

Explaining walking distance to public transport: the dominance of public transport supply

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<http://sydney.edu.au/business/itls>



- › Research motivation and literature
- › Methodology and data
 - Case study: Sydney
- › Analysis and results
 - Walk distance: means and distribution
 - Regression
- › Conclusions
 - Discussion
 - Policy implications
 - Future research



Source: *Parramatta Advertiser*, 13 Jan 2009



Source: *Sydney Morning Herald*, 1 Nov 2007

What explains current walking distance from home to public transport

- › Implications for accessibility and public transport planning
 - Walk is main access mode
 - Planning guidelines and 400 m “rule of thumb”
 - Flexible transport services
- › Role of demographics – do older people walk shorter distances?

Access mode from home in Sydney	To bus	To train
Walk	89%	50%
Car as driver	2%	17%
Car as passenger	9%	17%
Bus	-	14%
Other	0%	2%
Total	100%	100%



Source: Sutherland Council Annual Report 2008/09

Influences on walking distance

- › Walk only trips vs Walk as access mode to public transport
- › Demographics and trip characteristics
 - Trip purpose
- › Built environment
 - Density, diversity, design, ambience, aesthetics
- › Natural environment
 - Climate and topography
- › Supply of public transport
 - Walk further to train (but why?)

- › Interdependencies between factors
- › Influence once decision to walk has been made



Source: *Metropolitan Plan for Sydney 2036*, Dec 2010

Case study: Sydney, NSW

Why Sydney?	Bus	Train
Extensive pt network	35,000 stops	300 stations
Similar mode use	5.8% of all trips	5.2% of all trips
Access mode from home	90% walk	50% walk
Household Travel Survey – one day travel diary, continuous from 1997/98		



Source: *Southern Courier*, 6 Feb 2011



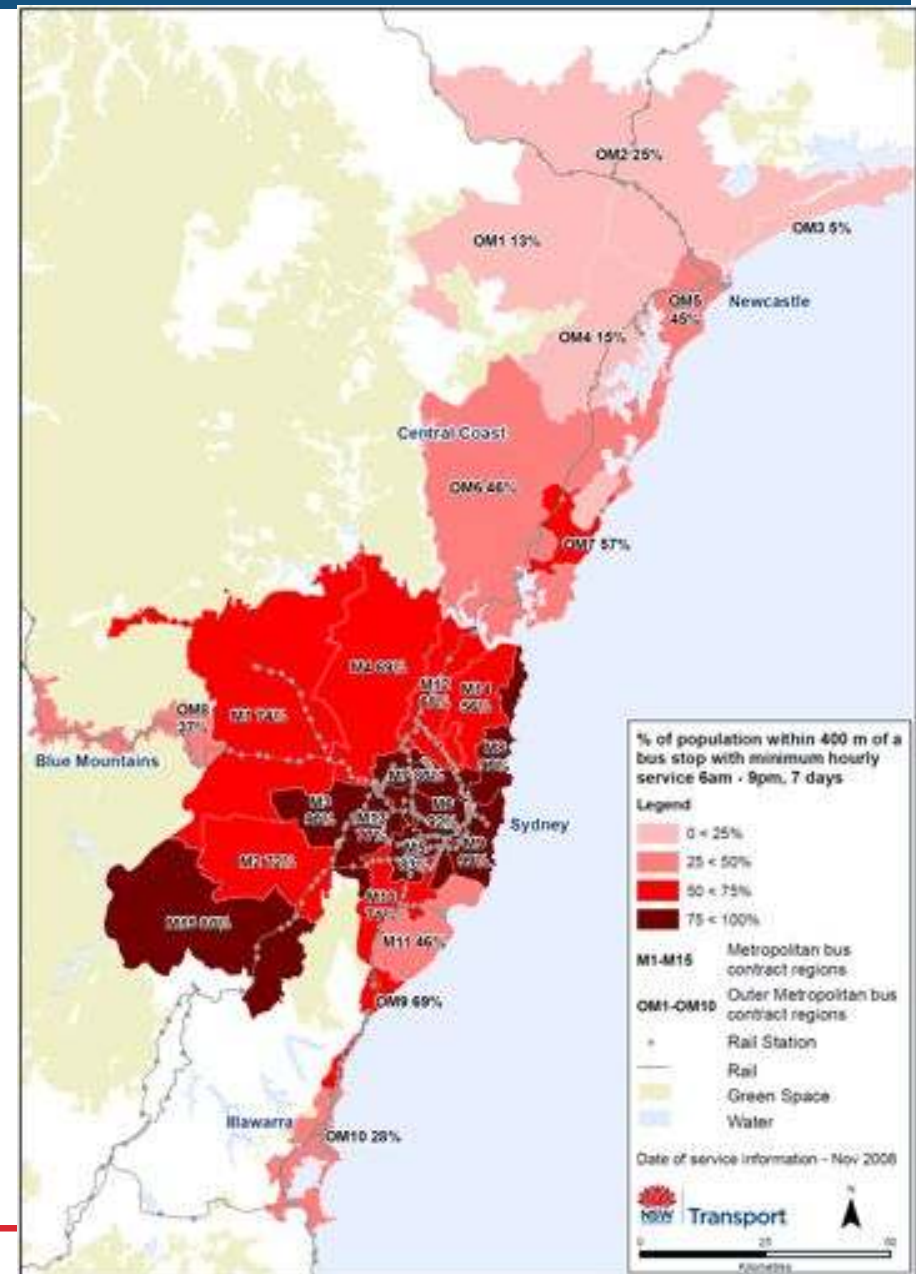
Source: *Daily Telegraph*, 21 March 2007

Household Travel Survey data

- › 3 years of HTS data (2006/7– 2008/9)
 - 1,952 walk trips from home to bus or train
- › Distance estimation
 - X,Y of home and X,Y of train station
 - Hierarchy of coding information for bus stops
 - ARCGIS road network distance
- › Issues
 - Actual walk path may be shorter or longer
 - Bus: home within 100 m of stop = 50 m walk
 - Train: minimum 100 m walk due to station platform centroid
 - Focus on trips less than 2 km (97.6%) = 1,906 trips

Type	Variables
Trip characteristics – walk trip	<ul style="list-style-type: none"> • Distance • Destination (mode) • Day of week • Time of day • Location (LGA)
Trip characteristics – public transport trip	<ul style="list-style-type: none"> • Purpose • Duration • Public transport mode • Fare type • Ticket type
Demographic characteristics	<ul style="list-style-type: none"> • Age • Sex • Personal income • Labour force status • Household size • Driving licence • No. of household vehicles
Other	<ul style="list-style-type: none"> • Reason for public transport use for work trip

- › Local Government Areas (50+)
 - Population density
 - % of all trips made by public transport
- › Bus contract regions (25)
 - % of households within 400 m of a bus stop with hourly services
- › Service planning target
 - 90% of households within 400 m of public transport in daytime and 800 m in evening

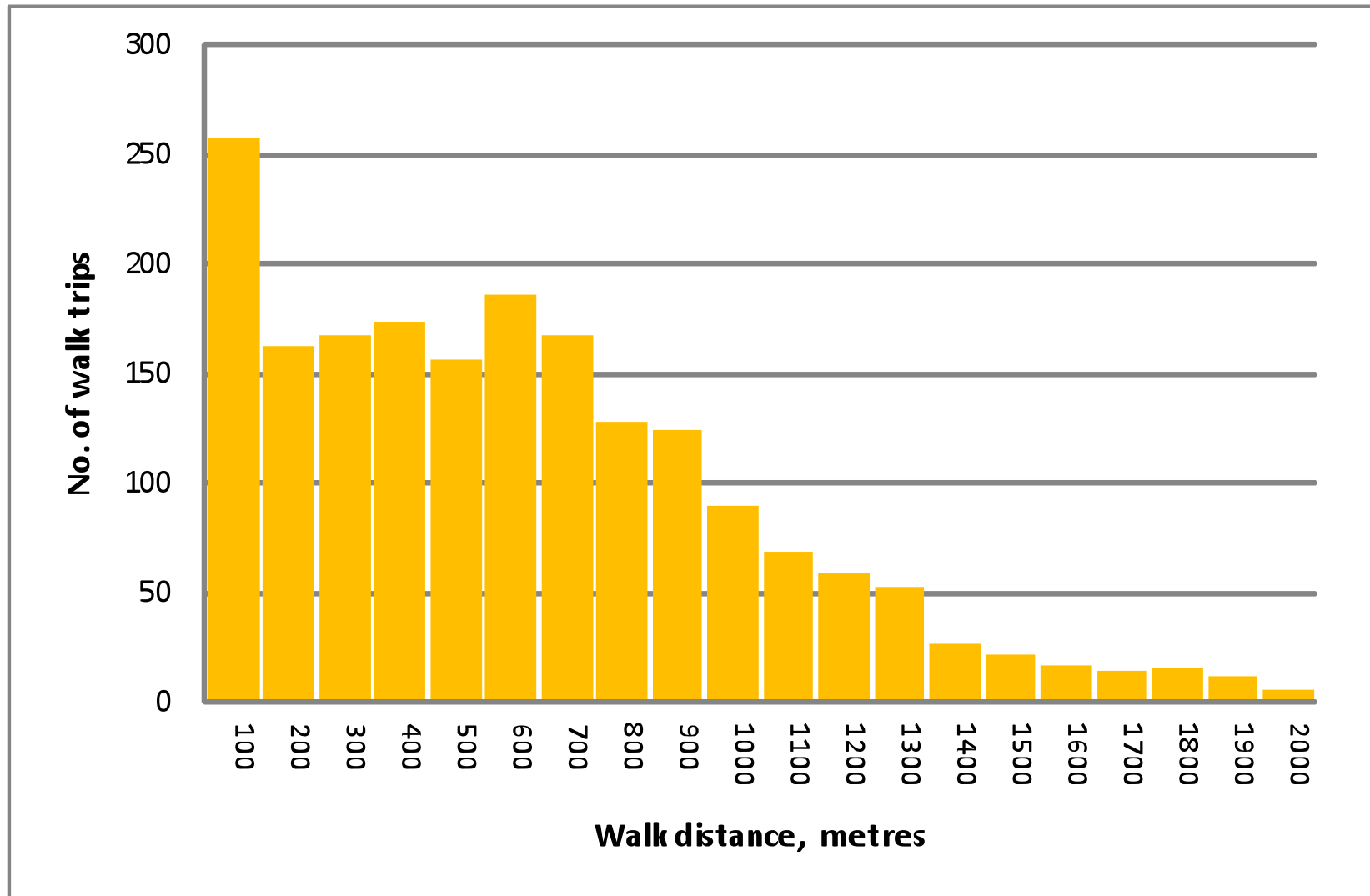


1. Mean walking distance and distribution
2. Explanatory factors
 - Trip and demographic characteristics
 - Differences between bus and train users
3. Regression

Walk to public transport

- › Bus and train combined
- › Bus vs train

Walk distance from home to bus and train (n=1,906)



- › Means
- › Medians
- › Lower and upper quartiles

Variable	Category ¹	N	Mean ²	p-value ⁴	SD ⁵	LQ ³	Median	UQ ³
Total	-	1906	573	-	417	235	518	824
Trip characteristics								
Transport mode	Train	667	805	**0.000	375	539	749	1018
	Bus	1084	451	Base	382	162	364	655
	School bus	155	360	**0.002	386	50	185	600
Region	Inner Sydney	968	570	Base	385	273	520	785
	Outer Sydney	638	636	**0.003	452	261	572	922
	Sydney Fringe	46	446	*0.034	429	50	342	781
	Central Coast	69	327	**0.000	338	50	185	611
	Newcastle	85	435	**0.002	435	52	285	676
	Illawarra	56	518	0.302	421	144	421	805
Trip purpose	Work	695	545	Base	418	316	582	900
	Education	471	483	**0.000	412	97	400	778
	Shopping/Pers business	394	501	**0.000	383	179	429	738
	Social/Recreation	295	639	0.817	429	304	582	878
Fare type	Full fare	902	536	Base	419	312	580	889
	Free: school pass	333	425	**0.000	393	50	320	679
	Concession: pensioner	251	485	**0.000	372	202	403	685
	Concession: student	189	643	0.832	411	318	582	921
Ticket type	Single or return	636	632	Base	425	287	582	906
	Periodical pass	569	645	0.599	425	313	581	886
	Multi-trip ticket	257	454	**0.000	322	206	394	654
Day of week	Weekday	1630	569	Base	417	227	513	824
	Weekend day ⁶	268	601	0.251	416	285	555	826
Time of day	Am peak	1164	554	Base	410	208	508	812
	Inter-peak	532	587	0.135	420	263	511	814
	Pm peak	83	593	0.404	392	256	570	825
	Evening	127	682	**0.003	461	330	633	1008
Public transport trip duration	Up to 15 minutes	782	545	Base	384	234	501	775
	15 – 29 minutes	689	567	0.300	419	235	518	790
	30 – 44 minutes	267	604	0.057	451	220	520	922
	45 minutes and over	168	680	**0.001	480	292	644	1012
Demographic characteristics								
Sex	Female	977	563	Base	421	223	505	813
	Male	929	584	0.270	411	250	531	844
Age	Under 19 years	498	505	**0.000	423	117	425	779
	19 – 29 years	445	634	0.587	416	303	570	889
	30 – 49 years	528	619	Base	400	305	583	870
	50 – 64 years	241	600	0.547	448	265	511	836
	65 years and over	194	452	**0.000	352	181	383	664
Labour force status	Full time work	685	544	Base	422	313	586	889
	Part time work	194	627	0.632	404	316	548	903
	Economically inactive	385	488	**0.000	378	208	397	693
	Post school education	194	621	0.512	408	250	570	902
Personal income pa	School	429	484	**0.000	417	78	398	775
	Less than \$13,000	545	579	*0.023	432	208	531	848
	\$13,000 – \$41,599	522	574	*0.012	410	256	502	812
	\$41,600 – \$83,199	367	644	Base	410	319	597	901
Vehicles in household	\$83,200 and over	187	619	0.479	398	313	581	850
	0	521	575	0.569	405	256	512	795
	1	750	587	Base	421	255	528	839
Driving licence	2 or more	632	559	0.226	421	196	507	839
	Yes	1007	611	Base	414	287	568	864
	No	614	573	0.077	420	233	515	818

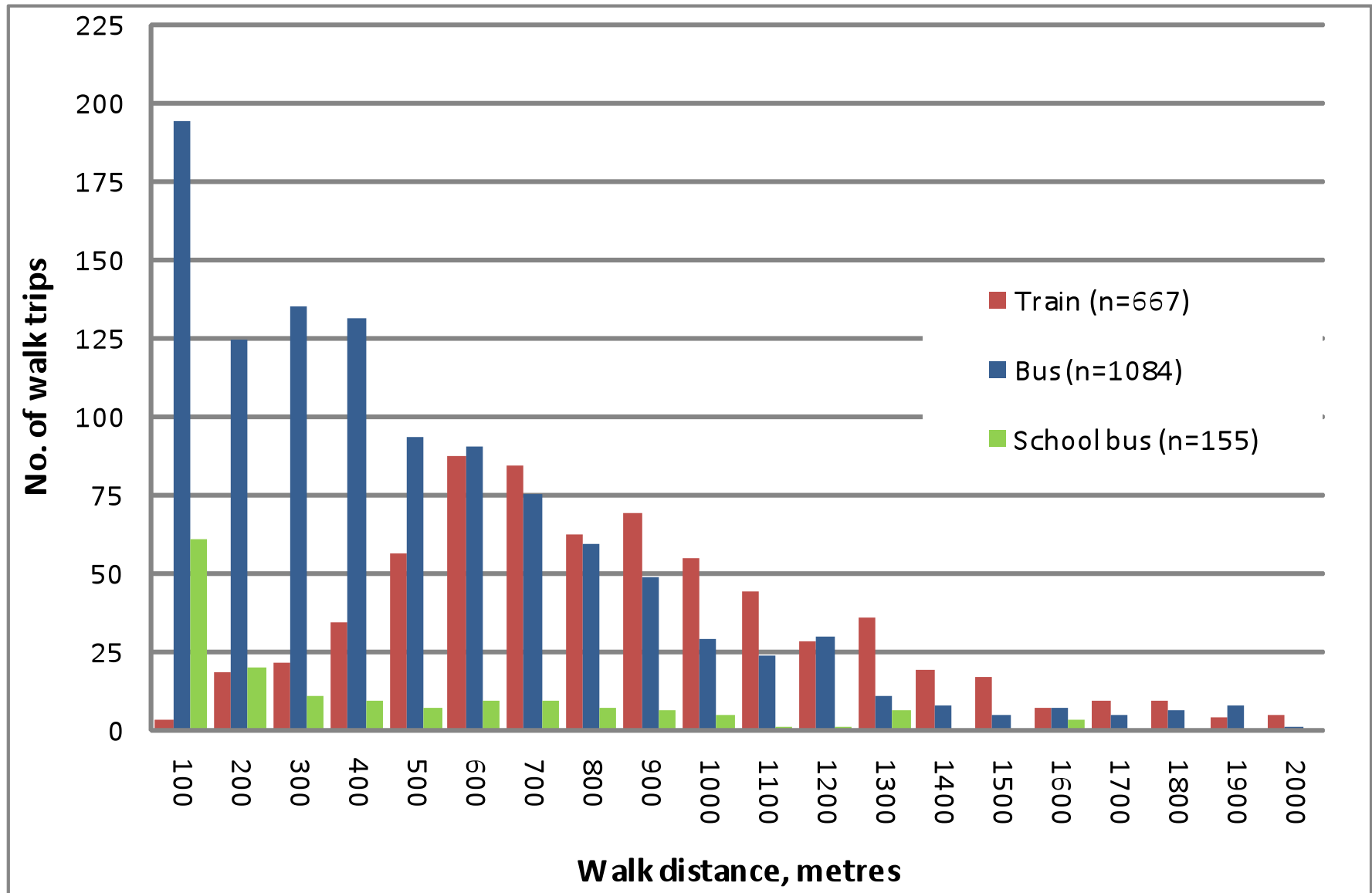
1. Total is all HTS walk trips from home to public transport of less than 2 km in 2006, 2007 and 2008.
2. Categories with less than 40 respondents or undefined ("other") are excluded from this table.
3. Mean walk distance is compared to a chosen base for each variable using a standard 2-tailed t-test.
4. *significant with p<0.05, **significant with p<0.01 (all tests are two tailed t-tests).
5. SD = Standard deviation; LQ= Lower quartile threshold (25%); UQ = Upper quartile threshold (75%).
6. Weekends include public holidays.

Explaining walking distance – mean walk distance

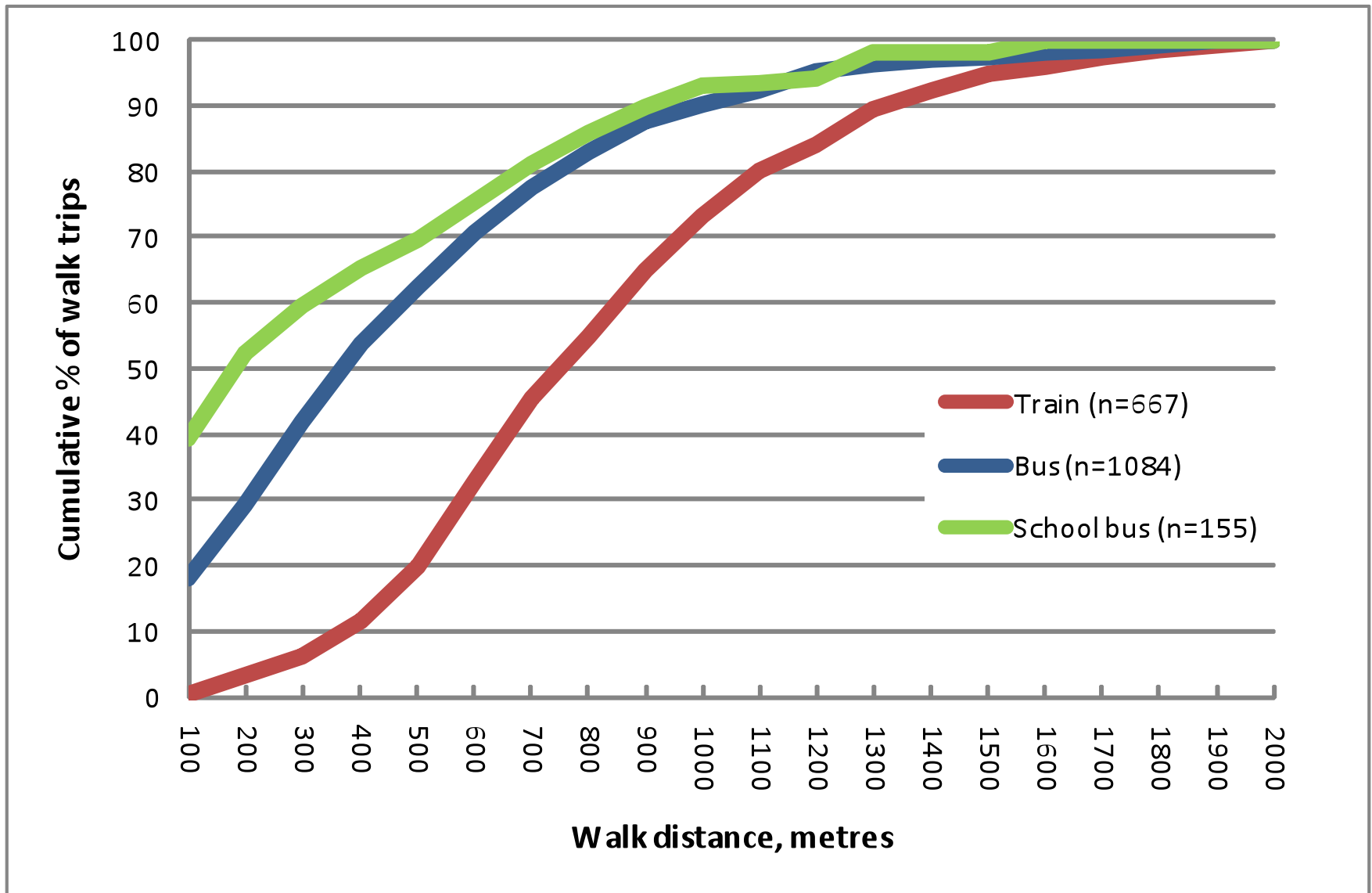
Trip characteristics	Significant difference (**1%, *5%)
Mode	Walk trips to train longer than to bus** and shorter to school bus**
Location	Walk trips in outer fringe areas shorter than in inner Sydney**
Purpose	Walk trips for education and shopping shorter than for work**
Time of day	Walk trips in evening longer than in morning peak**
Duration of pt trip	Walk trips for pt trips > 45 mins longer than for short pt trips**
Fare	Walk trips using free school pass and pensioner concession shorter than full fare**

Demographics	Significant difference (**1%, *5%)
Age	Walk trips by young and old shorter than by middle-aged**
Labour force	Walk trips by economically inactive and students shorter than by workers**
Personal income	Walk trips by lower income shorter than by middle income*

Distribution of walk distance



Cumulative distribution



Significant differences between train and bus users – Chi squared tests

Trip characteristics	Train users	Bus users
Purpose	Work	Education or shopping
Day of week	Weekends	-
Time of day	-	Interpeak
Fare	Full fare	Concession fare
Ticket	Periodical ticket	Multi-trip ticket
Duration of pt trip	Longer trips	Shorter trips

Demographic characteristics	Train users	Bus users
Age	19-49 years	Under 19 y, 65+ y
Sex	Men	Women
Labour force status	Full time work Post-school education	All others
Personal income	-	Low income
Licence	Licence	No licence

Train and bus users – different populations?

Variable	Category ²	N	Mean ³	p-value ⁴	SD ⁵	LQ ⁶	Median	UQ ⁶
Total	Train	567	805	-				
Trip characteristics								
Region	Inner Sydney	371	759	Base	360	512	688	963
	Outer Sydney	259	873	**0.000	386	590	829	1113
	Sydney Fringe	Less than 20 trips						
	Central Coast	Less than 20 trips						
	Newcastle	Less than 20 trips						
	Illawarra	Less than 20 trips						
Trip purpose	Work	341	810	Base	383	540	711	1037
	Education	97	830	0.614	377	543	508	1050
	Shopping/Pers business	102	754	0.156	337	519	745	930
	Social/Recreation	107	819	0.832	379	582	750	1038
Fare type	Full fare	457	809	Base	380	534	748	1029
	Free: school pass	40	725	0.176	315	503	671	913
	Concession: pensioner	40	718	0.144	342	502	673	861
	Concession: student	69	882	0.135	340	593	856	1130
Ticket type	Single or return	278	815	Base	357	549	785	1034
	Periodical ticket	287	810	0.872	392	541	721	1038
	Multi-trip ticket	Less than 20 trips						
Day of week	Weekday	546	805	Base	379	538	748	1017
	Weekend day	121	804	0.995	357	541	748	1050
Time of day	Am peak	396	795	Base	371	538	727	997
	Inter-peak	176	807	0.718	381	532	743	1080
	Pm peak	30	772	0.744	359	543	749	943
	Evening	65	873	0.118	389	607	804	1079
Public transport trip duration	Up to 15 mins	258	759	Base	372	499	707	1008
	15 – 29 mins	211	801	0.221	363	546	737	963
	30 – 44 mins	108	891	**0.002	389	581	848	1167
	45 mins and over	90	842	0.067	374	571	824	1085
Demographic characteristics								
Sex	Female	318	801	Base	381	526	748	1037
	Male	349	808	0.810	369	551	748	1011
Age	Under 19 years	99	854	0.250	388	577	791	1066
	19 – 29 years	216	789	0.691	363	528	722	1005
	30 – 49 years	241	803	Base	368	550	750	1036
	50 – 64 years	86	814	0.806	417	512	758	1019
	65 years and over	25	727	0.328	327	564	716	836
Labour force status	Full time work	328	807	Base	363	538	743	1022
	Part time work	96	801	0.883	376	524	723	1045
	Economically inactive	74	716	0.063	346	490	702	859
	Post school education	93	828	0.634	355	569	814	1048
	School	69	846	0.442	367	582	785	1045
Personal income pa	Less than \$13,000	159	837	0.467	359	568	794	1051
	\$13,000 – \$41,599	202	779	0.468	388	502	717	1011
	\$41,600 – \$83,199	177	808	Base	383	539	761	1035
	\$83,200 and over	80	815	0.893	361	574	698	959
Vehicles in household	0	190	767	0.181	370	509	721	999
	1	250	813	Base	366	552	745	1049
	2 or more	184	839	0.462	384	568	799	1020
Driving licence	Yes	424	799	Base	378	538	728	1009
	No	194	824	0.440	370	549	763	1052

1. Total is all HTS walk trips from home to train of less than 2 km in 2006, 2007 and 2008.
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6. Weekends include public holidays.

Variable	Category ²	N	Mean ³	p-value ⁴	SD ⁵	LQ ⁶	Median	UQ ⁶
Total	Bus	1084	461	-	375	162	364	655
Trip characteristics								
Region	Inner Sydney	586	454	Base	353	189	371	624
	Outer Sydney	371	502	0.070	422	165	394	756
	Sydney Fringe	Less than 20 trips						
	Central Coast	38	314	*0.017	310	50	167	541
	Newcastle	48	404	0.363	458	50	257	645
	Illawarra	28	416	0.578	312	200	355	647
Trip purpose	Work	354	486	Base	390	188	388	702
	Education	224	414	*0.023	357	81	350	604
	Shopping/Pers business	289	414	*0.014	359	125	318	615
	Social/Recreation	186	537	0.174	424	240	411	757
Fare type	Full fare	494	475	Base	387	167	372	676
	Free: school pass	151	403	*0.041	372	50	322	624
	Concession: pensioner	209	440	0.255	363	182	318	642
	Concession: student	113	519	0.286	389	204	415	755
Ticket type	Single or return	351	491	Base	421	159	392	699
	Periodical ticket	278	480	0.726	391	194	370	664
	Multi-trip ticket	253	448	0.150	321	202	366	641
Day of week	Weekday	938	466	Base	381	165	371	660
	Weekend day ⁶	146	430	0.298	386	125	350	607
Time of day	Am peak	616	447	Base	366	152	359	632
	Inter-peak	353	477	0.242	397	183	370	681
	Pm peak	53	491	0.406	376	191	479	758
	Evening	62	480	0.508	448	158	353	620
Public transport trip duration	Up to 15 mins	467	442	Base	340	169	366	655
	15 – 29 mins	420	480	0.135	398	167	371	692
	30 – 44 mins	136	443	0.986	398	105	326	639
	45 mins and over	61	517	0.271	511	50	381	860
Demographic characteristics								
Sex	Female	503	462	Base	392	156	352	661
	Male	501	459	0.892	370	171	374	639
Age	Under 19 years	248	452	0.671	380	107	377	700
	19 – 29 years	229	486	0.554	411	171	393	665
	30 – 49 years	286	466	Base	359	189	376	655
	50 – 64 years	154	482	0.674	421	188	343	656
	65 years and over	167	410	0.103	339	159	309	601
Labour force status	Full time work	357	492	Base	359	188	376	727
	Part time work	97	461	0.480	356	167	412	664
	Economically inactive	308	434	0.052	367	171	318	631
	Post school education	101	429	0.154	358	150	344	617
	School	209	453	0.254	387	93	382	699
Personal income pa	Less than \$13,000	332	481	0.777	412	156	381	683
	\$13,000 – \$41,599	317	445	0.178	371	171	344	608
	\$41,600 – \$83,199	190	491	Base	375	208	412	702
	\$83,200 and over	107	471	0.651	359	187	332	721
Vehicles in household	0	327	461	0.631	383	171	338	636
	1	420	448	Base	388	156	343	615
	2 or more	337	477	0.301	372	159	407	736
Driving licence	Yes	554	479	Base	383	186	384	669
	No	392	458	0.423	388	159	329	654

1. Total is all HTS walk trips from home to bus (excluding school bus) of less than 2 km in 2006, 2007 and 2008.
2. Categories with less than 40 respondents or undefined ("other") are excluded from this table.
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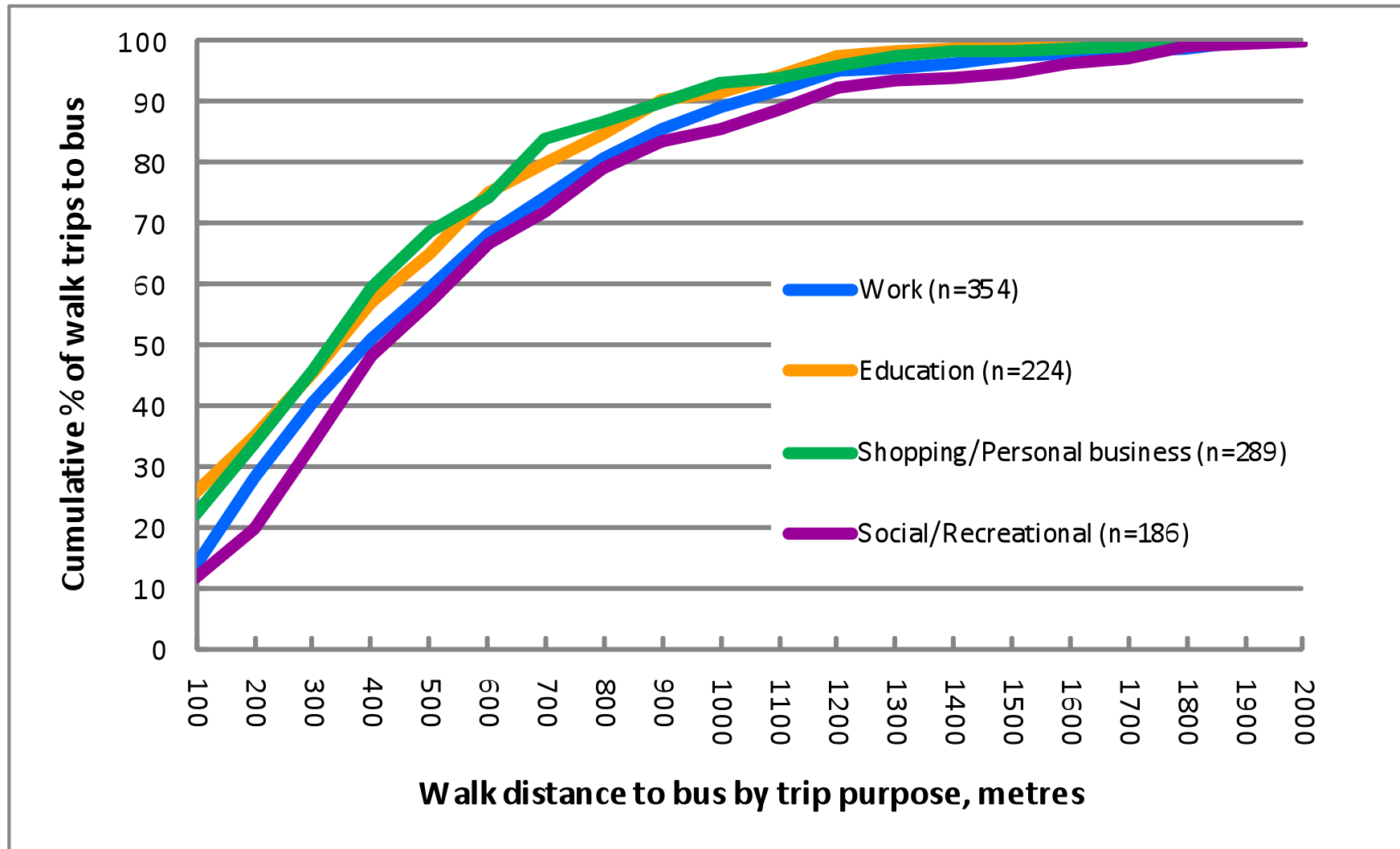
Most differences in walk distance due to characteristics of train and bus users

Train users	Significant difference (**1%, *5%)
Location	Walk trips in outer Sydney longer than in inner Sydney**
Duration	Walk trips for 30-44 min pt trips longer than for short pt trips**

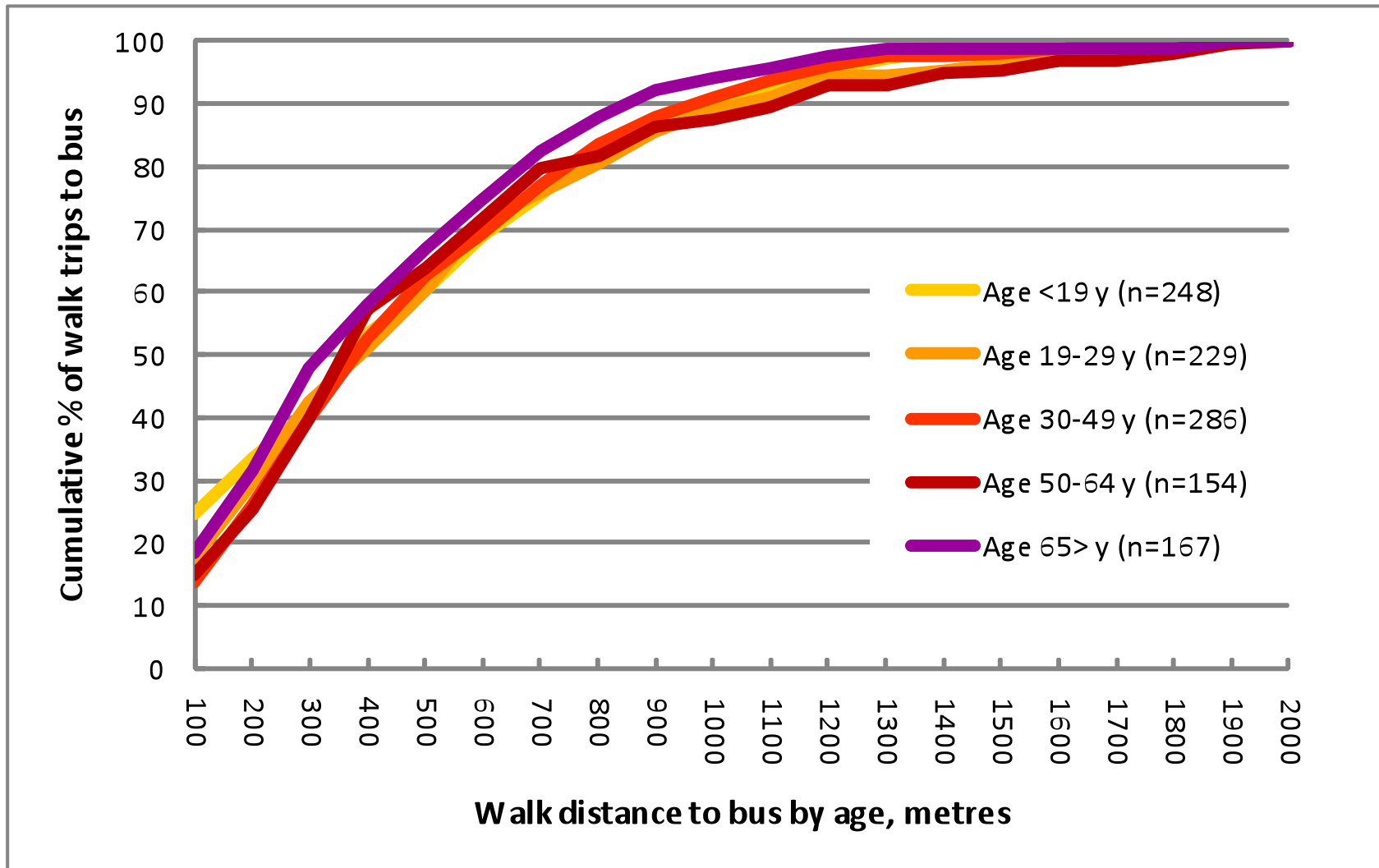
Bus users	Significant difference (**1%, *5%)
Location	Walk trips in Central Coast shorter than in inner Sydney*
Purpose	Walk trips for education and shopping shorter than for work*
Fare	Walk trips using free school pass shorter than full fare*

Walk to bus by purpose

Walk to bus for **education** and **shopping** significantly shorter than for work



Walk to bus: no significant difference by age



Explaining walking distance

- › Variables
 - › Trip and demographic characteristics + location variables
 - › Correlations between 3 locational variables
- › Model 1 – Walk to train and bus combined
 - Mode dummy variable
 - As expected, residuals had non-normal distribution
- › Model 2a – Walk to train
 - Low $R^2 = 0.008$
 - Single “explanatory” variable:
The higher % of trips by public transport, the shorter the walk distance to train
- › Model 2b – Walk to bus
 - Square root of walk distance to ensure residuals normally distributed
 - Low adjusted $R^2 = 0.02$

- › Analysis: means (combined and separate), distributions, Chi-squared, regression
- › Unable to find good independent explanatory variables
- › Once decision to walk has been made, train or bus is dominant factor
- › Main influence on walk distance is mode: train vs bus
- › Trip and demographic variables not significant in explaining walk distance
- › People walking to bus and train are different populations



Source: *Inner West Courier*, 26 Sept 2009



Source: *Daily Telegraph*, 13 April 2011

Why walk further to train than bus?

> Nature of train vs bus

- Supply and spacing: 35,000 bus stops vs 300 stations
- Local vs regional role: train trips longer in time and distance
- Catchment: stations have higher % non-residential uses
- Facilities: stations have more facilities than bus stops



Source: *Metropolitan Plan for Sydney 2036*, Dec 2010



Source: sydney.edu.au



Source: *Metropolitan Plan for Sydney 2036*, Dec 2010

Implications for service planning

- › People do walk further than 400 m

Walk distance	Median	75 th percentile
Bus	364 m	655 m
Train	749 m	1,018 m

- › How many more people would have walked if the stop or station was closer?
- › Walking distance not affected by demographic characteristics, once decision to walk has been made

Future research

- › Measuring pedestrian accessibility to public transport
- › Better information on characteristics of built and natural environment
- › Actual walking paths: GPS, drawing routes
- › Attitudes of walkers: contribution to physical activity
- › Maximum walking distances
- › Walk further to more frequent services?



Source: *Metropolitan Plan for Sydney 2036*, Dec 2010

Source: www.sydneybuses.info