Rebound effects of Smart transportation modes on mobility behaviors of citizens and car dependency

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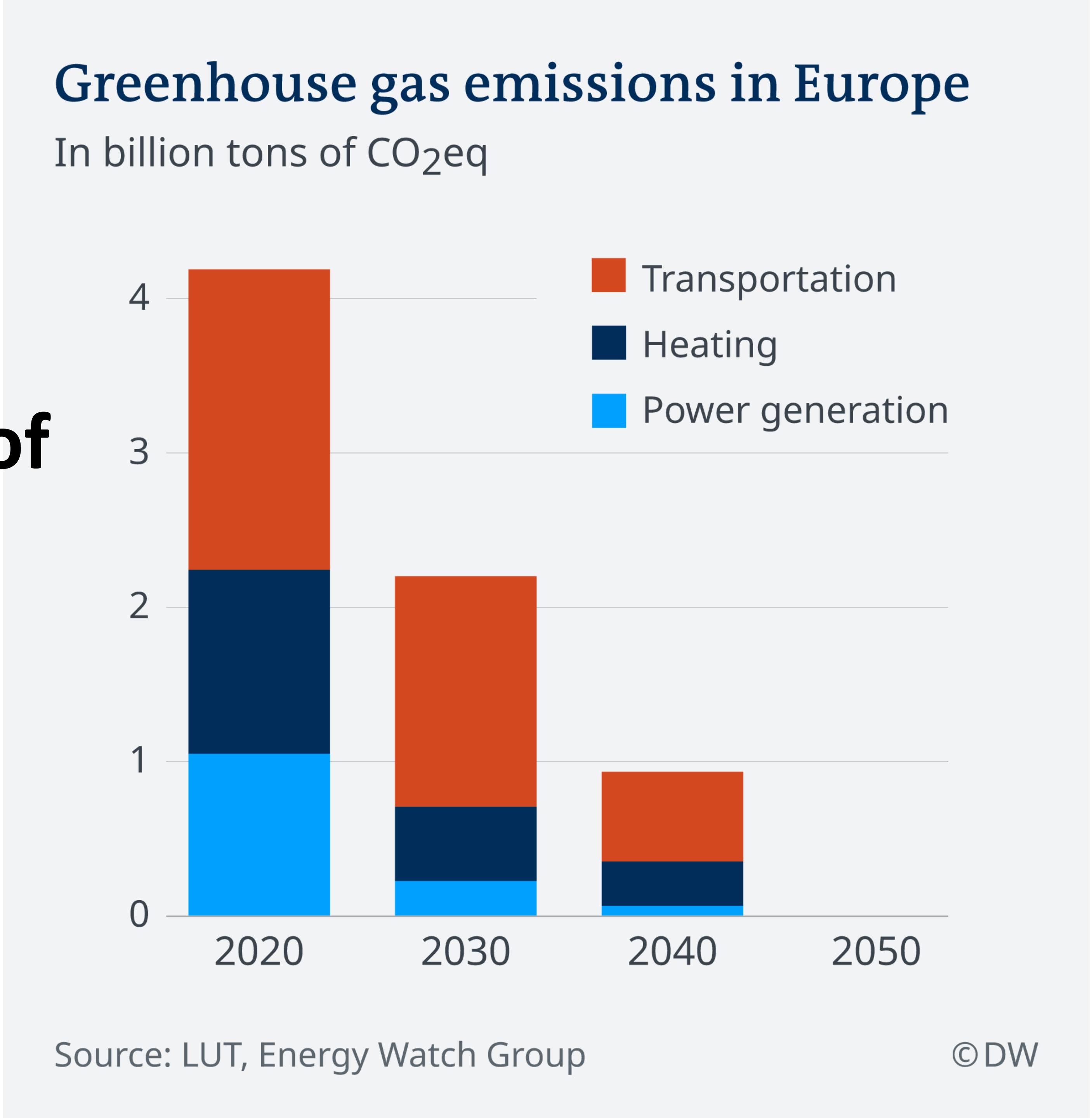
Zero carbon emissions target for 2050

Maybe a mistake to estimation of the share of transport sector ?

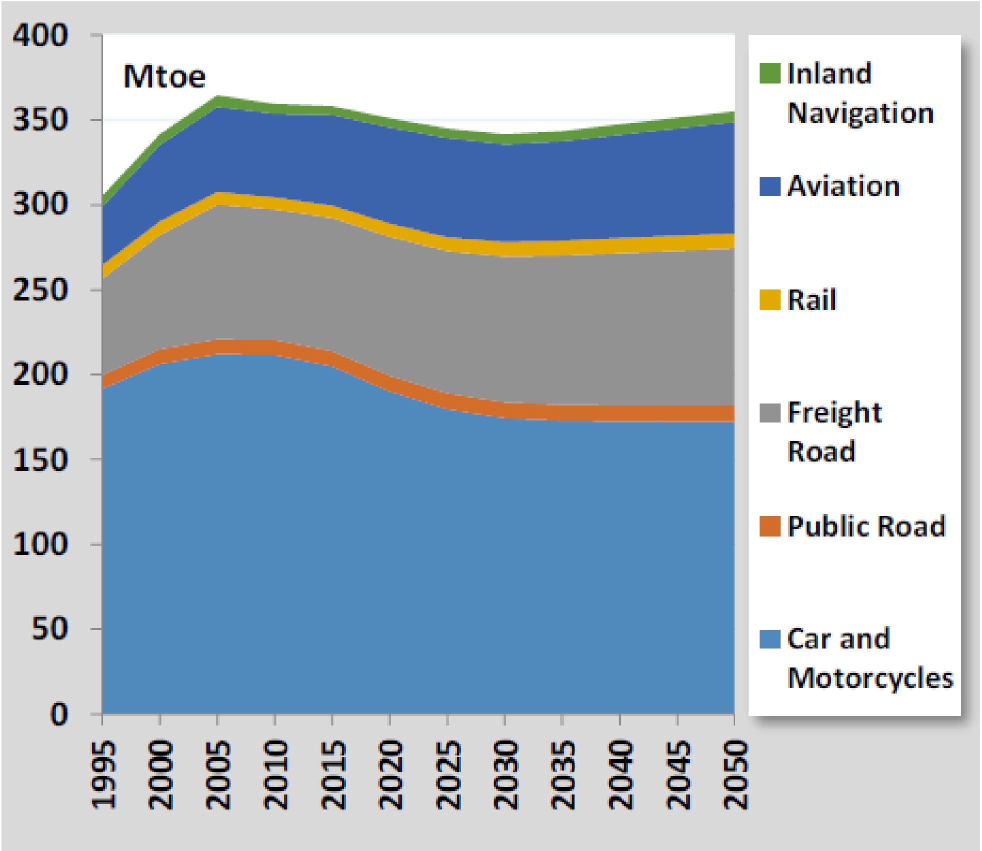
Car Use instead of Car ownership



Energy demand estimation for Car travel 2050

EU Reference Scenario 2016 -Energy, transport and GHG emissions Trends to 2050

- This share is projected to significantly decrease over the medium term and almost stabilize towards 2050 (51% and 49% in 2030 and 2050, respectively).
- The **energy efficiency improvements** for vehicles, driven by the CO2 standards set for 2020/2021, contribute to the reduction of total final energy demand for transport until 2030, but it is not enough to maintain this trend until the end of the projection period.

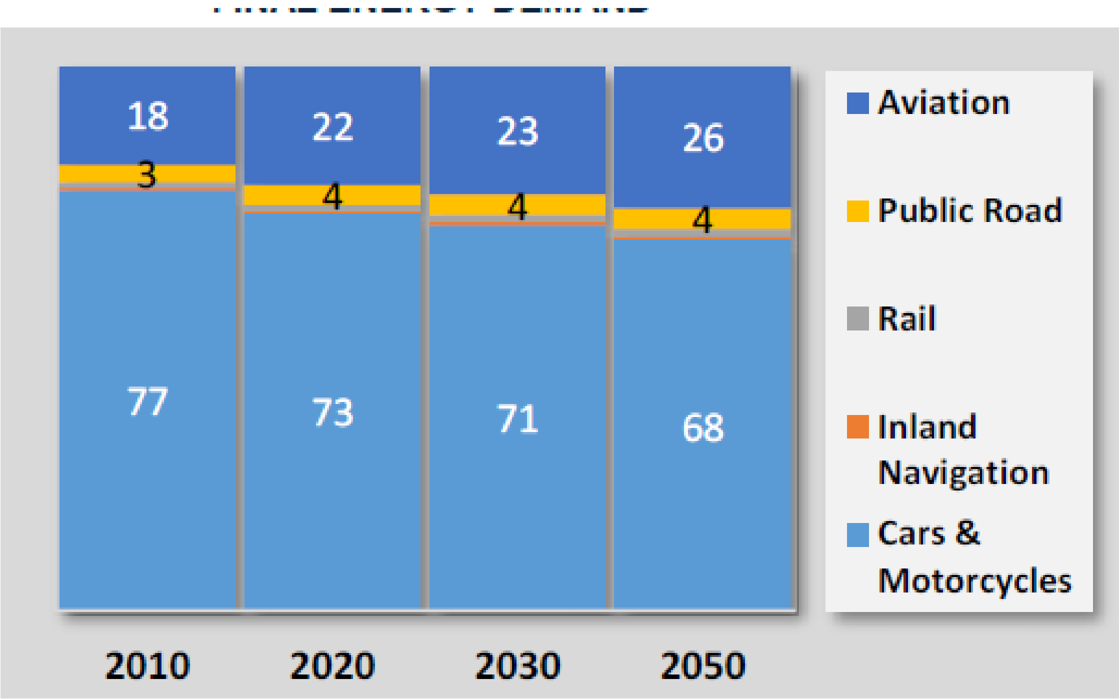


FINAL ENERGY DEMAND IN TRANSPORT

Shares of Passenger Transport modes in Final Energy Demand

EU Reference Scenario 2016 -Energy, transport and GHG emissions Trends to 2050

Car manufacturers are projected to increase their effort during the period from 2015 to 2020, which is reflected as higher improvements in specific fuel consumption compared to the recent trend. The **induced efficiency improvements** in passenger private road transport are expected to reduce the relevant share in final energy demand for passenger transportation (from 77% in 2010 to 71% and 68% in 2030 and 2050, respectively)



Failure in Estimation

- **We are in the time of Mobility as a service which is a shift away from personally-owned modes of transportation and towards mobility solutions that are consumed as a service.**

- **Estimation should be based on the more weighted parameter of Car Use instead of Car ownership**

The presentation focuses on two parts:

1. **Econometrics and System Dynamic modeling**
2. **Behavioral reasons:** Transport Mode choice Behaviors

Economic perspectives

Jevons Paradox

Technological progress that increases the efficiency with which a resource is used, tends to increase (rather than decrease) the rate of consumption of that resource. 1865

William Stanley Jevons

Neoclassical economics: Jevonsian school

Rebound effects in Transportation Economy

- Economists have observed that consumers tend to travel more when their cars are more fuel efficient, causing a 'rebound' in the demand for fuel.

- **By care sharing system a vehicle is used more efficiently by transporting more persons at a time, the cost per person kilometer is lower, which can lead to an increase in demand.**

Minute rates[5]

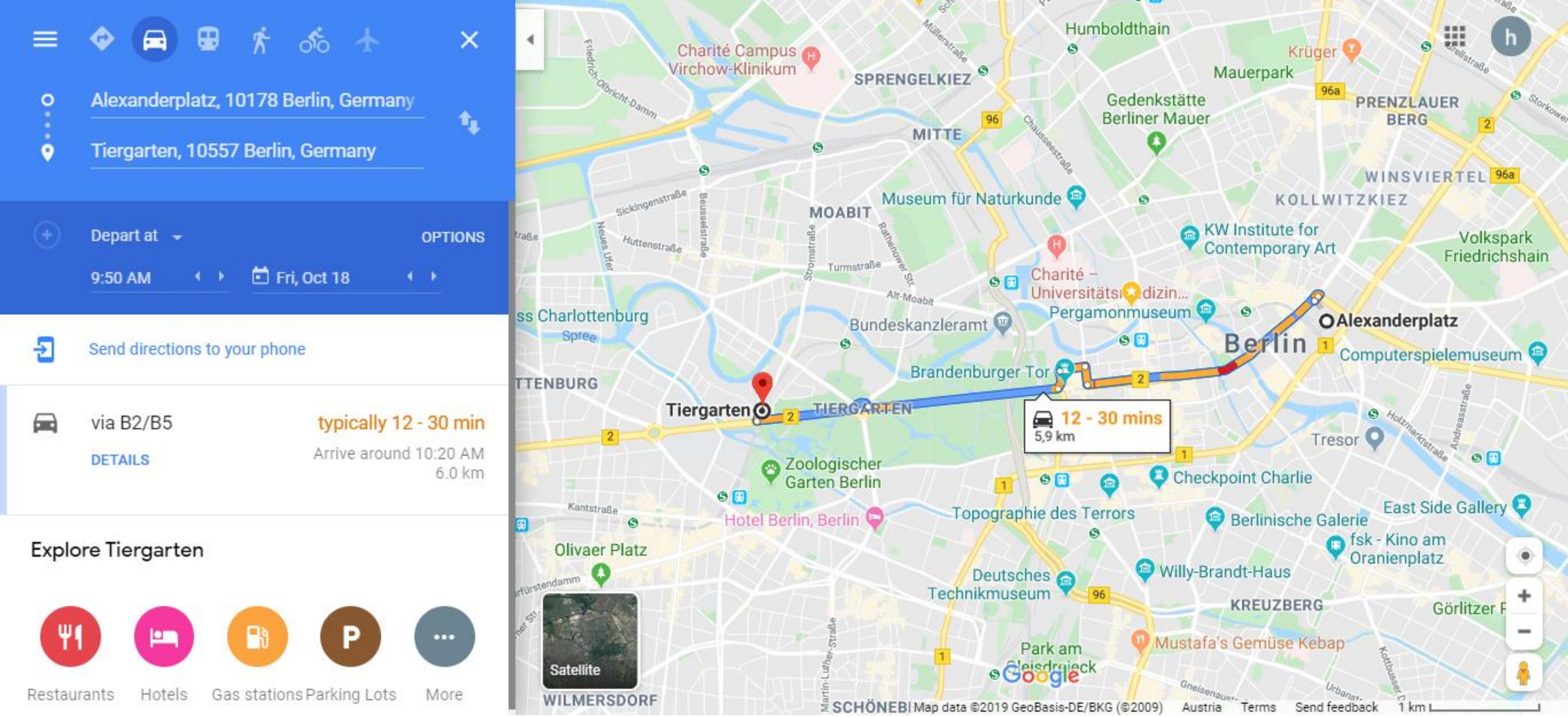
Worth every minute, that's car2go.

You only need a car for 5 minutes?

No problem. You only pay for what you actually use.

smart	A-Class	B-Class	CLA, GLA
from 0,19 € /min	from 0,28 € /min	from 0,31 € /min	from 0,31 € /min



0.31*20=6,20 Euro

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DB

Plan a Journey Route Map Tickets For Visitors

Search

Home › Tickets › All Tickets › Single Tickets › Short trip ticket

Menu

TICKETS

Short trip ticket

from 1,70EUR

Inexpensive ticket for short journeys.

Advantages

- Inexpensive mobility for occasional public transport users.
- Buy as many tickets as you want and use them as you need.

More information

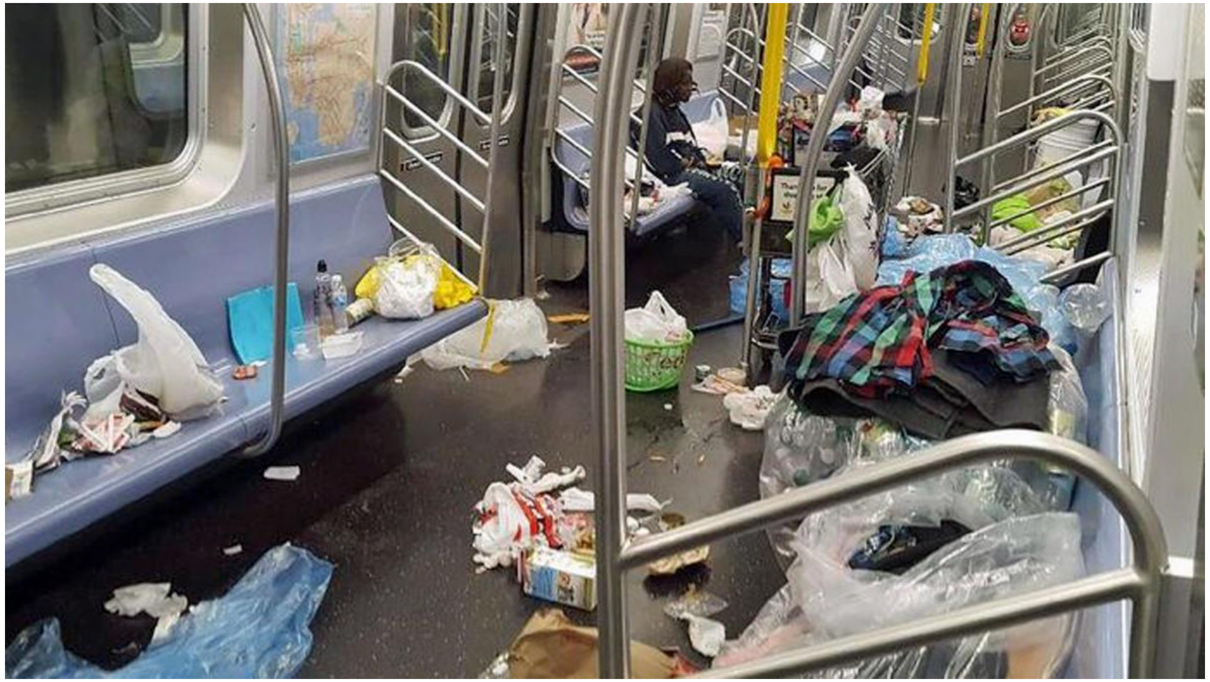
- For up to 3 stops on S-Bahn and U-Bahn services, or up to 6 stops on bus or tram services.
- You must validate the ticket before use.

Fares overview

Ticket	Fare	Concession fare*
Short journey	€ 1,70	€ 1,30
Single Ticket AB	€ 2,80	€ 1,70

5*2.8=14,00 Euros

Which one will be winner?



0.31*20=6,20 Euro

5*2.8=14,00 Euros

The Logit Model

- The Logit Model, widely used for in transportation forecasting in various forms to calculate the probability of a certain mode choice. Utility function: measures satisfaction derived from choices

$$v_A = \beta_0 + \beta_1 (c_A - c_T) + \beta_2 (t_A - t_T) + \beta_3 I + \beta_4 N$$

Public transport utility (Bus, LRT) = F (Average time of PT, Average cost of PT, Waiting time, PT Accessibility)

Car utility = F (Average Cost car trip, Average car trip time, Car ownership, Parking spaces,)

Logit Models

- Calculates the probability of selecting a particular mode

p: probability of selecting mode *k*

$$P_{iq} = \frac{\exp(\beta V_{iq})}{\sum_{A_j \in A(q)} \exp(\beta V_{jp})}$$

Mode Choice

(Logit)

$$Pij = \frac{e^{\text{transit utility}_{ij}}}{e^{\text{transit utility}_{ij}} + e^{\text{auto utility}_{ij}}}$$

$$P_{iq} = \frac{\exp(\beta V_{iq})}{\sum_{A_j \in A(q)} \exp(\beta V_{jp})}$$

Zone j

The Multinomial Logit Model is used to calculate the probability that a traveler will chose a given mode

Paradox effects of Car sharing = Rebound Effect

- The French environment and energy management agency (ADEME) found that each **shared car replaces on average 5 to 6 private** vehicles, **while freeing up at least 2 parking places**

$$PCUT_t = EXP((-1322\ PUCT_t/GDPP_t) + 0.02\ \dot{PSPE}_t + 2.08\ PVEH_t + 0.84\ PKJC_t + 0.05\ RODE_t)$$

Parking spaces per

Car ownership per capita

System Dynamics Modeling

- System dynamics modeling was developed from system thinking ideas. It started from the work of Jay Forrester, to study the behavior of various components interrelated each other in the system (Forrester, 1961).

- System Dynamics modeling is a computer-aided approach based on cause-and-effect analysis and feedback loop structures, used for to theory building, policy analysis and strategic decision support

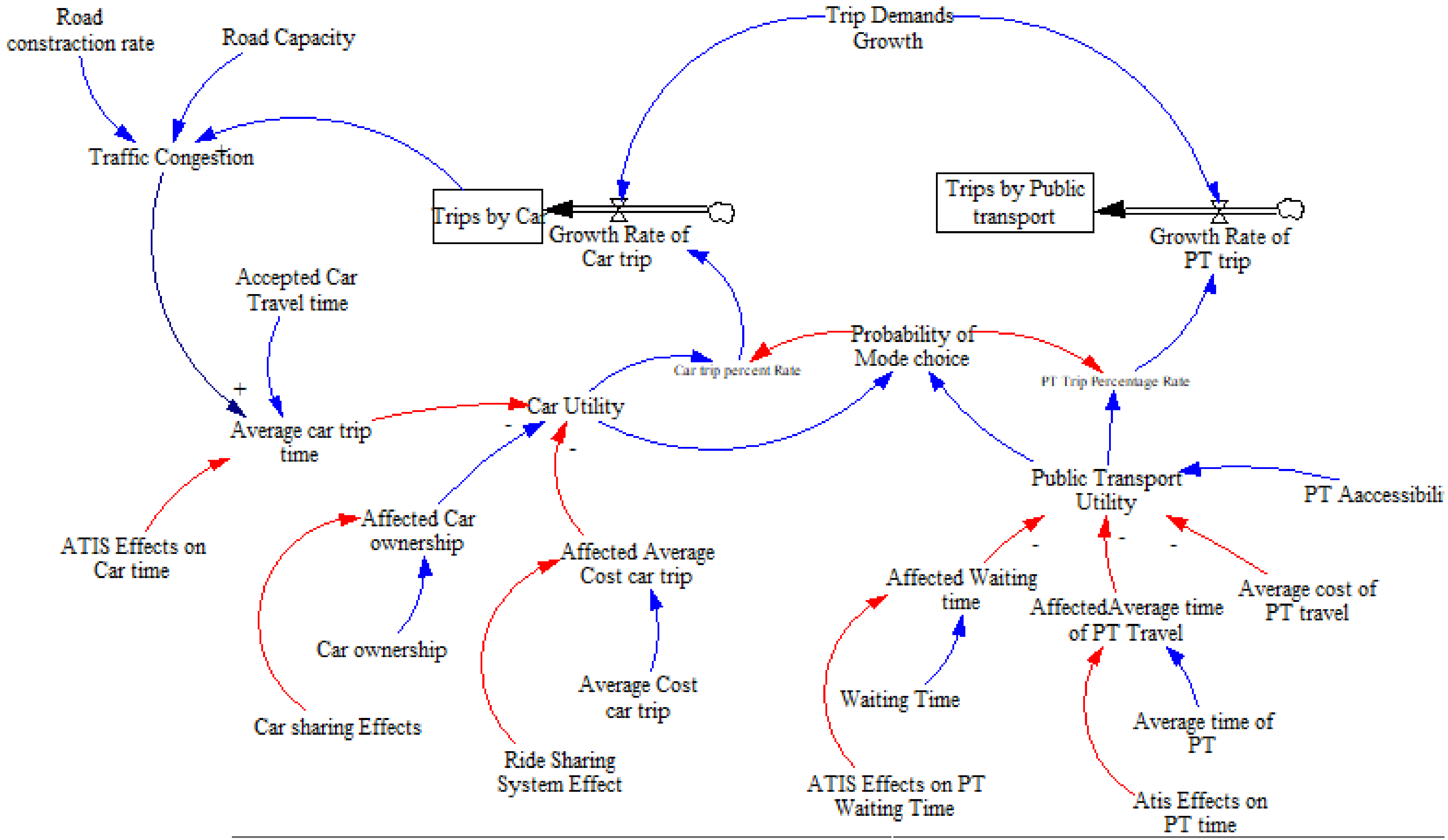
- To better understand the complexity of rebound effects of ICT in Transportation , Dynamic models have to be used.

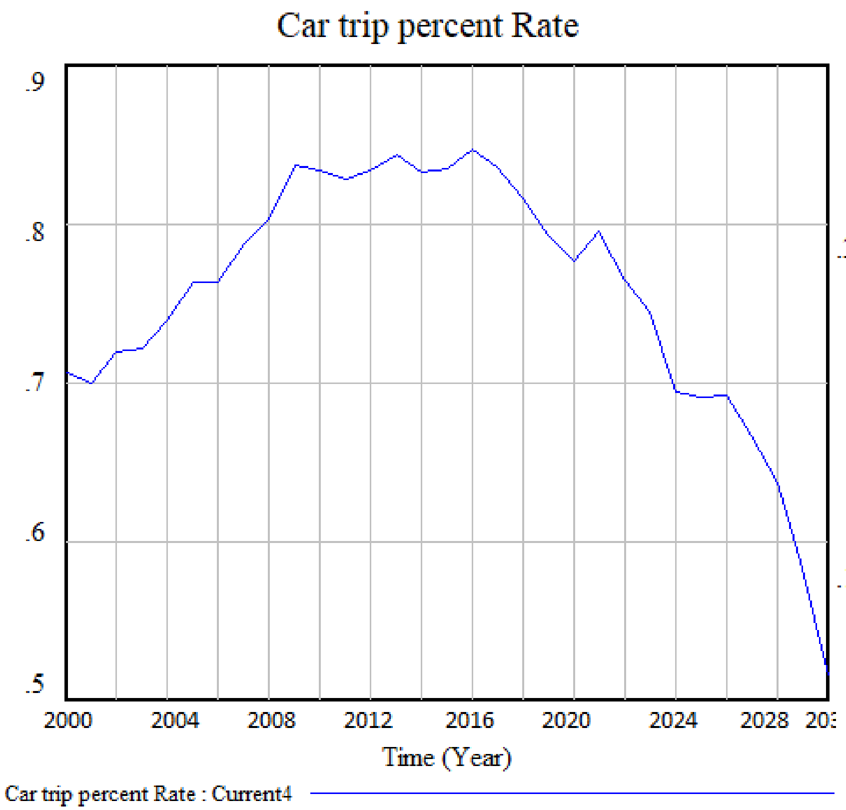
Variable of ICT in the model

- **ICT Advanced Traveler Information System (ATIS) Impacts**
- Cost of Traveling (cars and Public Transportation)
- Time of Travel (Cars – Public Transportation)
- Waiting Time for Public transportation

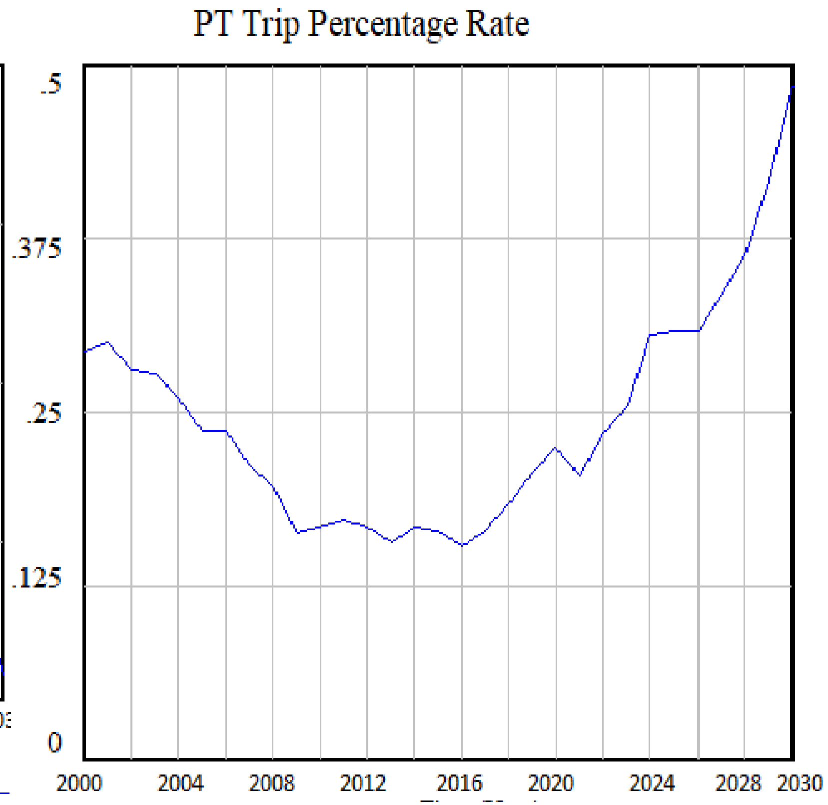
- **Car sharing based on ICT Platform**
- Car Use
- Car Ownership
- Car travel cost

- **Taxi booking system based on ICT platform**
- Cost of car travels

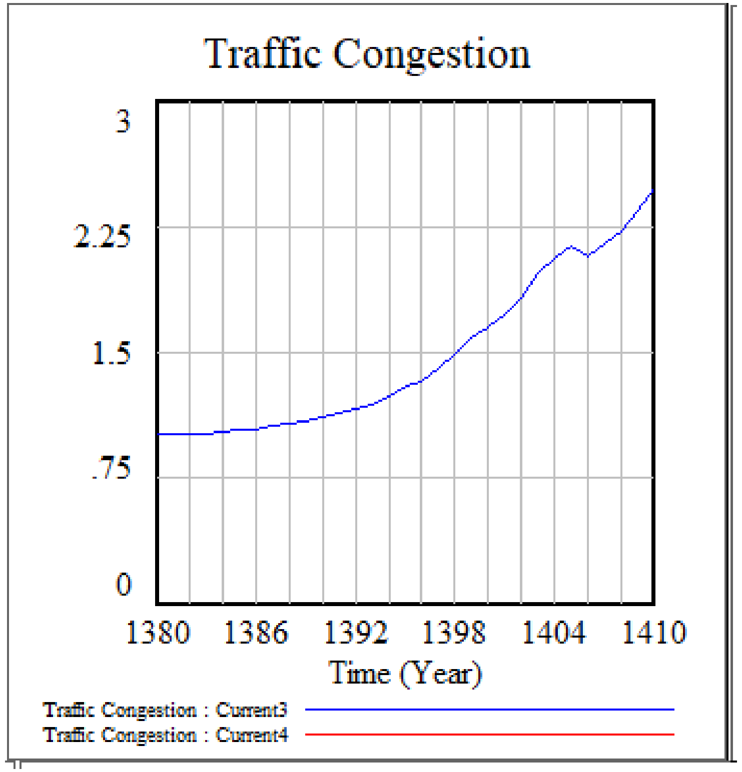

Road constraction rate
Road Capacity
Trip Demands Growth
Traffic Congestion
Trips by Car
Growth Rate of Car trip
Trips by Public transport
Growth Rate of PT trip
Accepted Car Travel time
Probability of Mode choice
Car trip percent Rate
PT Trip Percentage Rate
+
Average car trip time
Car Utility
-
-
Public Transport Utility
PT Aaccessibili
ATIS Effects on Car time
Affected Car ownership
Affected Average Cost car trip
Affected Waiting time
AffectedAverage time of PT Travel
Average cost of PT travel
-
-
-
Car ownership
Waiting Time
Average Cost car trip
Average time of PT
Car sharing Effects
Ride Sharing System Effect
ATIS Effects on PT Waiting Time
Atis Effects on PT time



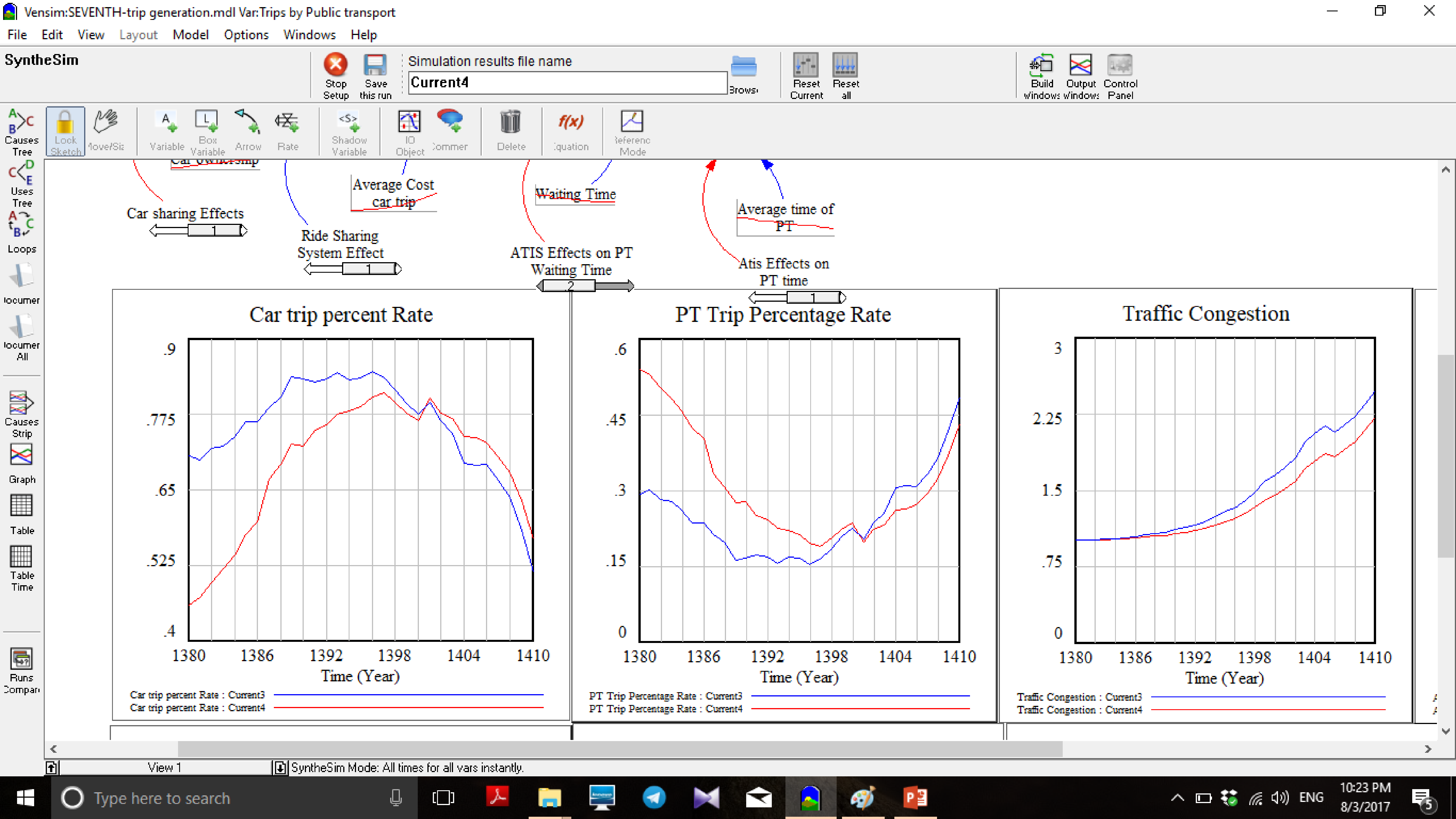
Car trip percent Rate
.9
.8
.7
.6
.5
2000
2004
2008
2012
2016
2020
2024
2028
203
Time (Year)
Car trip percent Rate : Current4



PT Trip Percentage Rate
.5
.375
.25
.125
0
2000
2004
2008
2012
2016
2020
2024
2028
2030



Traffic Congestion
3
2.25
1.5
.75
0
1380
1386
1392
1398
1404
1410
Time (Year)
Traffic Congestion : Current3
Traffic Congestion : Current4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Arrow
Rate
Shadow Variable
IO Object
Delete
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Loops
Causes Strip
Graph
Table
Table Time
Average Cost car trip
Waiting Time
Average time of PT
Car sharing Effects
Ride Sharing System Effect
ATIS Effects on PT Waiting Time
Atis Effects on PT time
Car trip percent Rate
PT Trip Percentage Rate
Traffic Congestion
Time (Year)
Car trip percent Rate : Current3
Car trip percent Rate : Current4
PT Trip Percentage Rate : Current3
PT Trip Percentage Rate : Current4
Traffic Congestion : Current3
Traffic Congestion : Current4
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ENG
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8/3/2017

Mobility Behavioral Perspective

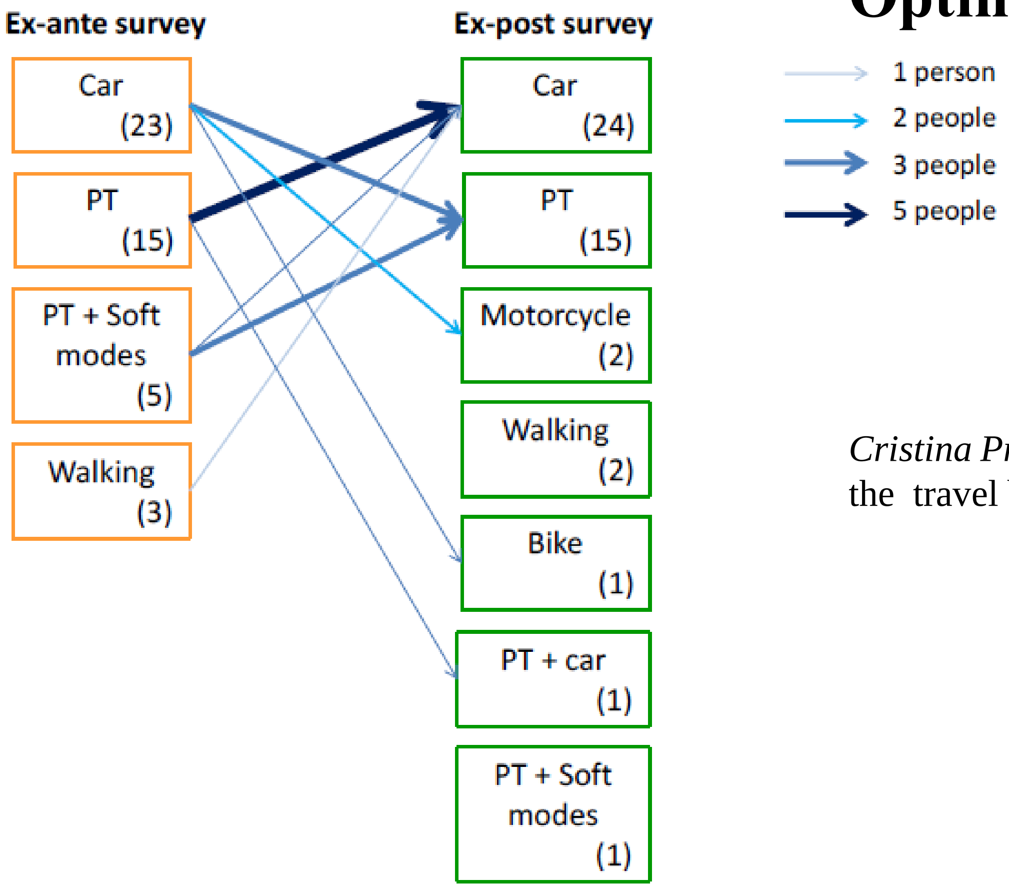
Rebound Effects and ATIS

Advanced Traveler Information System

- ATISs: are data integrated systems delivering accurate, reliable information to travelers which enable them to plan their route, estimate their travel time by real-time information via ICTs.

- In a complex system like urban traffic, there is typically a conflict between what is best for the system as a whole and what is best for the individual user. This conflict haunts Waze Google Map, too:
- **If everyone knows about a shortcut, it is no longer a shortcut.**

Mode shift to car travels
Optimod'Lyon Project in 2015-2016 (Lyon)



Cristina Pronello et al. The effects of the multimodal real time information systems on the travel behaviour ,/ *Transportation Research Procedia 25C (2017) 2681–2693*

Small increase of the car for the most frequent trip was observed. 17 percent of participants changed the mode used for the most frequent trip; however, their change was not related to the seek for a greater sustainability but for finding of a better route.

Impacts of ICT and Smart city Technologies on Car dependent or Independent Citizens ?

Behavioral Perspective: Transport Mode choice Behaviors

- **Impacts of Online ride sourcing services on choice of sustainable modes**
- Non motorized modes
- Public Transports

Urban Travel Behavior in Large Cities of MENA Region

- Funded by the German Research Foundation (DFG) undertaken in summer and autumn 2017 in Tehran, Istanbul, and Cairo. (1)
- The data for online riding is based on a face-to-face interviews with citizens, a database of 5500 validated subjects (Tehran: 2717, and Cairo: 2783) was created
- 12 Neighborhoods selected carefully from different land use types in different parts of the city including : Traditional parts of the city, new developed part and In-between (transitional) urban forms.

- (1) Masoumi, Houshmand, et.al, (2018), Urban Travel Behavior in Large Cities of MENA Region- Center for Technology and Society discussion paper series, paper Nr. 41/2018, DOI: 10.13140/RG.2.2.10912.48641

Tehran

Golestan Sharghi
Shahran Jonoubi
Towhid
Population Density per Hectare
0
950
Sadeghieh
Arg-Pamenar
Sangalaj
Legende
Green Areas
Water
Highways
Arterial Roads
Formation of Facilities
Area with Dispersed Facilities
Area with Concentric Facilities
Area with Commercial Facilties
Era of Foundation of the Neighborhood
Before 1930
In Between 1930 to 1970
After 1970
Network Type
Organic
Complete Grid
Semi-Grid
Cetrality of Facility
Center
Centerless

Cairo


ALAMEREYA
ALZAYTON ALSHARKEYA
ALMATAR
LEGENDE
GREEN AREAS
WATER
HIGHWAYS
ARTERIAL ROADS
ERA OF FOUNDATION OF THE NEIGHBORHOOD
BEFORE 1930
IN BETWEEN 1930 TO 1970
AFTER 1970
BAB ALSHAREYA
ALDARB ALAHMAR
NASR CITY

- The questionnaire contained 31 questions organized in six different sections including
- individual & household information,
- commuting, local activities
- public transport,
- pedestrian & bicycle facilities,
- Neighborhood variables

Three categories of the regular Online riding use

- Commuting to work/study
- Shopping/entertainment inside of neighborhood
- shopping /entertainment outside of the neighborhood

Travel purposes	Observed Frequencies
Commuting to work/study	60
Shopping – Entertainment inside of the neighborhood	28
Shopping -Entertainment Outside of the neighborhood	207
At least for one purpose	254
For more than one purposes	37

Perspective of commuter types

Demographics 4 types of Riders

		Car dependent N=468		Captive Riders N=1031		Choice Rider N=3428		Sustainable Choice Rider N=535	
		Count	N %	Count	N %	Count	N %	Count	N %
Age Group	15>	1	.2%	19	1.9%	36	1.1%	0	0.0%
	16-24	40	8.6%	240	23.4%	717	20.9%	114	21.3%
	25-34	129	27.6%	297	28.9%	968	28.3%	205	38.4%
	35-44	149	31.9%	202	19.7%	728	21.3%	97	18.2%
	45-54	103	22.1%	128	12.5%	520	15.2%	59	11.0%
	55-64	39	8.4%	97	9.4%	337	9.8%	40	7.5%
	65-74	5	1.1%	40	3.9%	98	2.9%	13	2.4%
	75<	1	.2%	4	.4%	19	.6%	6	1.1%
	No Response	11		4		5		1	
Gender	Female	119	25.4%	409	39.7%	1674	48.8%	208	38.9%
	Male	349	74.6%	622	60.3%	1754	51.2%	327	61.1%
Activity	No Work/Study	0	0.0%	377	36.6%	1044	30.6%	148	27.7%
	Work/Study	468	100.0 %	653	63.4%	2380	69.4%	387	72.3%
	No Response	0		1		4		2	
Income Group	500>	21	4.6%	114	11.1%	179	5.43%	27	5.1%
	501-1500	129	28.4%	206	20.1%	1271	38.59%	195	36.7%
	1501-3500	108	23.8%	273	26.6%	663	20.13%	90	16.9%
	3501-5500	24	5.3%	250	24.4%	370	11.23%	67	12.6%
	5501-7500	35	7.7%	130	12.7%	318	9.65%	70	13.2%
	7501-9500	31	6.8%	38	3.7%	181	5.49%	31	5.8%
	9501<	106	23.3%	14	1.4%	312	9.47%	51	9.6%
	No Response	188		6		134		4	

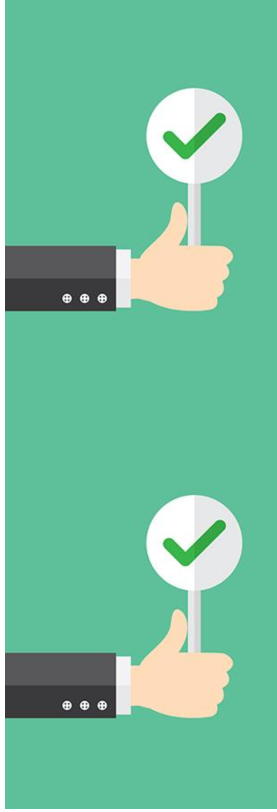
Demographic Comparison between Regular users and No-users of Online ride services

- The average age of **online riders** is less than the non-users' age.

- There is a significant difference at 0.05 level between **age** and **monthly household** income of the Online riders and other commuter types which are around five years and 4000 Euros .

- **There** is also significant association at 0.001 between variables of gender and taxi app use that **women** 24.4 % use more online ride-hailing services.

Online riders Vs Car dependent riders



Do you prefer to walk for near destination ?

Walking for near destination		No	Yes	Total	Test	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact S (1-side
Car dependent	Count	378	90	468	Pearson Chi-Square	216.931	1	0.000		
	%	80.80%	19.20%	100.00%	Likelihood Ratio	222.368	1	0.000		
Online taxi apps users	Count	63	191	254	Fisher's Exact Test				0.000	0.00
	%	20.30%	79.70%	100.00%	Lambda Symmetric	0.428		0.000	0.037	0.02
					Cramer's V	0.548		0.000		

Do you prefer to bike for near destination ?

Biking		No Response	No	Yes	Total	Test	Value	df	Asymp. Sig. (2-sided)
Car dependent	Count	0	455	13	468	Pearson Chi-Square	21.827	2	.000
	%	0.0%	97.2%	2.8%	100.0%	Likelihood Ratio	21.325	2	.000
Online taxi apps users	Count	2	226	26	254				
	%	0.8%	89.0%	10.2%	100.0%	Lambda Symmetric	.051		.021
						Cramer's V	.174		0.000

Captive riders vs Online riders

Do you prefer to walk for near destination ?

Walking for near destination		No	Yes	Total	Test	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact S (1-side
Captive Riders	Count	132	873	1005	Pearson Chi-Square	21.091	1	.000		
	%	13.1%	86.9%	100.0%	Likelihood Ratio	222.368	1	0.000		
Online taxi apps users	Count	63	191	254	Fisher's Exact Test				0.000	0.00
	%	24.8%	75.2%	100.0%	Cramer's V	.129		0.000		

Do you prefer to bike for near destination ?

Biking		No Response	No	Yes	Total	Test	Value	df	Asymp. Sig. (2-sided)
Captive Riders	Count	1	865	139	1005	Pearson Chi-Square	6.223	2	.045
	%	0.1%	86.1%	13.8%	100.0%	Likelihood Ratio	5.354	2	.069
Online taxi apps users	Count	2	226	26	254				
	%	0.8%	89.0%	10.2%	100.0%	Cramer's V	.070		045

Captive riders vs Online riders

- Online riders are younger and have more monthly household income than captive riders.
- The higher intersection density and shorter average distance to facilities on the neighborhood of captive riders indicate that their neighborhoods have better accessibility and connectivity than online riders.

Choice riders Vs Online riders

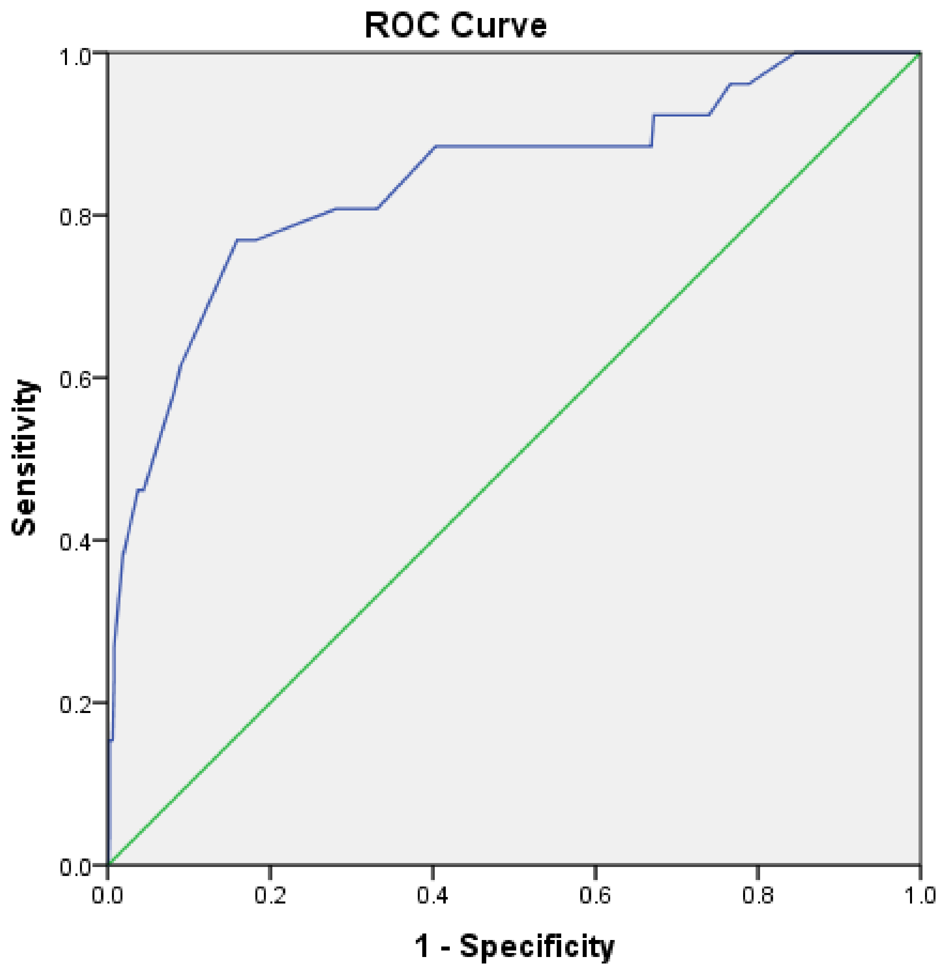
Walking for near destination		No	Yes	Total	Test	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact S (1-side
Choice Riders	Count	855	2355	3210	Pearson Chi-Square	1.002	1	.317		
	%	26.6%	73.4%	100.0%	Likelihood Ratio	.861	1	.354		
Online taxi apps users	Count	75	179	254	Fisher's Exact Test				.339	.17
		29.5%	70.5%	100.0%	Cramer's V	.017		.317		

Biking		No Response	No	Yes	Total	Test	Value	df	Asymp. Sig. (2-sided)
Choice Rider	Count	14	2899	297	3210	Pearson Chi-Square	.740	2	.691
	%	0.4%	90.3 %	9.3%	100.0%	Likelihood Ratio	.637	2	.727
Online taxi apps users	Count	2	227	25	254				
	%	0.8%	89.4 %	9.8%	100.0%	Cramer's V	.015		.691

Travel purpose	Walk …. Than Online rider	Cycle ….. than Online rider
Car-dependent	Less	Less
Captive riders	More	More
Choice Riders	No significantly different	No significantly different
Sustainable Choice Riders	More	No significantly different

Cutoff value of economic parameters between Captive and online riders

Receiver Operating Characteristic (ROC)



- The area of the ROC curve of household income is 0.842 which indicates the acceptable accuracy of this test to estimate the cutoff point.
- The cutoff of the monthly household income is 4500 euro.
- 80% of the regular users have more monthly income than 4500 and 70% of the non-users have a less monthly income than 4500 euros
.

The Impact on Public Transport

likert spectrum and Binary Variables for Frequency use of Public Transport

likert spectrum

- Every day
- a few times per week
- a few times per month
- rarely
- almost never

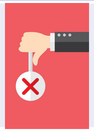
Binary Variables : More frequent or not ?

- Every day
- a few times per week
- a few times per month
- rarely
- almost never

Frequent Use of PT (Every day, a few times per week)

Non-Frequent (a few times per month, rarely, almost never)

Findings in Perspective of Traveler Types

Type	Public Transport
Vs Car dependent riders	
Vs Captive riders	No association
Vs Choice riders	No association
Vs Sustainable Choice Rider	

Intensity Taxi apps use and PT frequency

Intensity use of Taxi App2 * Likert PT frequency Crosstabulation

			Likert PT frequency					
			1	2	3	4	5	Total
Intensity use of Taxi App	2	Count	4	16	27	89	32	168
		%	2.4%	9.5%	16.1%	53.0%	19.0%	100.0%
	3	Count	2	1	2	8	2	15
		%	13.3%	6.7%	13.3%	53.3%	13.3%	100.0%
	4	Count	4	7	11	9	1	32
		%	12.5%	21.9%	34.4%	28.1%	3.1%	100.0%
	6	Count	9	6	8	11	3	37
		%	24.3%	16.2%	21.6%	29.7%	8.1%	100.0%
Total		Count	19	30	48	117	38	252
		%	7.5%	11.9%	19.0%	46.4%	15.1%	100.0%

Ordinal by Ordinal	Somers' d	Symmetric	-.294	.052	-5.437	.000
		Intensity use of Taxi App2 Dependent	-.255	.046	-5.437	.000
		Likert PT frequency Dependent	-.349	.062	-5.437	.000

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	-.298	.052	-5.437	.000
	Kendall's tau-c	-.239	.044	-5.437	.000
	Gamma	**-.464**	.075	-5.437	.000
	Spearman Correlation	**-.339**	.060	-5.705	.000[c]
Interval by Interval	Pearson's R	-.347	.064	-5.859	.000[c]
N of Valid Cases		252			

The impact of online Taxi on public transport use in Tehran and Cairo

- Users of taxi apps for commuting to their **works** use public transport significantly **less** than non users.

- If Users use taxi apps more for their different travel purposes they use significantly **less** public transport.

- There is **a negative correlation** between frequency use of taxi apps and PT (Gamma = -0.46 Spearman= -0.34)

Highlights

- Online riders are younger and have significantly more income in the MENA region
- Online riders have a significantly greater tendency to walk, bike and public transport than car-dependents
- Online riders have a smaller tendency to nonmotorized and PT modes than captive riders
- 2 variables of commuter types, trip purposes are essential to study of online mobility services

Car Sharing: an old friend, but a new enemy

1945

2019


TERIMA KASIH
GRACIAS
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SALAMAT
OBRIGADO
GRAZIE
謝謝
KIITOS
THANK YOU
БЛАГОДАРЯ
DZIĘKUJĘ
DANK U
감사합니다
DANKIE
TƏŞƏKKÜR
DĚKUJI
СПАСИБО
DANKE
FALEMNDERIT
MULȚUMESC
TACK
ありがとう
ÞAKKA ÞÉR