UNIVERSITY OF BIRMINGHAM

The individual as the key-stakeholder of Next Generation Infrastructure: Defining the social value of transport infrastructure in the United Kingdom

Nikos Kalyviotis, Chris Rogers, Miles Tight, Geoffrey Hewings & Hemanta Doloi

Introduction

The final users of transport infrastructure are a “key stakeholder”, since they elect the government ... *Rodríguez-Pose, 2015, p.32*

The economic and the social value gained from the individual are difficult to calculate due to the different behaviour of each individual user – yet understanding of these values for the collective (the group that constitutes the users) is essential

The Aim of this research (which aligns with both the iBUILD & Liveable Cities projects) is to address the question:

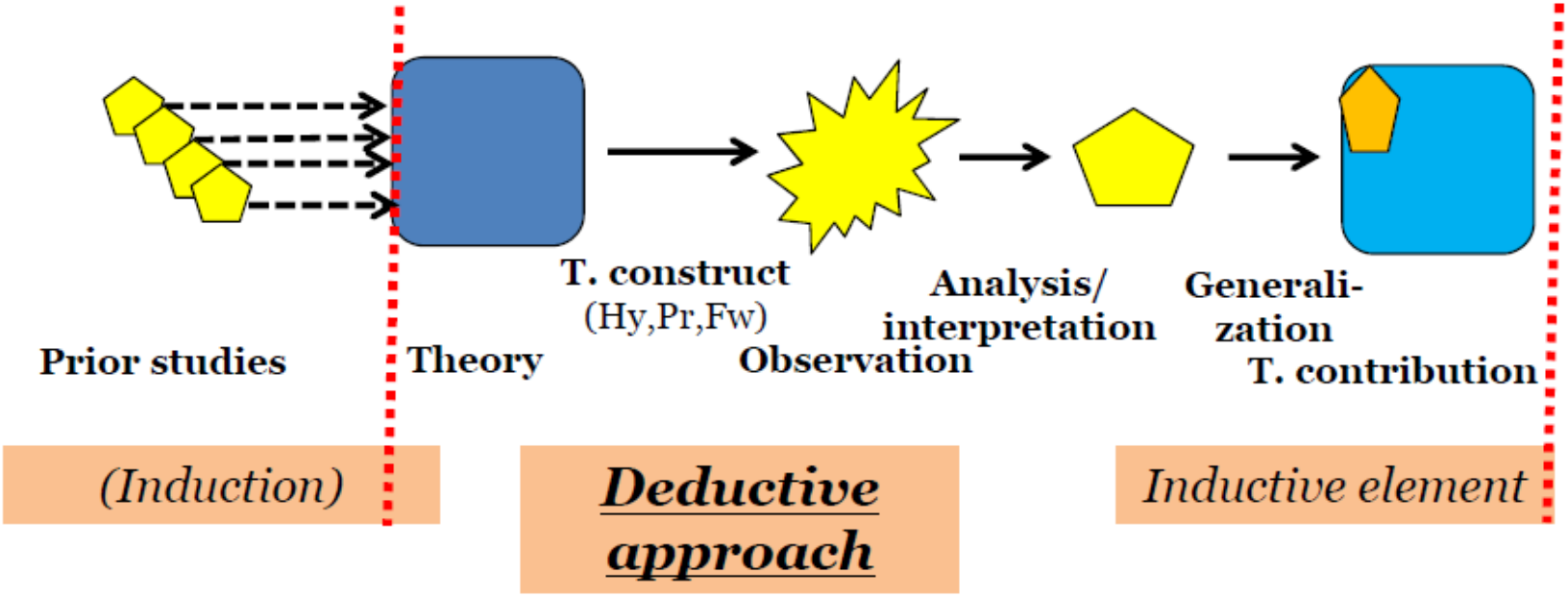
What is the Social Value of Transport Infrastructure?

Theoretical Methodology

Scientific ideal: Positivism (*Wainwright & Forbes, 2000*)

- Hypothetico-deductive model
- Quantitative methods

Deductive approach (*May, 2011*)



Theoretical Frame of Reference

Human behaviour defines the social value

… and more specifically the needs

According to Maslow's Hierarchy of Needs (1954), these needs belong to specific groups with the following hierarchy:

[1] physiological needs

[2] safety needs

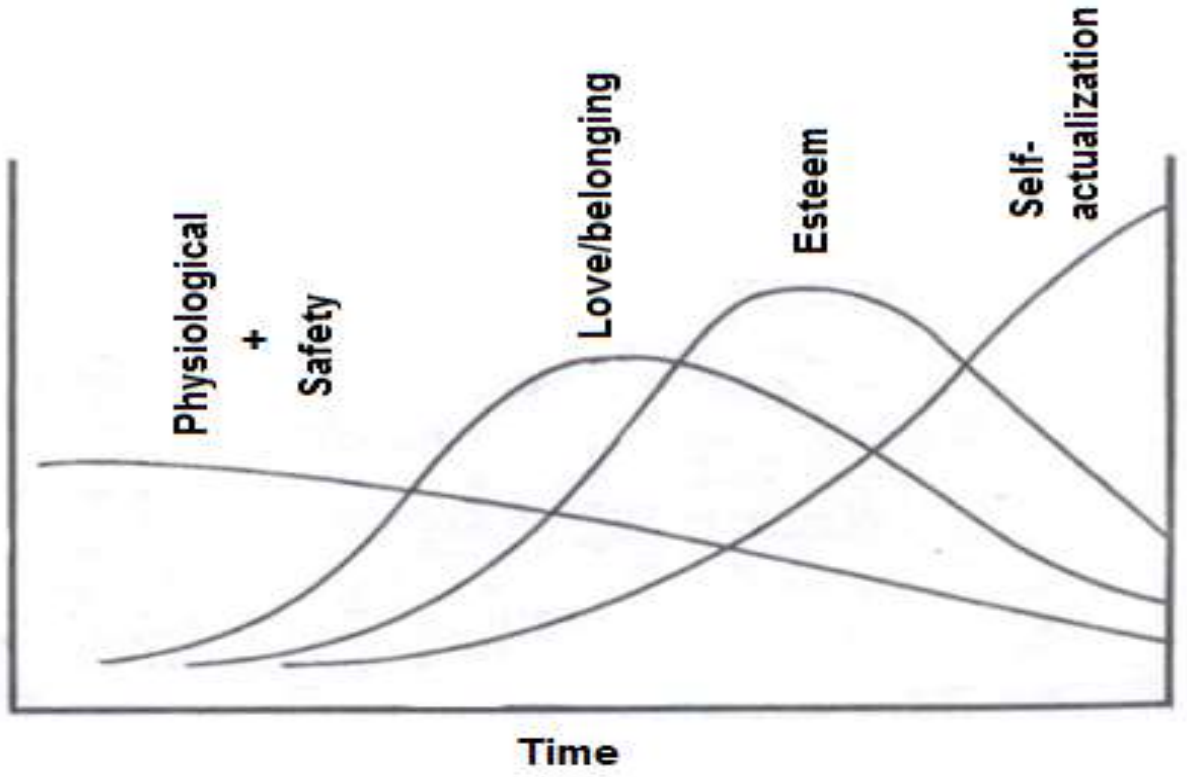
[3] love and belonging

[4] esteem

[5] self-actualization

Theoretical Frame of Reference

Value curves of Maslow's Hierarchy of Needs (*Bourantas, 2002*)



The sum of curves gives a **sigmoid curve** (almost)

Theoretical Frame of Reference

Research proposition: Social Value of Transport Infrastructure

Winter et al. (2001) did a Transportation Hierarchy of Needs :

- [1] safety and security
- [2] time
- [3] societal acceptance
- [4] cost
- [5] comfort and convenience

Theoretical Frame of Reference

Research proposition: Social Value of Transport Infrastructure

Winter *et al*. (2001) created a Transportation Hierarchy of Needs:

[1] safety and security

[2] time

[3] societal acceptance

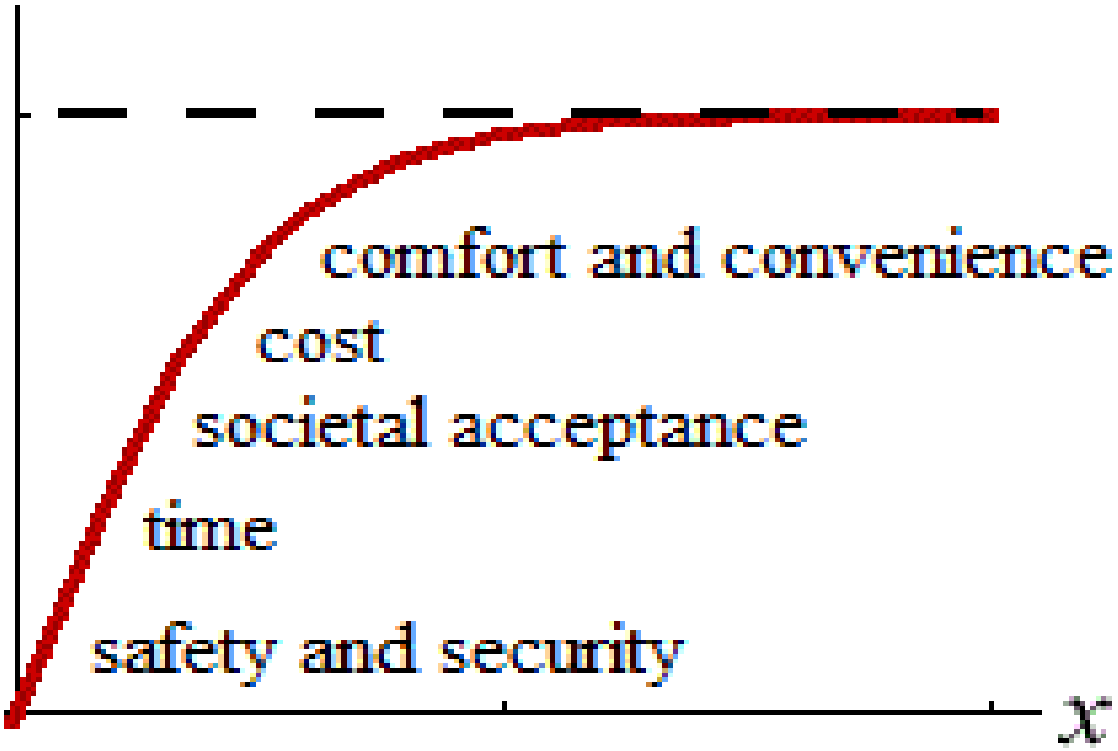
[4] cost

[5] comfort and convenience

Theoretical Frame of Reference

Research proposition: Social Value of Transport Infrastructure

So the value of the individuals **expected** to have an almost sigmoid curve relative to the needs covered by transport:



Practical Methodology

Initial findings from the Questionnaire Survey:

110 out of 300 individuals (880 out of 2400 evaluations)

1											Evaluation											
Postcode	Age	Ethnic	Gend.	Indiv.	Cars/ Veh.	Income (x1000)	Distan (Km)		Percent	Goods	Main	Walking	Cycling	Rail	Bus	Car	Taxi		Travel Time	Excess Time	Travel Cost	Confort & Conven.	Safety & Security
Birmingham B191L	20-29	White	F	2	0	0-10	7	Walking	15	x	Bus	4	-1	3	3	5	5	Walking	2	5	5	4	4
								Cycling										Cycling	0	4	1	-3	-3
								Rail										Rail	3	3	2	4	3
								Bus	80									Bus	3	4	4	-1	-1
								Car										Car	3	5	-1	4	4
								Taxi	5									Taxi	4	5	-2	4	4
Adjust to society:			Yes	Main reason:		Time			Trips	Distan													
Never cross the street if there is no zebra line								Air	1	311	General	Air			Water			Air	5	-1	0	4	4
								Water	4	186		4			4			Water	3	2	2	3	5

- Individuals were asked to evaluate the transport modes (8) and each factor (5) of each transport mode by assigning a value between -5 and 5.
- Checks were made on each individual's accessibility to each transport mode by using their postcode

Practical Methodology

Demographic analysis of the sample

Area	Population	Percentage	Expected
Belfast	585,996	1%	3
Birmingham	3,701,107	12%	36
Bristol	1,006,600	3%	9
Cardiff	1,097,000	3%	9
Edinburgh	1,339,380	4%	12
Glasgow	1,858,517	6%	18
Leeds	2,302,000	7%	21
Liverpool	2,241,000	7%	21
London	13,879,757	43%	129
Manchester	2,794,000	9%	27
Newcastle	1,650,000	5%	15
Total	32,455,357	100%	300

Age	Total Percentage (%)	Survey (%)	Expected
0-15	17.6	0	0
15-19	6.3	7.65%	23
20-29	13.6	16.50%	50
30-39	13.1	15.90%	48
40-49	14.6	17.72%	53
50-59	12.2	14.81%	44
60-65	6	7.28%	22
65+	16.6	20.15%	60
Total	100	100.00%	300

Gender	Percentage	Expected
Male	49.11%	147
Female	50.89%	153
Total	100.00%	300

Ethnic group	Percentage	Expected
White	87.17%	262
Asian	6.92%	21
Black	3.01%	9
Other	2.90%	8
Total	100%	300

Practical Methodology

Distance covered in Metropolitan areas

Transport Means	National	Expected		Percentage	Difference
Walking	3%	3.09%	Walking	5.44%	2.35%
Cycling	1%	1.03%	Cycling	6.30%	5.27%
Rail	10%	10.31%	Rail	12.19%	1.88%
Bus	5%	5.15%	Bus	10.68%	5.53%
Car/Taxi	78%	80.41%	Car/Taxi	64.44%	-15.02%
Other	3%	-		0.94%	
Total	100%	100.0%	Total	100%	0.0%

Practical Methodology

- Questionnaire:

Example

1											Evaluation											
Postcode	Age	Ethnic	Gend.	Indiv.	Cars/ Veh.	Income (x1000)	Distan (Km)		Percent	Goods	Main	Walking	Cycling	Rail	Bus	Car	Taxi		Travel Time	Excess Time	Travel Cost	Confort & Conven.	Safety & Security
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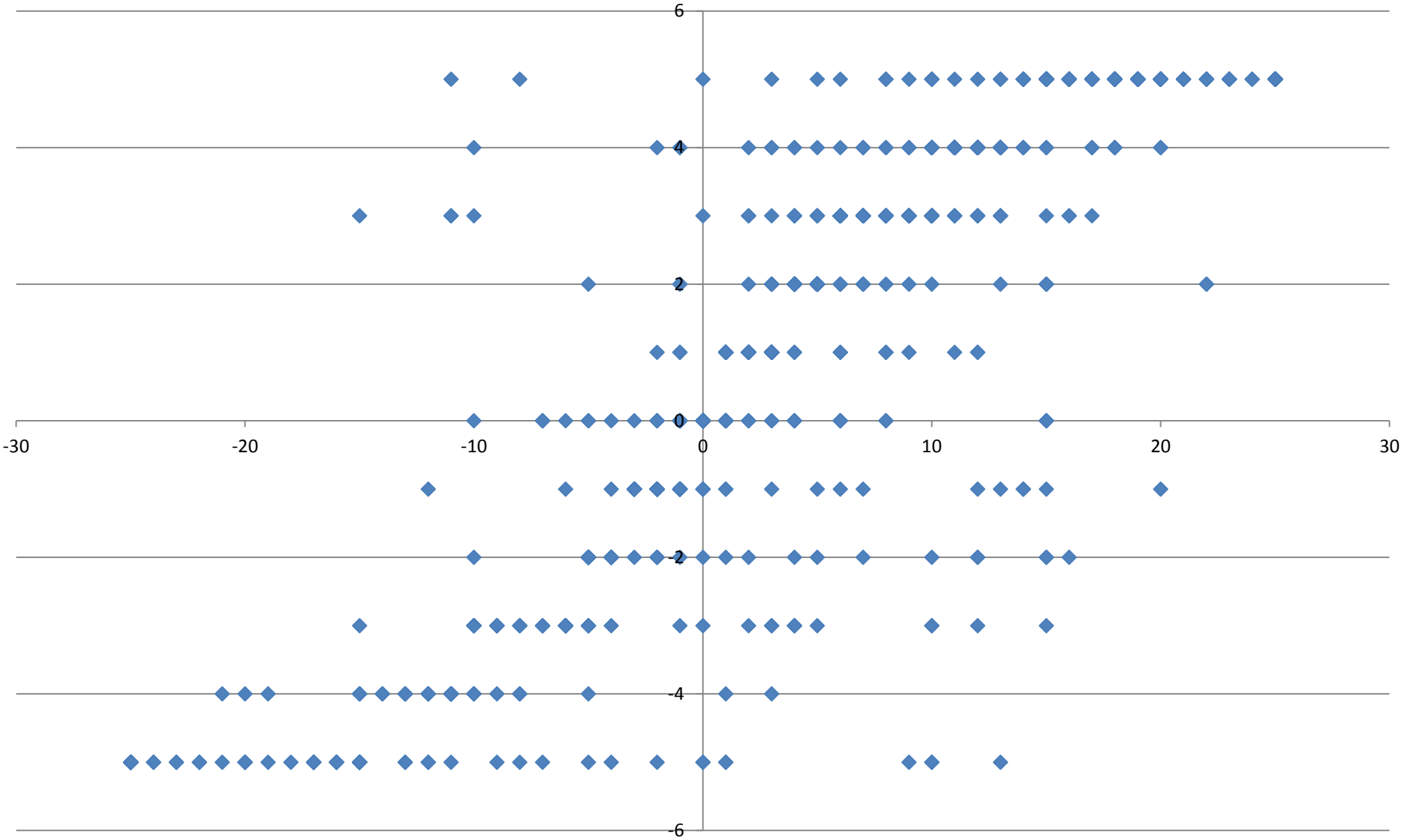
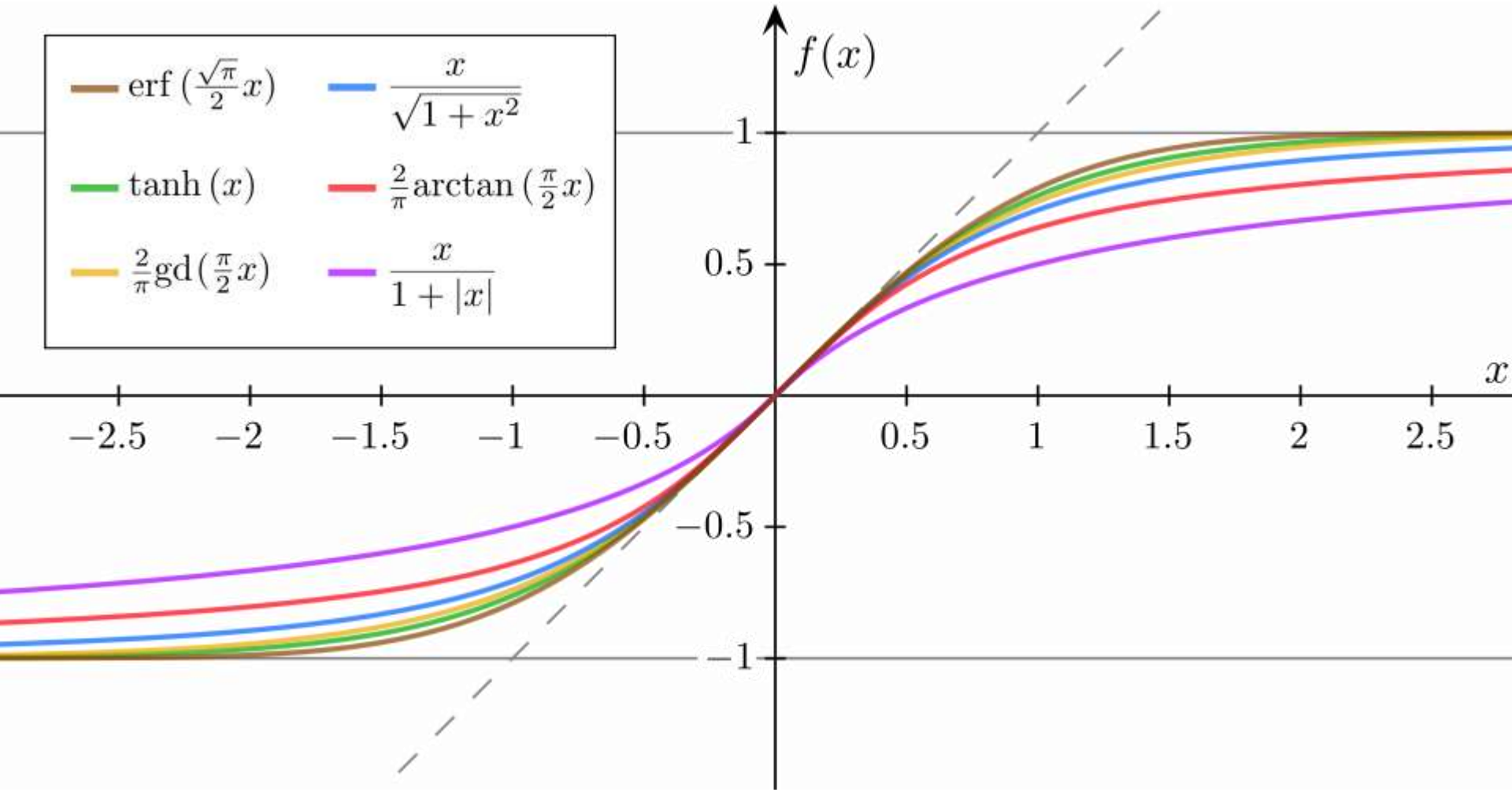
Adjust to society:			Yes	Main reason:		Time			Trips	Distan													
Never cross the street if there is no zebra line								Air	1	311	General	Air			Water			Air	5	-1	0	4	4
								Water	4	186		4			4			Water	3	2	2	3	5

- Add up the evaluation of the factors
  - Walking: 15 corresponds to 4
  - Cycling: -1 corresponds to -1
  - Rail: 16 corresponds to 3
  - Bus: 9 corresponds to 3
  - Car: 15 corresponds to 5
  - Taxi: 15 corresponds to 5
  - Air: 12 corresponds to 4
  - Water: 15 corresponds to 4

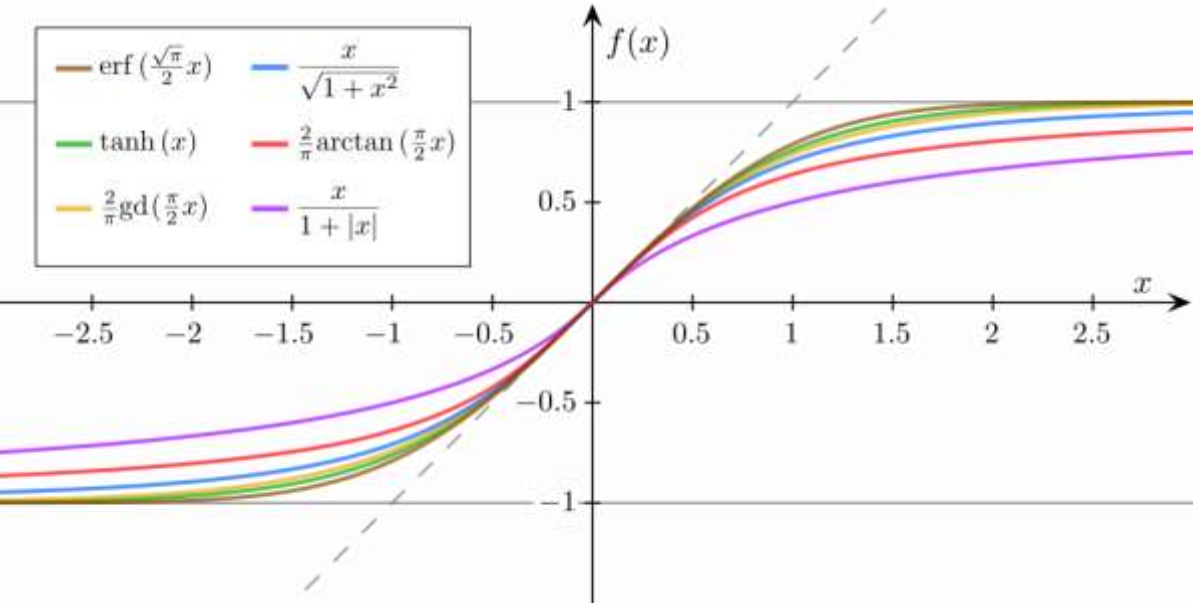
Empirical Findings and Analysis



Empirical Findings and Analysis



Empirical Findings and Analysis

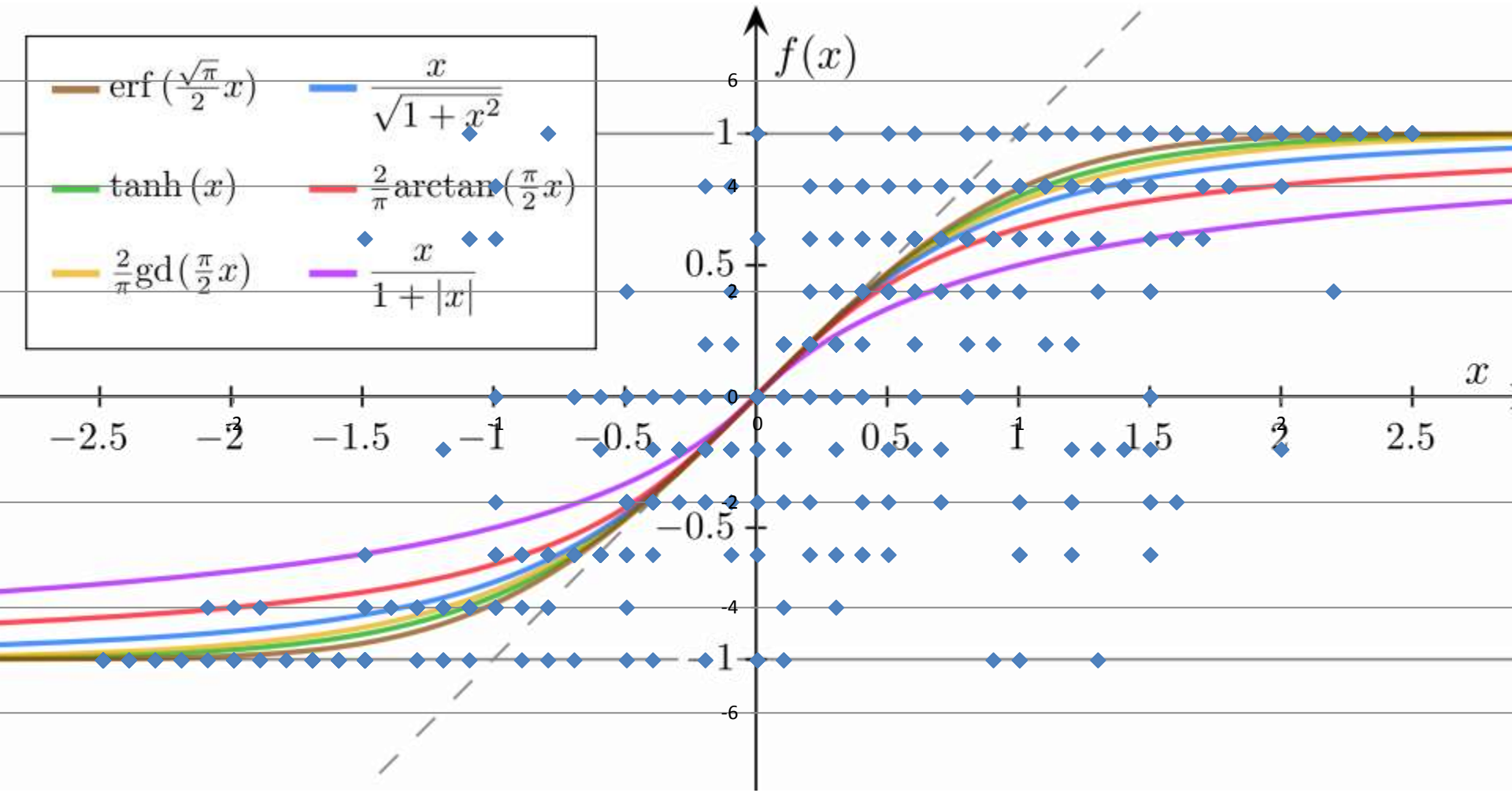


- **(0,0)** is the origin
- **Y-axis:** the maximum 5 corresponds to 1
- **X-axis:** the maximum 25 corresponds to 2.5 **(>2)**

X-axis maximum:

- "2.45782" calculated by using the slope of our data
- Step response is 0.1, so either 2.4 or 2.5 maximum
- Distribution of the answers results **2.5**

Empirical Findings and Analysis



Empirical Findings and Analysis

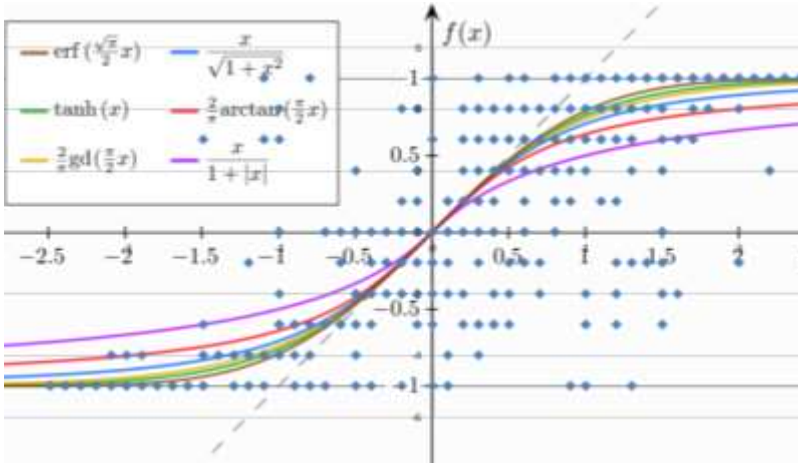
Round the evaluations

										Erf[(π/2)x]	tanhx	Guderman	x/[(1+x^2)^2]
Evaluation	Summary	5*tanh(x/10)	Round 5*tanh(x/10)	Gudermannian function	Round Gudermannian	x/[(1+x^2)^2]	Round x/[(1+x^2)^2]	erf[(π/2)x]	Round erf[(π/2)x]	**603**	**602**	**553**	**492**
3	9	4	4	3	3	3	3	4	4	FALSE	FALSE	1	1
3	10	4	4	4	4	4	4	4	4	FALSE	FALSE	FALSE	FALSE
3	0	0	0	0	0	0	0	0	0	FALSE	FALSE	FALSE	FALSE
3	-10	-4	-4	-4	-4	-4	-4	-4	4	FALSE	FALSE	FALSE	FALSE
5	15	5	5	4	4	4	4		5	1	1	FALSE	FALSE
0	0	0	0	0	0	0	0	0	0	1	1	1	1
5	-11	-4	-4	-4	-4	-4	-4		-4	FALSE	FALSE	FALSE	FALSE
0	0	0	0	0	0	0	0	0	0	1	1	1	1
1	2	1	1	1	1	1	1	1	1	1	1	1	1
-5	-9	-4	-4	-3	-3	-3	-3	-4	-4	FALSE	FALSE	FALSE	FALSE
0	0	0	0	0	0	0	0	0	0	1	1	1	1
0	0	0	0	0	0	0	0	0	0	1	1	1	1
5	17	5	5	5	5	4	4		5	1	1	1	FALSE
2	9	4	4	3	3	3	3	4	4	FALSE	FALSE	FALSE	FALSE
5	25	5	5	5	5	5	5	5	5	1	1	1	1
3	8	3	3	3	3	3	3	3	3	1	1	1	1
5	25	5	5	5	5	5	5		5	1	1	1	1
0	0	0	0	0	0	0	0	0	0	1	1	1	1
1	2	1	1	1	1	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1	1	1	1	1	1
5	8	3	3	3	3	3	3		3	FALSE	FALSE	FALSE	FALSE
-4	-10	-4	-4	-4	-4	-4	-4	-4	-4	1	1	1	1
3	8	3	3	3	3	3	3	3	3	1	1	1	1
0	6	3	3	3	3	3	3	3	3	FALSE	FALSE	FALSE	FALSE

Empirical Findings and Analysis

Evaluation alignment without excluding the outliners:

- 68.52% explained with $f(x) = \mathrm{erf}(\frac{\sqrt{\pi}}{2}x)$
- 68.41% explained with $f(x) = \tanh(x)$
- 62.84% explained with $f(x) = \frac{2}{\pi} gd(\frac{\pi}{2}x)$
- 55.91% explained with $f(x) = \frac{x}{\sqrt{1+x^2}}$
- 3.18% explained only with $f(x) = \frac{2}{\pi} gd(\frac{\pi}{2}x)$ and/or $f(x) = \frac{x}{\sqrt{1+x^2}}$



Conclusions and Recommendations

- The numerical expression $f(x) = \tanh(x)$ explains 68.41% of the results and is a good fit to the data
- If the results from the second and the fourth quarters are removed as outliers, then $f(x) = \tanh(x)$ explains more than 75% of the data

So the hypothesis was verified

- Other conclusions for the Metropolitan Areas:
  - Walking, Cycling, Rail and Bus usages in the Questionnaire Survey were found to be greater than the national usage by 2.4%, 5.3%, 1.9% & 5.5%, respectively.
  - Car and Taxi usage in the Questionnaire Survey was found to be less than the national usage by 15.0%

Conclusions and Recommendations

- Other findings for the Metropolitan Areas
  - The greatest car usage is in Birmingham and in Manchester
  - The greatest rail usage is in Newcastle and in Glasgow, where the rail got the highest “score”
  - The individuals have a **positive opinion** for the **Rail Network** all over the United Kingdom **EXCEPT** London (maybe because of the underground)

Conclusions and Recommendations

Thank you for your attention!