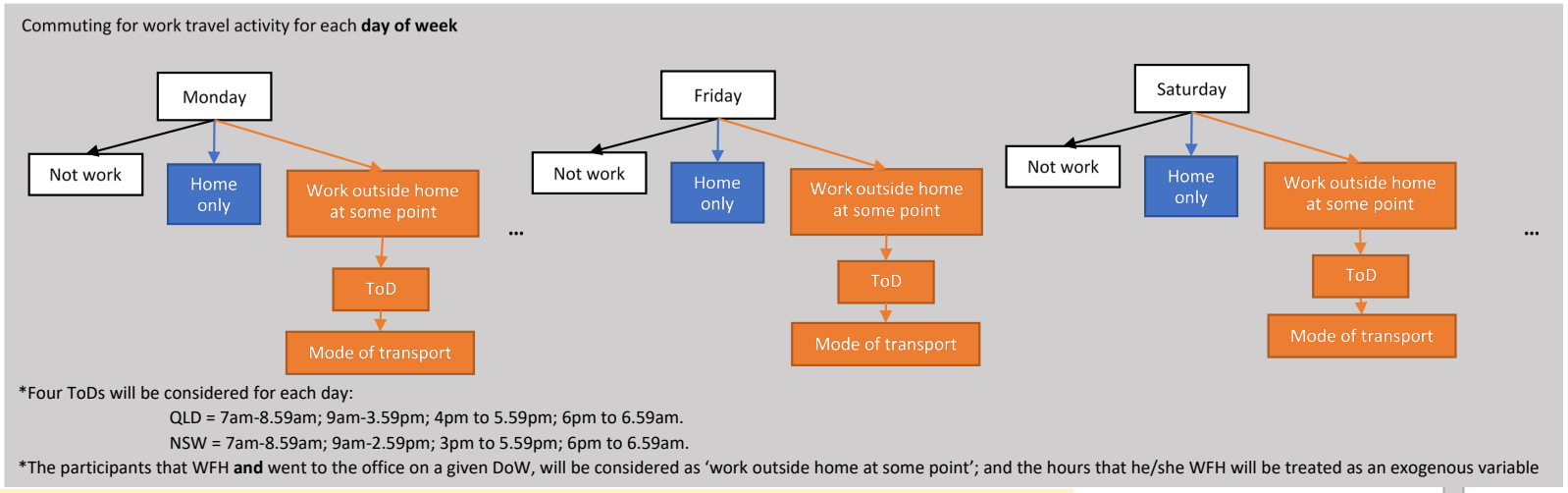
ITLS Models & DSS and Data & Statistics

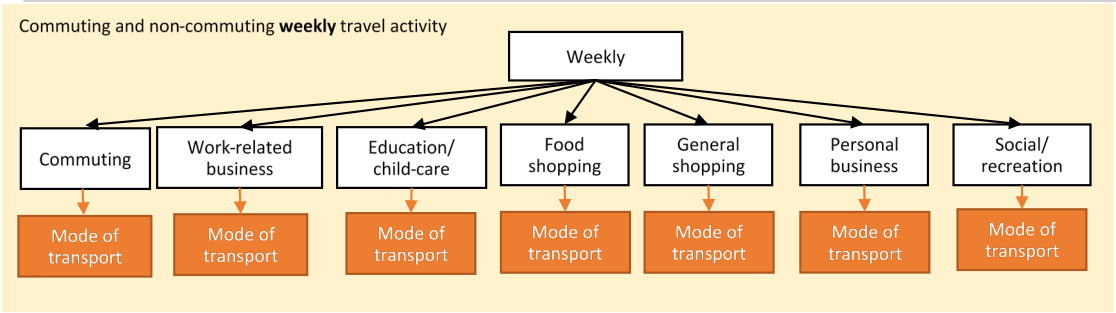


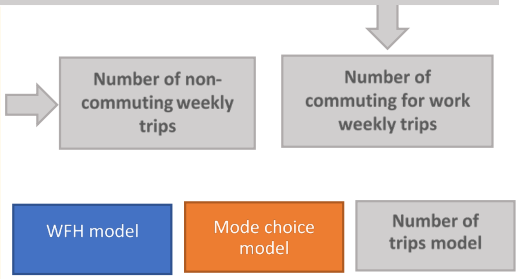
METHODOLOGY: Wave 4

Decision process WFH diagram

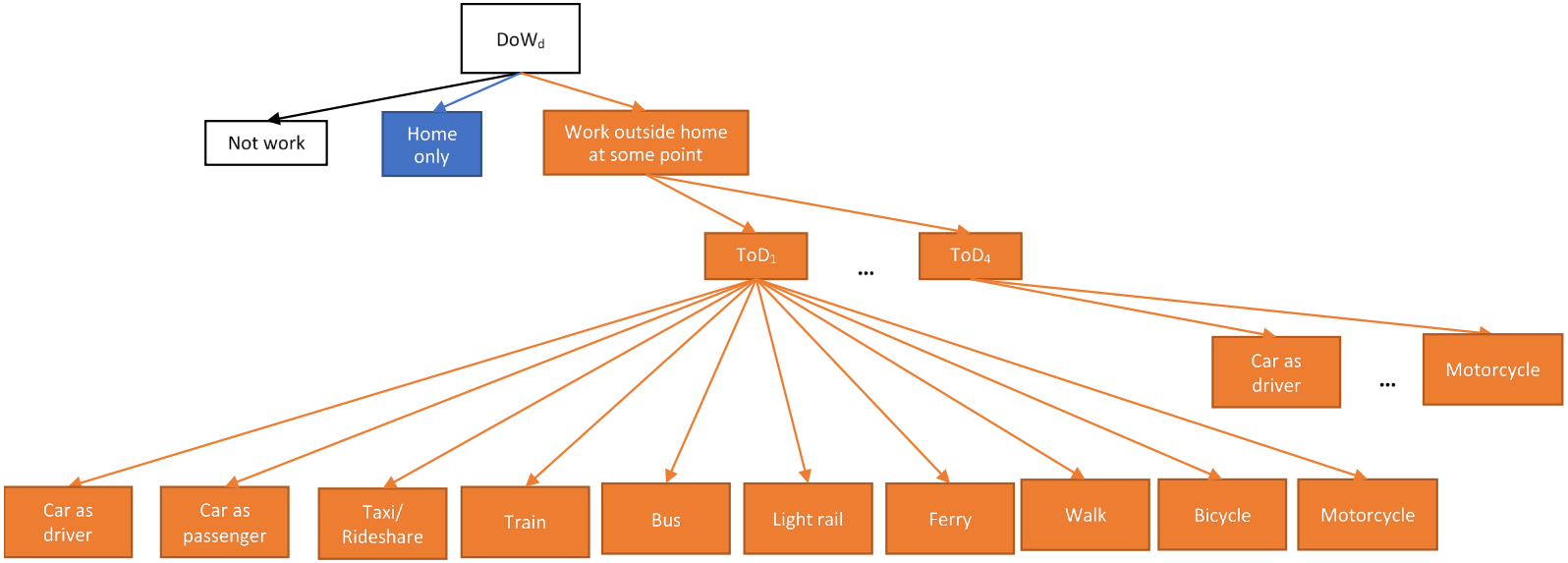
December 3, 2020







The WFH model and mode choice models will be estimated simultaneously. This **WFH/Mode choice model** is defined by a maximum of 42 alternatives for each day of week *d* (including weekends). The alternatives are described in Table 1 below.



Assumptions

We will assume that the reported travel time, costs, fuel, etc are the same for all ToDs. Will check once we get the final data.

Alternative numbers per DoW

Monday - Sunday	
Altij	Description
1	Not work
2	Work from home only
3	Work outside home ToD 1 - car driver
4	Work outside home ToD 1 - car passenger
5	Work outside home ToD 1 - taxi/rideshare
6	Work outside home ToD 1 - train
7	Work outside home ToD 1 - bus
8	Work outside home ToD 1 - light rail
9	Work outside home ToD 1 - ferry
10	Work outside home ToD 1 - walk
11	Work outside home ToD 1 - bicycle
12	Work outside home ToD 1 - motorcycle
13	Work outside home ToD 2 - car driver
14	Work outside home ToD 2 - car passenger
15	Work outside home ToD 2 - taxi/rideshare
16	Work outside home ToD 2 - train
17	Work outside home ToD 2 - bus
18	Work outside home ToD 2 - light rail
19	Work outside home ToD 2 - ferry
20	Work outside home ToD 2 - walk
21	Work outside home ToD 2 - bicycle

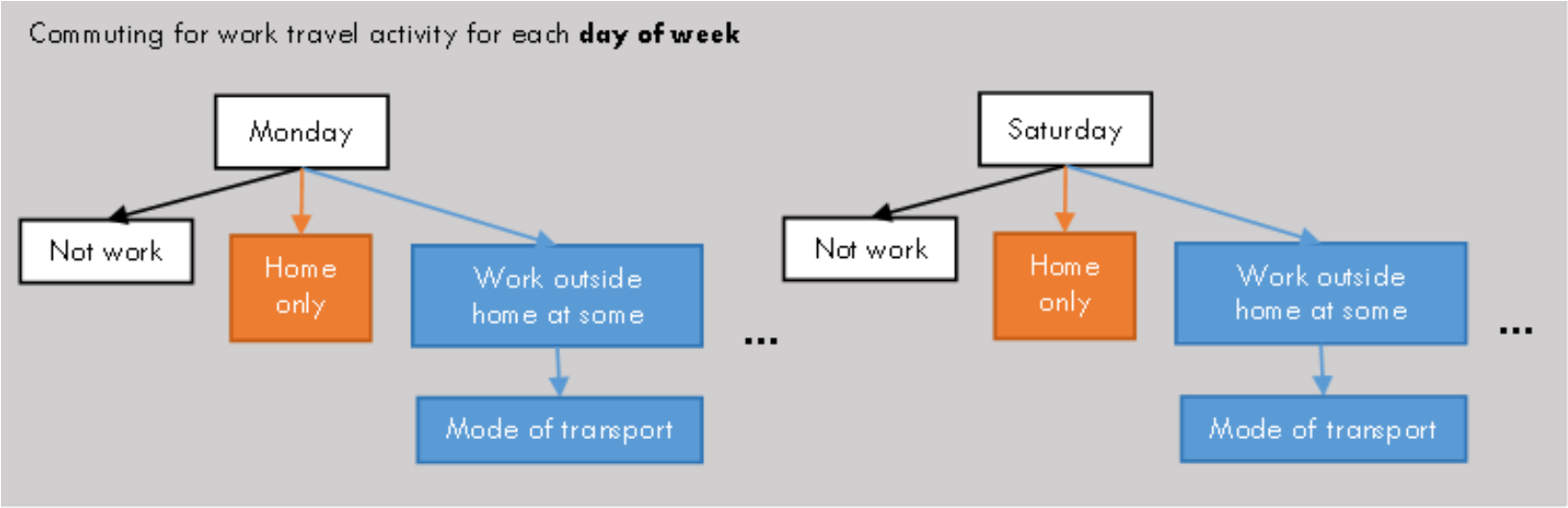
Monday - Sunday	
Altij	Description
22	Work outside home ToD 2 - motorcycle
23	Work outside home ToD 3 - car driver
24	Work outside home ToD 3 - car passenger
25	Work outside home ToD 3 - taxi/rideshare
26	Work outside home ToD 3 - train
27	Work outside home ToD 3 - bus
28	Work outside home ToD 3 - light rail
29	Work outside home ToD 3 - ferry
30	Work outside home ToD 3 - walk
31	Work outside home ToD 3 - bicycle
32	Work outside home ToD 3 - motorcycle
33	Work outside home ToD 4 - car driver
34	Work outside home ToD 4 - car passenger
35	Work outside home ToD 4 - taxi/rideshare
36	Work outside home ToD 4 - train
37	Work outside home ToD 4 - bus
38	Work outside home ToD 4 - light rail
39	Work outside home ToD 4 - ferry
40	Work outside home ToD 4 - walk
41	Work outside home ToD 4 - bicycle
42	Work outside home ToD 4 - motorcycle

ToD combinations available

ToD TfNSW	Time frame
1	7am to 8.59am
2	9am to 2.59pm
3	3pm to 5.59pm
4	6pm to 6.69am

At what time do you leave your house?		
Bin ranges	TMR definition	TfNSW definition
7am to 8.59am	1	1
9am to 2.59pm	2	2
3pm to 3.59pm	2	3
4pm to 5.59pm	3	3
6pm to 6.69am	4	4

METHODOLOGY: Wave 5 (No ToD)



Monday - Sunday	
Altij	Description
1	Not work
2	Work from home only
3	Work outside home - car driver
4	Work outside home - car passenger
5	Work outside home - taxi/rideshare
6	Work outside home - train
7	Work outside home - bus
8	Work outside home - light rail
9	Work outside home - ferry
10	Work outside home - walk
11	Work outside home - bicycle
12	Work outside home - motorcycle

Utility Expressions: Current application does not allow for blended location by day of Week unlike the March 2024 DC-CC model

$$U_{NoWork} = ASC_{NoWork} + \sum_{n} \beta_{NoWork,n} \cdot z_n$$

$$U_{WFH} = ASC_{WFH} + \sum_{n} \beta_{WFH,n} \cdot z_n + \sum_{n} \beta_{WFH,d} \cdot day_d$$

$$U^{PT}_{Mode_m} = ASC_{Mode_m} + \beta_{Mode_m,TT} \cdot TT_{Mode_m} + \beta_{Mode_m,Cost} \cdot Fare_{Mode_m} + \beta_{Mode_m,AEWT} \cdot \left(AcT_{Mode_m} + EgT_{Mode_m} + WT_{Mode_m} \right)$$

$$U^{Car/moto}_{Mode_m} = ASC_{Mode_m} + \beta_{Mode_m,TT} \cdot TT_{Mode_m} + \beta_{Mode_m,Cost} \cdot \left(Fuel_{Mode_m} + Park_{Mode_m} + Toll_{Mode_m} \right) + \sum_{n} \beta_{Mode_m,n} \cdot z_n + \beta_{WFH,Dist} \cdot Dist_{Home-work}$$

$$U^{Active}_{Mode_m} = ASC_{Mode_m} + \beta_{Mode_m,TT} \cdot TT_{Mode_m}$$

Wave 5 (Aug-Sep 2022) GSMA

```
Random Parameters Multinom. Logit Model
Dependent variable                CHOICE12
Log likelihood function       -8324.05148
Restricted log likelihood     -19168.56990
Chi squared [ 20](P= .000)     21689.03684
Significance level                .00000
McFadden Pseudo R-squared        .5657448
Estimation based on N =    7714, K =  20
Inf.Cr.AIC  =   16688.1 AIC/N =     2.163
---------------------------------------
            Log likelihood R-sqrd R2Adj
No coefficients **********   .5657 .5653
At start values -8328.3718   .0005-.0004
Note: R-sqrd = 1 - logL/Logl(constants)
---------------------------------------
Response data are given as ind. choices
Replications for simulated probs. = 100
Used Halton sequences in simulations.
Number of obs.=  7714, skipped     0 obs
```

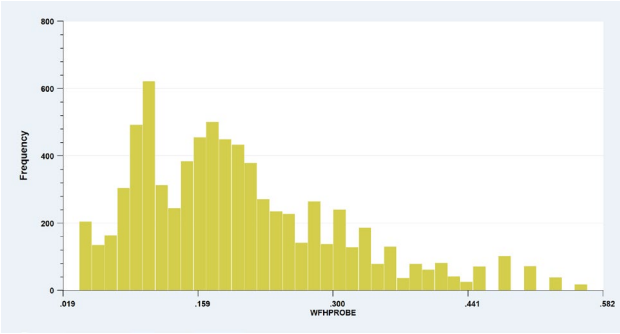
Monday - Sunday	
Alti j	Description
1	Not work
2	Work from home only
3	Work outside home - car driver
4	Work outside home - car passenger
5	Work outside home - taxi/rideshare
6	Work outside home - train
7	Work outside home - bus
8	Work outside home - light rail
9	Work outside home - ferry
10	Work outside home - walk
11	Work outside home - bicycle
12	Work outside home - motorcycle

VOT:$21.22/person Hr

```
--------+-------------------------------------------------------------------
        |                 Standard            Prob.      95% Confidence
CHOICE12|  Coefficient       Error       z    |z|>Z*         Interval
--------+-------------------------------------------------------------------
        |Random parameters in utility functions.........................
All mode alts except walk and bicycle:
     BTT|    -.00940**       .00368    -2.55  .0107      -.01662   -.00218 Travel time (mins
CD and CP alt:
  BDISTC|     .00983***      .00356     2.76  .0058       .00285    .01681 Distance (km)

All modes except CP, Walk, Bicycle:
    BCST|    -.02658***      .00550    -4.84  .0000      -.03735   -.01581 Travel cost ($)
        |Nonrandom parameters in utility functions.....................
No Work Alt:
  BAGENW|     .02540***      .00112    22.70  .0000       .02320    .02759 Age (years)
WFH alt:
 BBLCOWK|   -1.20109***      .14041    -8.55  .0000     -1.47628   -.92590 Blue collar (1,0)
   BDMON|     .90010***      .08617    10.45  .0000       .73121   1.06898 Monday (1,0)
  BDTUES|     .77406***      .08781     8.81  .0000       .60195    .94617 Tuesday (1,0)
  BDTHUR|     .54462***      .09109     5.98  .0000       .36608    .72315 Thursday (1,0)
    BFRI|     .90306***      .08591    10.51  .0000       .73468   1.07144 Friday (1,0)
CD and motorbike alt:
  BASCCD|     .53595***      .12943     4.14  .0000       .28228    .78963 CDASC
CD alt:
 BPINCCD|     .00036         .00057      .64  .5222      -.00075    .00148 Pers inc pa /1000
  BHCARS|     .00375         .04852      .08  .9384      -.09136    .09885 # cars in hhld
BPCVDRVC|    1.46657***      .08940    16.41  .0000      1.29136   1.64179 Drive pre COVID(1,0)
CP alt:
   BASCP|    -.76123***      .12926    -5.89  .0000     -1.01458   -.50788 CPASC
Ride Share alt:
 BASCRSH|   -1.22087***      .26739    -4.57  .0000     -1.74494   -.69681 RSASC
PT mode alts:
  BASCPT|    1.23916***      .14063     8.81  .0000       .96354   1.51478 PTASC
   BAEW|    -.01081***      .00239    -4.51  .0000      -.01550   -.00612 Access-egress time
Walk and Bicycle alts:
BASCWKBK|    1.11419***      .16448     6.77  .0000       .79181   1.43657 Walk-Bike ASC

Walk alt:
   BTTWK|    -.00820         .00509    -1.61  .1070      -.01816    .00177 Walk time (mins)
Bicycle alt:
   BTTBK|    -.03174***      .00902    -3.52  .0004      -.04942   -.01406 Bicycle time (mins
        |Distns. of RPs. Std.Devs or limits of triangular.............
   NsBTT|     .00940**       .00368     2.55  .0107       .00218    .01662
TsBDISTC|     .00983***      .00356     2.76  .0058       .00285    .01681
  NsBCST|     .02658***      .00550     4.84  .0000       .01581    .03735
--------+-------------------------------------------------------------------
```



Wave 5 Option 6: Interact Jobs per square km/1000 and Strategic Centres Dummy variables so Strategic centre specific Jobs per square km/1000 and no stand-alone Strategic centres Only Plus have a stand-alone jobs per square km/1000 for only non-strategic Centres

Comment: If you use this, we have a var for jobs per square km/1000 for new strategic centres or any other location.

Mapping equation between the probability of WFH vs commuting and statistical influences. Constrained (0,1) Tobit Model: probability WFH.

Variable	Mean (t-value)
Constant	0.093 (27.65)
Age (years)	-0.002 (46.41)
Cars per adult in household	-0.033 (10.98)
Number of people living in household	-0.002 (4.06)
Occupation manager (1,0)	0.113 (49.72)
Occupation professional (1,0)	0.117 (55.09)
Occupation clerical and administration (1,0)	0.111 (50.34)
Occupation sales (1,0)	0.124 (48.19)
Occupation community and personal services (1,0)	0.119 (43.90)
Occupation labourer (1,0)	0.010 (3.46)
Chose PT for commute (1,0)	0.012 (10.03)
Distance from home to work (kms)	0.001 (19.08)
Located in Newcastle (1,0)	-0.022 (11.39)
Located in Illawarra (1,0)	-0.015 (6.77)
Located in Central Coast (1,0)	-0.028 (14.14)
Monday (1,0)	0.118 (64.85)
Tuesday (1,0)	0.097 (57.67)
Thursday (1,0)	0.063 (42.48)
Friday (1,0)	0.118 (65.08)

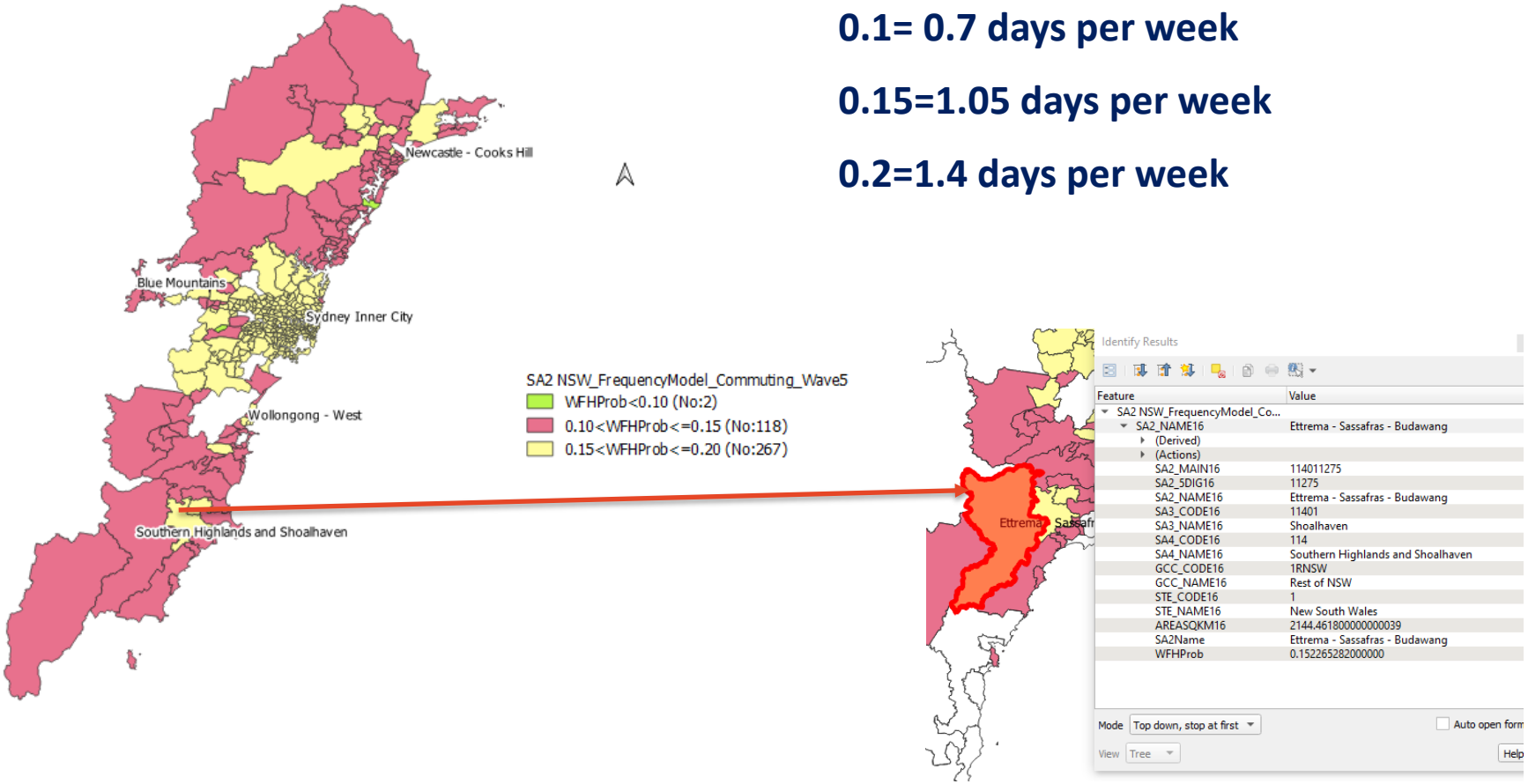
$$R^2_{DECOMPOSITION} = \frac{\frac{1}{n}\sum_{i=1}^{n}\left(\hat{y}_i - \bar{y}\right)^2}{\frac{1}{n}\sum_{i=1}^{n}\left(\hat{y}_i - \bar{y}\right)^2 + \frac{1}{n}\sum_{i=1}^{n}\left(y_i - \hat{y}_i\right)^2}$$

$$= \frac{\text{Variation of predicted mean}}{\text{Variation of predicted mean} + \text{Residual variation}}$$

Veall, M. and Zimmermann, K. (1992) propose a surrogate R-squared for a Tobit model. The measure, referred to as the decomposed R-squared takes the variance of the conditional mean function around the overall mean of the data in the numerator. The denominator contains the sum of the numerator and a residual variance, the true value minus the conditional mean function.

Variable	Mean (t-value)
Total jobs per square km/1000 at non-strategic centres (=0 in a strategic centre)	0.0002 (2.04)
Total jobs per square km/1000 in Bondi Junction	-0.001 (1.81)
Total jobs per square km/1000 in Campbelltown-Macarthur Metropolitan Cluster	-0.046 (0.98)
Total jobs per square km/1000 in Chatswood	0.006 (5.20)
Total jobs per square km/1000 in Greater Parramatta Metropolitan Centre	0.003 (8.39)
Total jobs per square km/1000 in Greater Penrith	-0.037 (8.22)
Total jobs per square km/1000 in City	0.0002 (13.18)
Total jobs per square km/1000 in North Sydney	0.0004 (2.41)
Total jobs per square km/1000 in Hornsby	0.003 (0.72)
Total jobs per square km/1000 in Kogarah	0.008 (4.02)
Total jobs per square km/1000 in Liverpool	-0.008 (1.96)
Total jobs per square km/1000 in Macquarie Park	0.001 (1.35)
Total jobs per square km/1000 in Norwest	-0.004 (1.60)
Total jobs per square km/1000 in St Leonards	0.001 (1.02)
Total jobs per square km/1000 in Olympic Park	-0.002 (1.10)
Commuting travel time by car to main office location (mins)	-0.001 (13.34)
Disturbance standard deviation: Sigma	***0.0423 (113)***
Sample size	***6,419***
Number of estimated parameters	***36***
Log-likelihood	***11185.4***
Adjusted R-squared (OLS)	***0.762***
R-squared (decomposition)	***0.438***

GSMA with Strategic Centre Dummy Variables interacted with Jobs per square km (Option 6): Wave 5



0.1= 0.7 days per week

0.15=1.05 days per week

0.2=1.4 days per week

Southern Highlands has a high WFH incidence in Wave 5

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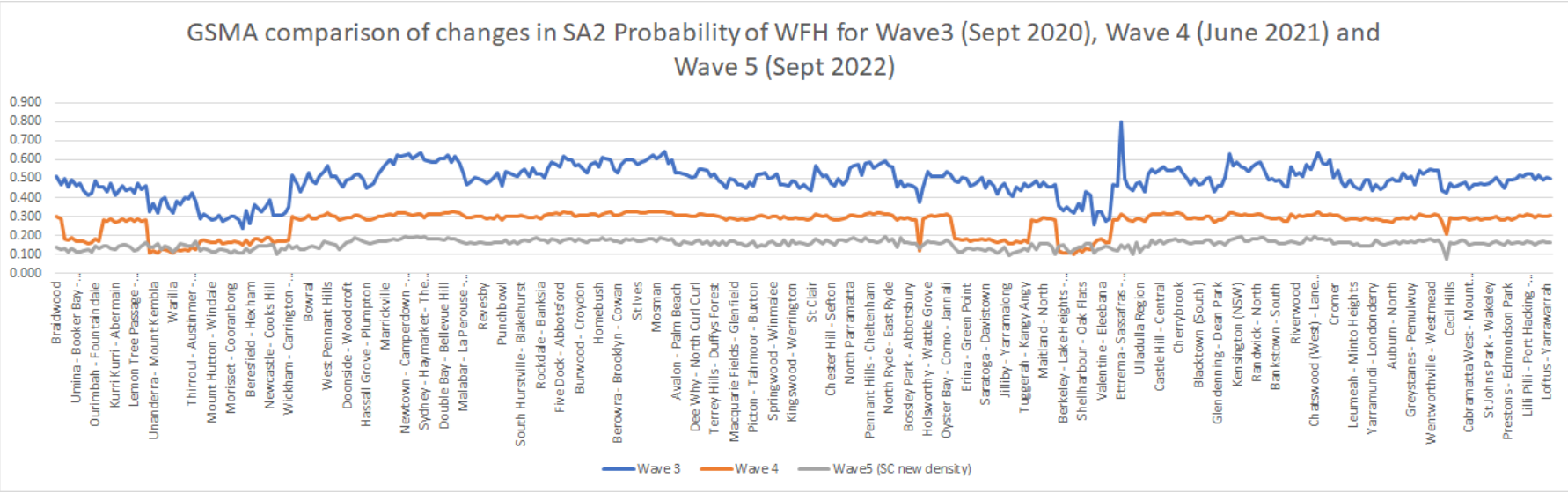
GSMA comparison of changes in SA2 Probability of WFH for Wave3 (Sept 2020), Wave 4 (June 2021) and Wave 5 (Sept 2022)
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Braidwood
Umina - Booker Bay -...
Ourimbah - Fountaindale
Kurri Kurri - Abermain
Lemon Tree Passage -...
Unanderra - Mount Kembla
Warilla
Thirroul - Austinmer -...
Mount Hutton - Windale
Morisset - Cooranbong
Beresfield - Hexham
Newcastle - Cooks Hill
Wickham - Carrington -...
Bowral
West Pennant Hills
Doonside - Woodcroft
Hassall Grove - Plumpton
Marrickville
Newtown - Camperdown -...
Sydney - Haymarket - The...
Double Bay - Bellevue Hill
Malabar - La Perouse -...
Revesby
Punchbowl
South Hurstville - Blakehurst
Rockdale - Banksia
Five Dock - Abbotsford
Burwood - Croydon
Homebush
Berowra - Brooklyn - Cowan
St Ives
Mosman
Avalon - Palm Beach
Dee Why - North Curl Curl
Terrey Hills - Duffys Forest
Macquarie Fields - Glenfield
Picton - Tahmoor - Buxton
Springwood - Winmalee
Kingswood - Werrington
St Clair
Chester Hill - Sefton
North Parramatta
Pennant Hills - Cheltenham
North Ryde - East Ryde
Bossley Park - Abbotsbury
Holsworthy - Wattle Grove
Oyster Bay - Como - Jannali
Erina - Green Point
Saratoga - Davistown
Jilliby - Yarramalong
Tuggerah - Kangy Angy
Maitland - North
Berkeley - Lake Heights -...
Shellharbour - Oak Flats
Valentine - Eleebana
Ettrema - Sassafras -...
Ulladulla Region
Castle Hill - Central
Cherrybrook
Blacktown (South)
Glendenning - Dean Park
Kensington (NSW)
Randwick - North
Bankstown - South
Riverwood
Chatswood (West) - Lane...
Cromer
Leumeah - Minto Heights
Yarramundi - Londonderry
Auburn - North
Greystanes - Pemulwuy
Wentworthville - Westmead
Cecil Hills
Cabramatta West - Mount...
St Johns Park - Wakeley
Prestons - Edmondson Park
Lilli Pilli - Port Hacking -...
Loftus - Yarrawarrah
Wave 3
Wave 4
Wave5 (SC new density)

Relating Non-Commuting Trips to Commuting Trips and WFH by Workers during COVID-19 late 2020 and two periods in 2021, pre- and post-lockdown

Balbontin, C., Hensher, D.A. and Beck, M. J (2024) The influence of working from home on the number of commuting and non-commuting trips during 2020 and 2021 pre- and post-lockdown in Australia, (paper presented at the *17th International Conference on Competition and Ownership of Land Passenger Transport* (Thredbo 17), Sydney, Australia, September 2022). Paper #24, *Transportation Research Part A*,179, 103937

Wave A: August-September 2020, when there were relatively minor restrictions in Australia

Wave B: April-May 2021, a period at the start of what would be the longest sustained period of lockdown in NSW (with relative freedoms still existing in QLD throughout the same time period)

Wave C: December 2021, the period at the end of this prolonged lockdown in NSW.

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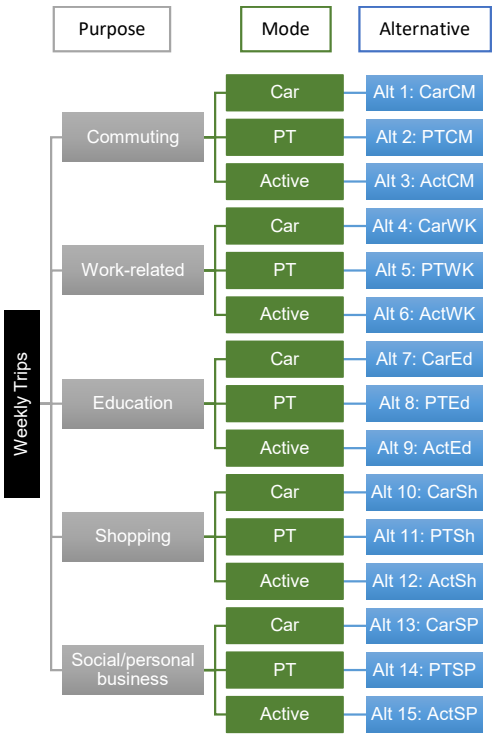
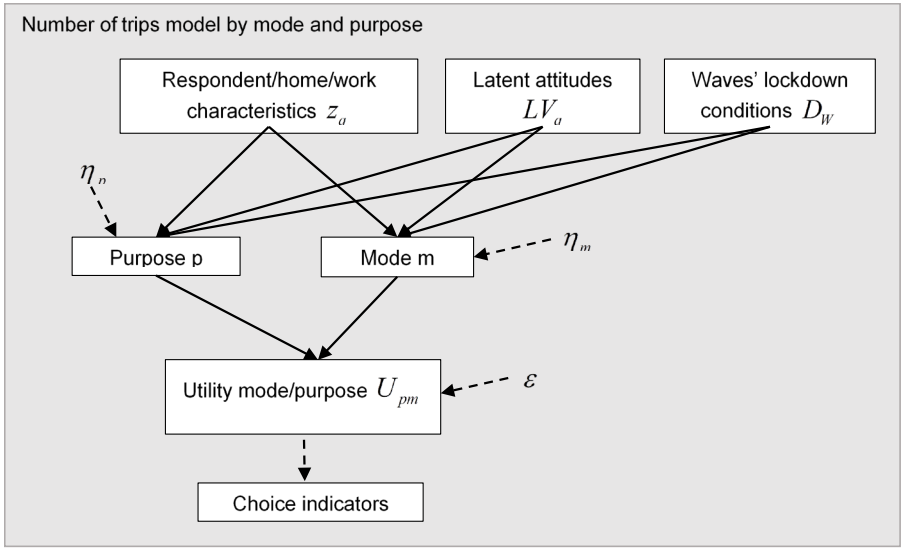
The multiple discrete-continuous extreme value (MDCEV) Model (Chandra Bhat Model Form)

Alternatives definitions





$$V_{pm} = ASC_{pm} + \sum_j \left(\beta_{mj} z_{qj} + \beta_{pj} z_{qj}\right) + \sum_i \left(\beta_{mi} LV_{qi} + \beta_{pi} LV_{qi}\right) + \beta_{WB} \cdot D_{WB} + \beta_{WA} \cdot D_{WA} + \eta_p + \eta_m$$

$$U(x) = \sum_{p=1}^{P}\sum_{m=1}^{M} \frac{\gamma_{pm}}{\alpha_{pm}} \psi_{pm} \left\{ \left(\frac{x_{pm}}{\gamma_{pm}} + 1 \right)^{\alpha_{pm}} - 1 \right\} \qquad \sum_{p=1}^{P}\sum_{m=1}^{M} x_{pm} p_{pm} = B \qquad \psi_{pm} = \exp(V_{pm} + \varepsilon_{pm})$$

x_{pm} is the number of weekly one-way trips by purpose *p* and mode *m*

The budget B is represented by the total number of one-way trips made by an individual last week

ψ_{pm} = baseline utility parameters or the marginal utility of one unit of consumption of alternative *pm* at the point of zero consumption for that alternative; α_{pm} and γ_{pm} are parameters that show the added benefit to the baseline utility of one additional trip.

The five latent variables extracted are represented as follows:

Authorities and community's response supporters: respondents that believe the authorities and community response towards the pandemic has been appropriate.

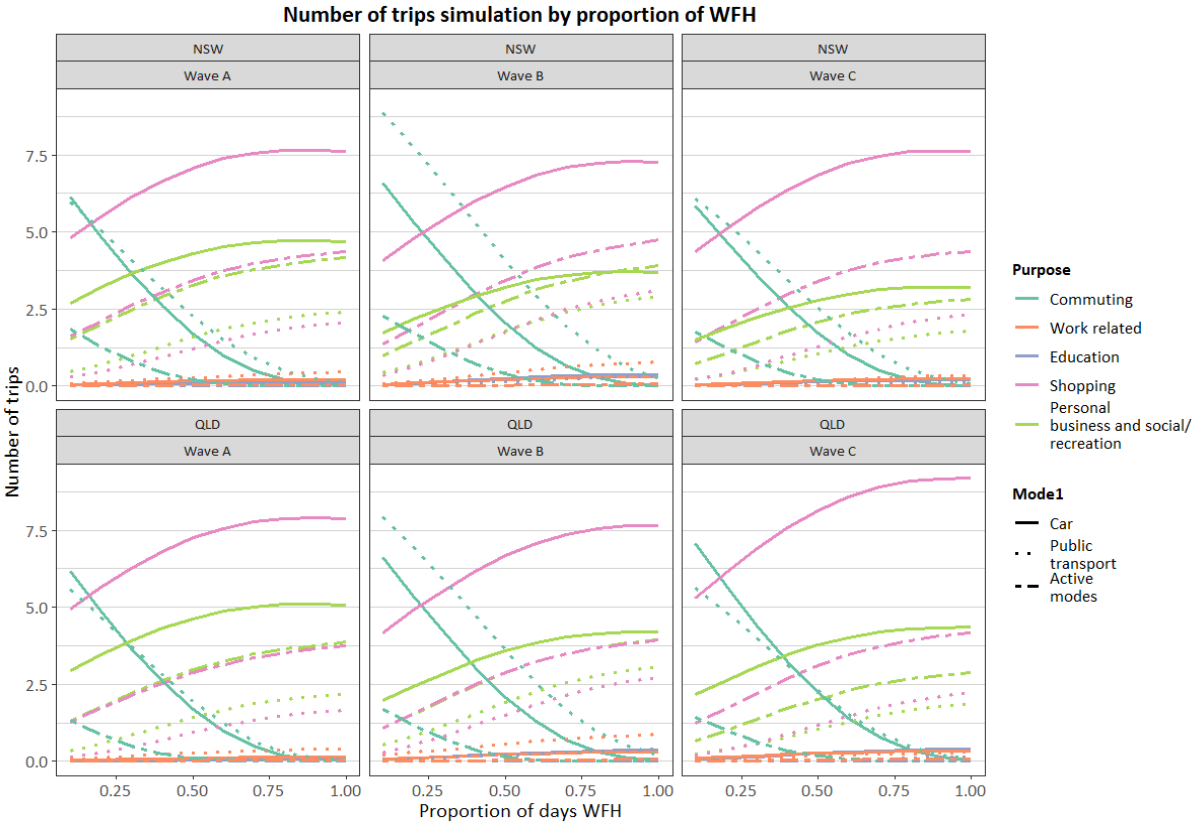
Massive meeting lovers: respondents that feel comfortable having any type of meeting, including music events, watching live entertainment, among others.

Social meeting lovers: respondents that feel comfortable having social meetings with friends, visiting restaurants and pubs, gyms and exercise groups, among others.

High level of life satisfactions: respondents that said to be satisfied and happy with their life.

Concerned about public transport: people that are concerned about hygiene and the number of people in public transport due to COVID-19.

Simulated number of one-way trips (by purpose) by proportion of WFH



Wave A: September-October 2020 when there were relatively minor restrictions

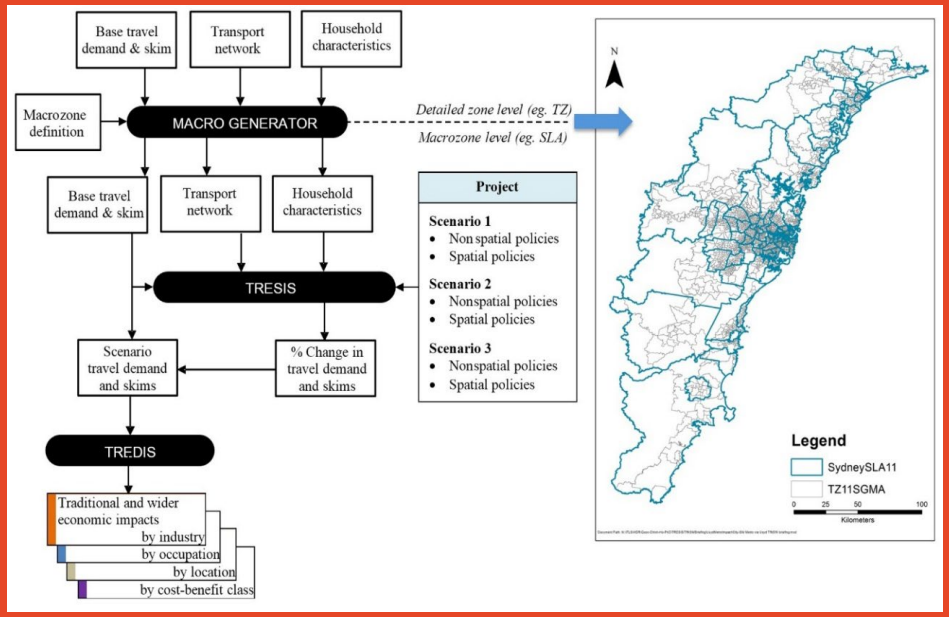
Wave B: March-May 2021, a period at the start of what would be the longest sustained period of lockdown in NSW (with relative freedoms still existing in Queensland throughout the same time period); and

Wave C: November-December 2021, the period at the end of this prolonged lockdown in New South Wales

Inferred Direct Elasticities

Metropolitan workers	Commute	Work-related	Education	Shopping	Personal business	Social/ recreation
Age (years)	-0.350		-0.870		-0.496	
Gender female (0,1)		-0.328	0.275	-0.045		-0.046
Personal income ('000AUD$)	0.052			0.022		0.146
Number of children in household	0.016	-0.162	0.405	0.099		-0.089
At least one child in primary school (0,1)	-0.041	0.182	0.520	-0.060		
Number of cars per adult in household	0.103	0.485	0.382		0.224	0.108
Distance from home to office (kms)	-0.026	0.053	-0.131	-0.067		
Proportion of days WFH	**-0.132**	**-0.231**	**0.204**	**0.039**	**0.039**	**0.053**
Occupation clerical and administration (0,1)	0.042	-0.177				
Used car to go to work last week (0,1)	-0.165	-0.151	-0.166	-0.065	0.158	-0.073
Work located in CBD area (0,1)		0.123	-0.213	0.071		
Central Coast (0,1)					-0.295	
Brisbane (0,1)	-0.063	-0.317			-0.151	-0.148
Located in the state of NSW (0,1)			-0.223			-0.097

Integrated Transport, Land Use and Environmental Model Systems: GSMA MetroScan



Hensher, D.A., Wei, E, and Liu, W. (2023) Accounting for the spatial incidence of working from home in MetroScan - an integrated transport and land model system, *Transportation Research Part A (* See also and early version: https://ses.library.usyd.edu.au/handle/2123/27127), 173, 103793

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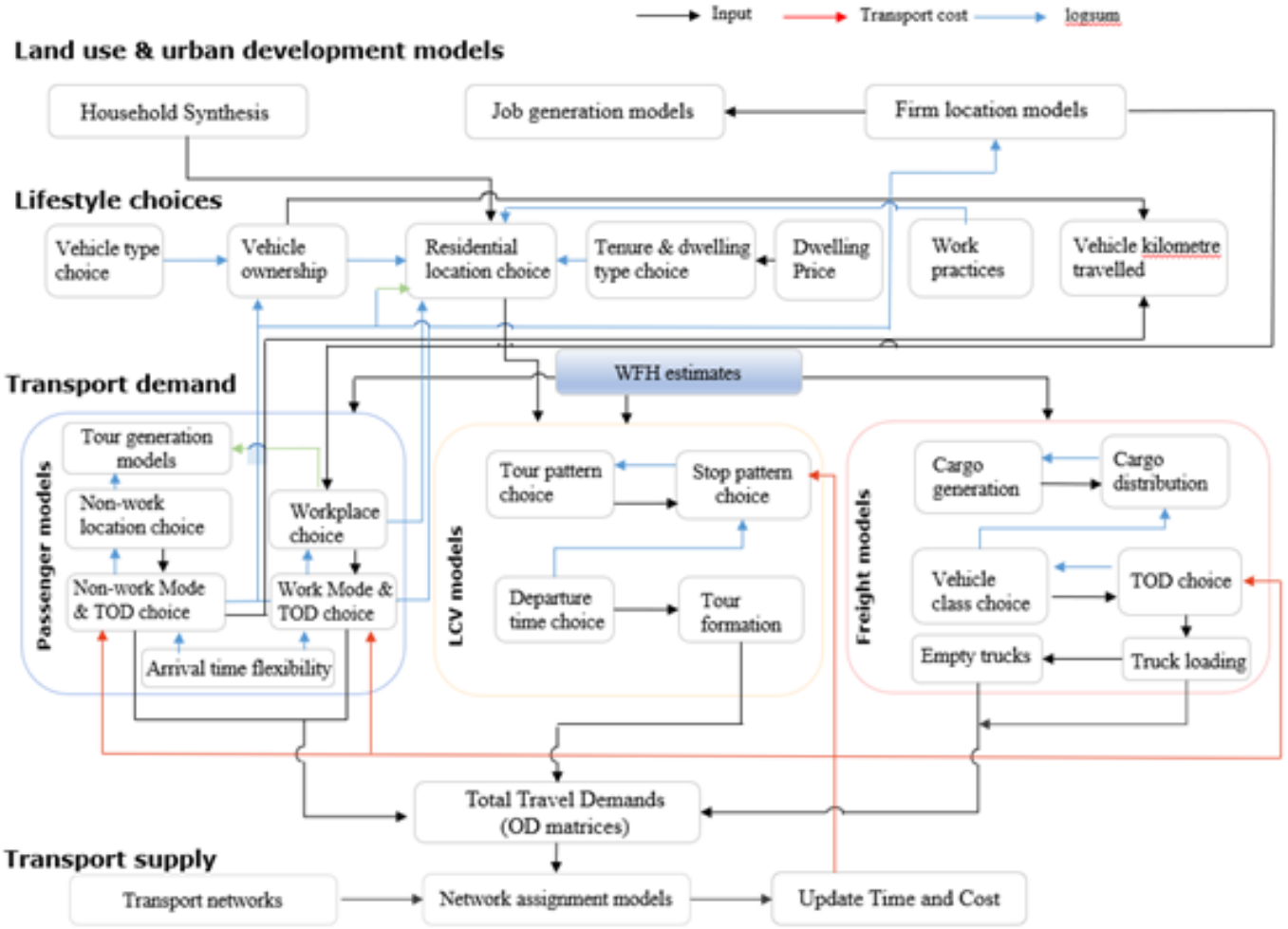
Tracing changes in accessibility on location responses: and where WFH impacts fit in

MetroScan (GSMA)- very fast runs <40 mins on HPC

The demand-side behavioural model system for passenger, light commercial, and freight travel activity. **Built in is Freight, WFH, Electric car transition……numerous outputs; agglomeration, social exclusion, well-being…**



MetroScan W/Wo WFH June 2021

Modal Activity per annum (all trip purposes):	Base (before WFH)	Allowing for WFH	Percentage change
Car drive alone	3,063,173,050	2,970,069,248	-3.039
Car with passengers	1,650,606,668	1,669,612,761	1.151
Bus	194,705,461	178,345,562	-8.402
Train	252,787,164	229,722,719	-9.124
Total motorised modes	5,161,272,343	5,047,750,290	-2.199
Modal shares (all trip purposes):			
Car drive alone	59.35%	58.84%	-0.859
Car with passengers	31.98%	33.08%	3.427
Bus	3.78%	3.53%	-6.411
Train	4.90%	4.55%	-7.122
Passenger Vehicles:			
Total daily car kms	252,725,288	225,630,166	-4.848
Total revenue for PT use ($pa)	1,482,019,696	1,352,421,896	-8.745
Total revenue from parking ($pa)	302,715,424	301,733,633	-0.325
Total government revenue for GST	64,381,101,223	61,259,401,088	-4.848
Total revenue from toll roads ($)	867,317,568	849,985,927	-1.998
Total annual auto VKM ($)	9,165,032,041	8,720,639,491	-4.848
Total government revenue from fuel excise ($pa)	3,302,013,595	3,141,906,108	-4.848
Generalised cost per annum for PT ($pa)	9,726,699,697	8,806,113,504	-9.423
Generalised cost per annum for car ($pa)	104,504,496,348	98,546,845,871	-5.53
Generalised cost per person trip for PT ($)	21.726	21.58	-0.672
Generalised cost per person trip for car ($)	22.13	21.24	-4.022
Generalised cost per person trip car & PT ($)	22.095	21.267	-3.745
Freight Vehicles:			
Total government revenue from fuel excise ($pa)	1,162,090,474	1,168,269,296	0.532
Annual Total distance travelled Articulated	3,478,798,038	3,497,879,878	0.549
Annual Total distance travelled Rigid	2,331,654,333	2,343,466,600	0.507
Generalised cost per trip for freight ($)	126,303	123,487	0.532
Emissions and Pollution:			
Total CO_2 for passenger and freight movements	16,746,997,718	16,144,193,943	-3.599
Total CO_2 for passenger movements	12,432,062,391	11,829,258,616	-4.849
Total annual carbon dioxide for trucks	4,314,935,327	4,337,961,459	0.534
Total annual local air pollution costs for trucks	2,674,467,833	2,688,976,524	0.542

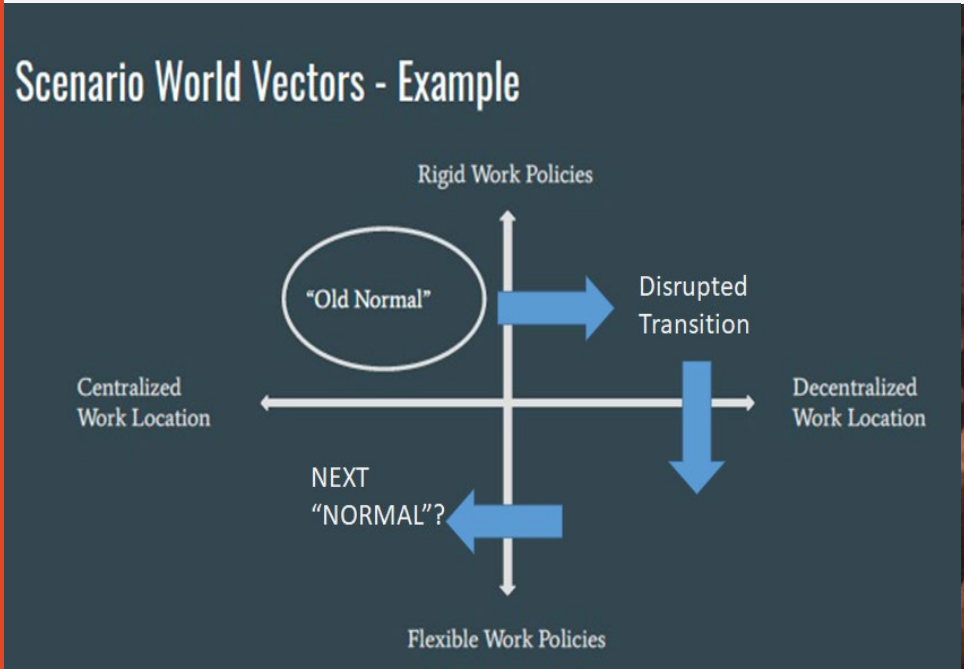
The Big Accumulating Take Away Evidence: Structural Change

Beck, M. J. and Hensher, D.A. (2022) Australia 6 months After COVID-19 Restrictions Part 1: Changes to Travel Activity and Attitude to Measures, Paper #7a. *Transport Policy*, 128, 286-298.

https://doi.org/10.1016/j.tranpol.2021.06.006

Beck, M. J. and Hensher, D.A. (2022) Australia 6 months After COVID-19 Restrictions Part 2: The Impact of Working from Home, Paper #7b. *Transport Policy*, 128, 274-285. https://doi.org/10.1016/j.tranpol.2021.06.005

Hensher, D.A., Beck, M.J., and Nelson, J. (2024) What have we learned about long term structural change brought about by COVID-19 and working from home? *Transportation Letters*, online 19 July 2023. https://doi.org/10.1080/19427867.2023.2237269 (Third most read article as on April 2024),. 16 (7), 738–750



The Key Policy Take Away ('Until we come fully out of COVID jail"): Love it or hate it, remote and hybrid/blended work is the future.

- With WFH being seen as one of, if not the most, impactful transport policy instrument available for many years,
  - **the policy settings that flow from this WFH and WNH 'next normal' are expected to include infrastructure investments that align more with suburban investments to benefit walking and cycling and the broader agenda of the 20 minute city where reduced commuting distances become a greater priority.**

- Importantly the changed profile of commuting may look more like reduced frequency over a week while preserving much of the longer distance commute over fewer days while either avoiding commuting at all on some days or commuting to a close by satellite office.

- **These structural changes are evolving and look like becoming a permanent fixture of the mobility land use scape.**

- Lot of trends in place that are being reinforced.

- Interesting comments re "Return to the Office":
  - Having a window cf. not, increases productivity by 13% (many homes have a window in a study/office)
  - Offices with poor light penetration are a concern with many offices (except if open office design)
    - Meeting rooms may be less windows compared to where people sit most of the time

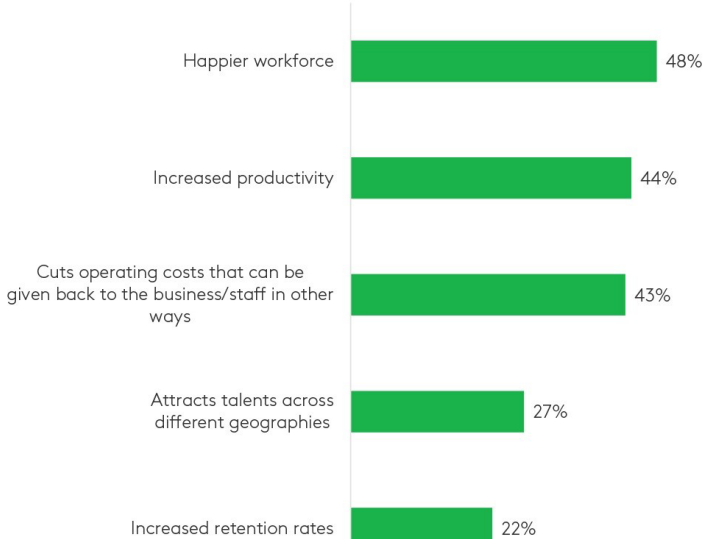
- Some offices are becoming apartments and retail also becoming multi-use.

- Let's give everybody access – democratise the office place and given them better choices – so it is about giving people better access to choices

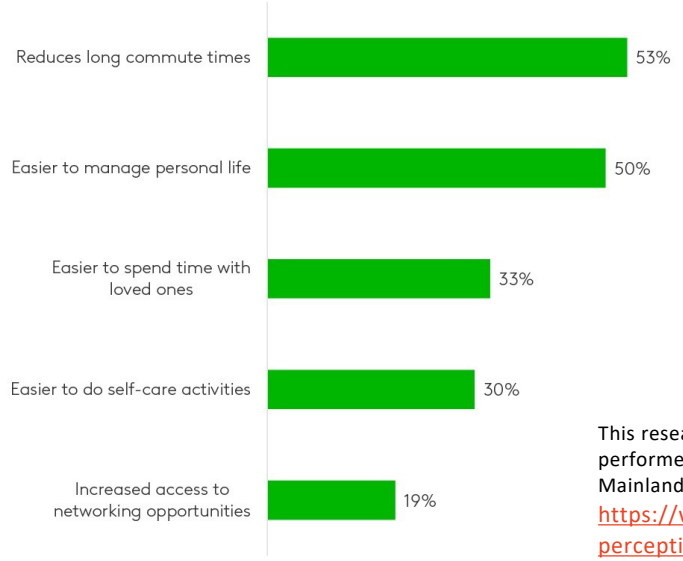
- But caution about overestimating the impact of the short turn; but there is no 'normal' – we will not return to the past and why would we want to?.

Aligns well with other surveys: Flexibility is here to stay

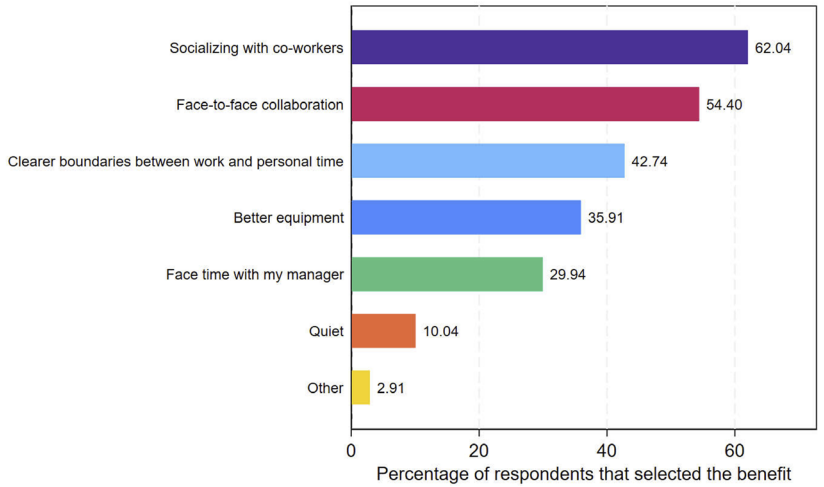
What postitives do you think flexibilty creates for companies?



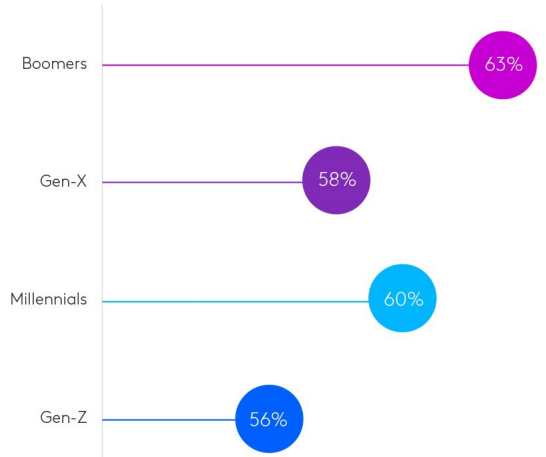
What positives do you think flexible working creates for employees?



Q: "What are the top three benefits of working on your employer's business premises?" N=20,732 workers in 34 countries surveyed in April-May 2023.



Ideal % of Workweek Spent Remote



This research was conducted online among 7,985 full or part-time workers (whose job function could be performed remotely at least part-time) across eight global markets: US, UK, France, Germany, India, Singapore, Mainland China and Brazil between 14-15 January 2022

https://www.kantar.com/inspiration/research-services/future-of-work-employee-perception-on-flexibility-pf

https://imoveaustralia.com/project/project-outcomes/covid-and-working-from-home-how-has-it-impacted-transport/

https://imoveaustralia.com/wp-content/uploads/2023/02/Working-from-Home-and-implications-for-revision-of-Metropolitan-Strategic-Transport-Models.pdf

https://www.seriouslysocialpodcast.org.au/e/how-avoiding-the-commute-is-making-us-happier

Working from Home Final Report

Working from Home (WFH) and Implications for Revision of Metropolitan Strategic Transport Models

iMOVE Projects 1-031 and 1-034 (2020-2022)

'Flexibility is here to stay' and 'employers who offer a balance of WFH and in office will attract more high-quality employees'

The Future of Office Space Summit, 17 February 2021

iMOVE Australia Limited ("Company")

Transport and Main Roads Qld ("TMR")

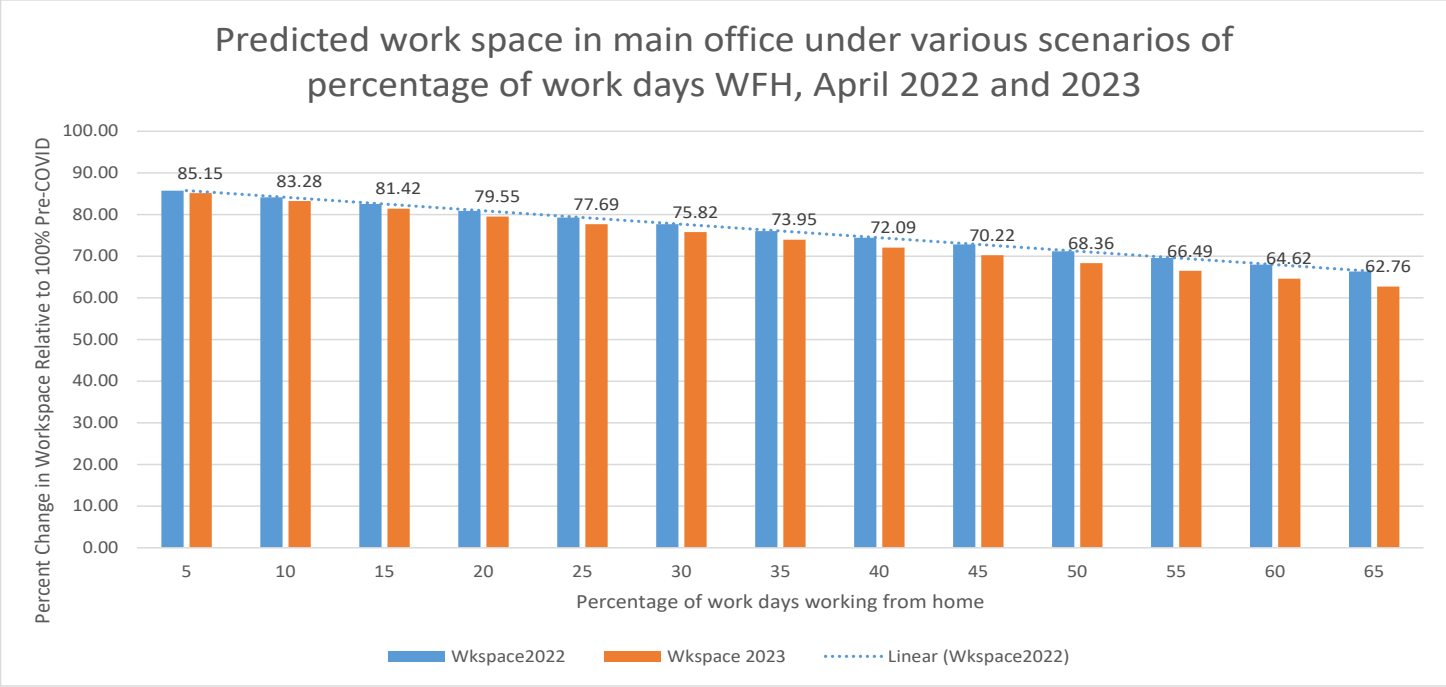
Transport for New South Wales ("TfNSW")

Western Australia Department of Transport ("WA DoT")

Institute of Transport and Logistics Studies ("ITLS"), The University of Sydney ("University of Sydney")

22 December 2022

The expected influence of WFH levels on required office space in the main location in April 2022 and 2023: GSMA Scenario Analysis



If we work with what appears to be the most likely scenario of one to two days WFH per week for many occupations:

Our model predicts a reduction in the percentage of office space compared to pre-COVID-19 to 79.6% for an average of one day WFH and 72.1% for an average of two days WFH.

The decline of 20% to 28% in 2023 relates reasonably well to an occupancy rate in 2022 of 18% for the Sydney metropolitan area.

THANK YOU

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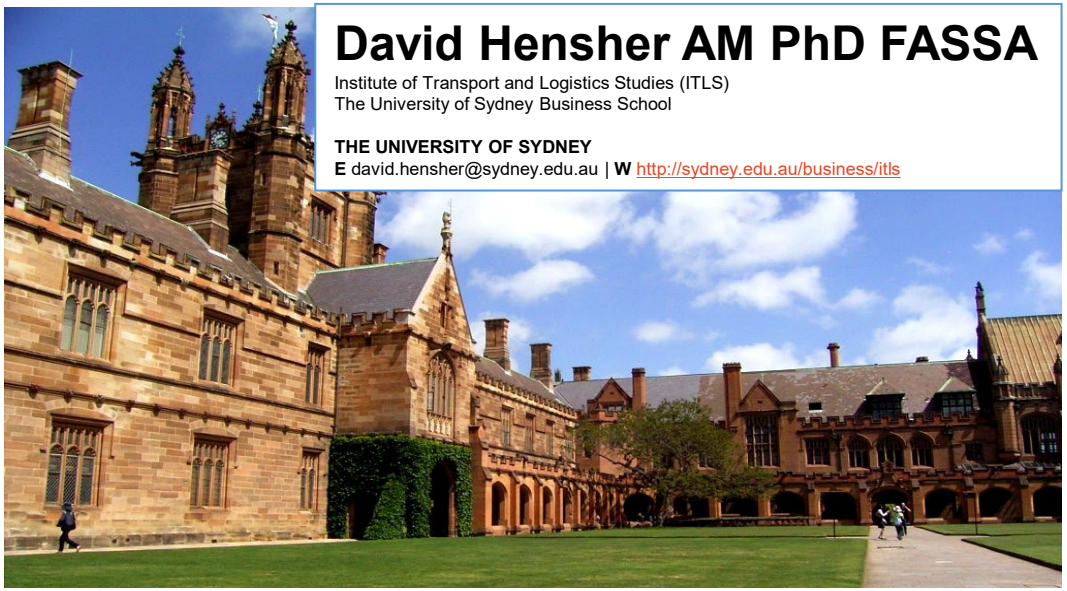

David Hensher AM PhD FASSA

Institute of Transport and Logistics Studies (ITLS)
The University of Sydney Business School

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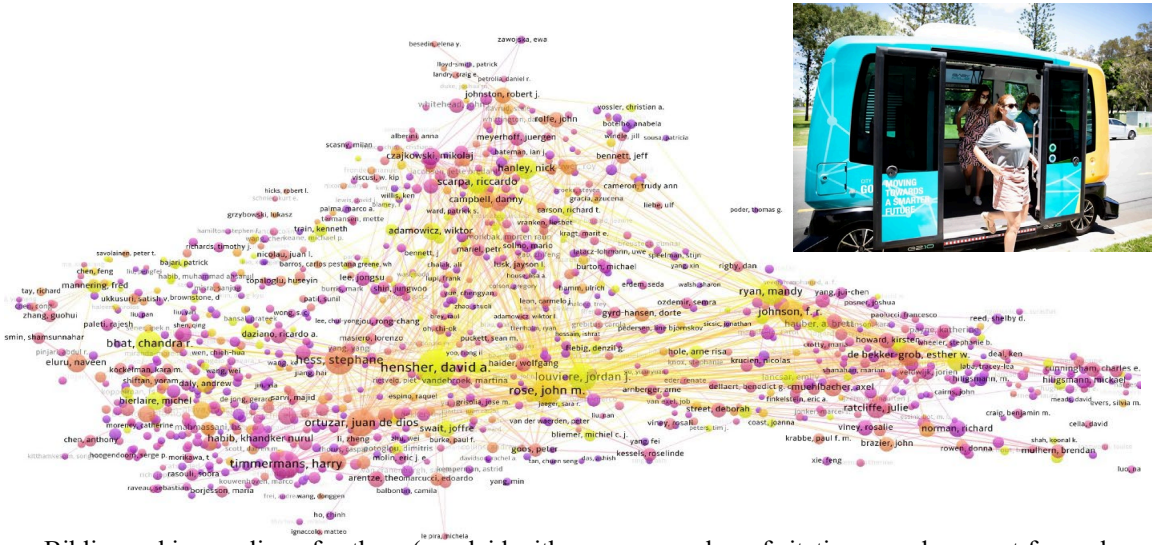

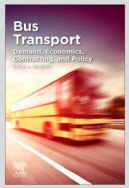

Bus Transport

Demand, Economics, Contracting, and Policy

David A. Hensher, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia

ISBN: 978-0-12-820132-9
VOLUME:
EDITION: 1
PUB DATE:
LIST PRICE: RRP AUD 195, RRP NZD 266
FORMAT: Paperback
TRIM: 8.5w x 10.875h
PAGES: c. 250

The latest public transportation insights on contracting, performance, image, crowding, and Mobility as a Service

KEY FEATURES

- Compiles, in one source, up-to-date insights on the most important public transport themes, issues, and debates
- Examines a wide range of public transport topics in the multidisciplinary fields of economics, policy, operations and planning
- Bridges the gap between scientific research and policy implementation

DESCRIPTION

Bus Transport: Demand, Economics, Contracting, and Policy examines in one source the most critical and current research themes of public transport regulators, planners, operators, researchers, and educators. It highlights the wider economic impacts of public transport and compares energy usage across all public transport modes. The book examines the evolving debate on Mobility as a Service (MaaS) and includes discussion of such themes as; public image issues, performance measurement and monitoring, contract procurement and design models, travel choice and demand, and global public transport reform. The book reflects the leading perspectives on the preservation and health of the bus sector, intending to move public transport reform forward.

This book reflects the leading perspectives on the preservation and health of the bus sector, intending to move public transport reform forward.

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Understanding Mobility as a Service (MaaS)

Past, Present and Future

David A. Hensher, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia; Corinne Mulley, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia; John D. Nelson, Institute of Transport and Logistics Studies, The University of Sydney Business School Australia; Chinh Ho, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia; Göran Smith, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia and Chalmers University, Sweden and Yale Wong, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia

ISBN: 978-0-12-820044-5
EDITION: 1
PUB DATE: July 2020
LIST PRICE: RRP AUD 195, RRP NZD 255
FORMAT: Paperback
TRIM: 6w x 9h
PAGES: c. 240

Examines all facets of MaaS, assessing its role in the evolution of today's and tomorrow's transport systems

KEY FEATURES

- Includes case studies to show how MaaS is delivered around the world
- Covers foundational aspects of MaaS, clarifying what it is for those new to the concept
- Offers an in-depth analysis on a wide range of MaaS topics including governance, contracts, consumer and supplier preferences, links to societal objectives, the role of trials, assessments, and more

DESCRIPTION

The widespread adoption of smartphones, ridesharing and carsharing have disrupted the transport sector. In cities around the world, new mobility services are both welcomed and challenged by regulators and incumbent operators. Mobility as a Service (MaaS), an ecosystem designed to deliver collaborative and connected mobility services in a society increasingly embracing a sharing culture, is at the center of this disruption.

Understanding Mobility as a Service (MaaS): Past, Present and Future examines such topics as:

- How likely MaaS will be implemented in one digital platform app
- Whether MaaS will look the same in all countries
- The role multi-modal contract brokers play
- Mobility regulations and pricing models
- MaaS trials, their impacts and consequences

Written by the leading thinkers in the field for researchers, practitioners, and policy makers, *Understanding Mobility as a Service (MaaS): Past, Present and Future* serves as a single source on all the current and evolving developments, debates, and challenges.

The authors dedicate this book as a contribution to the Volvo Research and Educational Foundations (VREF) Bus Rapid Transit (BRT+) Centre of Excellence (http://www.brt.cl/) and the iMOVE Cooperative Research Centre (CRC) (https://imoveaustralia.com/).

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Bibliographic coupling of authors (overlaid with average number of citations per document for each author) in choice modelling as of June 2020

VOSviewer

Countries differ in their norms, but office workers everywhere want the same thing: **flexibility**

- In the **United States**, about a third of office workers had returned to fully in-person work by the end of the first quarter of this year, according to Future Forum, a research group at Slack that surveyed more than 10,000 knowledge workers across six countries.
- And the rest of the world isn't rushing back to the office either:
  - Only 26 percent in **Britain**, 28 percent in **Australia**, 32 percent in **Germany**, and 35 percent in **France** have done so.
- **Japan** is a bit of an outlier—there, more than half of white-collar workers are back in the building
- but elsewhere, most employees either continued working fully remotely or split their time in a hybrid model; more than three-quarters of those canvassed in a separate, published survey from Future Forum said they liked this flexibility.
- **Britain**, where before the pandemic, workers would on average spend more than an hour commuting each day—time that has since been repurposed for catching up on sleep, doing household chores, or caring for family members and pets.
  - **In London, despite an extensive mass-transit system, nearly three-quarters of workers say they'll never go back to their pre-pandemic ways.**

https://www.businessinsider.com/remote-work-from-home-surviving-return-to-office-mandates-era-2026-1

Relationship between Office Space Capacity, Working from Home and Remote Working at a Satellite Office: Pre-COVID, now (April 2022) and 2023

A survey undertaken in April 2022 for the Greater Sydney Metropolitan Area (GSMA)
Survey 4D (focus on the Firm)
459 organisations

Hensher, D.A., Wei, E. and Beck, M.J. (2022) The Impact of COVID-19 and working from home on the main location office space retained and the future use of satellite offices *Transport Policy*, 130, 184-195. Paper #30.

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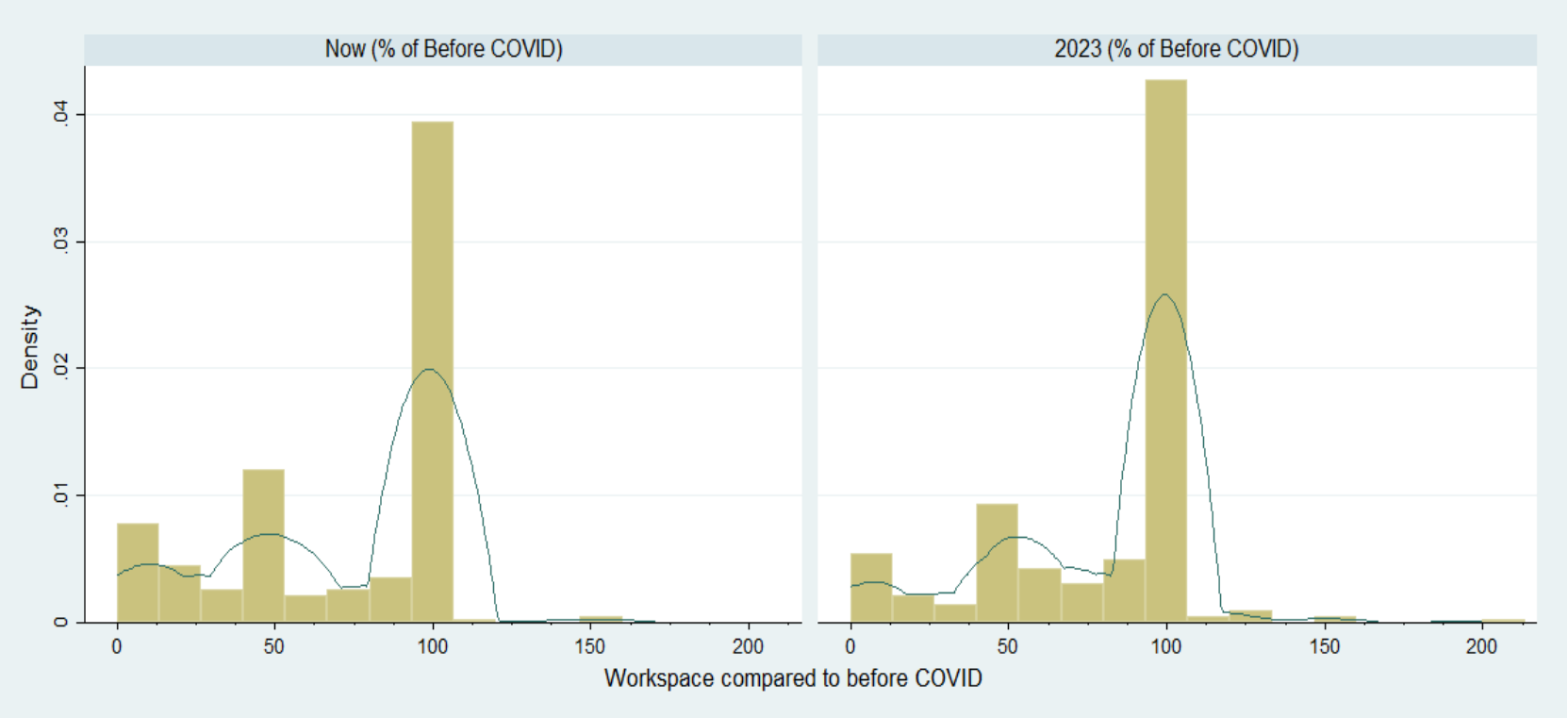
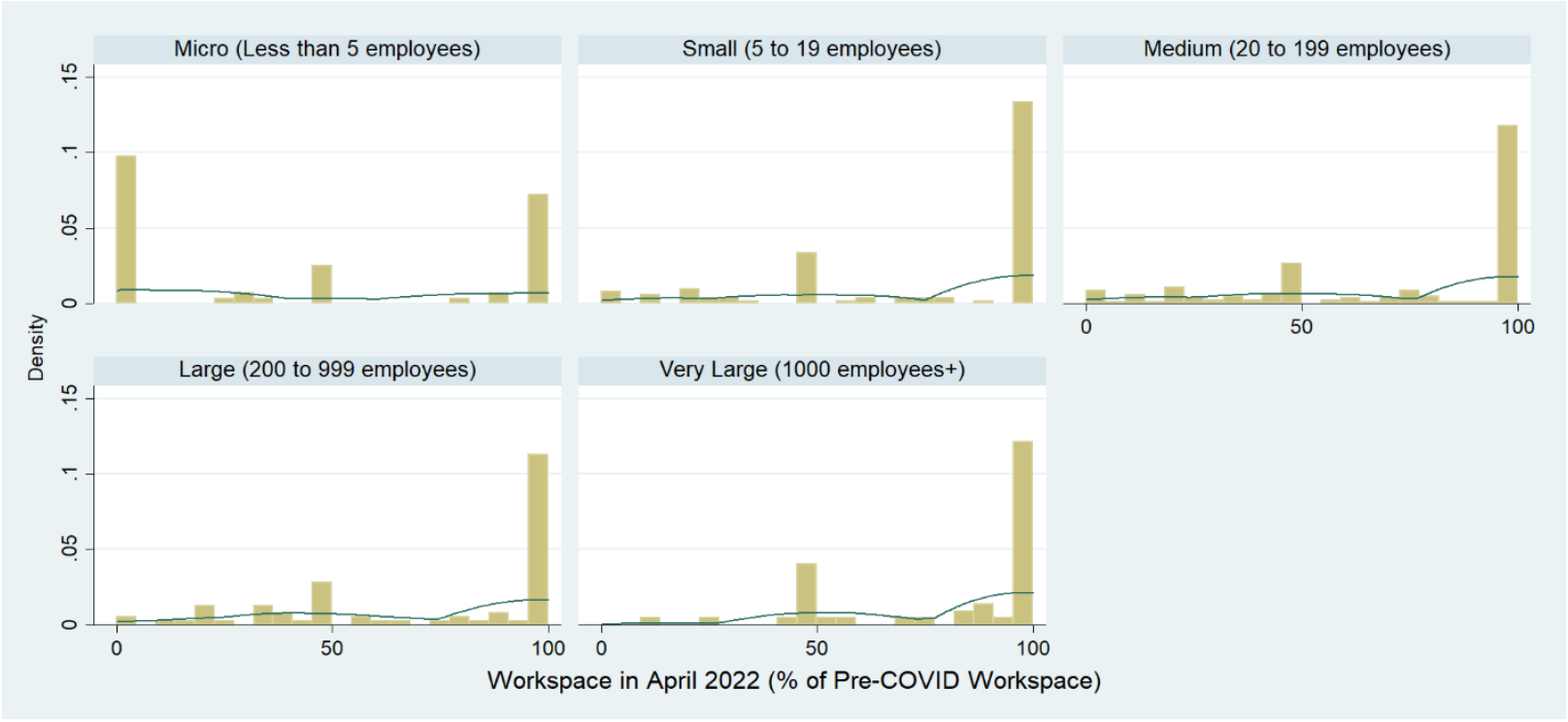
Percentage of Work-Space (relative to Pre-COVID) in April 2022 and Sept 2023 (100% is no change): GSMA



Y axis: probability density is the probability per unit on the x-axis;
X axis is the number of firms

The distribution of main location office space in 2022 compared to Pre-COVID-19 by organisation size: GSMA (459 organisations)
Note: 100% means same as pre-COVID-19



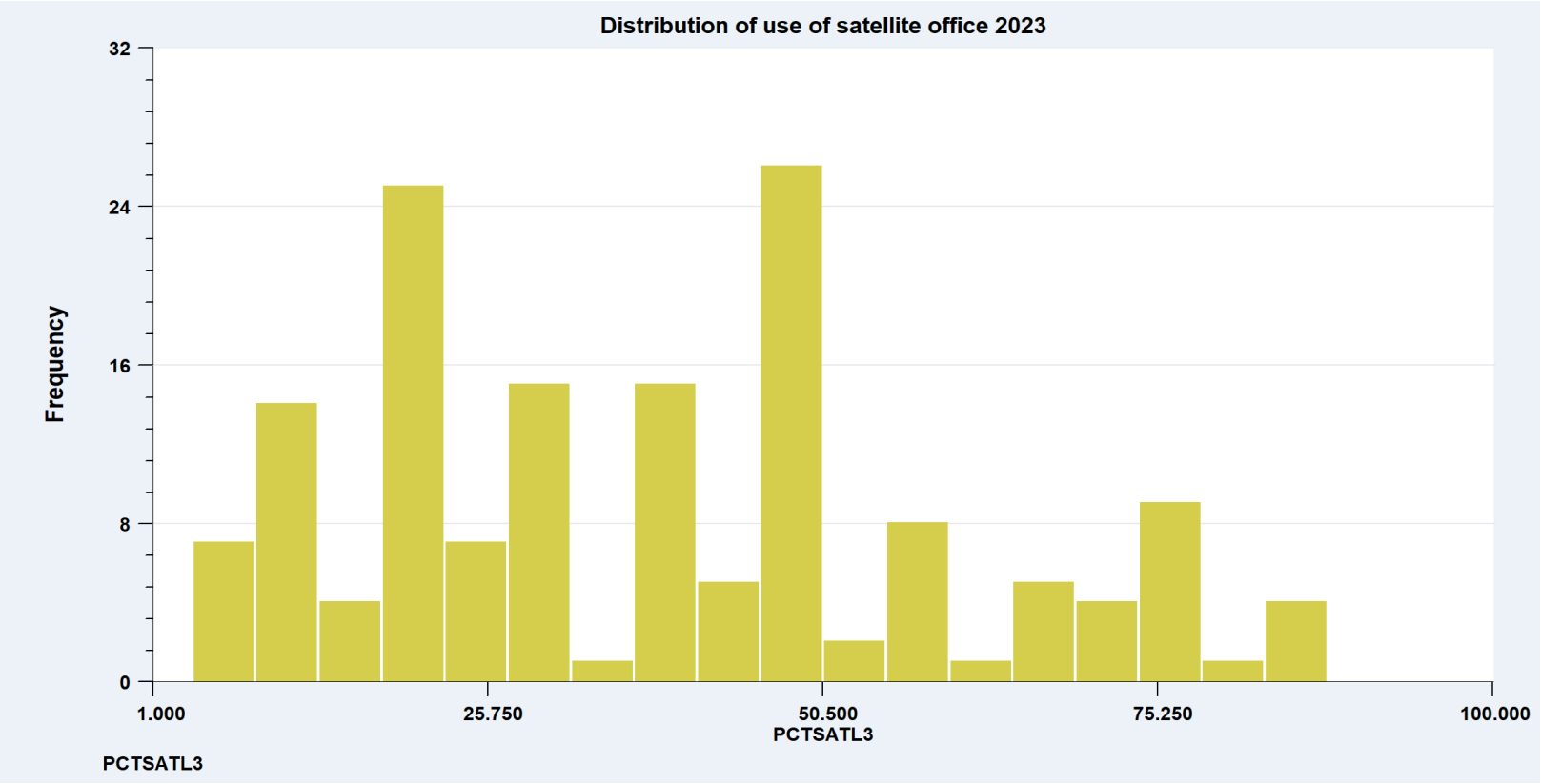
Y axis: probability density is the probability per unit on the x-axis; X axis is the number of firms

Some Key Descriptive Statistics: 459 organisations in GSMA, April 2022 and Sept 2023. Note workspace change (72%-80% cf. pre-COVID-19)

Before COVID	Mean	STD	Median	Min	Max
Number of working days	4.4	1.3	5	0	7
WFH Proportion (to some extent)	20.5	32.5	0	0	100
Employer supported WFH days	1.3	1.7	1	0	5
Employee Numbers	847	4081	50	0	50000
Commuting time in minute	35	25	30	0	180
April 2022	Mean	STD	Median	Min	Max
Number of working days	4.1	1.4	5	0	7
WFH Proportion (1-2 days per week)	35.5	37.5	20	0	100
Employer supported WFH days	2.8	1.4	3	0	5
Employee Numbers	711	3654	50	0	45000
Workspace (cf 100% pre-COVID)	72	36	100	0	150
Commuting time in minute	31	23	30	0	150
In Sept 2023	Mean	STD	Median	Min	Max
Number of working days	4.1	1.4	5	0	7
WFH Proportion	35.2	35.7	25	0	100
Employer supported WFH days	2.5	1.5	2	0	5
Employee Numbers	728	3643	50	0	45000
Workspace (cf 100% pre-COVID)	80	32	100	0	200
Commuting time in minute	31	23	30	0	150

Satellite Office Impact (distributed spatial work): GSMA.

34.72% of the sampled organisations (Figure below) indicated that they will use satellite offices to some extent, which represents an average 14.34% of staff in the future working in a satellite office or, on average one in 6.7.



Wave 3 Modelling (Aug/Sept 2020)

Reminder: Wave 3 is designed for exploratory testing and guidance for Wave 4a

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Modelling Effective Sample NSW Wave 3

- We have 507 respondents' observations for the final data:
  - 409 (80.7%) are for the GSMA model
  - 98 (19.3%) for the Regional model
- For the models we have a total of 49,759 observations that represent the different available alternatives for each DoW-respondent (plus commuting alternative).
  - 40,735 (81.9%) are for the GSMA model
  - 9,024 (18.1%) for the Regional model

Modelling Effective Sample Qld Wave 3

- We have 478 respondents' observations for the final data:
  - 222 (46.4%) are for the Metro (SEQ) model: Brisbane (C), Gold Coast (C), Sunshine Coast (R)
  - 256 (53.6%) for the Regional Towns model: Townsville (C), Bundaberg (R), Cairns (R), Gladstone (R), Mackay (R), Rockhampton (R), Toowoomba (R)

- For the models, we have a total of 43,088 observations that represent the different available alternatives for each DoW and ToD -respondent.
  - 20,691 (48.0%) are for the Metro model: Brisbane (C), Gold Coast (C), Sunshine Coast (R)
  - 22,397 (52.0%) for the Regional Towns model: Townsville (C), Bundaberg (R), Cairns (R), Gladstone (R), Mackay (R), Rockhampton (R), Toowoomba (R)

Wave 3 (Aug/Sept 2020)

Commuter Mode Choice Model GSMA NSW and SEQ Qld: Preferred Models as of February 2021

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Interesting Results: GSMA NSW Wave 3

This analysis was undertaken in response to a question on whether there is a relationship between the number of days WFH each week, the commuting distance for people who WFH to vary degree (assuming those who WFH more tend to have the longest commuting distance), and how the number of days WFH is related to average one-way weekly commuting and non-commuting trips.

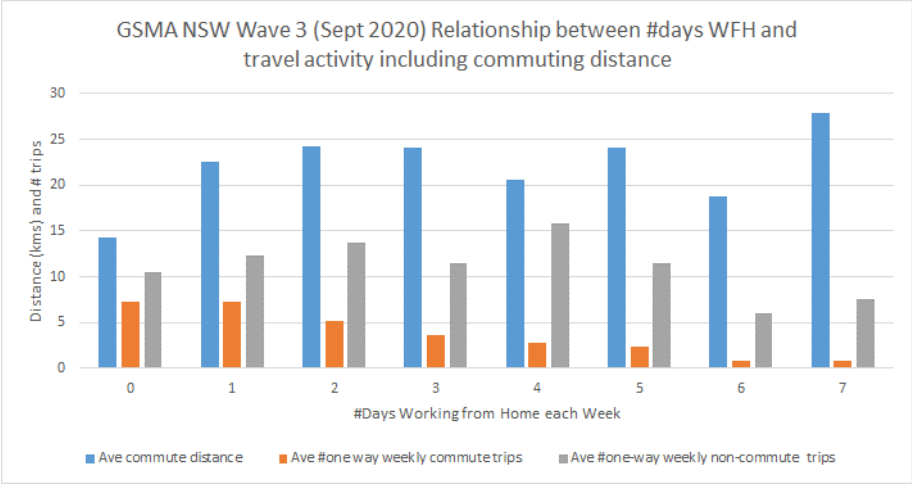
Major findings:

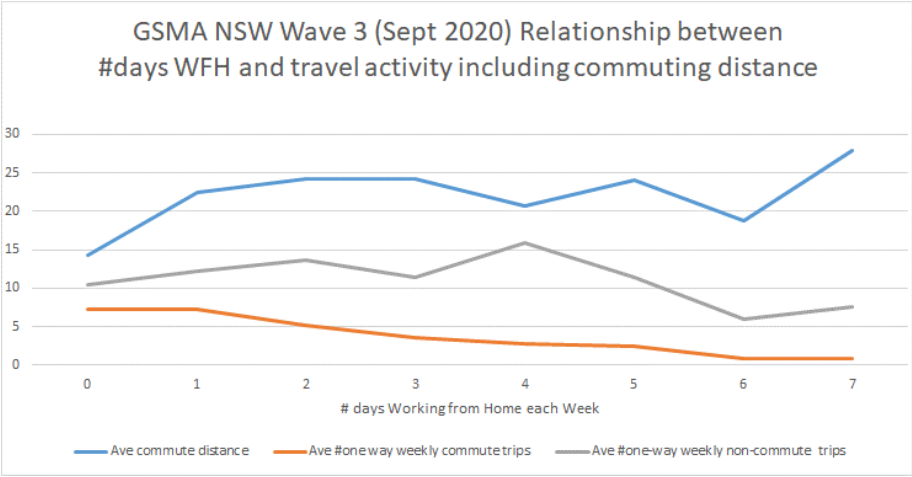
1. Those who spend more days WFH tend, on average, to have a longer commute.
2. As the number of days WFH increases, we see a reduction, on average, in the number of weekly commuting trips, as expected.
3. As the number of days WFH increases, we see on average the number of weekly non-commuting trips, being at its greatest for 4 days WFH per week and at its lowest (excluding weekends) when WFH there is no weekday WFH.
4. This is the first time we have observed this and reported it.

Variable	Mean	Standard Deviation	Minimum	Maximum	Cases	Missing Values
DISTHMWK	18.74059	19.56272	.2	100.0	403	0
WFHDAYS	1.808933	2.17533	0.0	7.0	403	0
TCOMM	5.498728	8.738294	0.0	110.0	393	10
TCOMGP	3.416873	2.512637	1.0	10.0	403	0
DISTGP	3.863524	2.305894	1.0	9.0	403	0

Cor.Mat.	DISTHMWK	WFHDAYS	TCOMM	TCOMGP	DISTGP
DISTHMWK	1.00000	.20746	-.06718	-.12037	.90578
WFHDAYS	.20746	1.00000	-.25736	-.48862	.20580
TCOMM	-.06718	-.25736	1.00000	.77646	-.05082
TCOMGP	-.12037	-.48862	.77646	1.00000	-.11897
DISTGP	.90578	.20580	-.05082	-.11897	1.00000

#WFH days	Ave commute distance	Ave #one way weekly commute trips	Ave #one-way weekly non-commute trips
0	14.33	7.33	10.44
1	22.49	7.25	12.29
2	24.28	5.13	13.7
3	24.17	3.59	11.48
4	20.64	2.79	15.89
5	24.12	2.4	11.43
6	18.71	0.86	6
7	27.83	0.83	7.6





Interesting Results: SEQ Qld Wave 3

18 November 2020

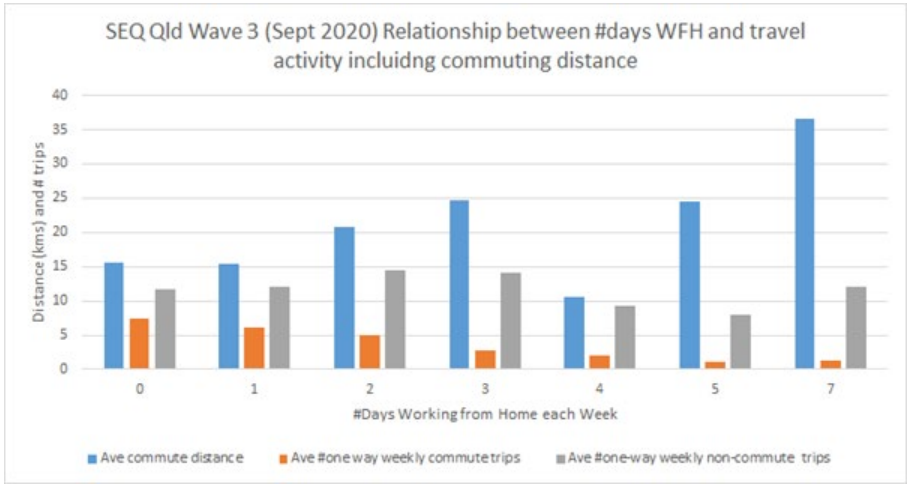
This analysis was undertaken in response to a question on whether there is a relationship between the number of days WFH each week, the commuting distance for people who WFH to vary degree (assuming those who WFH more tend to have the longest commuting distance), and how the number of days WFH is related to average one-way weekly commuting and non-commuting trips.

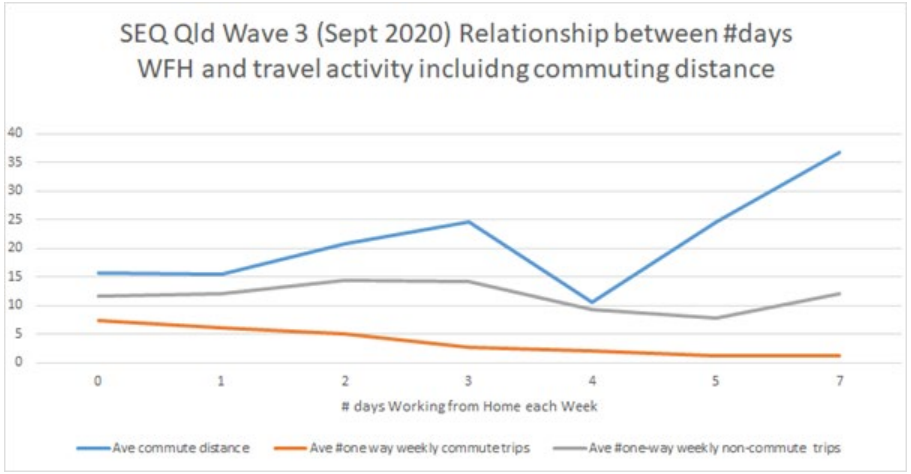
Major findings:

1. Those who spend more days WFH tend, on average, to have a longer commute.
2. As the number of days WFH increases, we see a reduction, on average, in the number of weekly commuting trips, as expected.
3. As the number of days WFH increases, we see on average what appears to be a U-shaped relationship (for weekdays) with the average number of weekly non-commuting trips, being at its greatest for 2 and 3 days WFH per week and at its lowest when WFH occurs on 4 or 5 days per week.
4. This is the first time we have observed this and reported it.

	#WFH days	*Ave commute distance*	*Ave #one way weekly commute trips*
#WFH days	1		
Ave commute distance	0.700894	1	
Ave #one way weekly commute trips	-0.930575159	-0.514857371	1
Ave #one-way weekly non-commute trips	-0.357031989	0.186490738	0.426865908

#WFH days	Ave commute distance	Ave #one way weekly commute trips	Ave #one-way weekly non-commute trips
0	15.63	7.42	11.71
1	15.4	6.15	12.05
2	20.84	5	14.47
3	24.64	2.73	14.09
4	10.62	2	9.25
5	24.58	1.18	7.89
7	36.67	1.33	12





Best Model results SEQ and GSMA, Wave 3 (September 2020)

Parameters	Acronym	Alternatives	SEQ Mean (t value)	GSMA Mean (t value)
ASC no work	ASC_NoWork	1	-	-
ASC work from home	ASC_WFH	2	-2.239 (5.94)	-
ASC car driver/motorcycle	ASC_CarMoto	3, 12, 13, 22, 23, 32, 33, 42	-0.889 (4.30)	-0.203 (1.01)
ASC car passenger	ASC_CarP	4, 13, 24, 34	-2.086 (9.78)	-1.654 (7.75)
ASC taxi/ridesharing	ASC_Taxi	5, 15, 25, 35	-4.233 (6.79)	-3.600 (6.69)
ASC public transport	ASC_PT	6-9, 16-19, 26-29, 36-39	-1.761 (7.27)	-1.410 (7.86)
ASC active modes	ASC_Act	10, 11, 20, 21, 30, 31, 40, 41	-0.426 (1.67)	-0.877 (3.44)
ASC ToD 1 and 3	ASC_T13	3-12, 23-32	0.513 (5.23)	0.391 (4.94)
ASC ToD 2	ASC_T2	13-22	-	-
ASC ToD 4	ASC_T4	33-42	0.408 (3.68)	0.217 (2.36)
No Work - Age	Age_NW	1	0.026 (7.74)	0.027 (10.36)
No Work - Male (1,0)	Male_NW	1	-	-0.326 (3.55)
WFH - Distance from home to work	DistHW_WFH	2	0.011 (2.50)	-
WFH - Age	Age_WFH	2	0.018 (2.96)	-
WFH - Number of people in household	HPers_WFH	2	0.105 (1.88)	-
WFH - Income	Inc_WFH	2	0.006 (3.80)	-
WFH - High level of concern number of people in PT	ConcPT_WFH	2	0.482 (3.27)	0.477 (4.39)
WFH - Professional (industry category) (1,0)	Prof_WFH	2	0.957 (5.70)	-
WFH - Industry (industry category) (1,0)	Ind_WFH	2	0.494 (2.46)	-
WFH - Occupation professional (1,0)	OcProf_WFH	2	-	5.184 (12.50)
WFH - Occupation manager (1,0)	OcMng_WFH	2	-	5.235 (12.25)
WFH - Occupation sales (1,0)	OcSale_WFH	2	-	4.507 (10.03)
WFH - Occupation blue collar worker (1,0)	OcBlCl_WFH	2	-	5.058 (11.34)
WFH - Monday dummy variable (1,0)	DMon_WFH	2	1.366 (6.49)	-1.325 (8.17)
WFH - Tuesday dummy variable (1,0)	DTue_WFH	2	1.135 (5.34)	-1.333 (8.18)
WFH - Wednesday dummy variable (1,0)	DWed_WFH	2	1.126 (5.27)	-
WFH - Thursday dummy variable (1,0)	DThu_WFH	2	1.316 (6.24)	-1.044 (6.44)
WFH - Friday dummy variable (1,0)	DFri_WFH	2	-	-0.975 (6.07)
WFH NSW - Wollongong residential location (1,0)	Woll_WFH	2	-	-0.571 (2.76)
WFH NSW - Newcastle residential location (1,0)	Newc_WFH	2	-	-0.855 (4.24)
WFH QLD - work located in CBD (1,0)	CBD_WFH	2	0.309 (1.98)	-
Car driver - Income	Inc_CarD	3, 13, 23, 33	0.005 (3.16)	0.002 (1.97)
Car driver - Number of cars in household	NCar_CarD	3, 13, 23, 33	-	0.339 (5.33)
Car driver - Number of cars per person in household	NCar_CarD	3, 13, 23, 33	0.149 (3.23)	-
Travel time all modes except active - mean	TT_CarPT	3-9, 12-19, 22-29, 32-39, 42	-0.003 (1.35)	-0.029 (4.98)
- standard deviation			0.00015 (1.35)	0.029 (4.98)
Travel time walking	TT_Walk	10, 20, 30, 40	-0.028 (4.95)	-0.029 (4.70)
Travel time bicycle	TT_Bike	11, 21, 31, 41	-0.029 (3.02)	-0.043 (3.30)
Cost all modes except car pax and active - mean	Cost_CarPT	3, 5-9, 12, 13, 15-19, 22, 23, 25-29, 32, 33, 35-39, 42	-0.019 (2.52)	-0.068 (4.34)
- standard deviation			0.019 (2.52)	0.068 (4.34)
Access + egress + waiting time taxi/PT modes	TTAEW	5-9, 15-19, 25-29, 35-39	-0.012 (2.44)	-

Number of parameters estimated	28	28
Sample size	1,718	2,825
Log Likelihood at convergence	- 3,094.11	- 4,775.84
Log likelihood at zero	- 6,421.32	- 10,558.92
McFadden Pseudo R squared	0.52	0.55
AIC/n	3.64	3.40

Hensher, D.A, Balbontin, C., Beck, M.J. and Wei, E. The Impact of working from home on modal commuting choice response during COVID-19: Implications for two metropolitan areas in Australia, **Paper # 8** submitted to a Special Issue on COVID-19 (edited by Hani Mahmassani and Patricia Mokhtarian), *Transportation Research Part A,* 31 January 2020.

Calibration Commuter Mode Shares: GSMA and SEQ

The mode (STM priority mode) shares for commuting trips in the 2018/19 HTS are:

GSMA

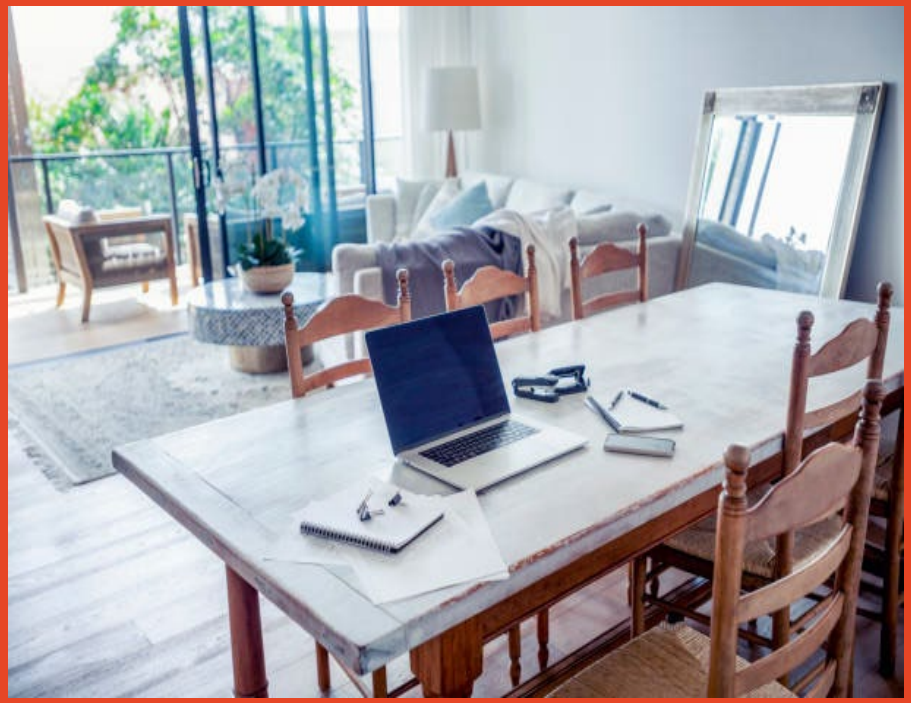
Purpose	Variable	Mode share
Commute	Vehicle driver	60.6%
Commute	Vehicle passenger	5.5%
Commute	Train	16.4%
Commute	Bus	6.8%
Commute	Walk	8.0%
Commute	Other	2.6%

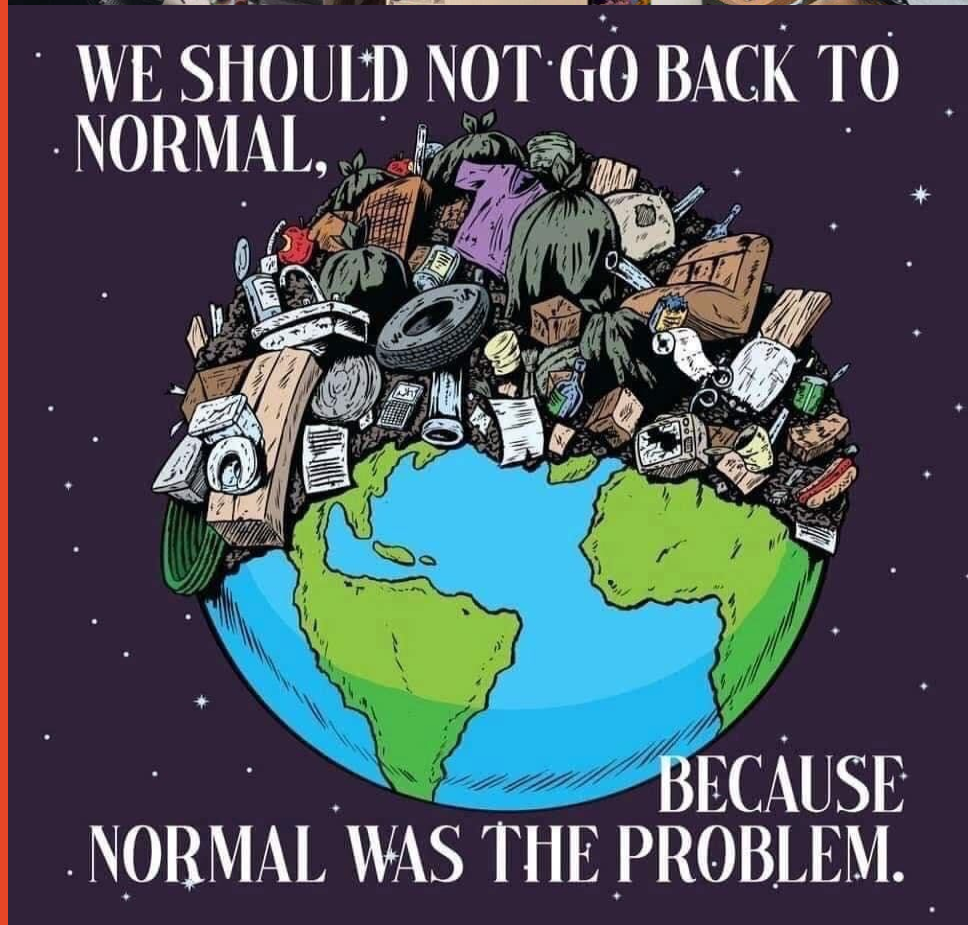
SEQ

Mode Share (%)							
trip purpose	cd	cp	wpt	pnr	knr	cyc	wlk
hbb	83	7	4	1	1	2	2
hbw	74	6	10	4	2	1	3
hbe	39	39	9	0	2	2	10
hbt	41	8	29	6	5	2	8
shp	63	26	4	0	0	1	6
hbo	50	35	2	0	1	1	11
nhb	60	24	3	1	0	1	11
wbw	86	8	1	0	0	0	5

hbb	home based work - blue
hbw	home based work - white
hbe	home based education - Primary and Secondary
hbt	home based education tertiary
shp	home based shopping
hbo	home based other
nhb	non home based
wbw	work based work

Moving on to March 2024





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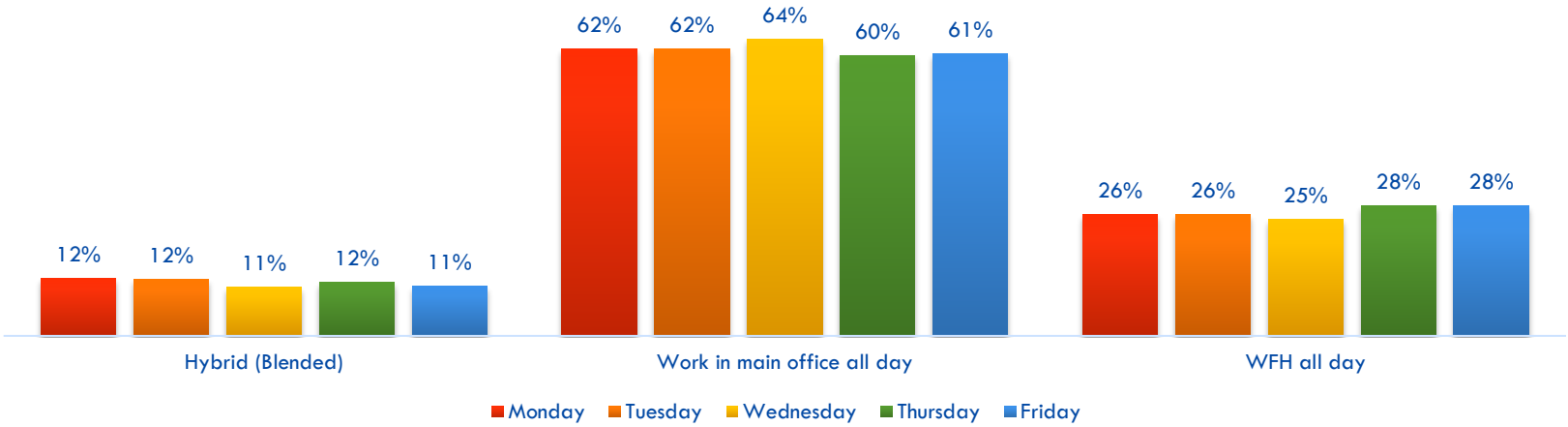
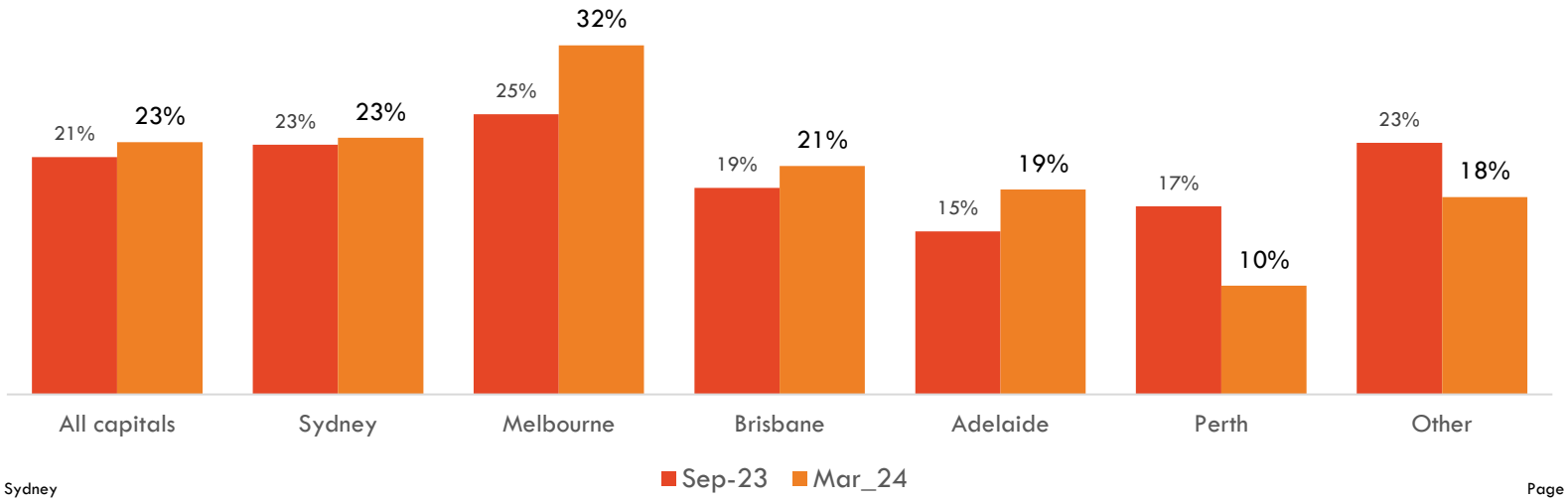
Moving on to March 2024: Composition of Work location by DoW: Office, Blended and WFH, Australia Wide

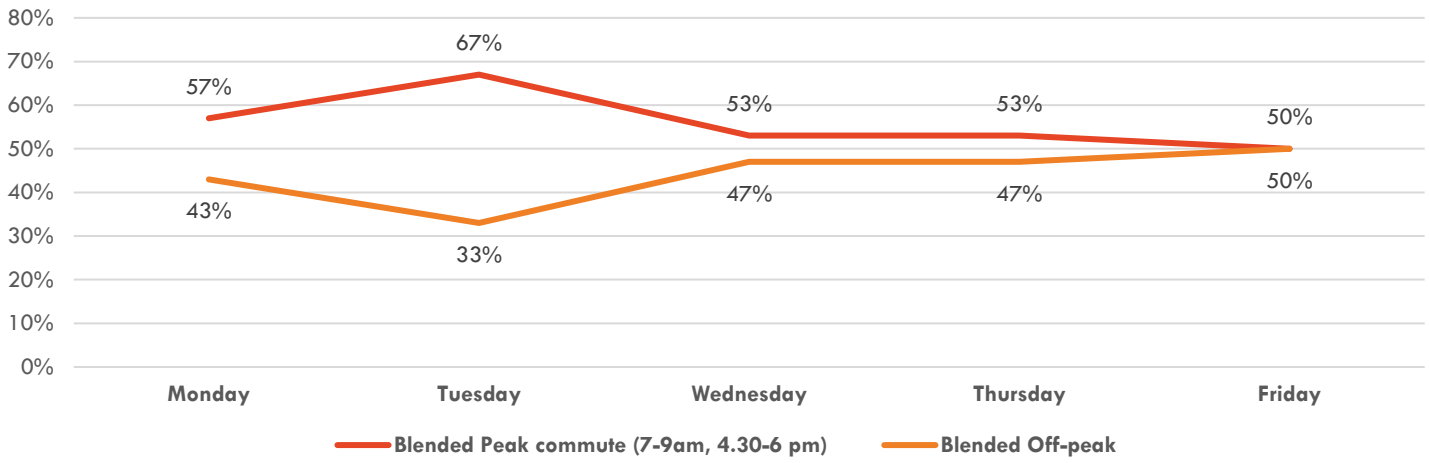


Average % of working time WFH - Capital Cities Sept 23 vs March 2024

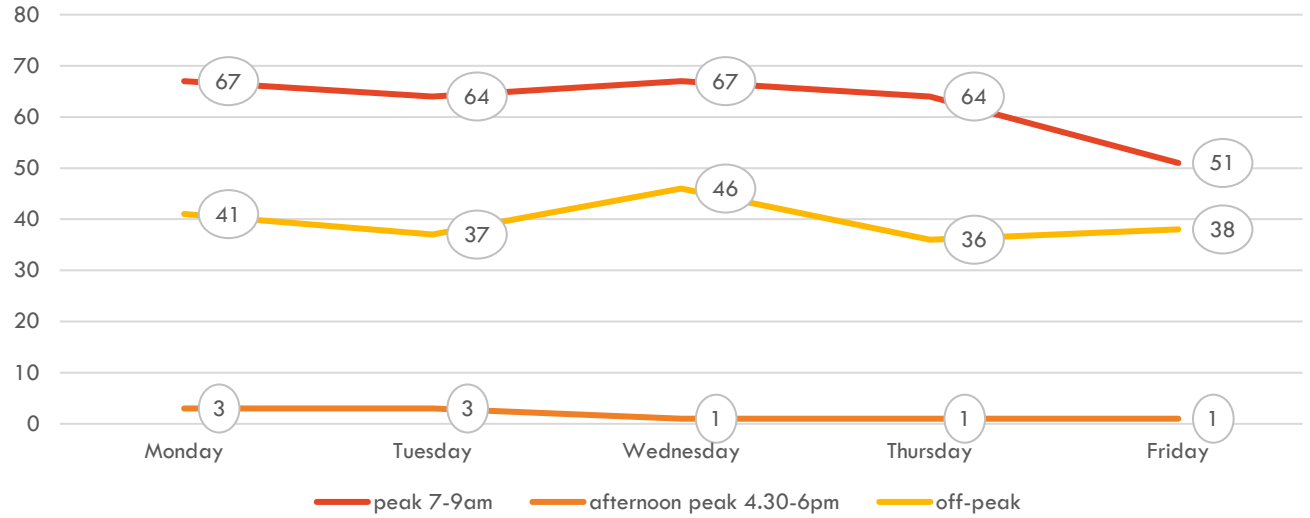


Time of Day Commuter Profile by Day of Week (All Modes)

Time of Day Departure for Commuters who undertake Blended work locations in each DoW, March 2024 GSMA



Commuting to work by **Public Transport** GSMA, March 2024 TOPS survey of ITLS: Time of day shares by Day of Week



Employer stipulated that workers must return to the office a particular number of days each week? March 2024