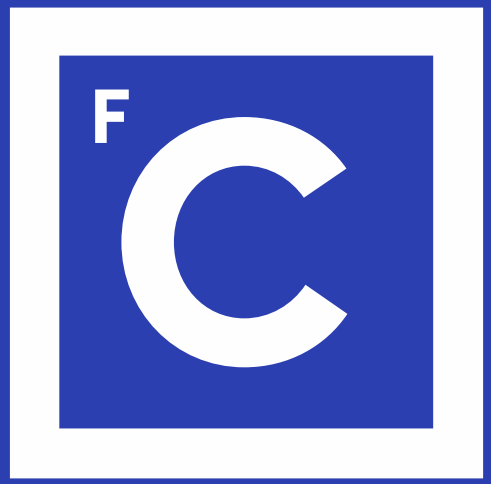


Ciências ULisboa

Faculdade
de Ciências
da Universidade
de Lisboa

DISCIPLINA MIEA 2018

Mobilidade Sustentável

What is sustainable mobility?

Comparing transport systems??

Sustainable mobility indicators

Indicators of sustainable Mobility

11 Indicators

1 DIMENSION

Environmental

Emissions per year (per capita)

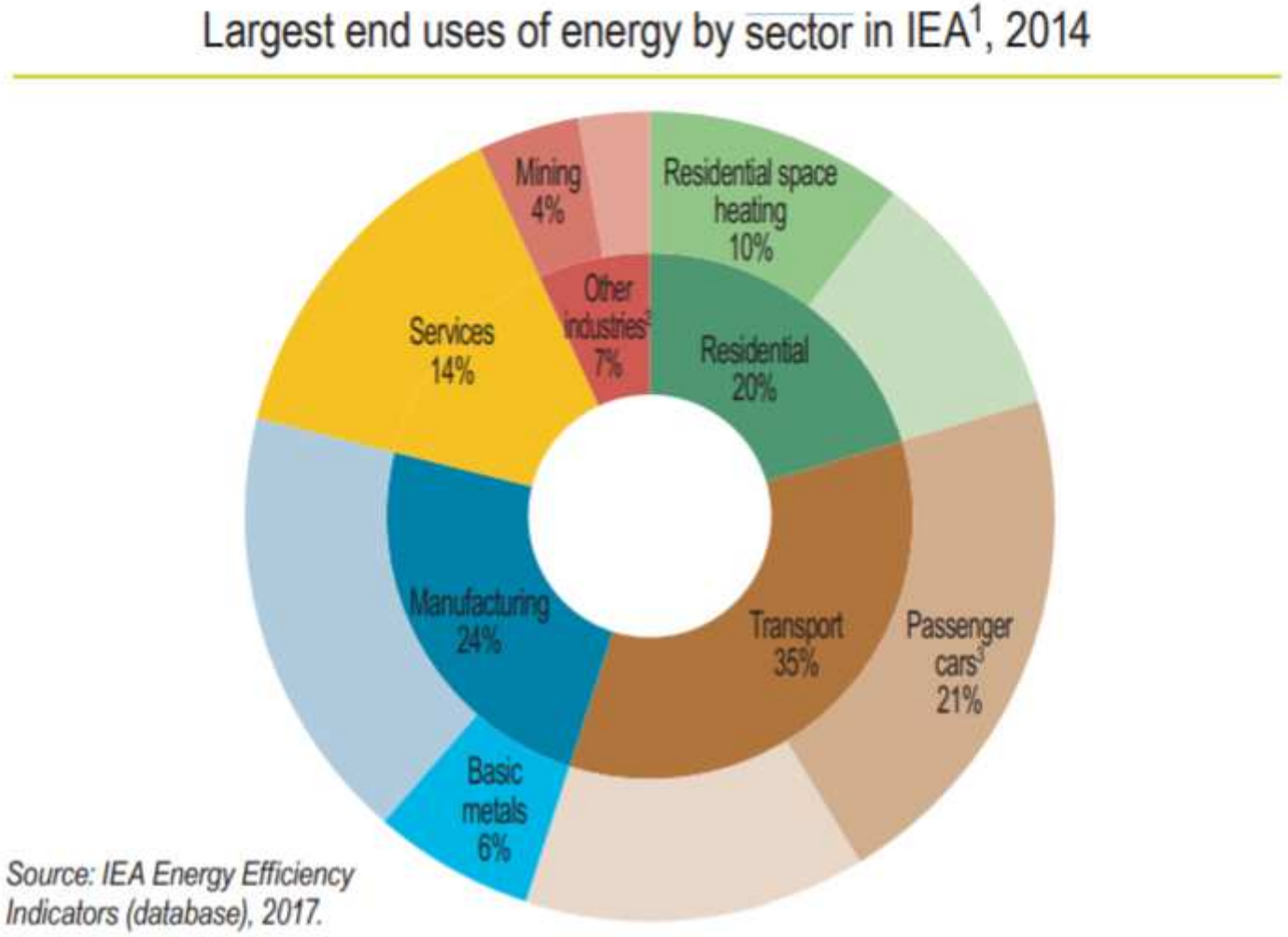
- NOx (NO and NO_2)
- VOCs
- CO
- PM10
- PM2.5
- SOx
- O_3
- CO_2
- N_2O
- CH_4

Ton or g/year

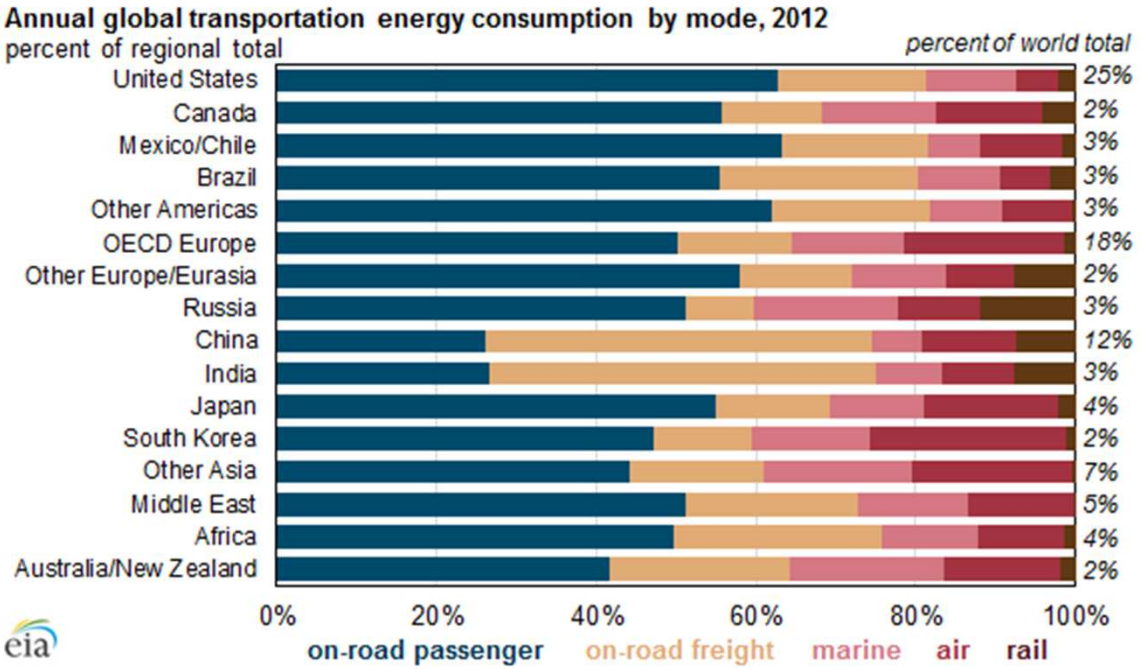
Energy consumption per year (per capita)

MJ or MJ/year

Transports share



Transports mode share

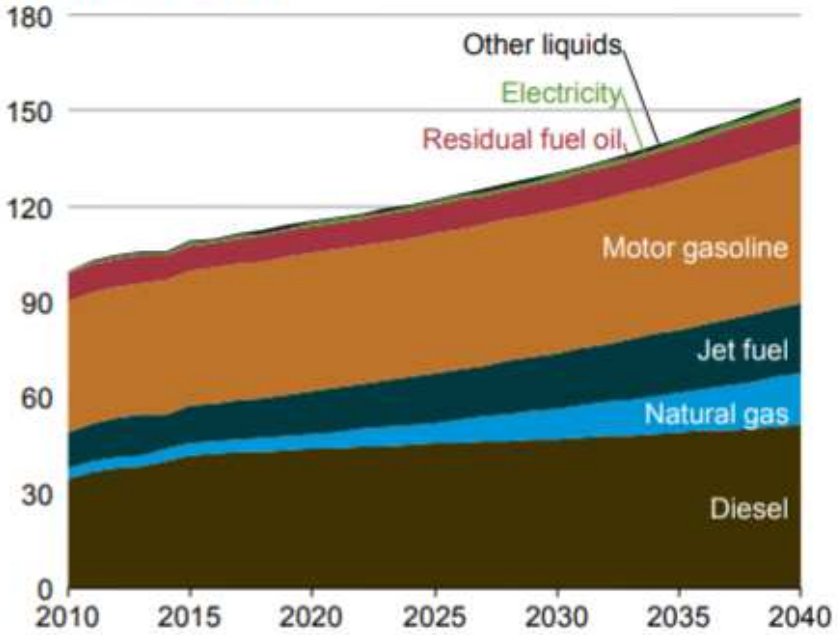


Source: EUROSTAT
http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Energy_consumption_of_transport_by_mode_EU-28.jpg

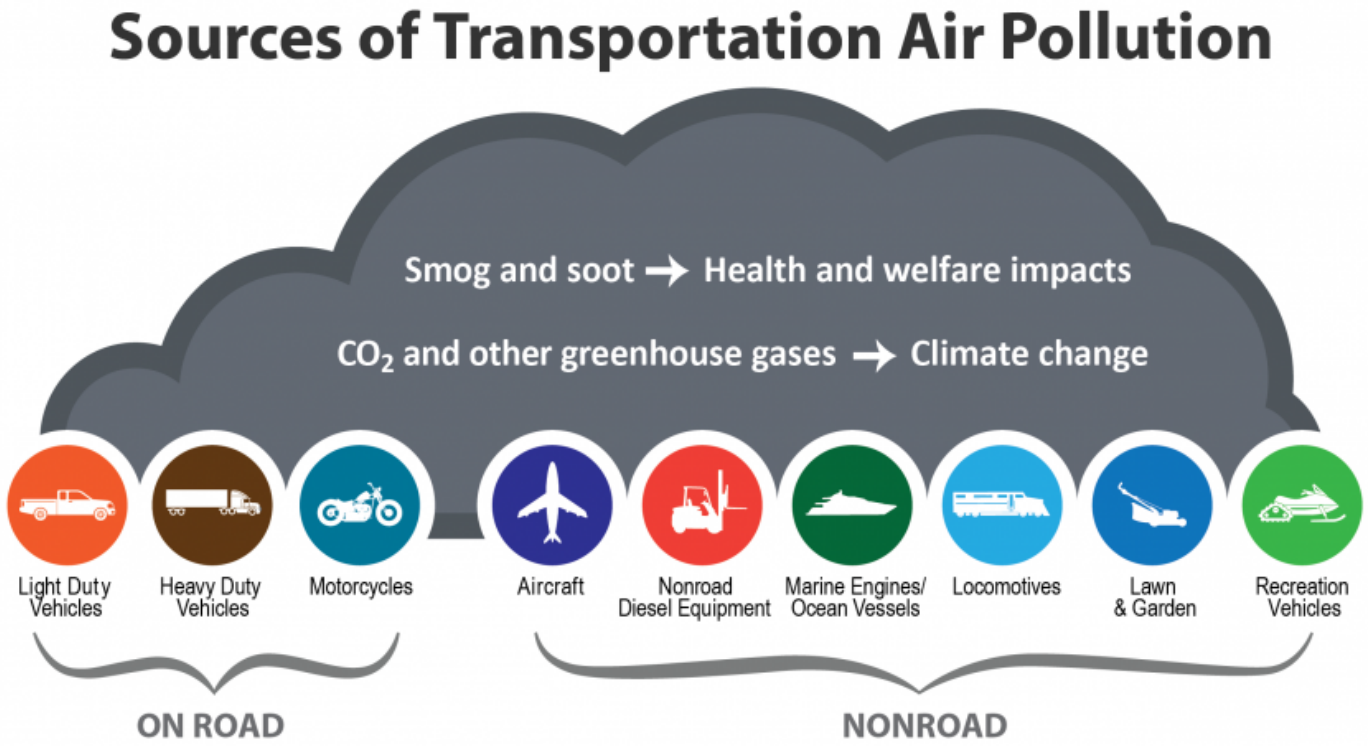
Transports share by energy source

eia

Figure 8-2. World transportation sector delivered energy consumption by energy source, 2010–40 (quadrillion Btu)

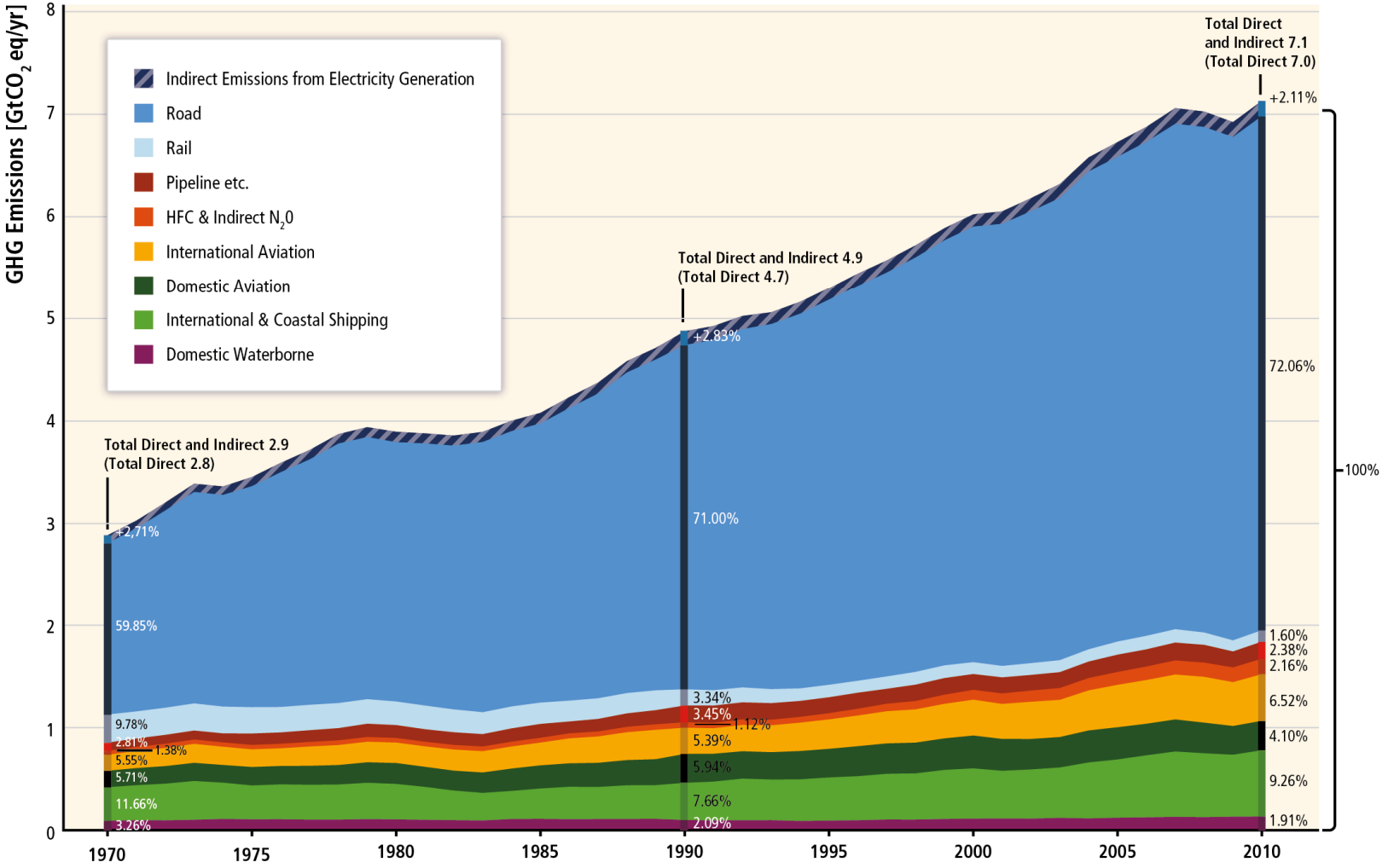


Transports share by energy source

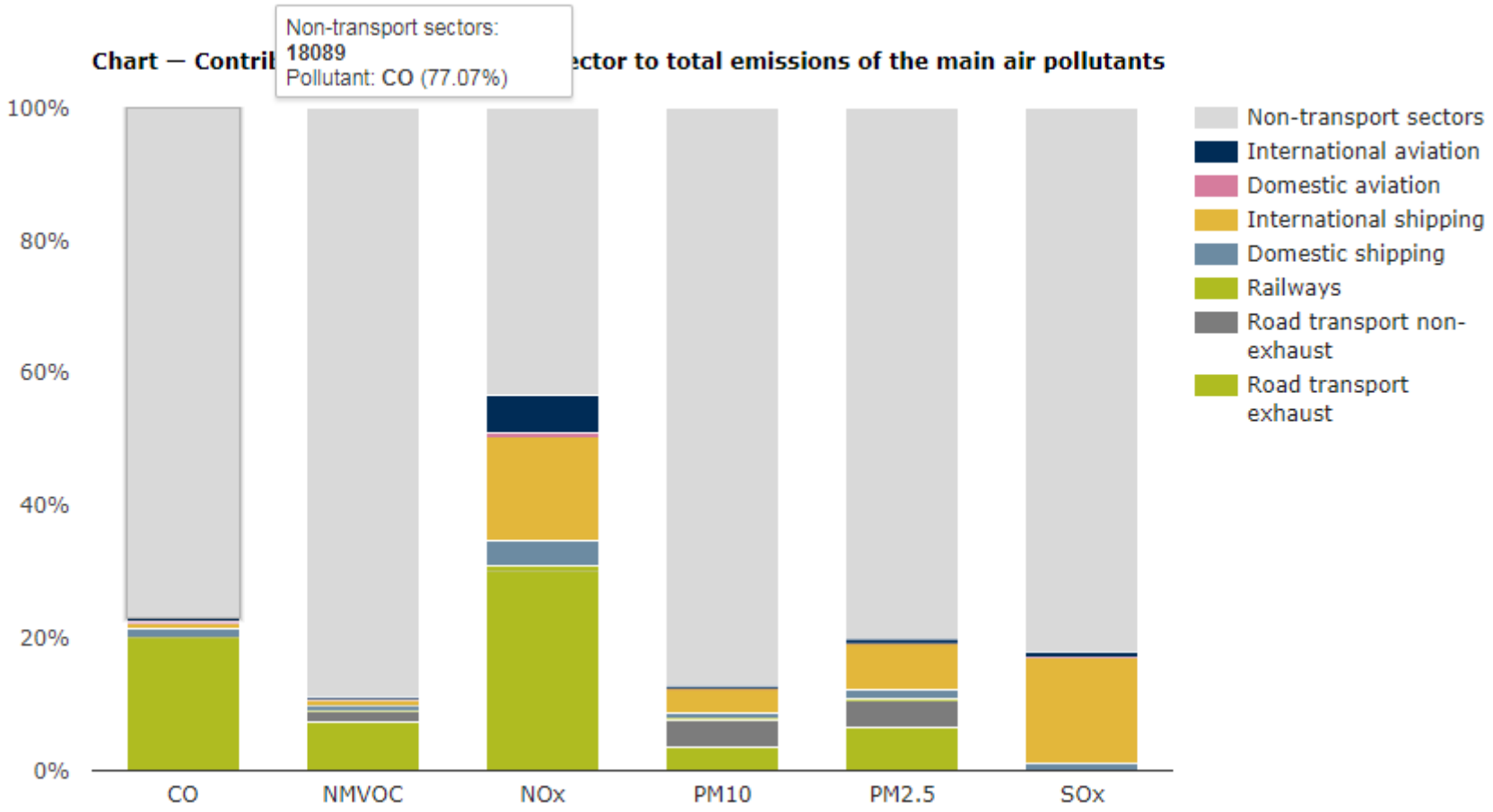


Transport share

IPCC (2014)



Transport share



2017

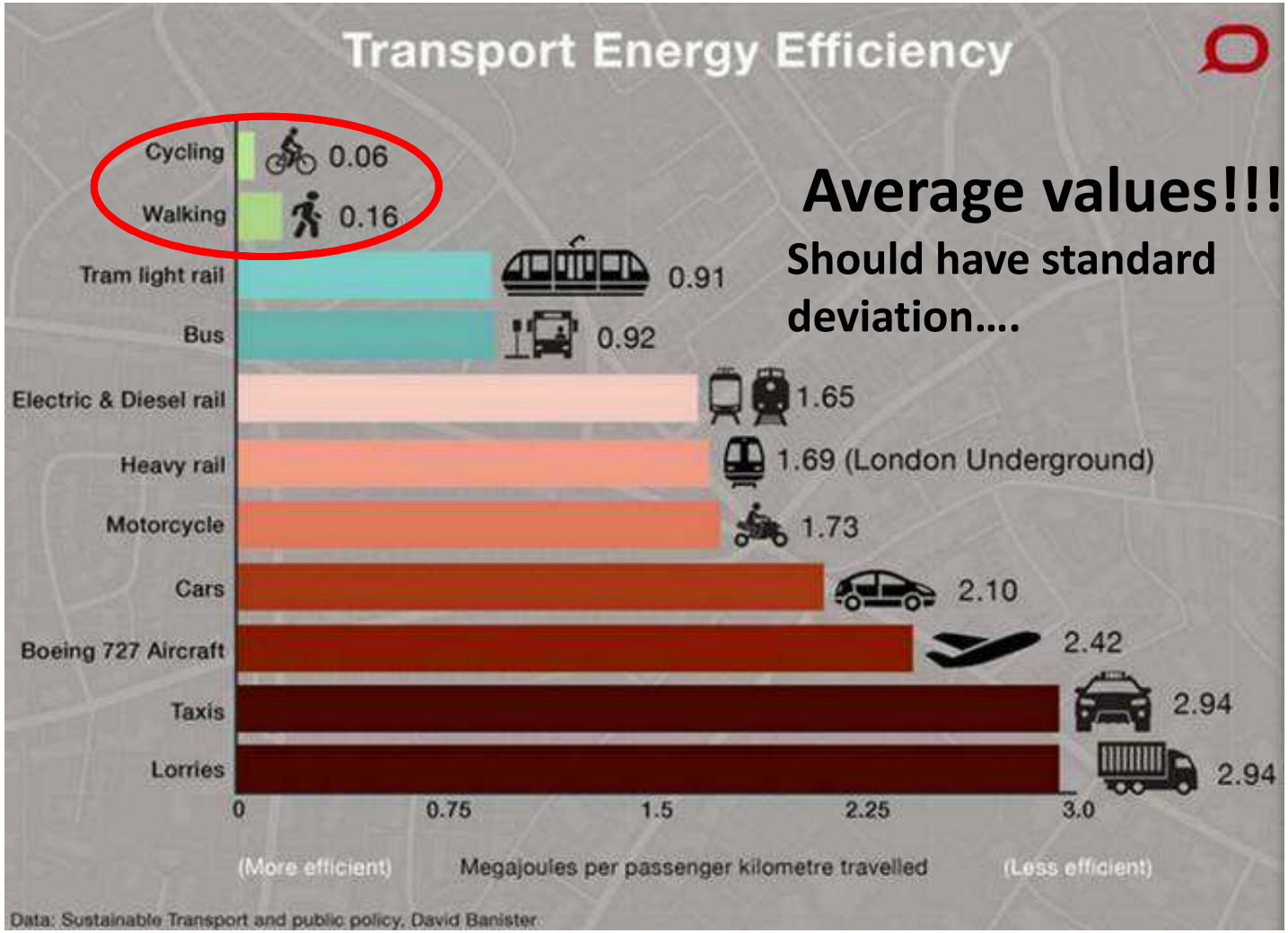
European Environment Agency

Minimum energy and emissions

Emissions

Energy

UK transport energy efficiency

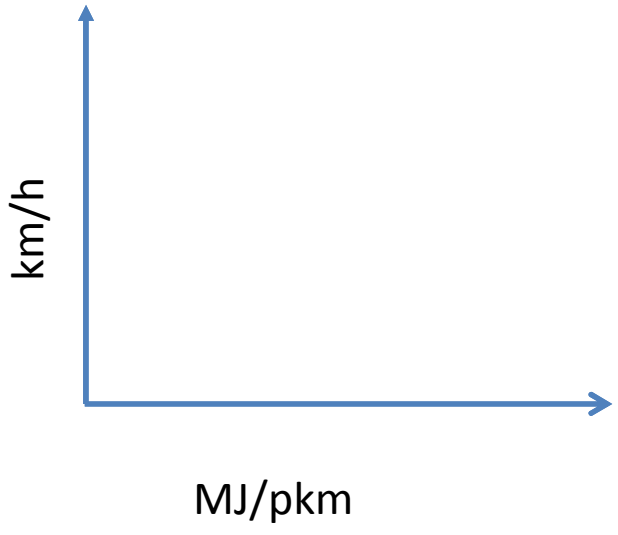


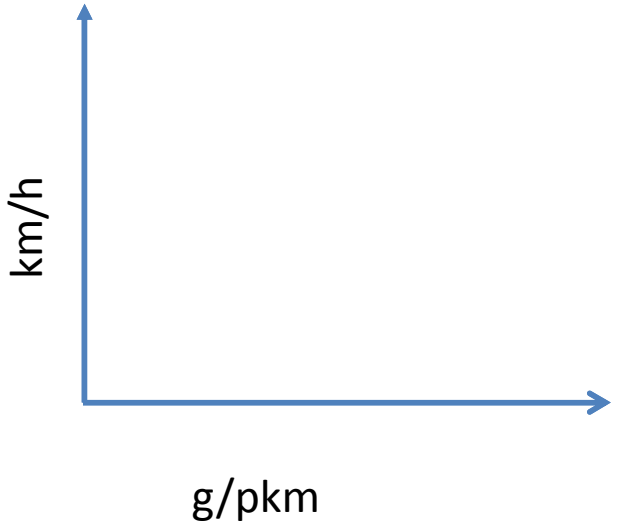
Average values!!!!!

Should have standard deviation….

Estimate your energy for regular walking (at least 3 repetitions of the measurements), in MJ/pkm, and speed (km/h). What would be your graph?

Excel file by e-mail



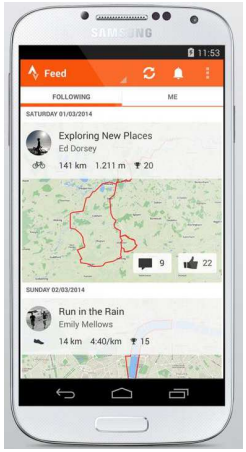


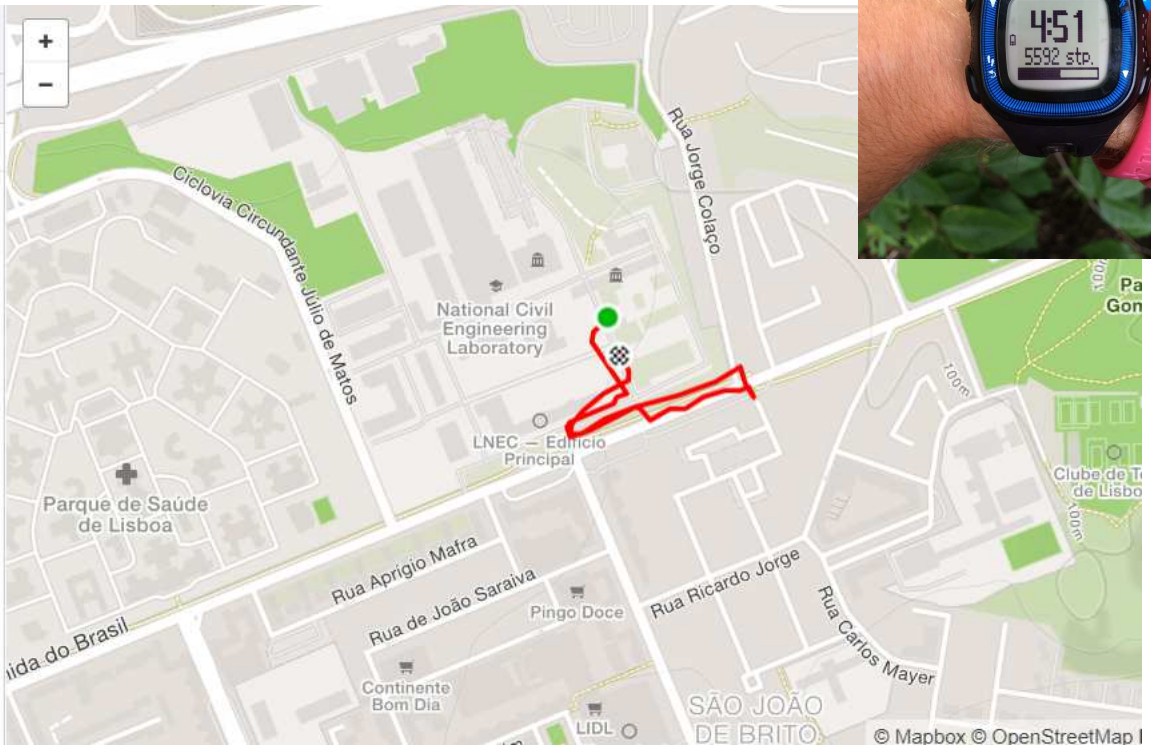
Measurements by ACTIVITY WATCH w/ GPS

Splits

KM	Pace	Elev
0.79	13:43 /km	178 m

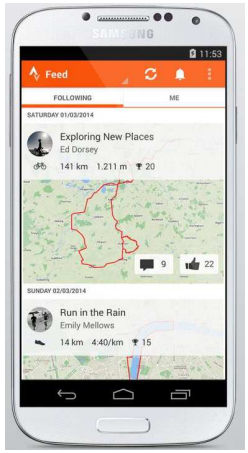
STRAVA™

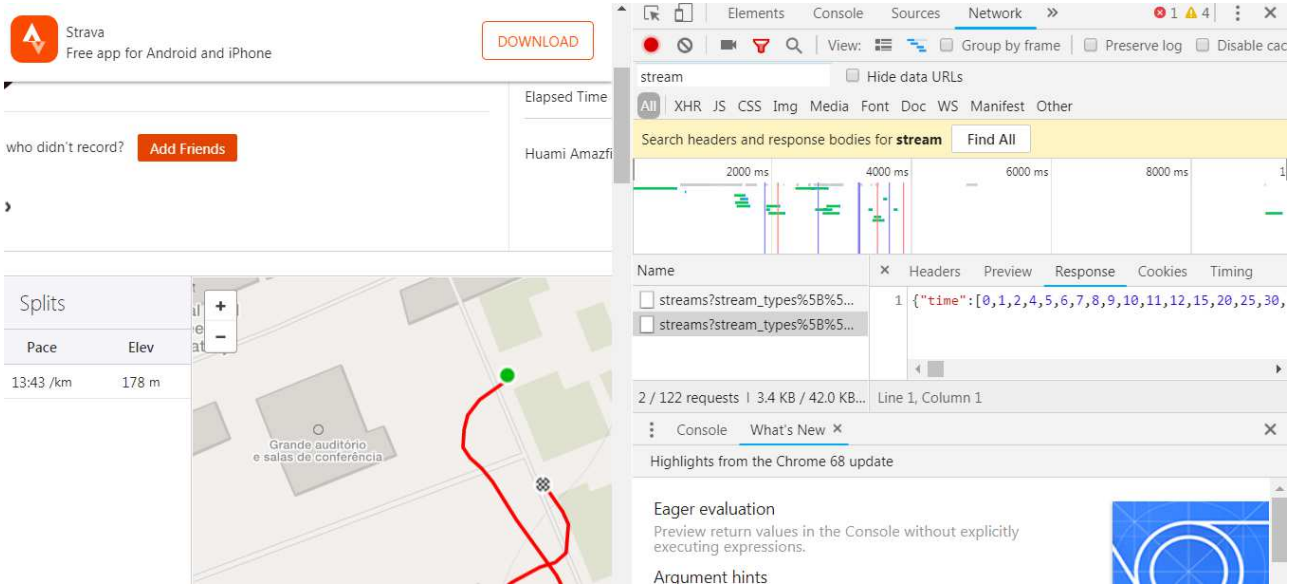




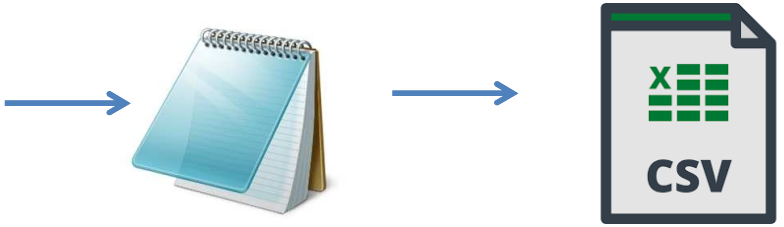
Measurements by ACTIVITY WATCH w/ GPS

STRAVA™



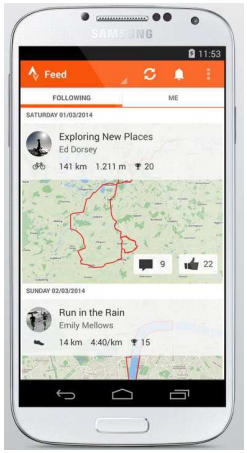


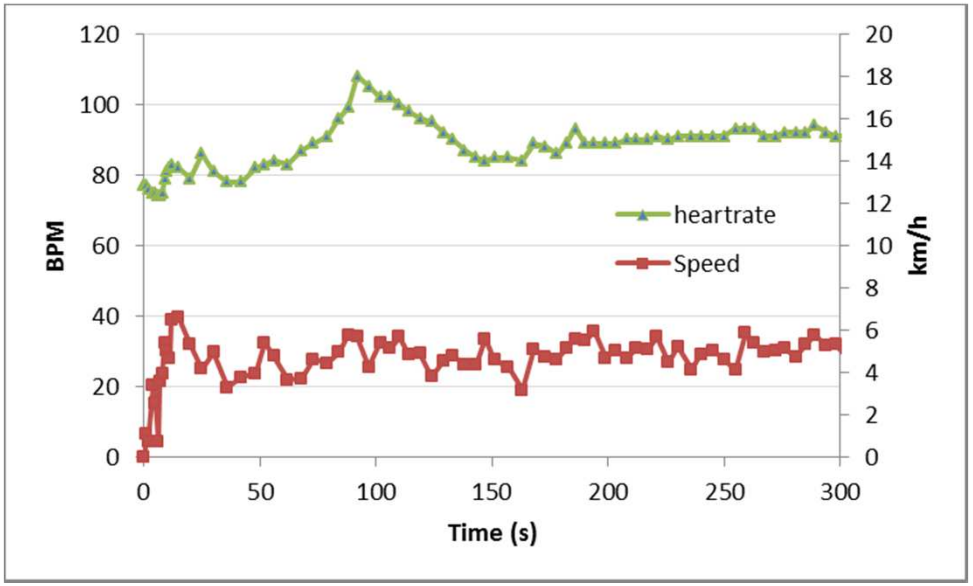
Mouse right click;
Inspect;
Network;
Filter by “stream”;
Select Response;



Measurements by ACTIVITY WATCH w/ GPS

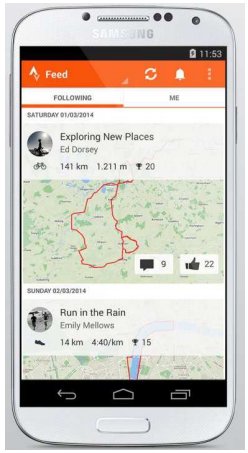
STRAVA™

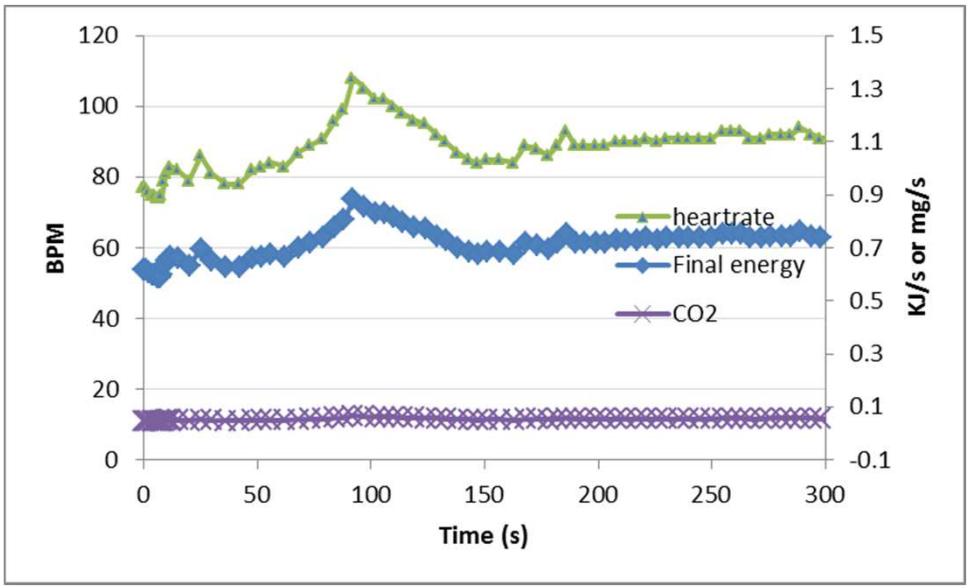




Measurements by ACTIVITY WATCH w/ GPS

STRAVA™



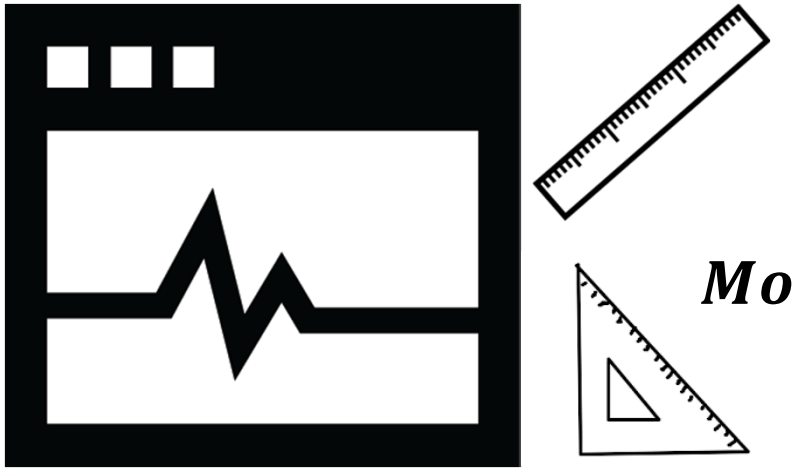


distance 0.8 km
bpm 89 bpm
time 644.64 seconds
Speed 4.5 km/h

Correlation #1 $\frac{Walk-Basal}{Distance}$ **0.14286** MJ/pkm **0.010** g/pkm

Correlation #2 $\frac{Combined}{Distance}$ **0.170023** **0.012**

Measurements of sustainable Mobility



$$\boldsymbol{Mobility} = \text{Passengers x km}$$

$$\boldsymbol{Motorization\ index} = \frac{N^{er} vehicles}{1000\ inhabitants}$$

Potential of transferring car trips to public transport and soft modes
= $\%\ of\ trips\ by\ public\ transport\ and\ soft\ modes$

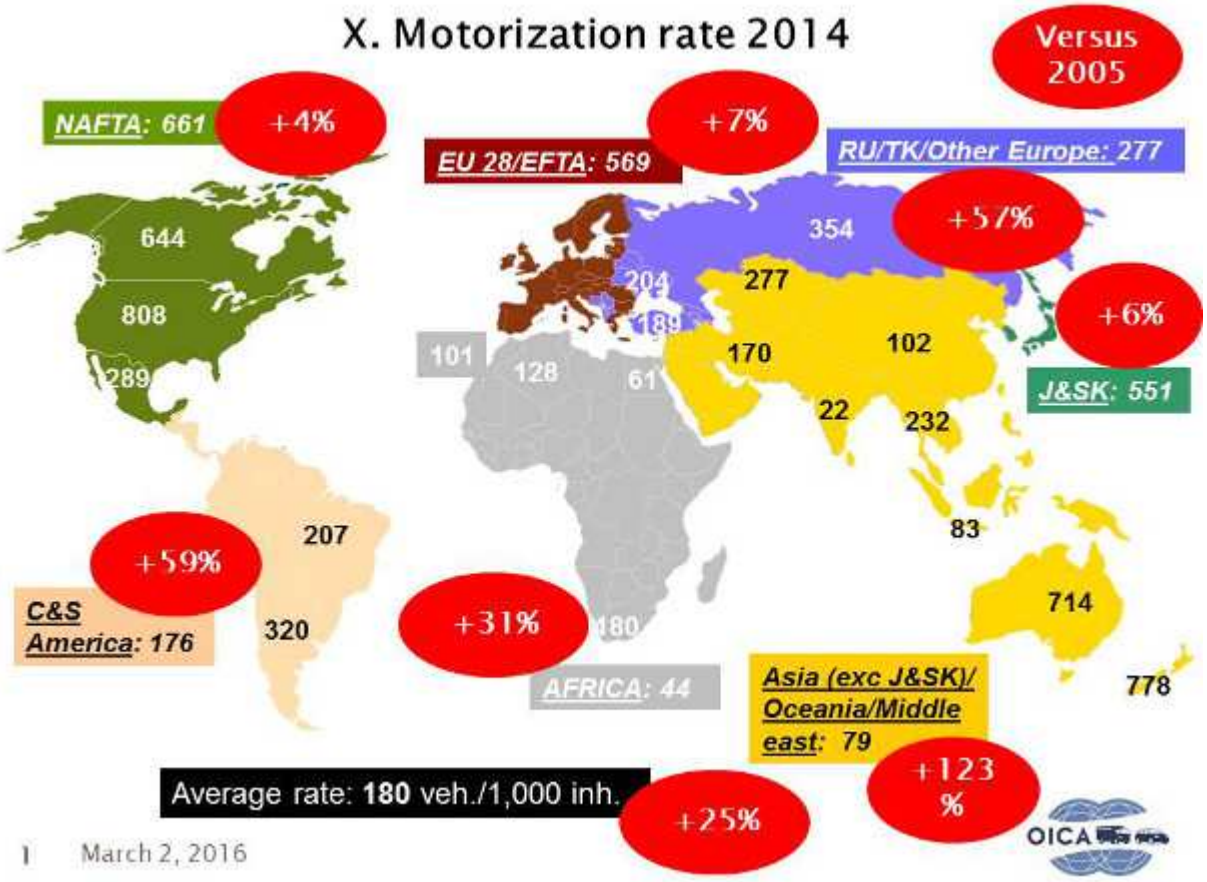
$$\boldsymbol{Final\ energy\ Efficiency} = MJ/pkm$$

$$\boldsymbol{Local\ impact}\ HC, CO, NOx, PM2.5, PM10\ \boldsymbol{emissions} = g/pkm$$

$$\boldsymbol{Global\ impact}\ CO_{2eq}\ \boldsymbol{emissions} = g/pkm$$

Motorization

Motorization index



Motorization

Motorization index evolution….

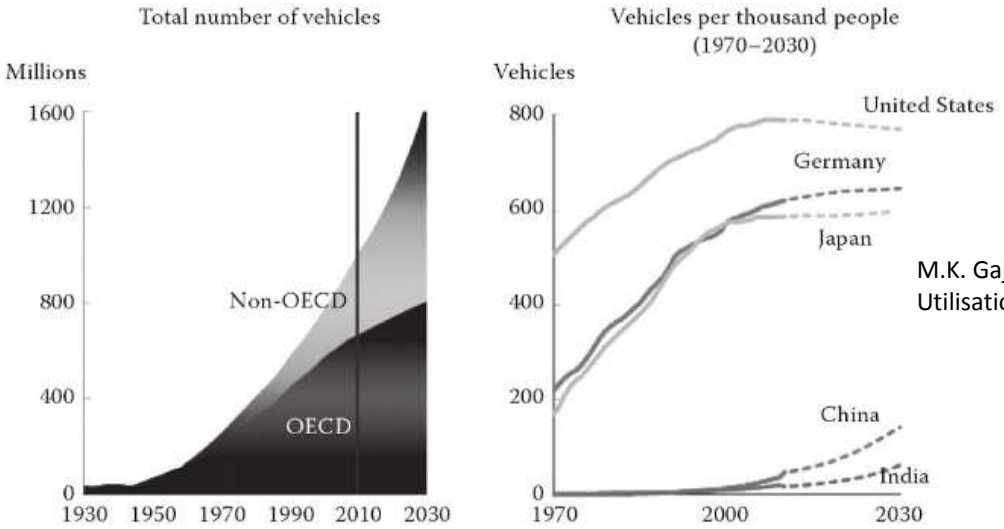


FIGURE 1.13
Growth of global vehicle fleet. (Adapted from BP Energy Outlook 2030, London, January 2012.)

M.K. Gajendra Babu,K.A. Subramanian Alternative Transportation Fuels: Utilisation in Combustion Engines. 2013. CRC Press.

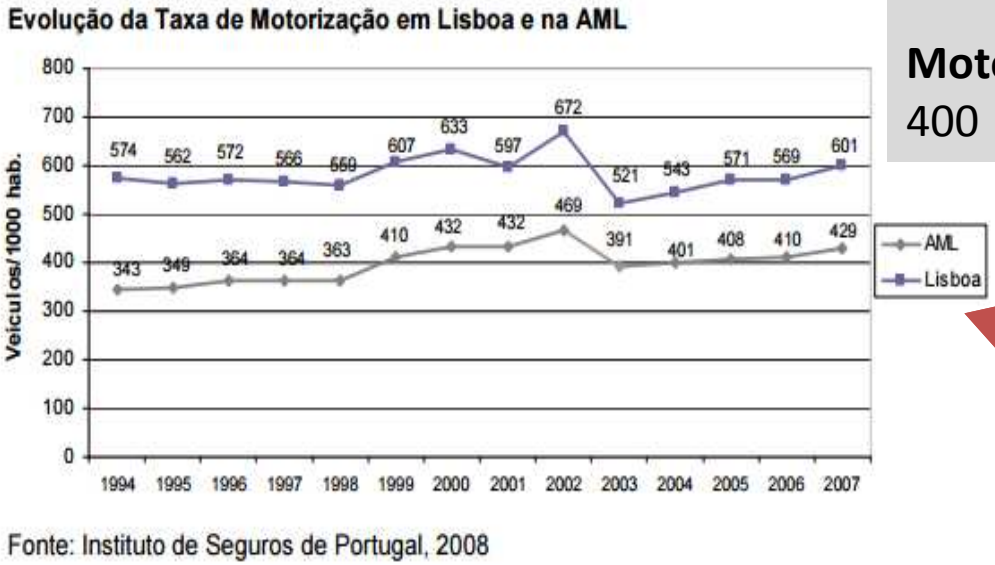
- Increase the need for mobility……private transport

Motorization

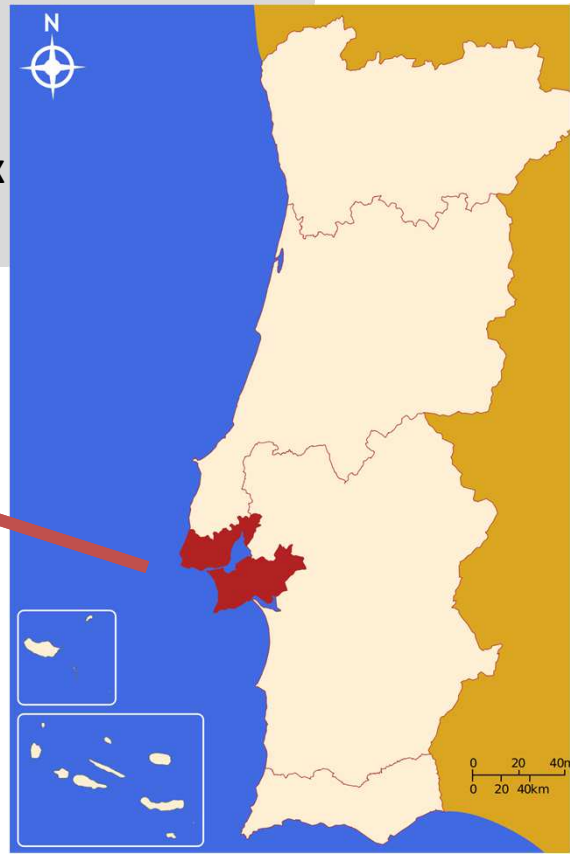
Portugal case study

@2015
~ 10 million
~ 64% urban zones
~ 4 million cars

Motorization index
400



Fonte: Instituto de Seguros de Portugal, 2008

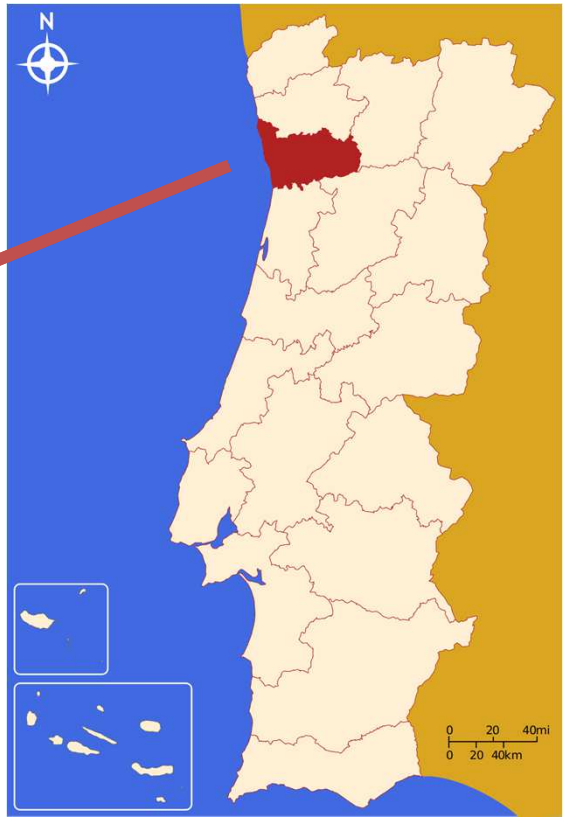


Motorization

Portugal case study

Quadro 3 - Taxa de motorização nos concelhos da AMP (Fonte: INE, 2000)

Concelho	Taxa de Motorização (veíc./1000 hab.)
Espinho	362
Gondomar	348
Maia	388
Matosinhos	365
Porto	346
Póvoa de Varzim	342
Valongo	337
Vila do Conde	354
Vila Nova de Gaia	357



Intermodality

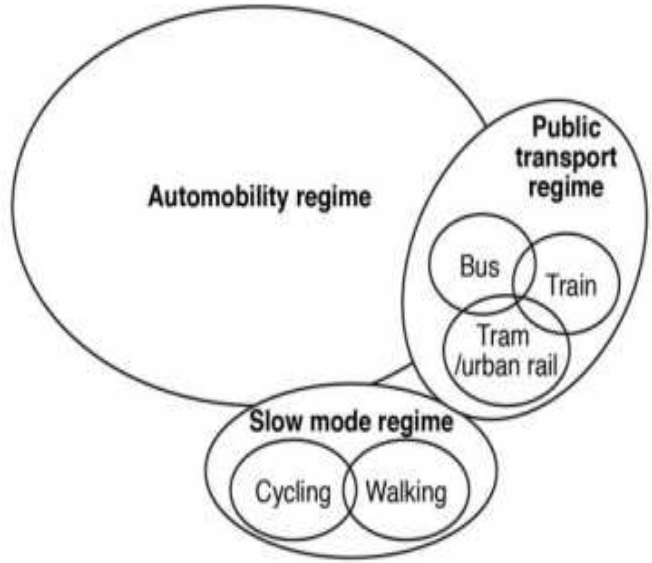
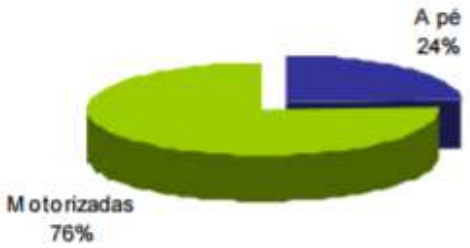


Figure 2: Schematic representation of interlinkages between regimes and sub-regimes in land-based personal mobility

Intermodality

Figura 3 - Viagens diárias dos residentes da AML[6]



Fonte: DGTT, 2000

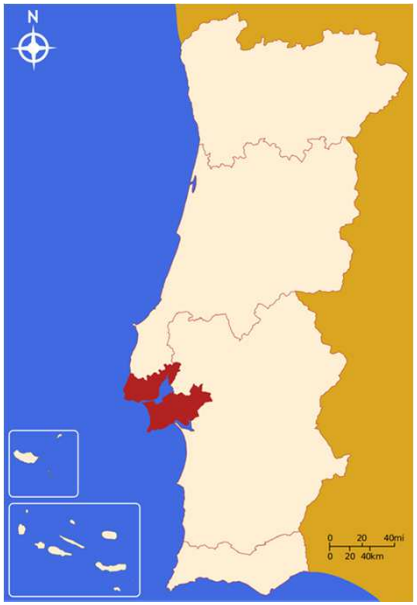
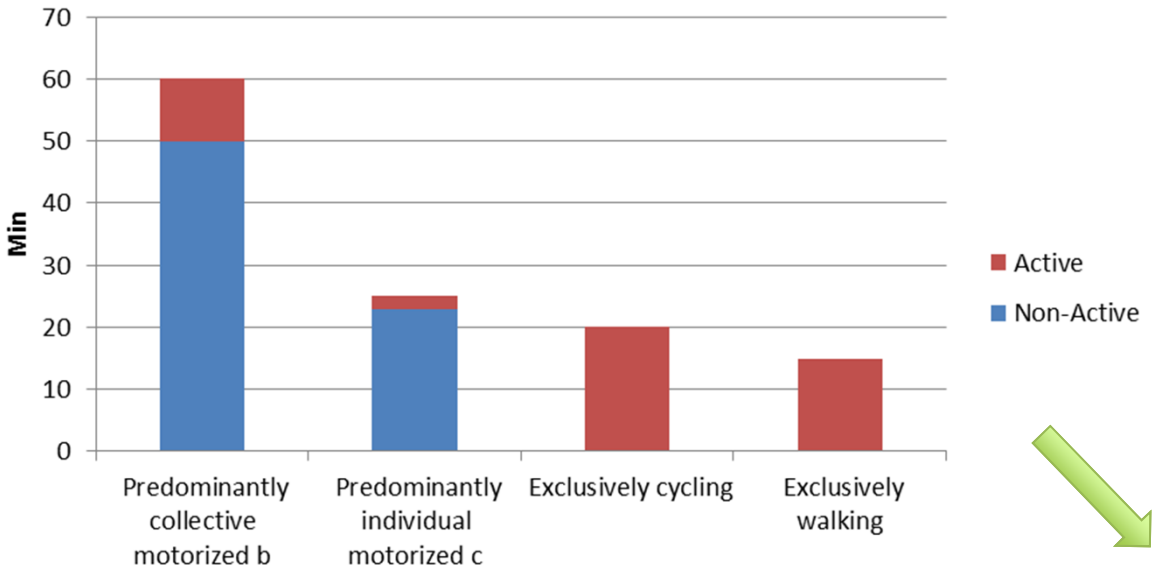


Figura 4 – Modos de transporte utilizados nas viagens diárias motorizadas dos residentes da AML

Intermodality

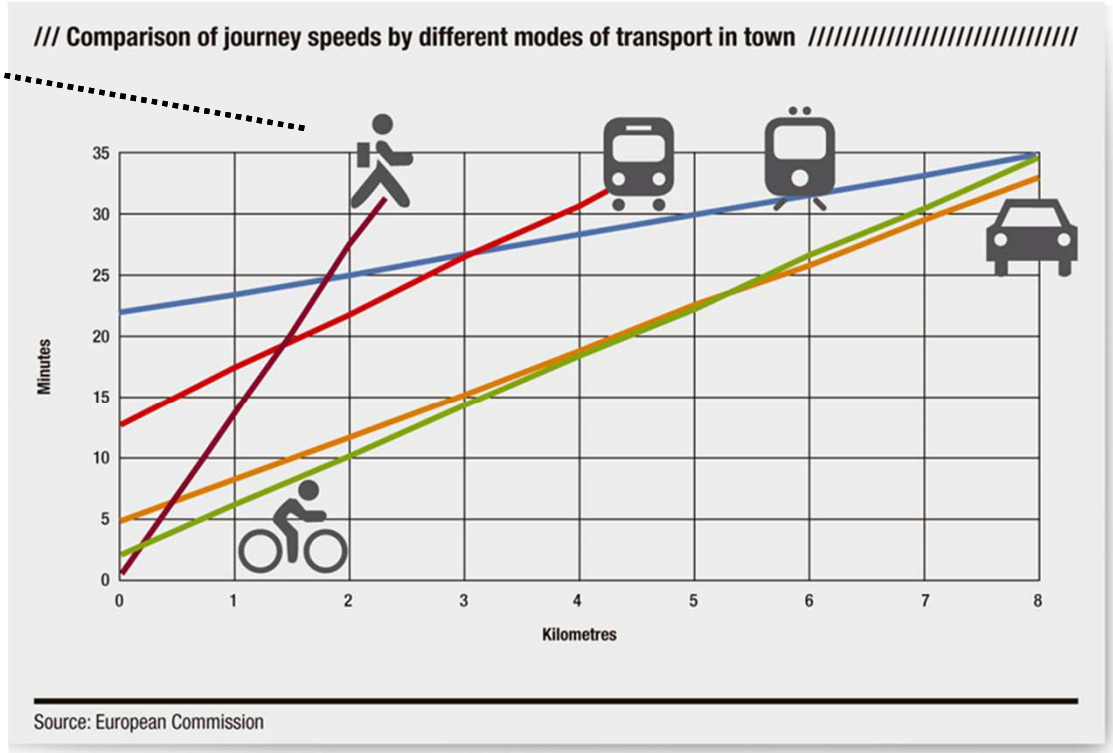


Active = Soft modes= bike + walking

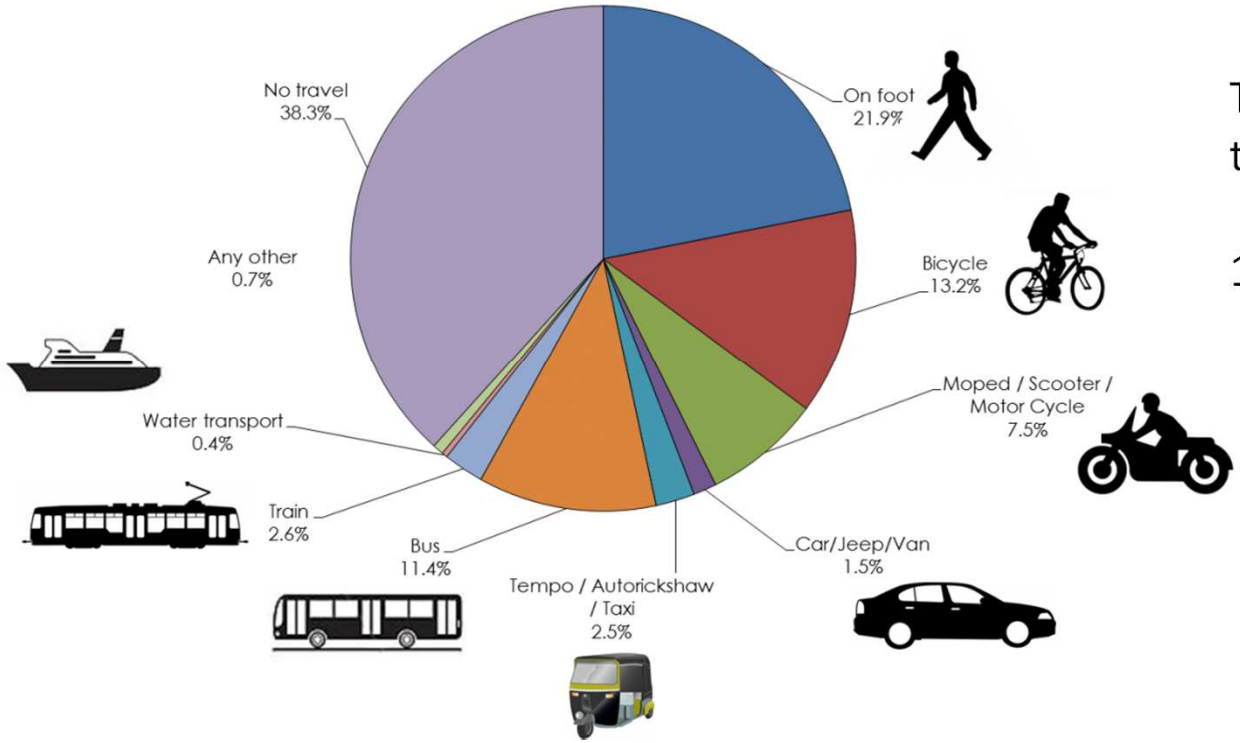
@ Impact of travel mode shift and trip distance on active and non-active transportation in the São Paulo Metropolitan Area in Brazil, Preventive Medicine Reports Volume 2, 2015, Pages 183–188

Total travel times

~ 4.5 km/h



Knowing how people move???

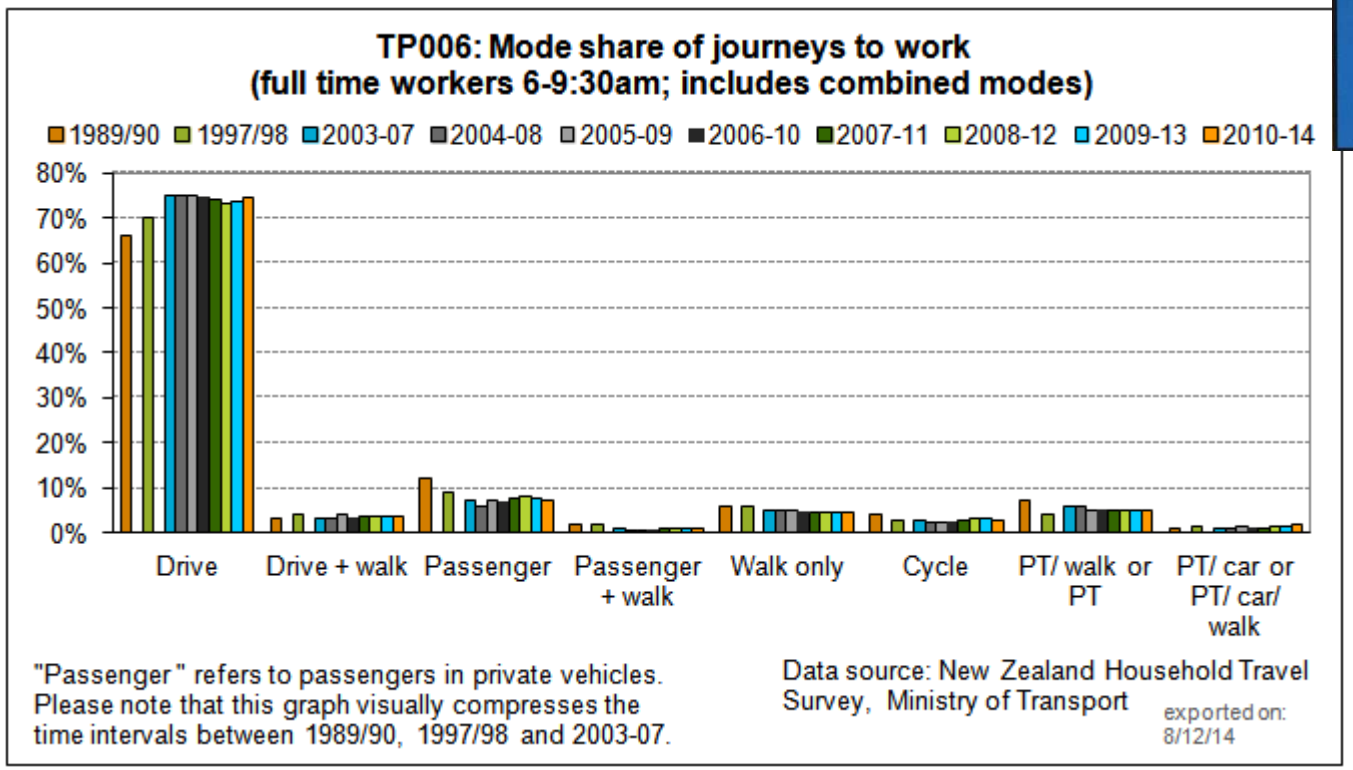


Travel to work by modes of transport, 2011.

100% = 200.4 million.

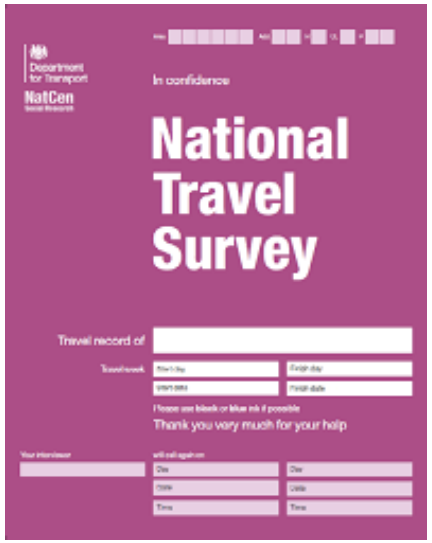
Surveys….

Knowing how people move???



Surveys….

How people travel?



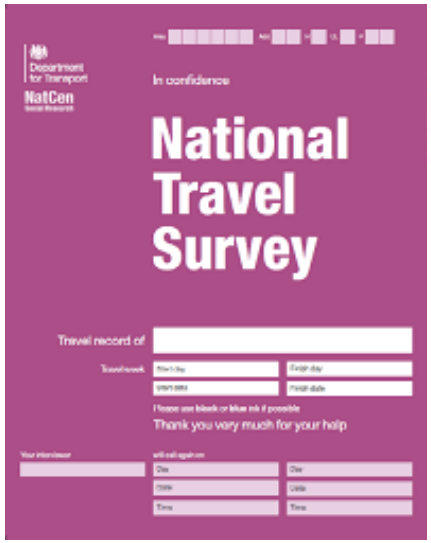
Why people travel?

How people travel?

When people travel?

Surveys

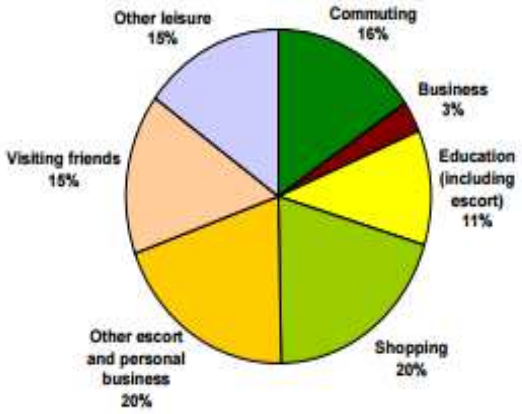
How people travel?



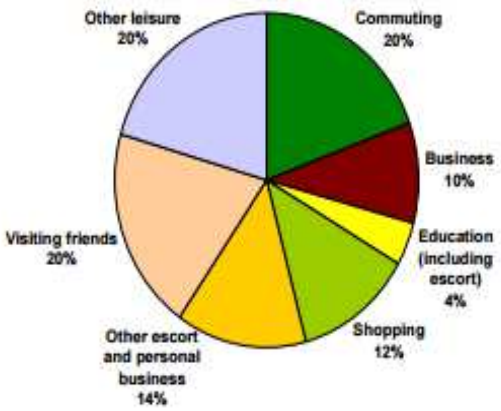
Why people travel?

Purpose share: Great Britain, 2010
(NTS web tables NTS0401 and NTS0402)

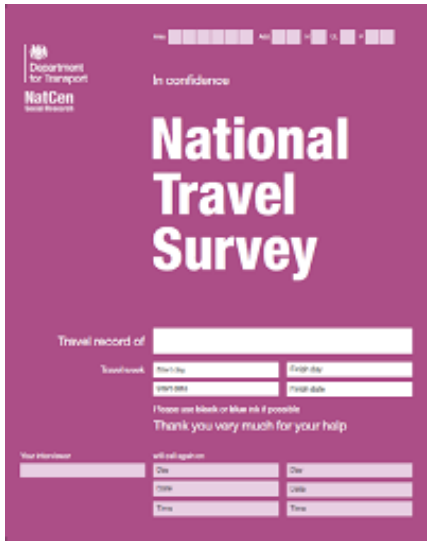
Average number of trips



Average distance travelled



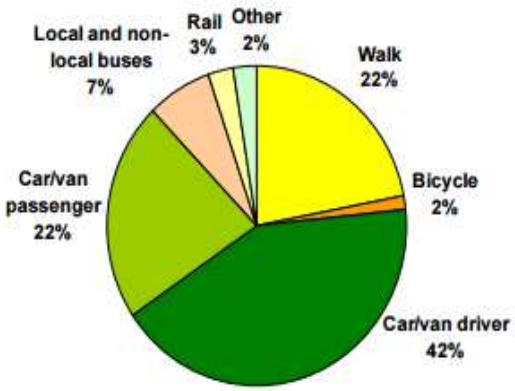
How people travel?



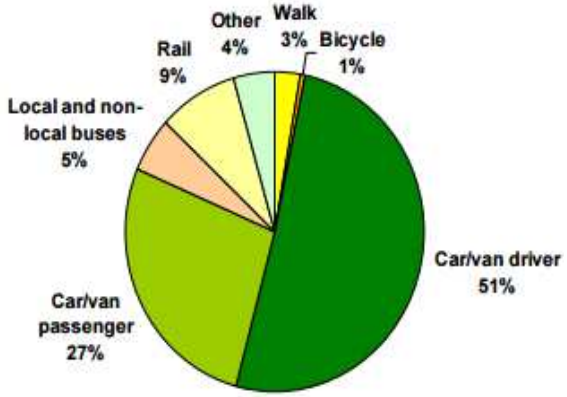
How people travel?

Mode share: Great Britain, 2010
(NTS web tables NTS0301 and NTS0302)

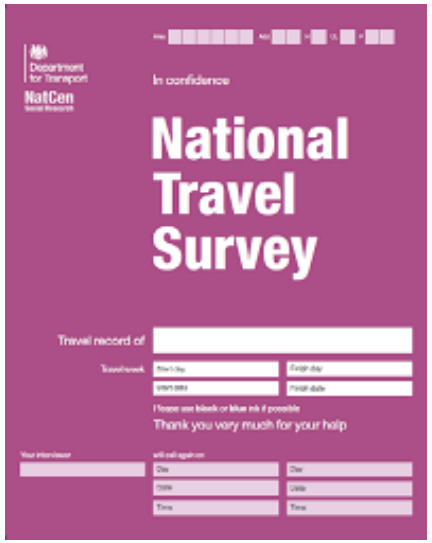
Average number of trips



Average distance travelled

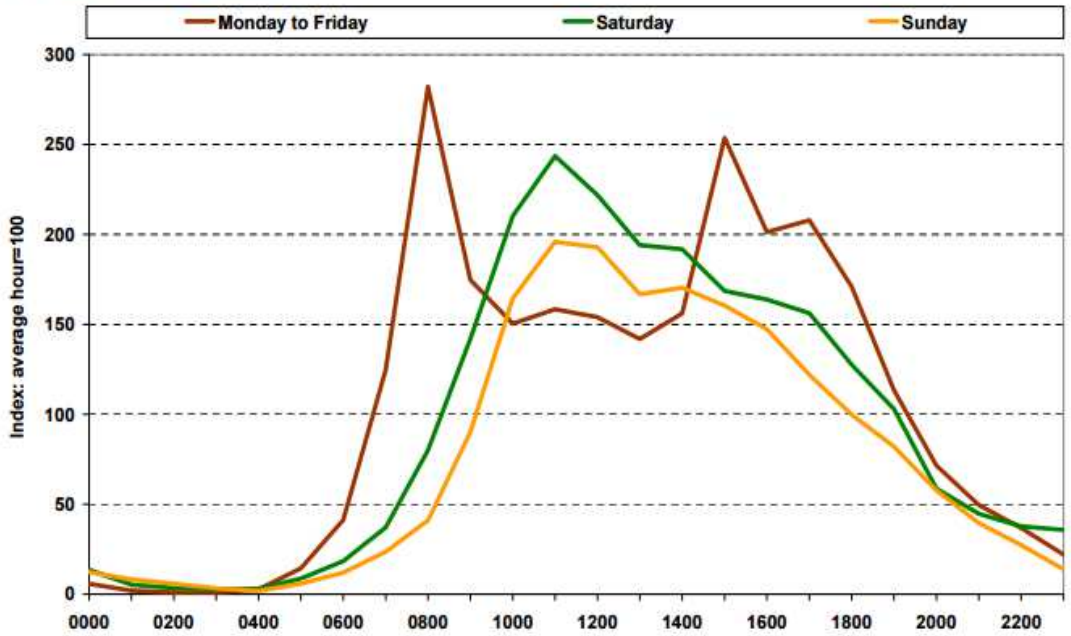


How people travel?

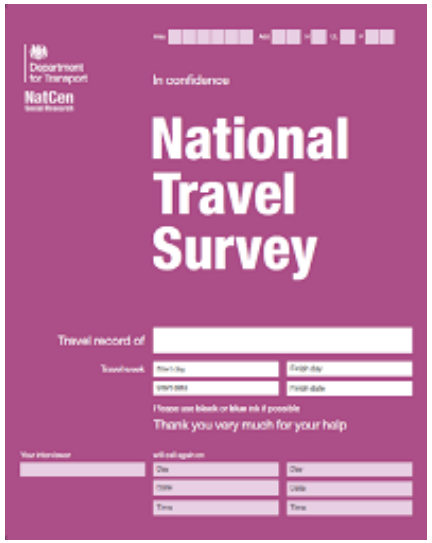


When people travel?

Trips in progress by time of day and day of week - index: Great Britain, 2010
(NTS web table NTS0501)



How people travel?



Why people travel?

How people travel?

When people travel?

Surveys

Surveys

1st design
2nd test in a few people
3rd did you get the info you needed?

No

Yes!
Ready to go…

On-line

Google Forms

surveygizmo

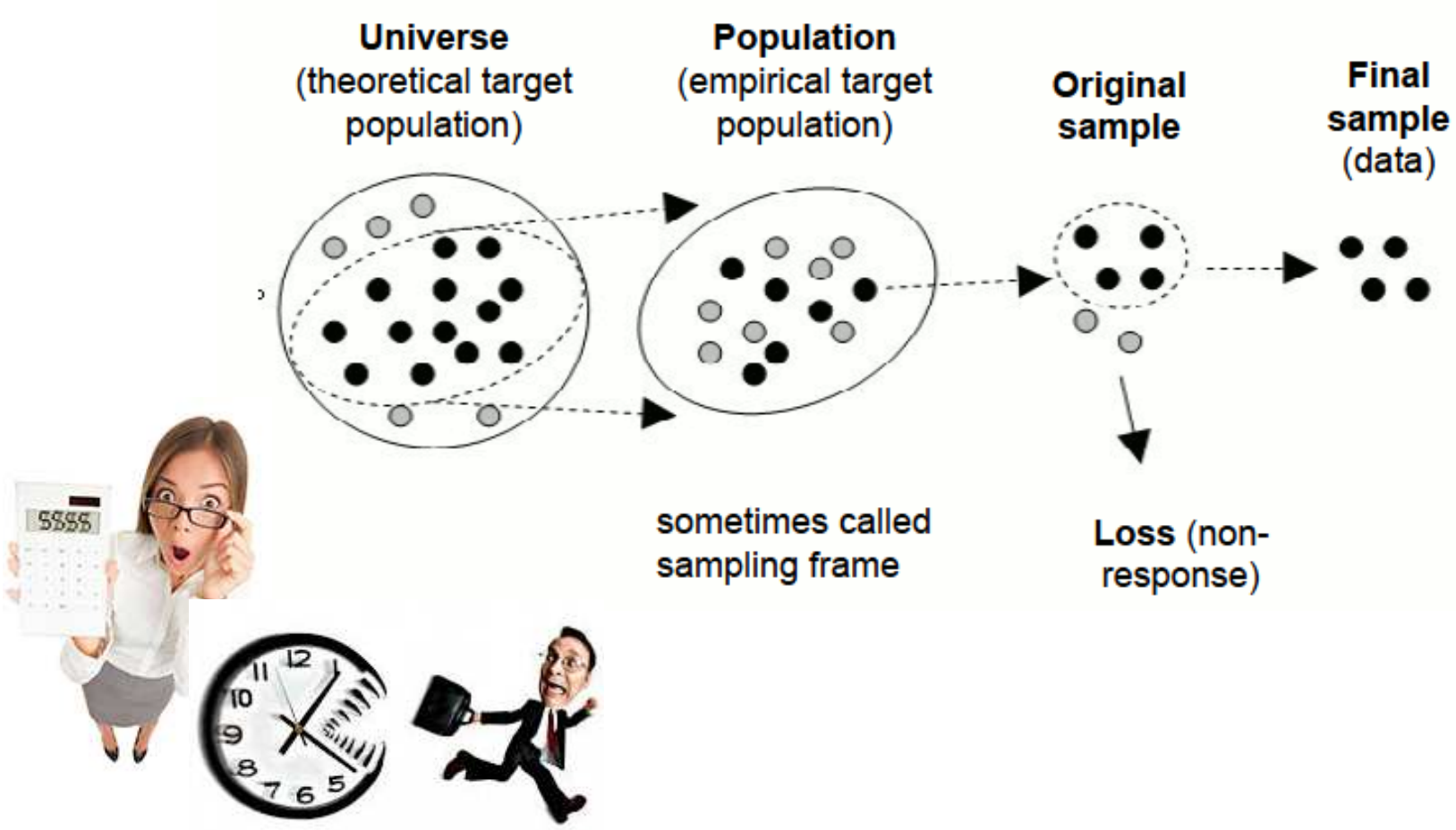
SurveyMonkey

QuestionPro

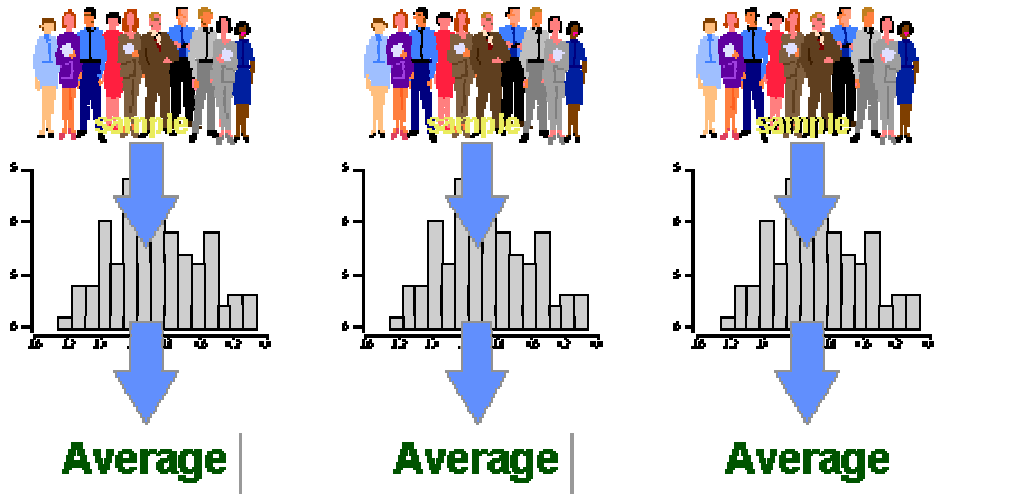
In person

Surveys

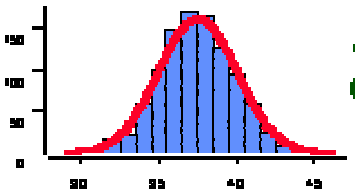
How people travel?



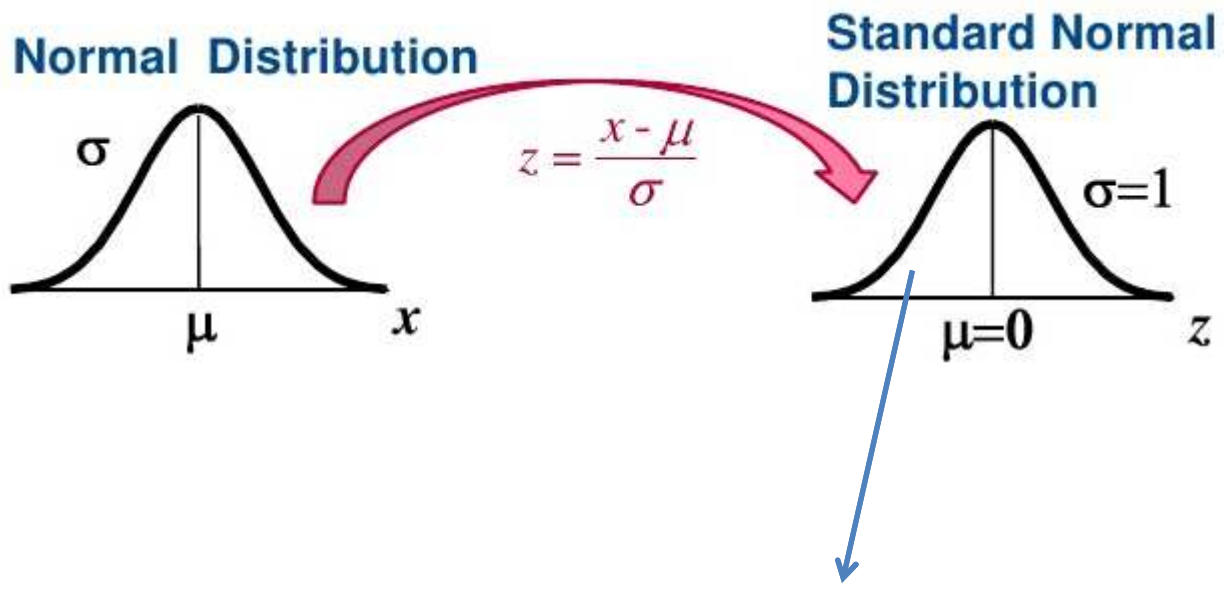
How people travel?



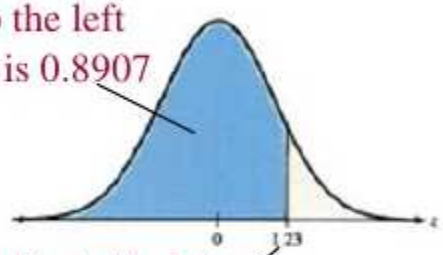
The Sampling Distribution...



...is the distribution of a statistic across an infinite number of samples



2. The area to the left of $z = 1.23$ is 0.8907



1. Use the table to find the area for the z-score

Surveys

How people travel? Origin –Destination

How many respondents?

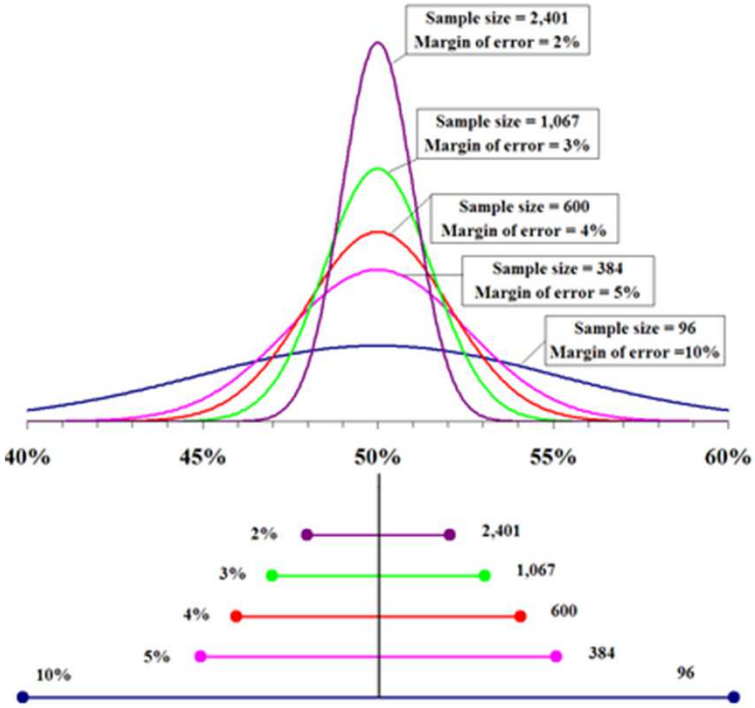
$$Sample\ Size = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1+(\frac{z^2 \times p(1-p)}{e^2 N})}$$

N= total population (small size)
Z = confidence level (90%, 99%, 95%)
e = margin of error (e.g. 5% input 0.05)
p= 50% (estimative of answer, 0.5)

N > 100.000 individuals $\Rightarrow$ Sample size $\frac{z^2 \times p(1-p)}{e^2}$

Surveys

How many respondents?



margin of error (or confidence intervals)

Suppose in your survey 40% of the respondents pick a certain answer and your margin of error is 2%. This would mean that if you interrogate the total population, you can be sure that between 38% and 42% would pick the same answer

Surveys

How many respondents?

Confidence level 90% -> Z=1.645

Confidence level 95% -> Z=1.96

Confidence level 99% -> Z=2.575

Confidence level

How often the actual percentage of the population that picks a certain answer, lies within the margin of error. In market research, margins of error are calculated generally for a confidence level of **95%**.

Surveys

How people travel? Origin –Destination

How many respondents?

Respondents Needed at Error of ±3%, ±5%, & ±10%			
Population	**±3%**	**±5%**	**±10%**
500	345	220	80
1,000	525	285	90
3,000	810	350	100
5,000	910	370	100
10,000	1,000	385	100
100,000	1,100	400	100
1,000,000	1,100	400	100
10,000,000	1,110	400	100

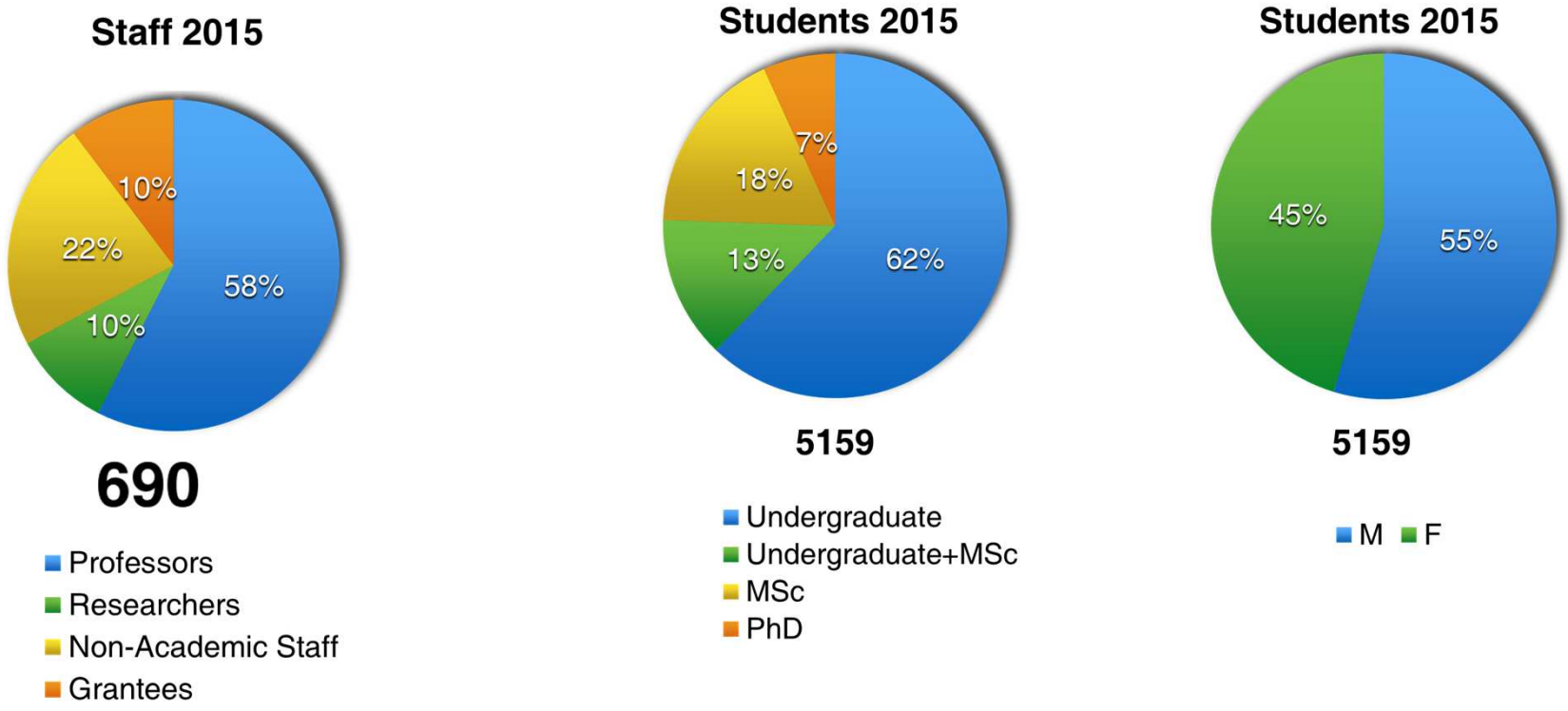
N > 100 000

$$\frac{z^2 \times p(1-p)}{e^2}$$

Exercice

Your survey results are meanfull for FCUL population?

FCUL population 5849



Exercice

Your survey results are meanfull for FCUL population, respondents 23?

FCUL population N=5849 < 100 000 $\Rightarrow$

$$Sample\ Size = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1+(\frac{z^2 \times p(1-p)}{e^2 N})}$$

Several questions for example: **Willing to use an Autonomous Vehicle?**

1. Margin or error, i.e, expect the population answer will be in 2% of the sample's **e=0.02**
2. We think the answer would be 50% chance of yes or no **p=0.5**
3. Level of confidence, i.e., 95% chance of population answers fall within the margin of error **Z=1.96**

Exercice

$$Sample\ Size = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1+(\frac{z^2 \times p(1-p)}{e^2 N})}$$

Z	1.96
p	0.5
e	0.02
N	5849
Sample size	1702.236

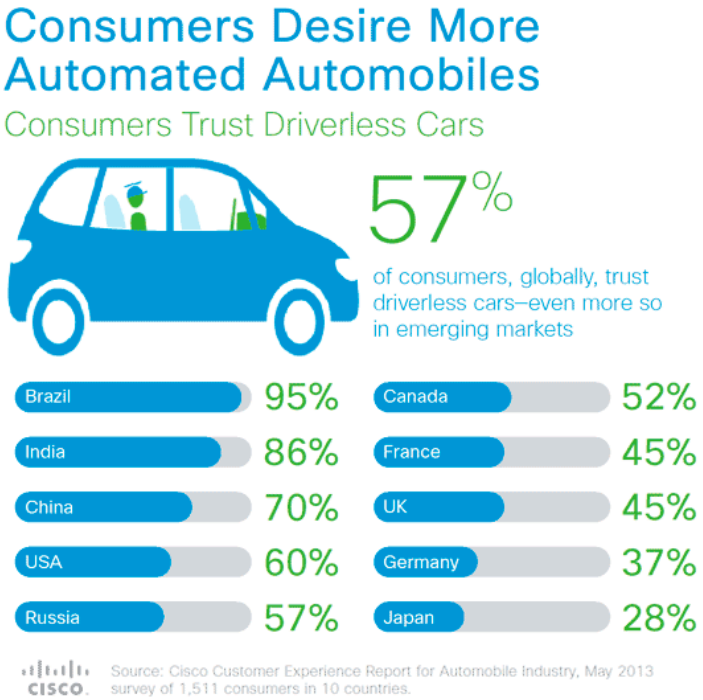
Z	1.96
p	0.5
e	0.1
N	5849
Sample size	94.48

Z	1.645
p	0.5
e	0.1
N	5849
Sample size	66.87711

Not even at 10% margin error and 90% confidence!!

Surveys

the following survey results are meaningful?



1511 persons

10 countries (overall population > 2 000 million)

Surveys

N >> 100 000

$$\frac{z^2 \times p(1-p)}{e^2}$$

Z	1.96
p	0.5
e	0.02
N	2000000000
Sample size	2400.99712

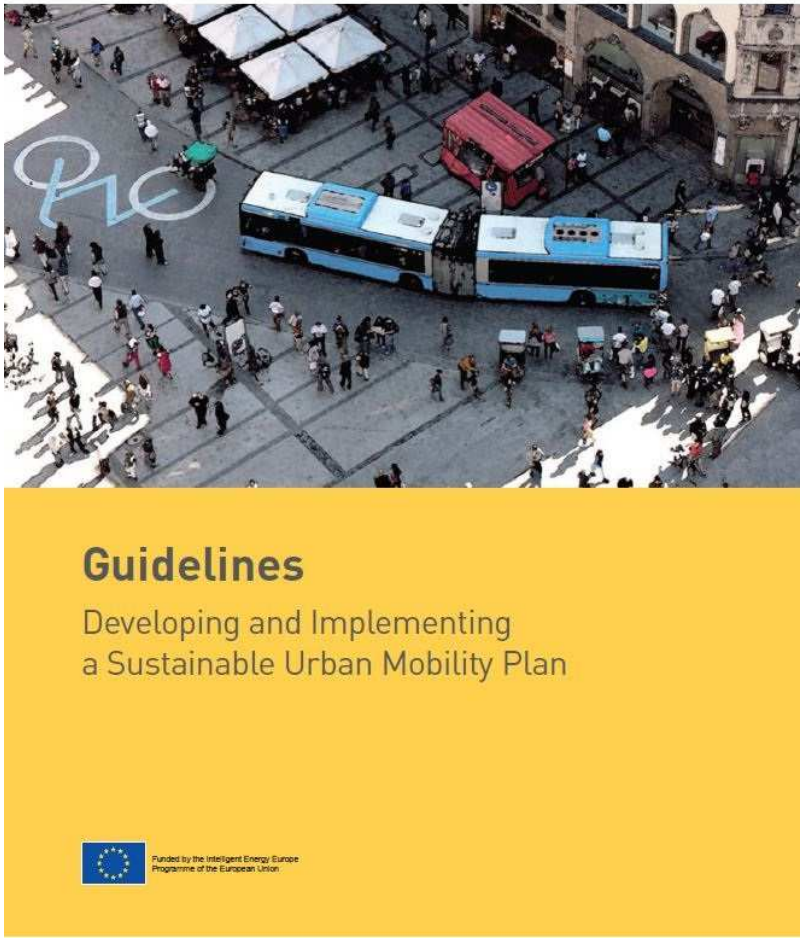
N	Sample size
100000	2344.70367
500000	2389.5255
1000000	2395.24901
1000000000	2400.99424
2000000000	2400.99712

Margin of error increase

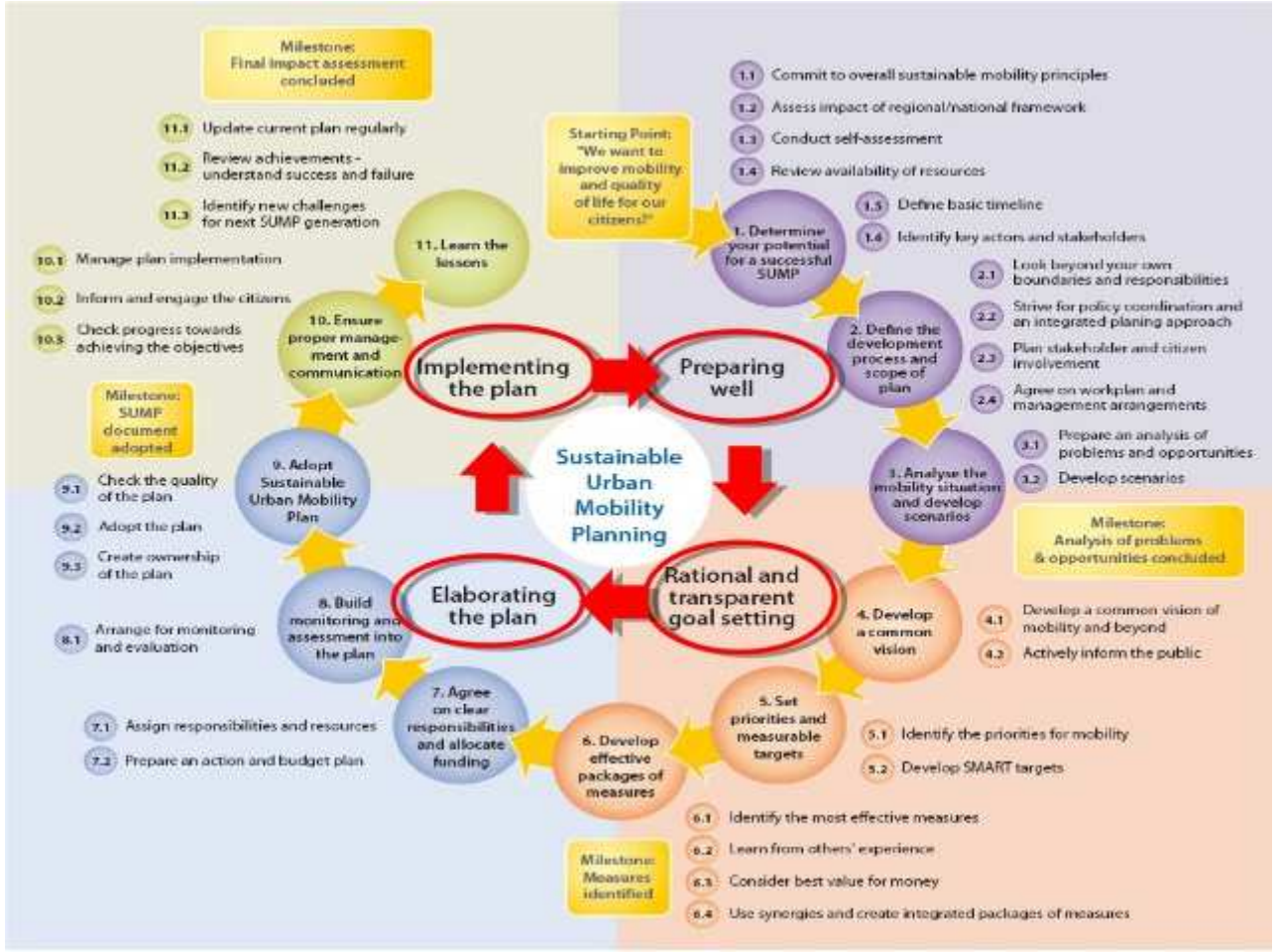
Z	1.96
p	0.5
e	0.03
N	2000000000
Sample size	1067.11054

SUMP - Sustainable urban mobility plans

European Platform on Sustainable Urban Mobility Plans



SUMP - Sustainable mobility plans



Characterization of current status
SURVEYS

Vision for the future
Scenario building

Surveys

CENSOS 2011

XV recenseamento geral da população
V recenseamento geral da habitação

RESULTADOS DEFINITIVOS

LISBOA

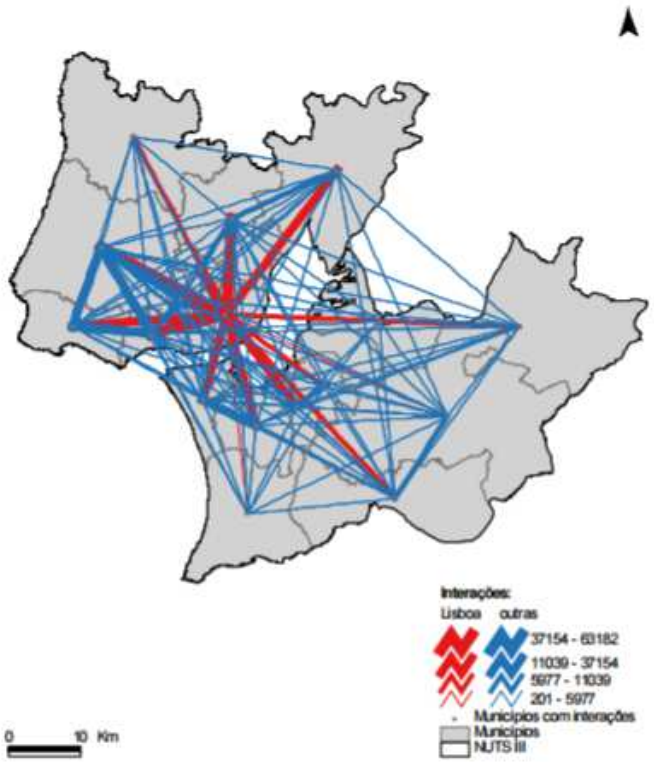
MOVIMENTOS PENDULARES .....

MEIO DE TRANSPORTE UTILIZADO NOS MOVIMENTOS PENDULARES .....

TEMPO MÉDIO POR DESLOCAÇÃO PENDULAR .....

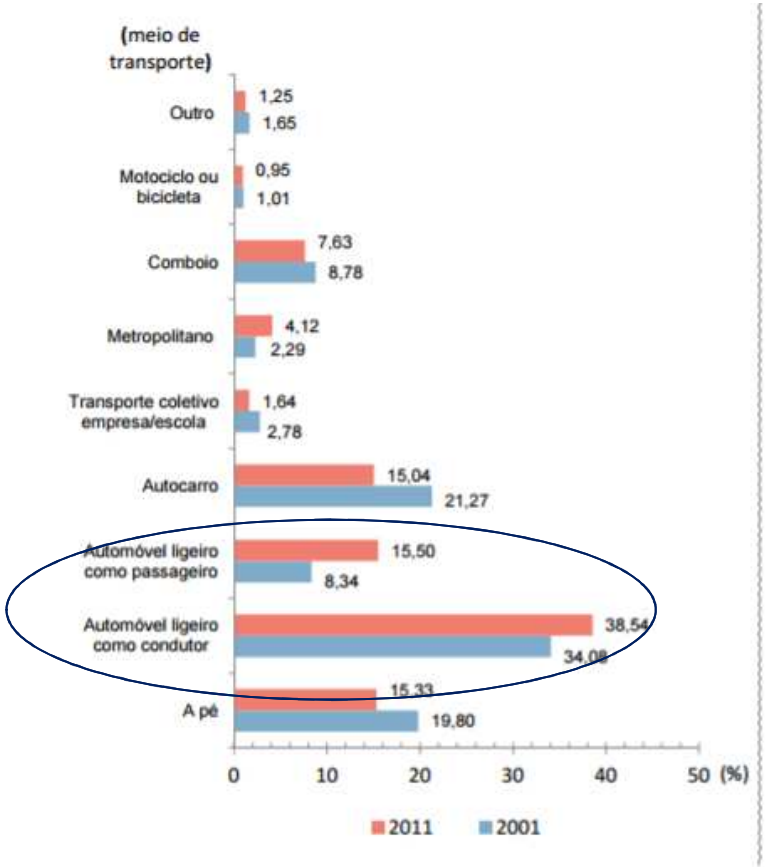
Surveys

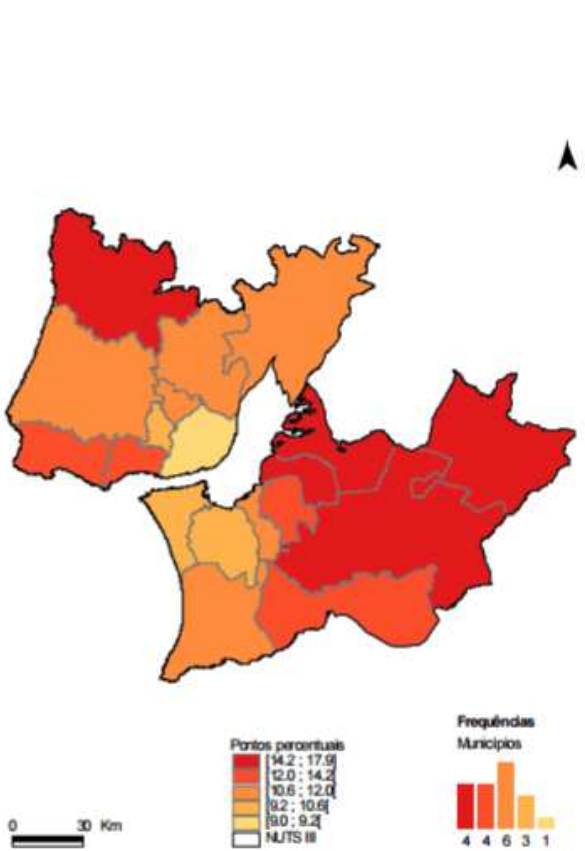
Commuting(regional interactions), 2011



Surveys

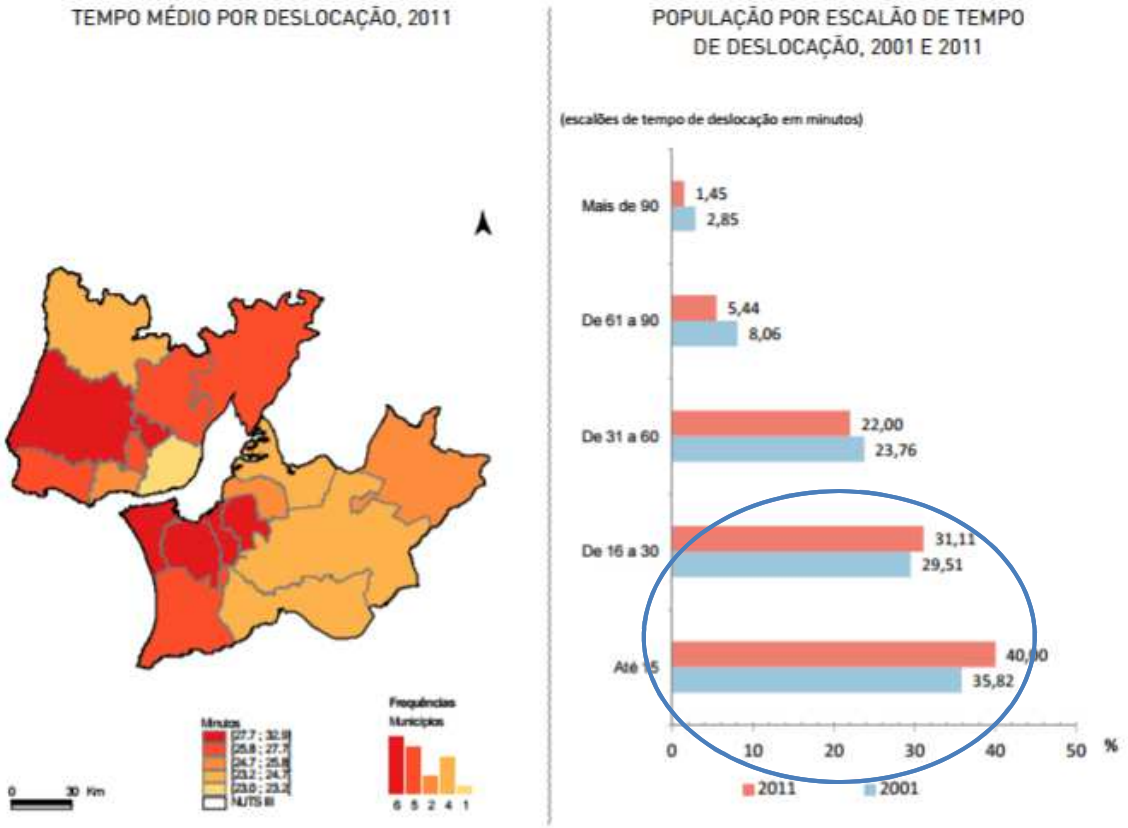
Means of transport in commuting





Surveys

Average time in commuting (average 30 min 2001; 26 min 2011)



Surveys

Recent mobility survey 2017 Porto and Lisbon

European Commission

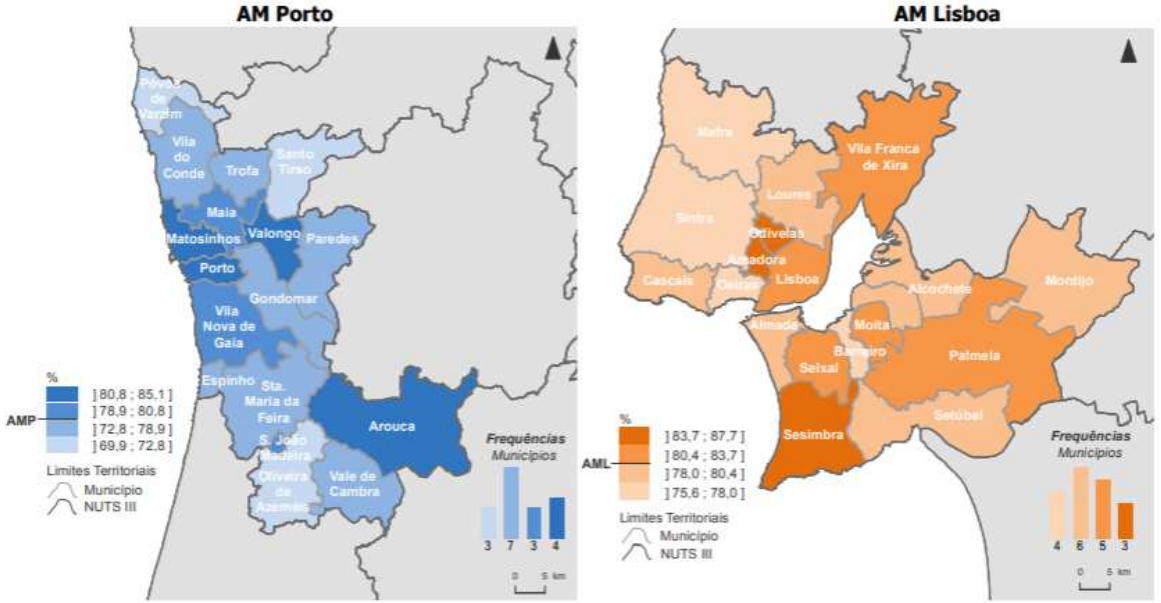
eurostat

INSTITUTO NACIONAL DE ESTATÍSTICA

STATISTICS PORTUGAL

1,60 milhões de pessoas

2,57 milhões de pessoas



Surveys

Recent mobility survey 2017 Porto and Lisbon

46 080 valid answers, 18169 na AMP e 27911 na AML, contemplando um total de 99144 indivíduos (40393 na AMP e 58751 na AML).

Campain: October-December 2017

1st **Web (Computer Assisted Web Interview-CAWI**)

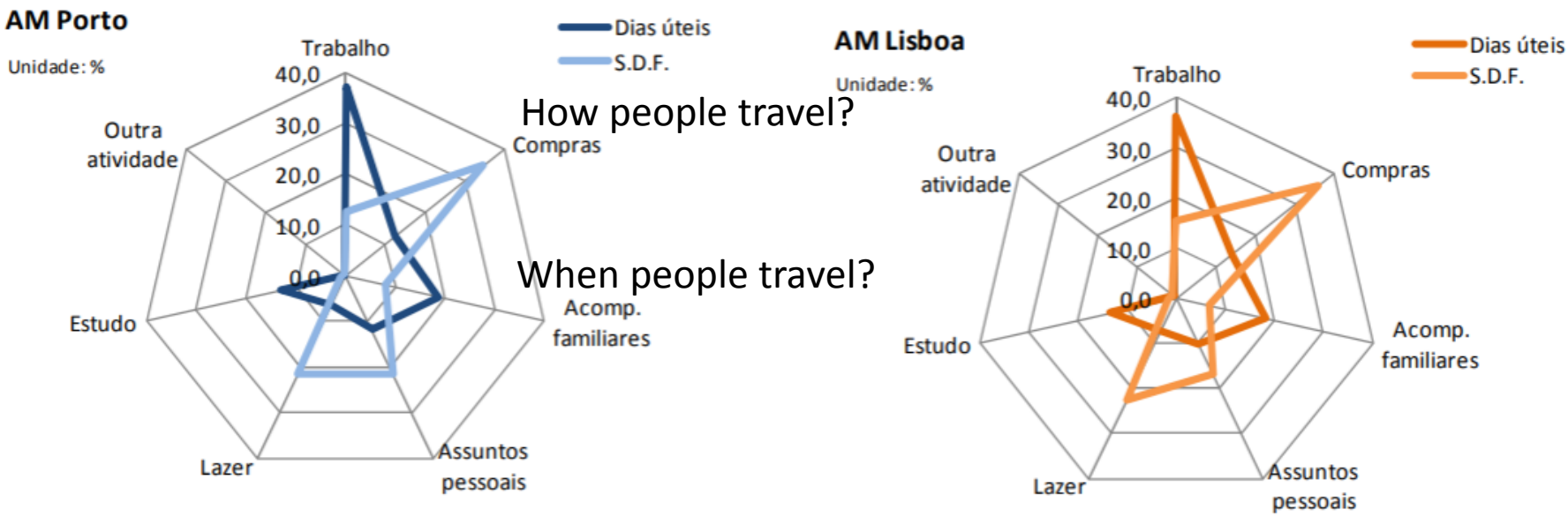
2nd Face to face interviews(**Computer Assisted Personal Interview-CAPI**) for the non respondants 1st stage.

Surveys

Recent mobility survey 2017 Porto and Lisbon

Why people travel?

Figura 16 – Distribuição do número de deslocações por motivo de deslocação (excluindo "regresso a casa")



How people travel?

When people travel?

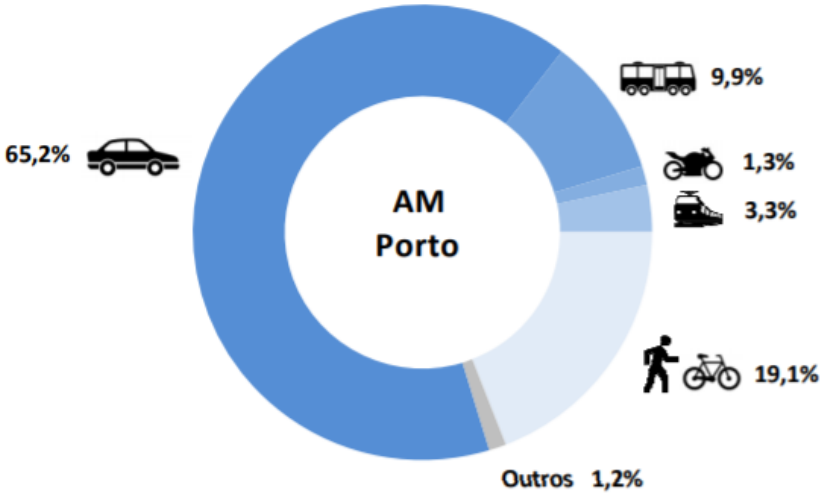
Surveys

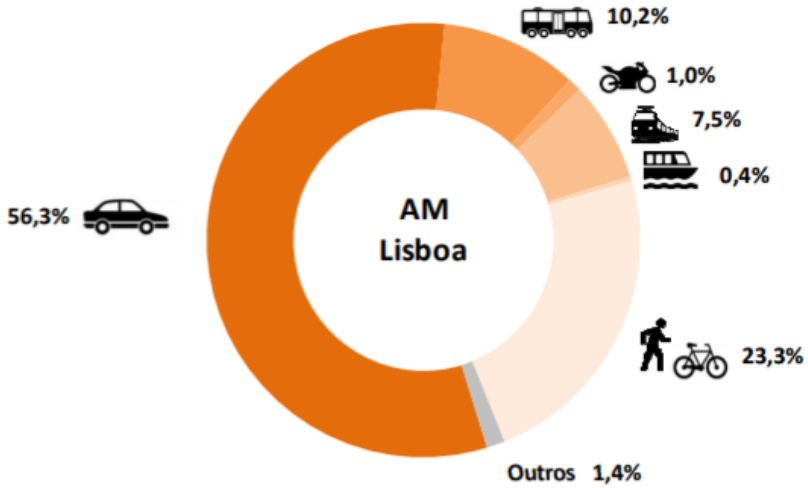
Recent mobility survey 2017 Porto and Lisbon

How people travel?

Figura 18 – Distribuição do número de deslocações por principal meio de transporte, nos dias úteis

(globalidade dos meios de transporte)





Surveys

Recent mobility survey 2017 Porto and Lisbon

How fast people travel?

Average 30 km/h

Why car?

- Speed;
- Confort;
- No public transport direct connection between origin and destination.

Recent mobility survey 2017 Porto and Lisbon

Impact of people travel?

Quadro 6

Voltar ao Índice

Deslocações por tipo de dia e meio de transporte principal da deslocação

AM Lisboa

Unidade:10^3

	Deslocações		
	Total semanal	**Dias úteis**	**SDF a)**
AM Lisboa	**37,697.1**	**27,439.7**	**10,257.4**
Transporte individual	**22,542.4**	**15,715.5**	**6,826.9**
Automóvel - condutor	17,326.3	12,334.4	4,992.0
Automóvel - passageiro	4,884.7	3,110.2	1,774.5
Motociclo/ciclomotor	331.3	270.9	60.4
Transporte público ou coletivo	**5,939.5**	**5,056.6**	**882.9**
Dos quais:			
Autocarro	2,945.9	2,476.0	469.9
Comboio	1,215.7	1,032.0	183.7
Metropolitano	1,167.8	1,014.6	153.2
Modos suaves (a pé e bicicleta)	**8,857.7**	**6,404.3**	**2,453.4**
Outro/desconhecido	**357.4**	**263.4**	**94.1**

a) SDF - Sábados, domingos e Feriados

Number trips Per mode

Recent mobility survey 2017 Porto and Lisbon

Impact of people travel?

Quadro 9

Tempo e distância por deslocação, segundo o principal meio de transporte das deslocações

AM Lisboa

km per trip

	Duração média (minutos)	Distância média (km)
AM Lisboa	**24.3**	**10.3**
Automóvel - condutor	21.7	12.7
Automóvel - passageiro	20.8	13.3
Motociclo/ciclomotor	18.0	11.7
Autocarro (transporte público)	45.7	12.1
Comboio	53.4	19.1
Metropolitano	39.7	8.5
Barco	58.1	19.5
Táxi	19.6	6.4
Transporte escolar / empresa	32.6	17.2
A pé	17.0	1.5
Bicicleta	36.2	8.8
Outro/desconhecido	31.7	24.2

Nota: Exclui as deslocações internacionais

Surveys

Recent mobility survey 2017 Porto and Lisbon

Impact of people travel?

$$\Sigma_i(\text{Number trip}_i \text{ X km per trip}_i \text{ X } EC_i)$$

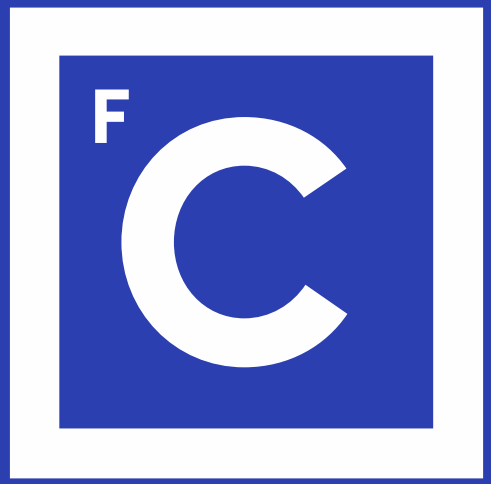
$_i$ mode of transport

EC_i final energy consumption by mode (MJ/pkm)

You learned….

- First steps in a sustainable mobility plan;
- Mobility measures;
- How to design a survey to get the right answers;
- Minimum number of answers for the sake of statistical meaning;
- Final energy consumption estimation from surveys.

Obrigado



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