Welsh Index of Multiple Deprivation, 2014
Access to Services - Technical Paper
Methodology for combining public and private transport times

1. Background Method

As outlined in the WIMD consultation we are currently investigating the use of 2011 Census data on car ownership to weight the average road travel times together with average public transport travel times.

Our preference is for weights to be applied at an LSOA level, reflecting the considerable variation that may exist within wider areas, for example, Local Authority or national level (see Annex E of consultation document).

We acknowledge that car/van ownership at a household level does not tell us whether individuals within the household are able to access the vehicle when needed. But our proposed method below adjusts the vehicle ownership data to better reflect access to the vehicle - by comparing number of vehicles with number of adults aged 17 and above in a household.

We commissioned a household level data table from the 2011 Census (LSOA) – number of cars in household by number of people aged 17+ in household.

As calculations for this domain are undertaken at the household level, our proposed weighting factor is based on households (rather than people).

2. Method Illustrated by a fictional example

Values used in this example are completely fictional.

Household type = 20 different categories based on combination of number of cars and number of adults 17+

Table Population: Households

		Number of Cars					
		0	1	2	3	4+ (a)	**Total**
Number of Adults	1	2	10	1	1	1	**15**
	2	0	4	8	0	0	**12**
	3	0	3	5	4	1	**13**
	4	0	0	1	2	2	**5**
	5+ (b)	0	0	0	1	0	**1**
	Total	**2**	**17**	**15**	**8**	**4**	**46**

(a) For the purpose of this analysis, we assume these households have 4 vehicles.
(b) For the purpose of this analysis, we assume these households contain 5 people aged 17+.

Total Households	46
Total People	103
Total Cars	87

Option 1

Calculate proportion of households where all adults aged 17+ have potential access to a vehicle (i.e. number of cars is greater than or equal to the number of people aged 17+).

In this example this gives 28 divided by 46 or 0.61.

Option 2

Calculate proportion of households where at least one adult aged 17+ has potential access to a vehicle (i.e. number of cars is greater than 0).

In this example this gives 44 divided by 46 or 0.96.

Option 3

Step 1 – Calculate likelihood that adults in household have access to a car

For each household type, divide number of cars by number of people.

		Number of Cars				
		0	1	2	3	4+ (a)
Number of Adults	1	0	1	1	1	1
	2	0	0.5	1	1	1
	3	0	0.333333	0.666667	1	1
	4	0	0.25	0.5	0.75	1
	5+ (b)	0	0.2	0.4	0.6	0.8

Step 2 – Calculate number of full household equivalents with access to a car

For each household type, multiply Step 1 matrix with original data. This gives us the number of full household equivalents with access to a car in each household type.

		Number of Cars				
		0	1	2	3	4+ (a)
Number of Adults	1	0	10	1	1	1
	2	0	2	8	0	0
	3	0	1	3.333333	4	1
	4	0	0	0.5	1.5	2
	5+ (b)	0	0	0	0.6	0

So for example, there were 5 households containing 3 adults aged 17+ and 2 cars. 10 adults had potential access to a car. This is equivalent to 3.3 full households of this household type with access to a car.

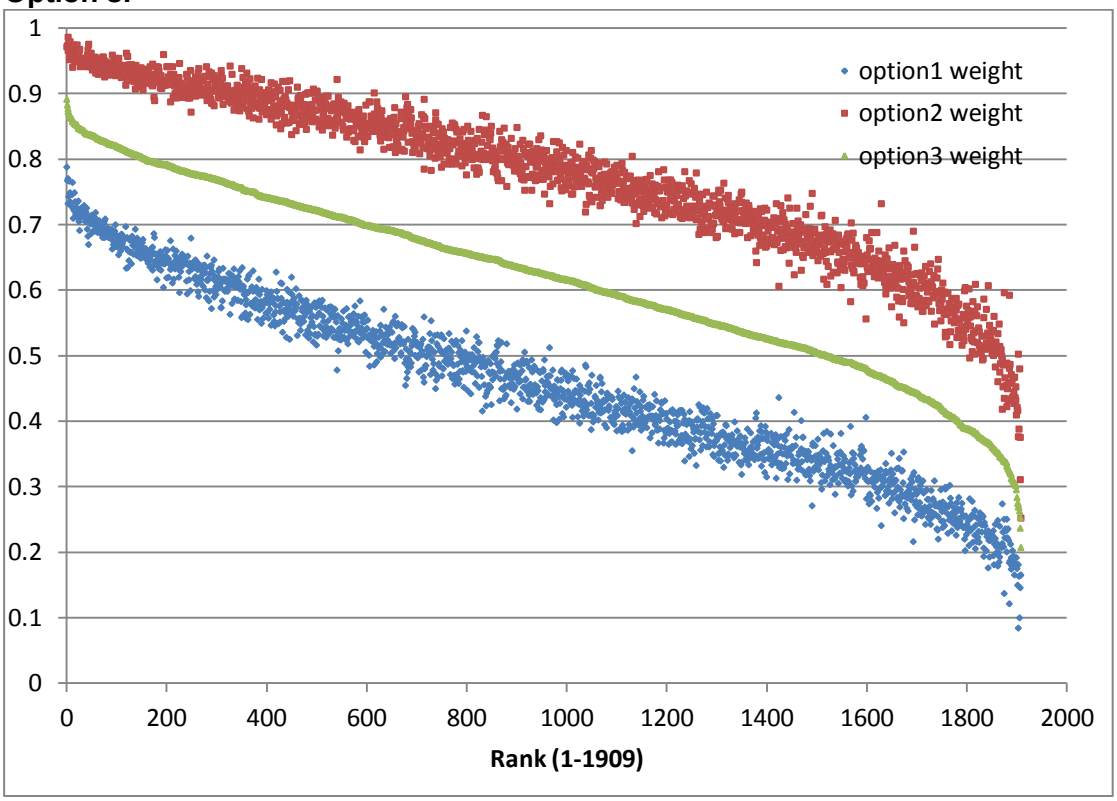
Step 3 – Calculate proportion of full household equivalents with access to a car

Sum the number of households in Step 2 above and divide by total number of households. This gives 36.9 divided by 46 or 0.8.

3. Resulting weights using data from the Census

We calculated the weights for each LSOA; the graph below shows the distribution of private transport weights.

Graph 1: Private transport weight using each of the three options, ranked by Option 3.



All three methods for calculating the private transport weights show a large variation between LSOAs, with each method providing a range of weights.

4. Comparing these analysis with the National Survey for Wales

The National Survey for Wales asks whether respondents have the use of a car for activities such as visiting local shops or going to the doctor. The annual sample size does not allow for robust data for LSOAs, but may be useful to indicate disparity between individuals' access to, and household ownership of a car.

In 2011/12, 79% of adults said that they had the use of a car, which compares to 77% of households owning at least one car/van according to the 2011 Census. Although patterns may vary by area, at a Wales level, this does not suggest that there are a large number of adults unable to access a vehicle, despite living in a household owning one or more vehicles.

The table below compares the data from the National Survey for Wales, for each Local Authority, with the options for private transport weighting.

Local Authority	Private weighting, Option 1	Private weighting, Option 2	Private weighting, Option 3	Use of a car, National Survey for Wales
Isle of Anglesey	0.53	0.82	0.68	0.88
Gwynedd	0.50	0.79	0.65	0.75
Conwy	0.48	0.78	0.64	0.82
Denbighshire	0.48	0.79	0.64	0.79
Flintshire	0.52	0.83	0.68	0.84
Wrexham	0.47	0.78	0.63	0.79
Powys	0.57	0.85	0.71	0.86
Ceredigion	0.52	0.82	0.67	0.81
Pembrokeshire	0.52	0.82	0.68	0.86
Carmarthenshire	0.50	0.81	0.66	0.83
Swansea	0.43	0.74	0.59	0.77
Neath Port Talbot	0.40	0.74	0.58	0.80
Bridgend	0.44	0.78	0.61	0.80
Vale of Glamorgan	0.50	0.81	0.66	0.86
Cardiff	0.40	0.71	0.55	0.72
Rhondda Cynon Taf	0.40	0.73	0.57	0.78
Methyr Tydfil	0.34	0.70	0.52	0.77
Caerphilly	0.41	0.76	0.59	0.77
Blaenau Gwent	0.37	0.71	0.54	0.76
Torfaen	0.43	0.76	0.60	0.79
Monmouthshire	0.56	0.85	0.71	0.85
Newport	0.41	0.72	0.57	0.76
Wales	0.46	0.77	0.62	0.79

The data from the National Survey for Wales suggests that option 2 provides the nearest estimate for those with access to private transport. This is not surprising since option 2 is in conceptually measuring the same as the National Survey for Wales.

5. Testing the use of the weights

The National Travel Survey collects data on public and private travel times to the closest: GP, Pharmacy, Major hospital, Primary education, Secondary education, Key visitor attraction, Higher Education, and Key centre.

Analysis was run using this data to compare the three weighting methods, as well as 100% public weighting and 100% private weighting. These indicators were then combined using factor analysis. Initially, we looked at just using public times, against just using private times.

In the following tables decile is the 10% of Wales with the worst access to the services lists, and decile 10 is the 10% of Wales with the best access to the services lists.

Table 2: 100% Public compared with 100% Private weighting

		100% Private										
	Deciles	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
100% Public	**1**	**167**	23	1								191
	2	24	**114**	38	10	4		1				191
	3		43	**81**	49	16	2					191
	4		11	48	**70**	45	14	3				191
	5			15	52	**68**	42	13	1			191
	6			7	8	42	**75**	47	11	1		191
	7			1	2	15	36	**85**	41	10	1	191
	8						20	37	**100**	33	1	191
	9					1	2	5	35	**124**	24	191
	10								3	23	**164**	190
	Total	191	191	191	191	191	191	191	191	191	190	1909

Comparing the 100% Public and 100% Private weighting options, we see some changes, although the majority of the changes appear to be around the 40%-60% most deprived area.

The analysis below compares each of the weighted options against the 100% public weighting.

Table 3: 100% Public compared with weighting option 1

		Option 1										
	Deciles	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
100% Public	**1**	**163**	28									191
	2	28	**96**	53	10	4						191
	3		49	**56**	42	19	17	6	1	1		191
	4		15	39	**42**	38	25	17	11	3	1	191
	5		3	30	44	**37**	29	23	14	9	2	191
	6			7	34	39	**31**	34	24	17	5	191
	7			5	18	26	29	**42**	35	23	13	191
	8			1	1	26	45	28	**39**	30	21	191
	9					2	12	31	39	**62**	45	191
	10						3	10	28	46	**103**	190
	Total	191	191	191	191	191	191	191	191	191	190	1909

Table 4: 100% Public compared with weighting option 2

		Option 2										
	Deciles	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
100% Public	**1**	**132**	50	7	2							191
	2	38	**47**	39	30	15	10	5	5	2		191
	3	11	28	**35**	29	20	21	16	16	12	3	191
	4	6	26	24	**15**	14	29	24	23	19	11	191
	5	3	21	18	23	**23**	25	26	19	18	15	191
	6		7	21	26	25	**22**	22	24	23	21	191
	7	1	7	21	17	20	22	**31**	20	25	27	191
	8		2	18	24	28	19	19	**21**	27	33	191
	9			5	13	23	20	28	35	**25**	42	191
	10		3	3	12	23	23	20	28	40	**38**	190
	Total	191	191	191	191	191	191	191	191	191	190	1909

Table 5: 100% Public compared with weighting option 3

		Option 3										
	Deciles	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
100% Public	**1**	**147**	43	1								191
	2	35	**66**	52	21	12	3	2				191
	3	5	40	**46**	30	21	21	16	9	2	1	191
	4	3	24	27	**26**	23	33	19	18	13	5	191
	5	1	13	27	34	**29**	17	26	20	16	8	191
	6		1	21	30	28	**22**	27	24	22	16	191
	7		3	13	22	19	27	**35**	24	25	23	191
	8		1	2	22	33	27	20	**27**	29	30	191
	9				5	18	16	29	41	**40**	42	191
	10			2	1	8	25	17	28	44	**65**	190
	Total	191	191	191	191	191	191	191	191	191	190	1909

When comparing each of the options against just using a public weighting we notice a large change. Further investigation into this highlighted that the weights from the factor analysis are more affected when combining public and private weights together.

Table 6: Factor scores for each service, by weighting structure

Service	Just Public	Just Private	Option 1	Option 2	Option 3
GP	0.21	0.25	0.16	0.08	0.11
Pharmacies	0.21	0.23	0.16	0.08	0.11
Higher Education	0.14	0.14	0.21	0.35	0.29
Primary	0.11	0.11	0.10	0.08	0.09
Secondary	0.11	0.10	0.16	0.26	0.22
Key Centre	0.09	0.07	0.09	0.06	0.07
Key Visitor Attraction	0.07	0.05	0.06	0.04	0.05
Major Hospital	0.07	0.06	0.07	0.05	0.06
Squared Canonical Correlations (h^2)	0.911	0.894	0.868	0.898	0.878

The squared canonical correlation of the model, which ranges between 0 and 1, is typically used to estimate the amount of common variance between each of the services where 1 means that the indicators are perfectly correlated. If the number is closer to 1 the model is more representative of the indicators that feed into it, making it a better model. We see that each model has approximately the same coverage of common variance.

For Options 1, 2 and 3, we see a drop in the weighting for the GP and Pharmacies; and an increase in Higher Education and Secondary Schools. The Key Centre, Key Visitor attraction and Major Hospital services all stay approximately the same.

The changes in ranking of the weights for each model can be more easily observed in the table below.

Table 7: Rank of each factor scores for each service, by weighting structure

Service	Rank_Pub	Rank_Priv	Rank_Op1	Rank_Op2	Rank_Op3
GP	1	1	2	3	3
Pharmacies	2	2	4	4	4
Higher Education	3	3	1	1	1
Primary	4	4	5	5	5
Secondary	5	5	3	2	2
Key Centre	6	6	6	6	6
Key Visitor Attraction	7	8	8	8	8
Major Hospital	8	7	7	7	7

From the output that accompanied each of the models, it was also clear that certain services were strongly positively correlated: GPs and Pharmacies; and Higher Education and Secondary Schools (correlation coefficients of 0.75 and 0.80 respectively). The other variables showed some/moderate positive correlation with each other, with coefficients typically between 0.3 and 0.5.

6. Recommendation

It is recommended that a single factor analysis should be used, after weighting the indicators (as previously agreed)

This analysis highlights the impact of a change to the factor analysis weights, and how this would impact on the overall domain. It's also noted that, due to factor analysis, a higher weight is given to factors that have a higher correlation with each other (e.g. pharmacies and GPs).

It was therefore considered whether factor analysis is still appropriate after combining the indicators together, or whether factor analysis should be carried out on a public and private domain, and then combined. Conceptually, if combining together first then running factor analysis on a single indicator, the domain would look to identify areas with an overall deprivation of access to services.

If we were to run factor analysis on two subdomains (public and private transport), then combine these together, there was a concern that: the factor weights would be different for individual services; and that there would be a different number of factors in each sub domain, due to petrol stations being considered for private transport only.

Conceptually, the subdomains would consider access to services deprivation by private and public transport separately. It would therefore be likely that an area with a high proportion of households with access to a car could be shown as deprived of public transport.

It is recommended that Option 3 should be used for WIMD 2014

Option 1 considers those who have access to a car at all times. This is considered to be an undercount, due to multiple persons being able to use a car at once. This model also has the lowest coverage of shared variation between the indicators.

Option 2 considers those who could have access to a car. This is considered to be an over estimate, as it assumes availability of a car for all in the household. Whilst it is also quite similar to values from the National Survey for Wales, it is thought that the National Survey for Wales' results are more likely to consider whether the household has a car, rather than if they have access to a car.

Option 3 estimates the expected number of households with access to a car. This is considered to be the most conceptually sound methodology.