



STARS

Shared mobility opportunities And
challenges for European cities



TRANSPORT SYSTEMS
RESEARCH GROUP
Politecnico di Torino - DIATI

Learning from the STARS Italian case study results

STARS final event, Bremen 13 February 2020, Andrea Chicco (POLITO)

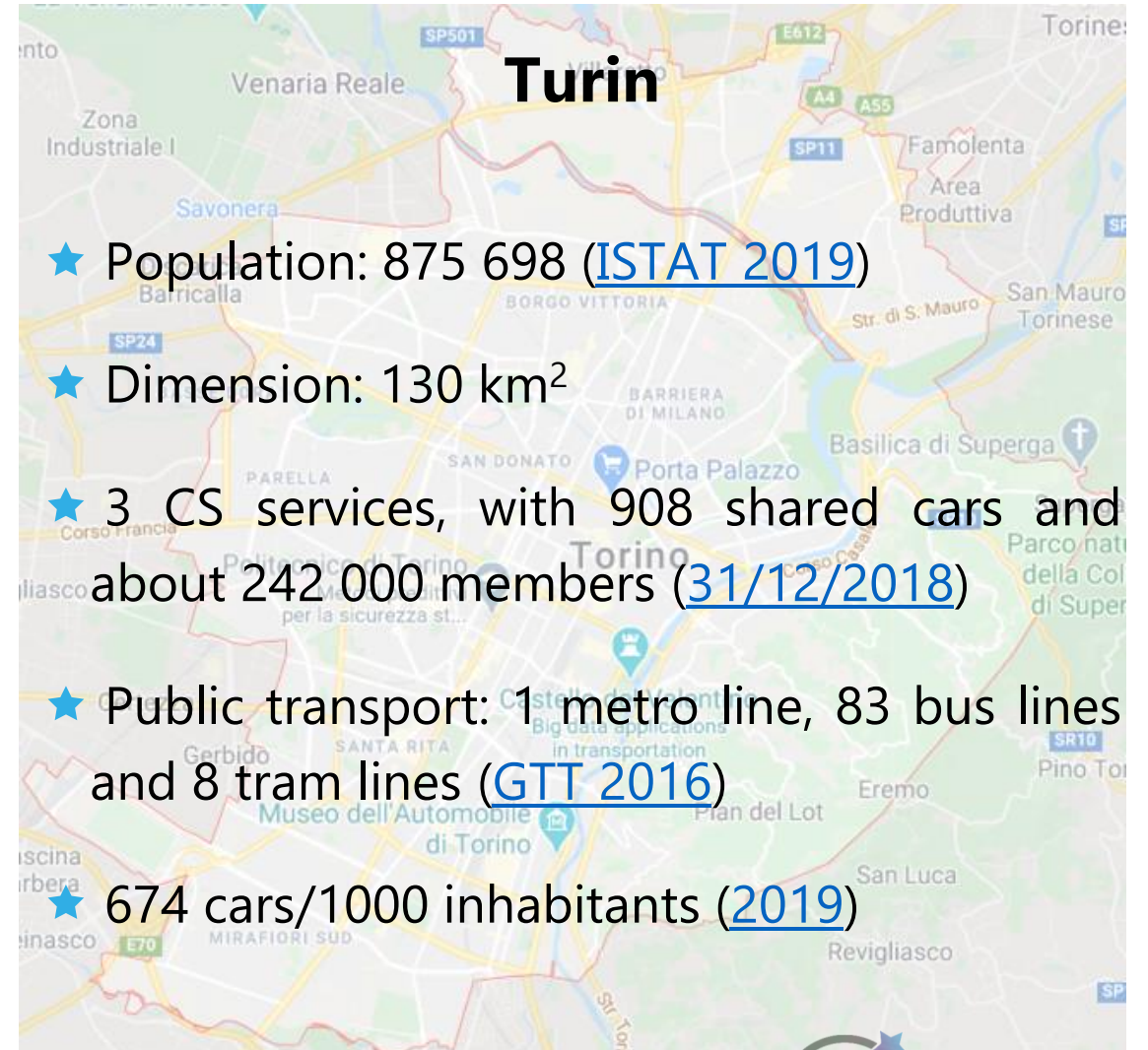
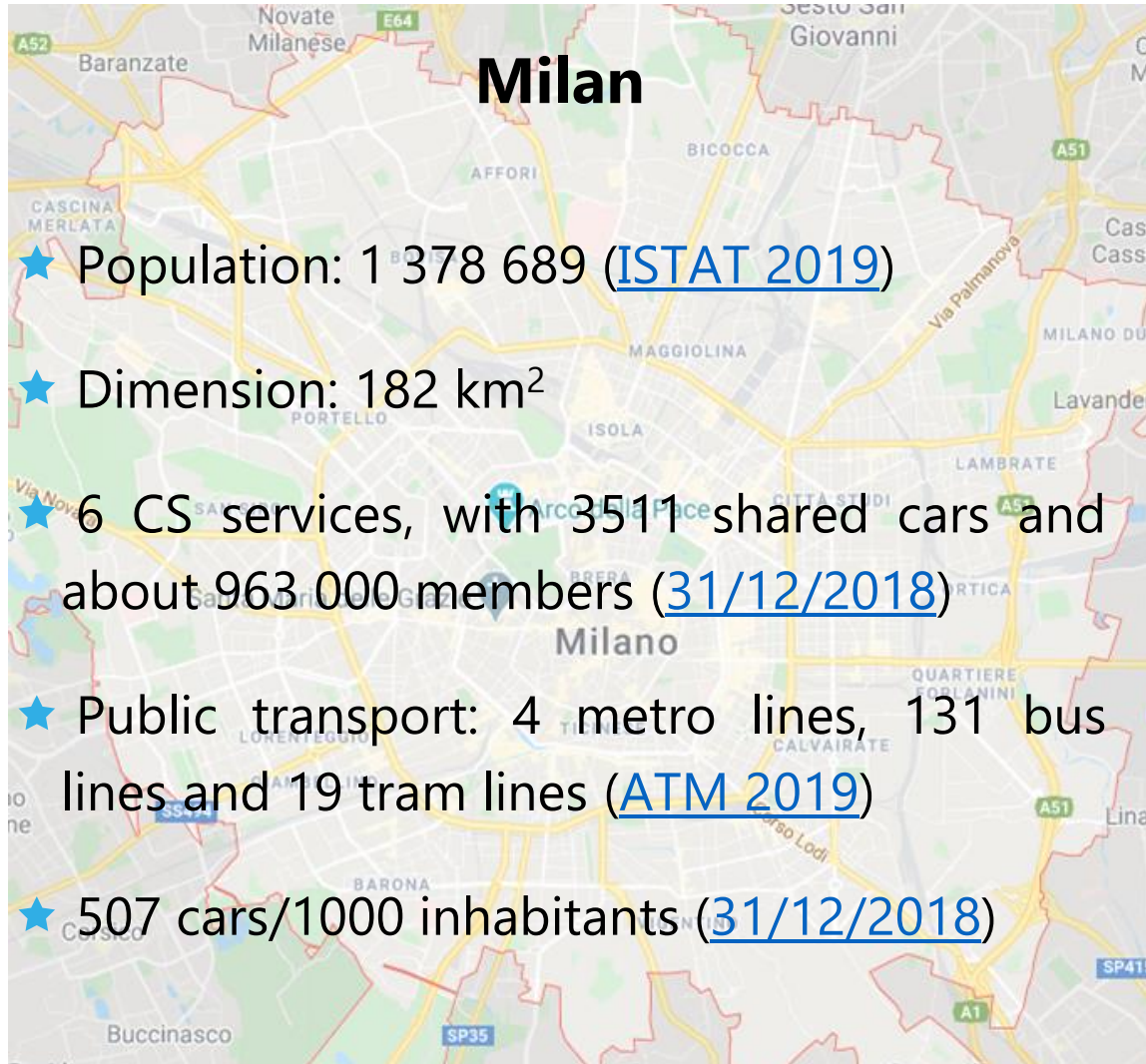


This project has received funding from the Horizon 2020 programme under grant agreement n°769513

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 - Impacts on greenhouse gas and air pollution emissions
 - Impacts on parking demand

Study areas



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Survey protocol

- ★ a sample of **users** of car sharing services within the study areas
- ★ a sample of **non-users** within the study areas
- ★ a **control group**: a subset of non-users jointly having the same socioeconomic profile of the sample of users (Gender, age, household dimension, number of household's children, driving licences, Income)

The control group is useful to understand car sharing membership **causality** on travel behaviour, car ownership...



Questionnaire contents

Questionnaire made of **4 sections**
(56 questions in total):

- ★ Travel habits
- ★ Car ownership
- ★ Travel diary for the last trip
- ★ Sociodemographic characteristics of the respondents

The screenshot displays the 'TRAVEL SURVEY' interface. At the top, it features the STARS logo (a car icon with a star) and the text 'STARS Shared mobility opportunities And challenges for European cities', along with the Politecnico di Torino logo. The main heading is 'TRAVEL SURVEY'. Below this, a welcome message states: 'Welcome and thank you for being part of our survey. This survey is part of a European project called STARS (http://stars-h2020.eu) created by Politecnico di Torino, which aims to understand opportunities and challenges of the sharing mobility with emphasis on car sharing.' A note for participants says: 'As a participant, you will be asked some questions about your transport experiences and opinions according with your life routine. Your answers will be important to understand the impact of car sharing on other transport modes, on car ownership and its contribution to public space consumption in our cities.' The survey progress is shown as '1%'.

The first section is titled 'Car sharing and travel behaviour'. It includes a sub-header: 'In this section information about car sharing subscription and usage frequency of different transport means will be asked.' A dark blue box contains the question: 'Which car sharing operator are you a member? When did you subscribe?' followed by instructions: 'If you are registered to more than one service, please report them in chronological order from the least recent to the most recent.' A red warning icon and text state: 'Please select at least one answer'.

The next section is 'Car sharing subscription 1'. It contains a dropdown menu labeled 'Name of the service' with 'Enjoy' selected.



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Survey implementation

- ★ Phone (CATI) + Web (CAWI) interviews
- ★ **Representative sample** of the population living in **Turin** and **Milan** (gender and age)
- ★ **Oversampling** to get more **car sharing members interviews**

City	Survey protocol	Members	Non-members	Total
Milan		485	553	1038
	CAWI	105	278	383
	CATI	75	275	350
	CAWI (oversampling)	305	0	305
Turin		181	255	436
	CAWI	40	140	180
	CATI	42	115	157
	CAWI (oversampling)	99	0	99
Total		666	808	1474

Data collection closed by 31/05/2019



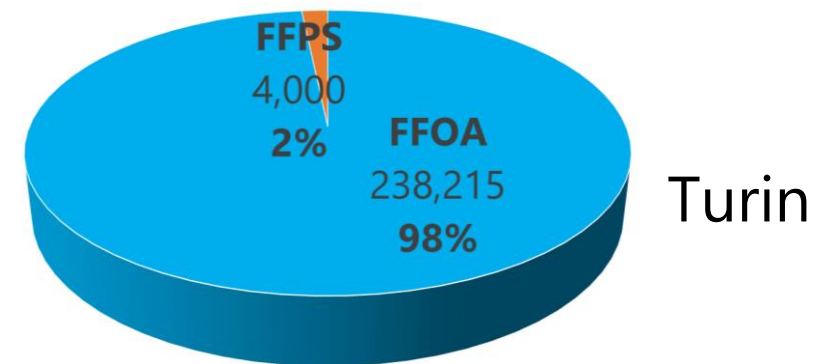
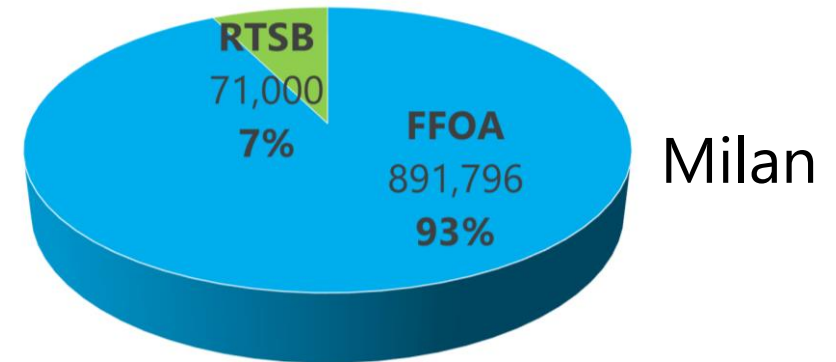
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Car sharing members breakdown

City	Car sharing variant	Members interviewed (%)	
Milan	Roundtrip station-based (RTSB)	9	(2%)
	Free-floating with an operational area (FFOA)	439	(91%)
	Free-floating with pool stations (FFPS)	0	(0%)
	Multi-subscribers	37	(8%)
	Total	485	(100%)
Turin	Roundtrip station-based (RTSB)	0	(0%)
	Free-floating with an operational area (FFOA)	151	(83%)
	Free-floating with pool stations (FFPS)	14	(8%)
	Multi-subscribers	16	(9%)
	Total	181	(100%)

Members of different CS variants from operators' feedback



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Car sharing members breakdown

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	Free-floating with pool stations (FFPS)	14	(8%)
	Multi-subscribers	16	(9%)
	Total	181	(100%)

Very few interviewees of RTSB and FFPS services... all the results will be referable to FFOA



The **Italian case study** focused on **free-floating services** only



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Matching algorithm based on propensity score to build the control group

Summary of balance for **all data**:

	Means Treated (CS members)	Means Control (Non-members)
distance	0.3148	0.2230
Age	43.0833	51.7233
GenderMale	0.6389	0.4575
GenderFemale	0.3611	0.5425
HHsize	2.5889	2.6890
HHdrivLic	1.9778	2.0398
HHchild	0.5444	0.6854
HHincome	3502.7778	3282.5497

Summary of balance for **matched data**:

	Means Treated (CS members)	Means Control (CG)
distance	0.3148	0.3023
Age	43.0833	43.1889
GenderMale	0.6389	0.6389
GenderFemale	0.3611	0.3611
HHsize	2.5889	2.5833
HHdrivLic	1.9778	1.9944
HHchild	0.5444	0.5056
HHincome	3502.7778	3447.2222

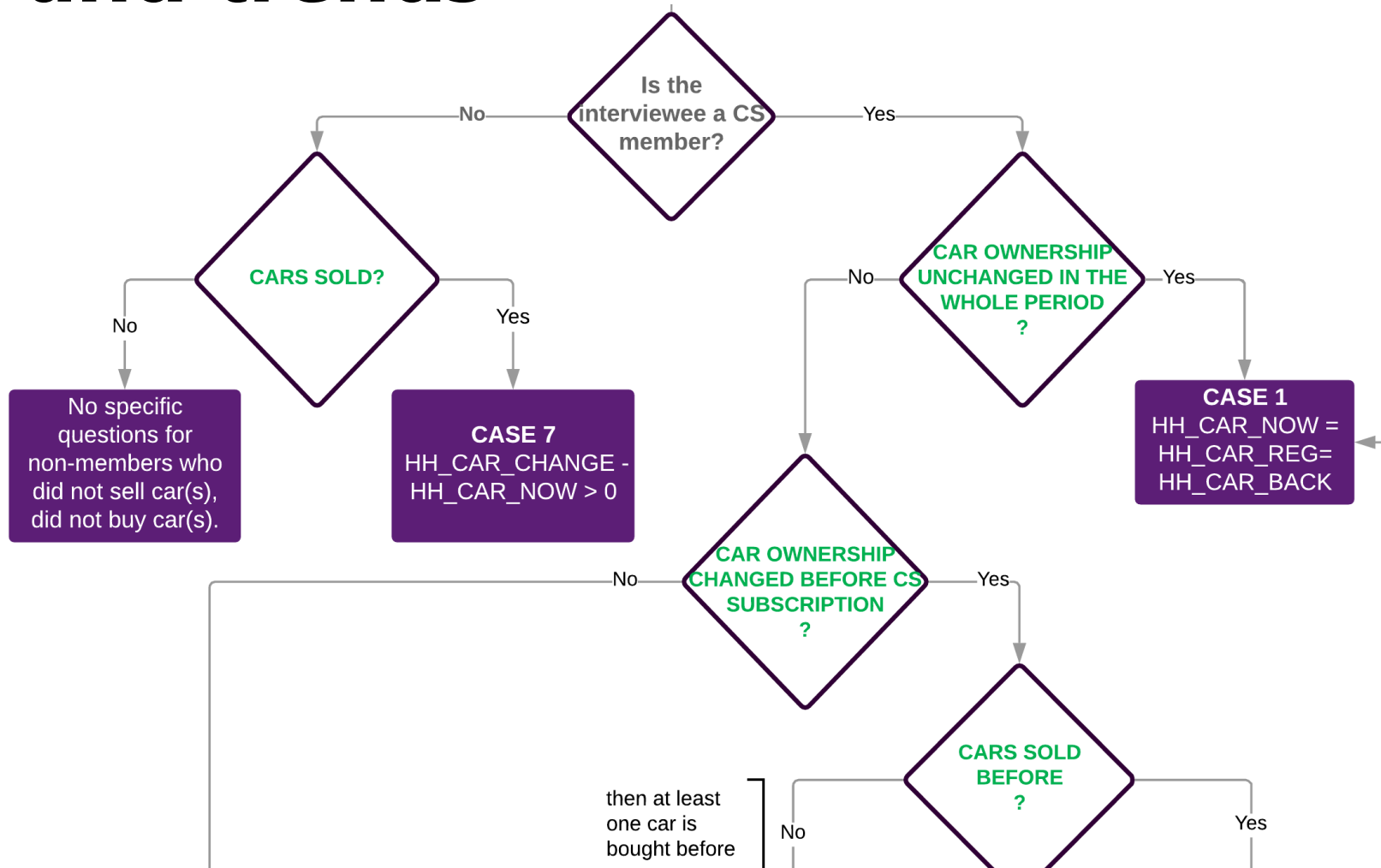
Control groups have the same dimension of user groups



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Person-level analyses: car ownership levels and trends



HH_CAR_NOW = no. of cars owned at the household level at the time of the interview

HH_CAR_REG = no. of HH's cars at the time of the **first registration** (CS members)

HH_CAR_BACK = no. of HH's cars **one year before** the first registration (CS members)

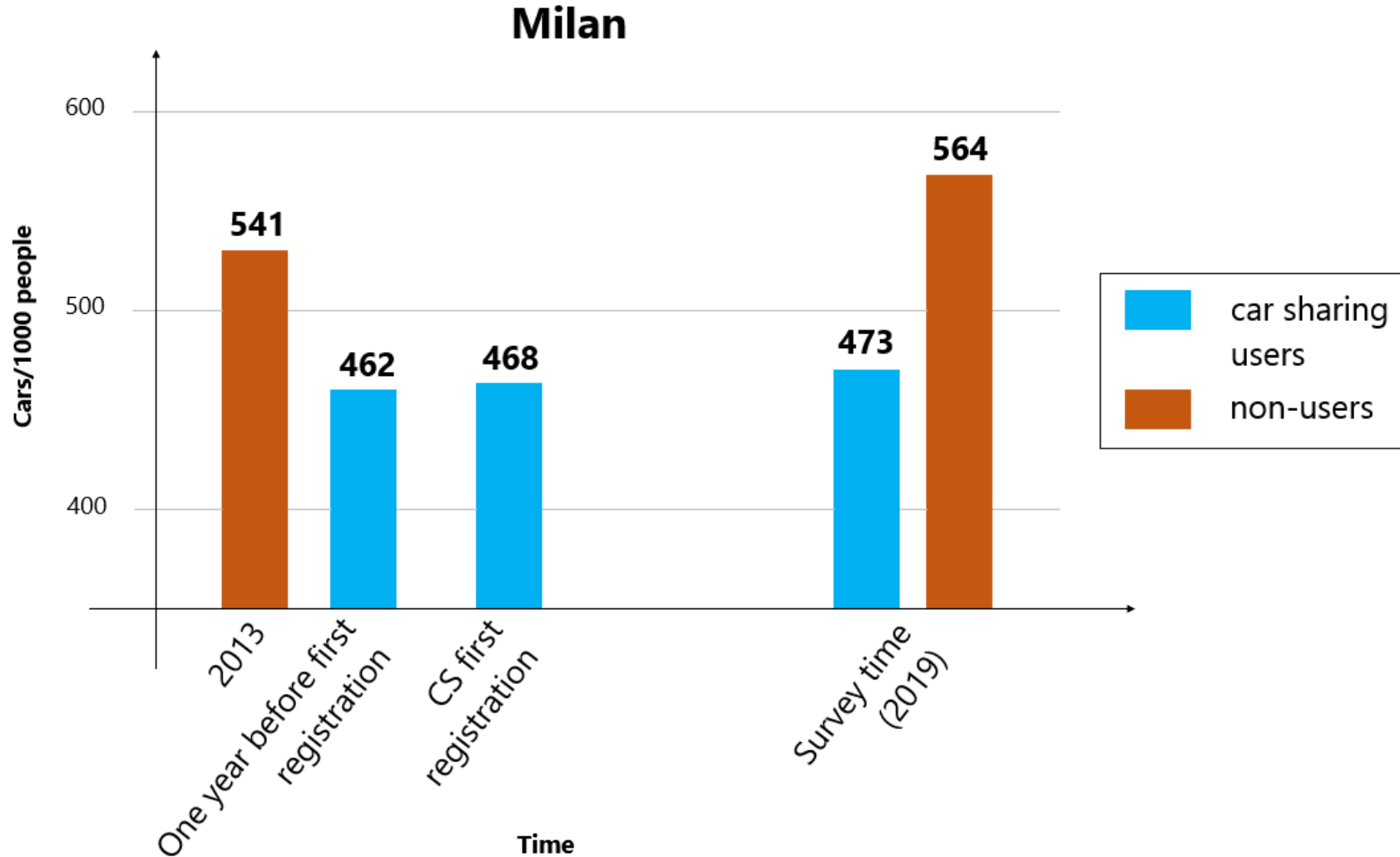
HH_CAR_CHANGE = no. of HH's cars **before the last change** in car ownership (Non-members)



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Car ownership levels



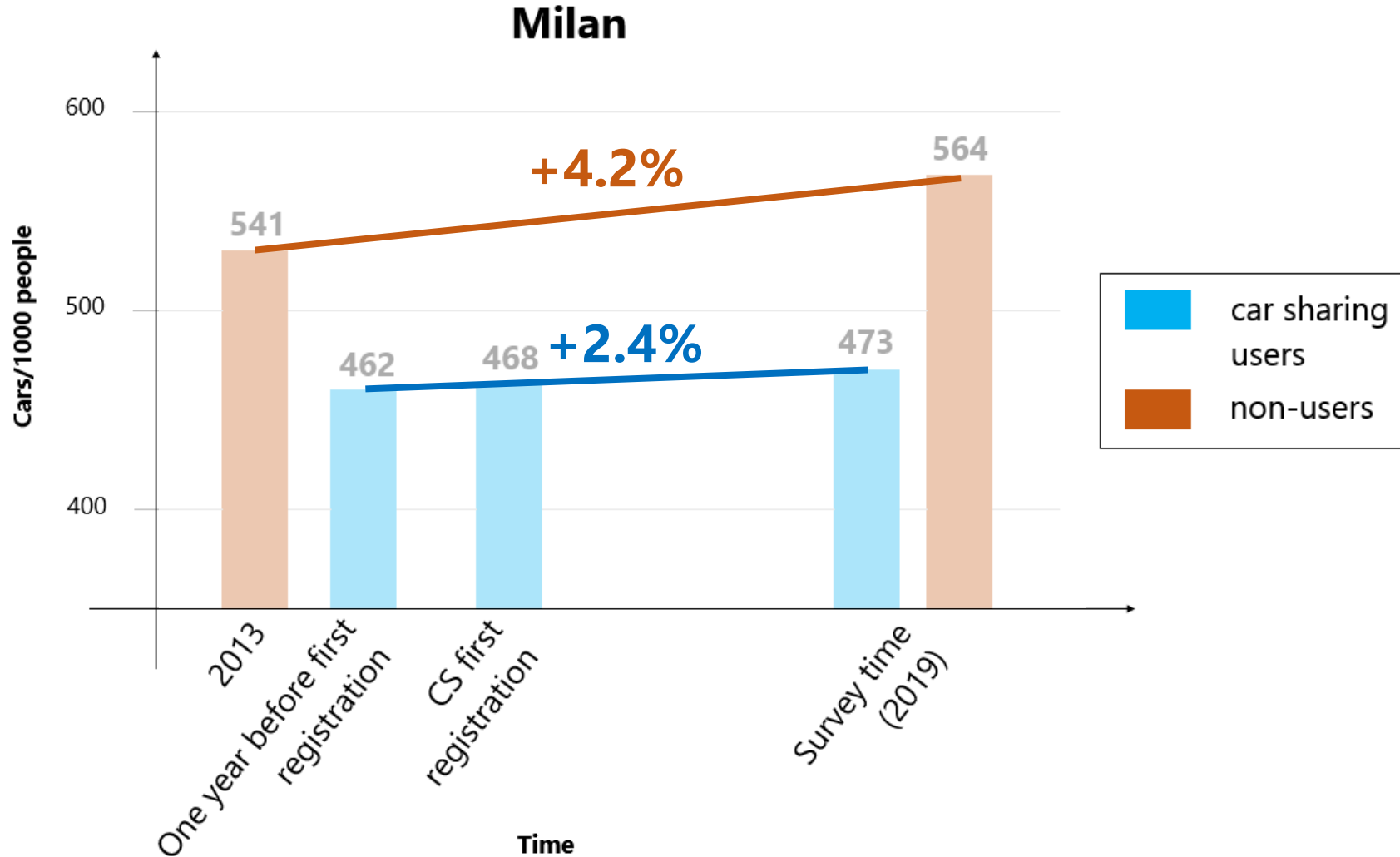
- ★ CS members have lower cars
- ★ **1.22 avg.** cars in CS members' household
- ★ **1.43 avg.** cars in non-members' household



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Changes in car ownership



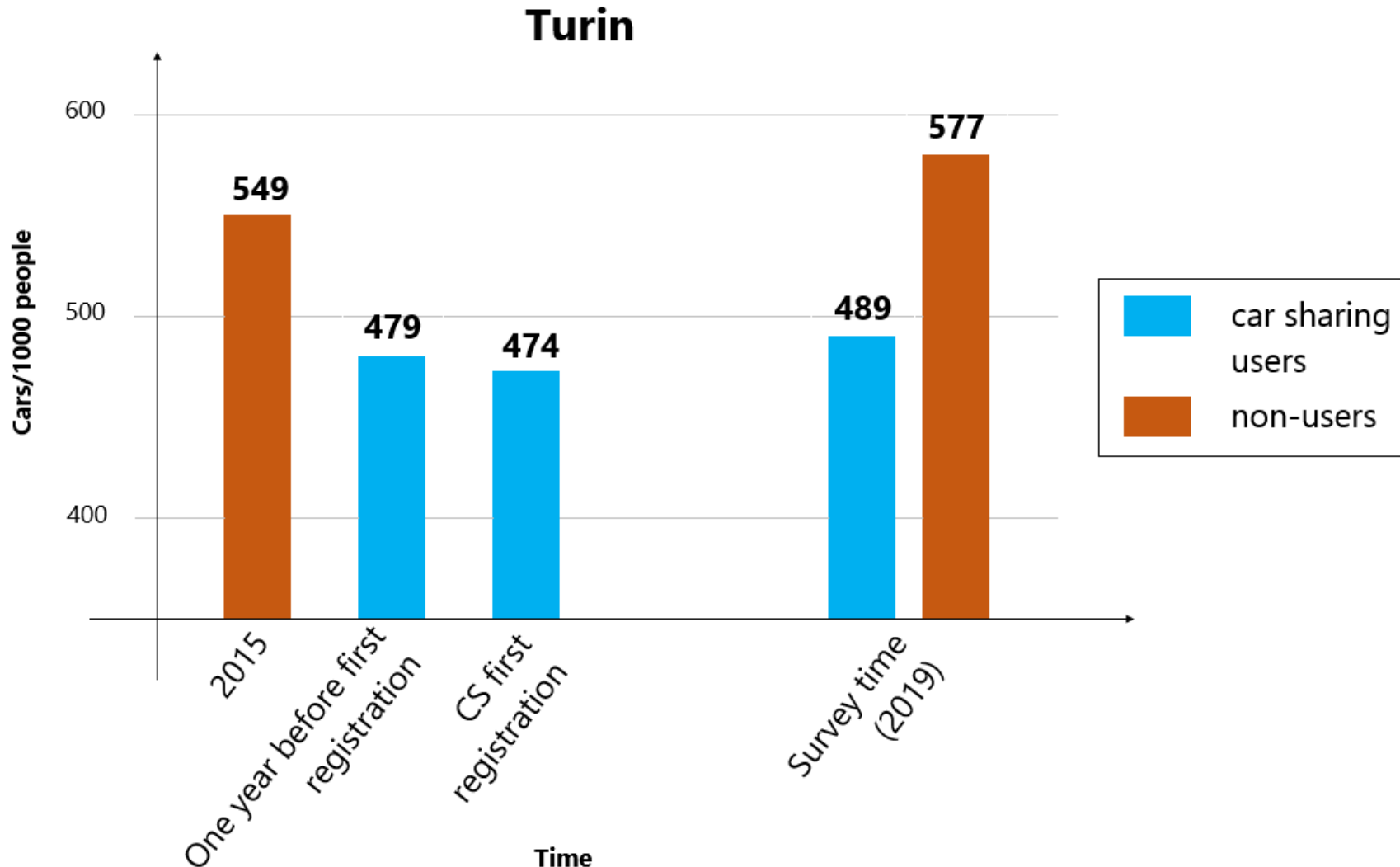
- ★ Car sharing in Milan is **not reducing** the number of cars owned
- ★ Not significant early adopters effect
- ★ Positive effect in **limiting car purchases**



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Car ownership levels



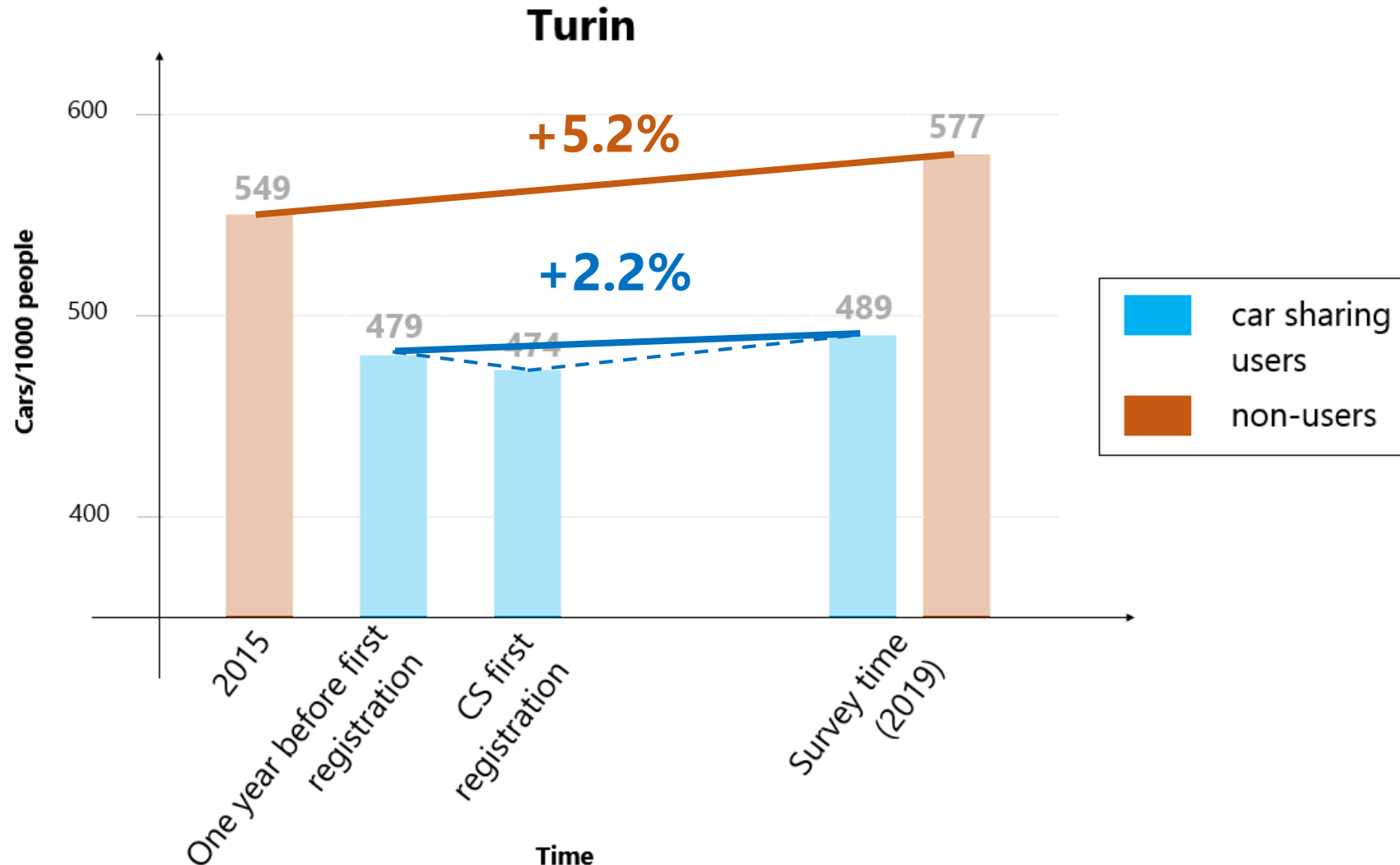
- ★ **1.29 avg.** cars in CS members' household
- ★ **1.40 avg.** cars in non-members' household
- ★ Not statistically significant



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Changes in car ownership



- ★ Car sharing in Turin is **not reducing** the number of cars owned
- ★ Not significant early adopters effect
- ★ Positive effect in **limiting car purchases**



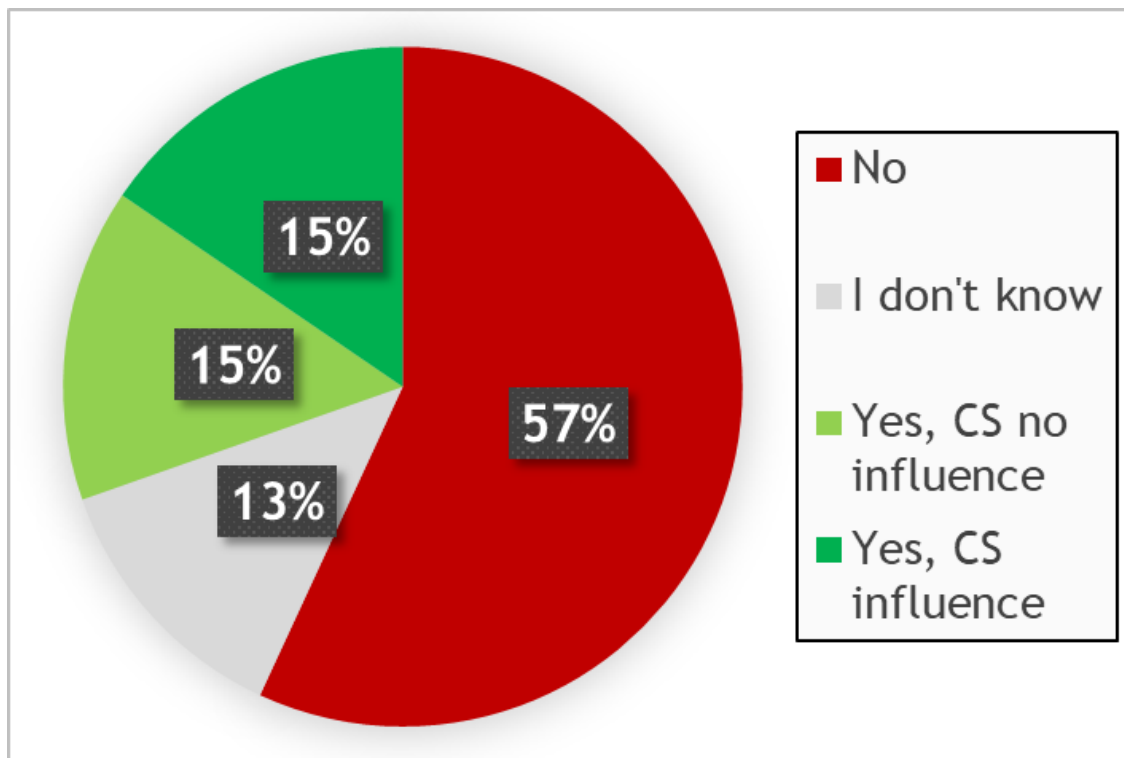
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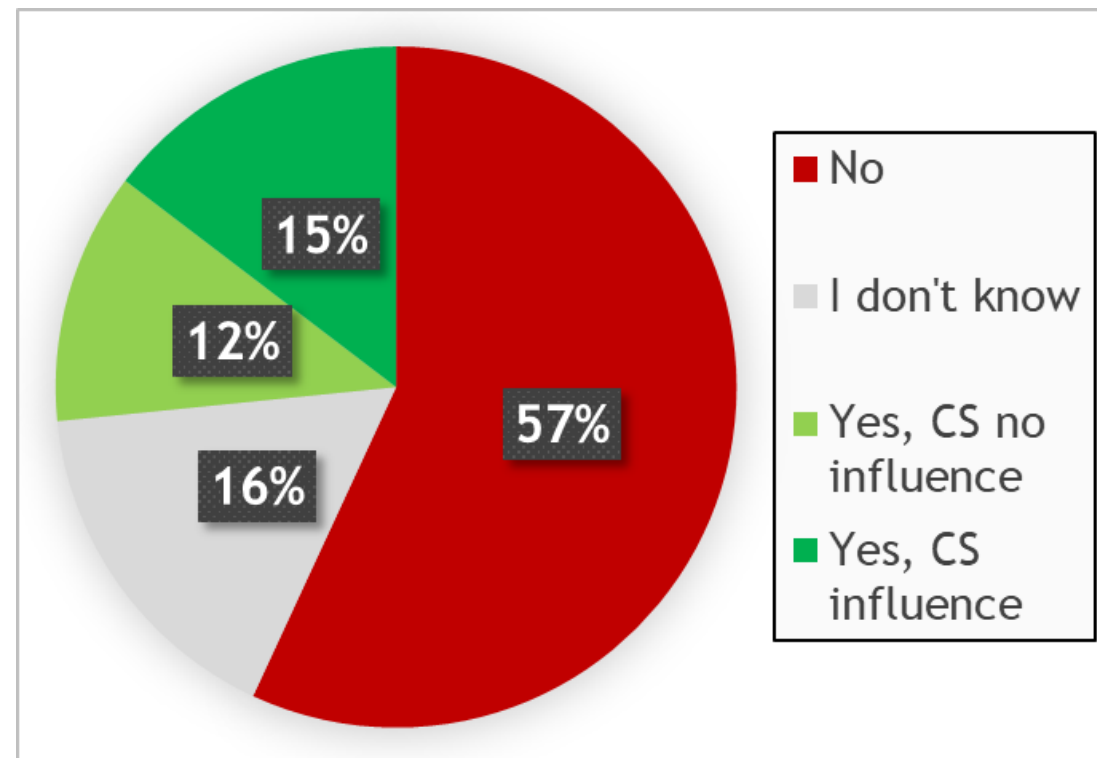
Attitudes related to car purchases

I gave up buying an extra car

Turin (n=181)



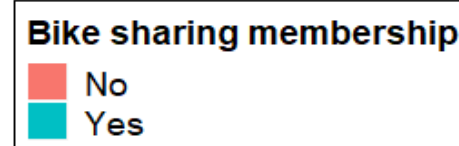
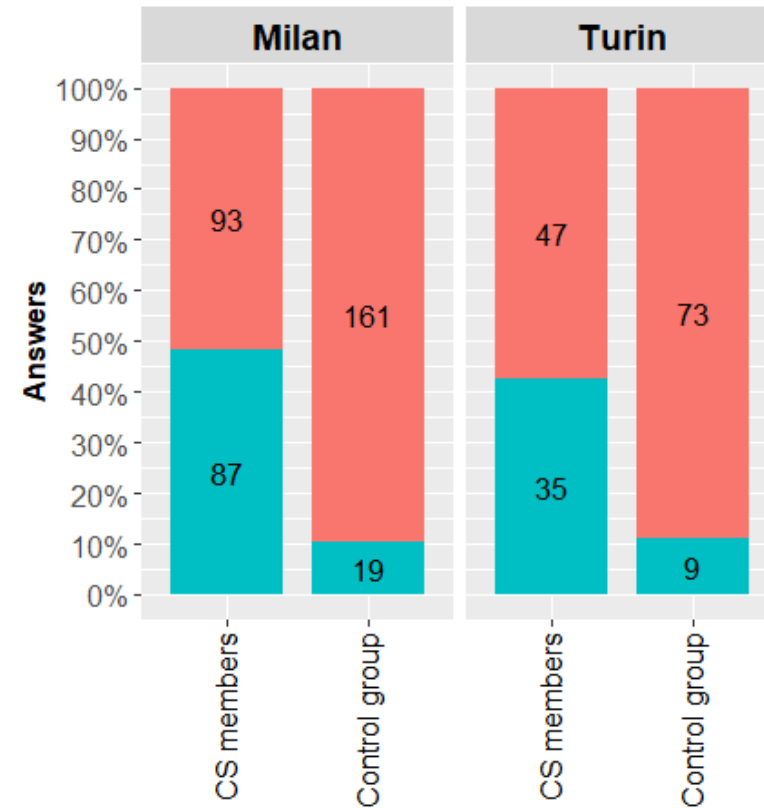
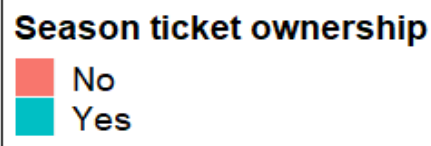
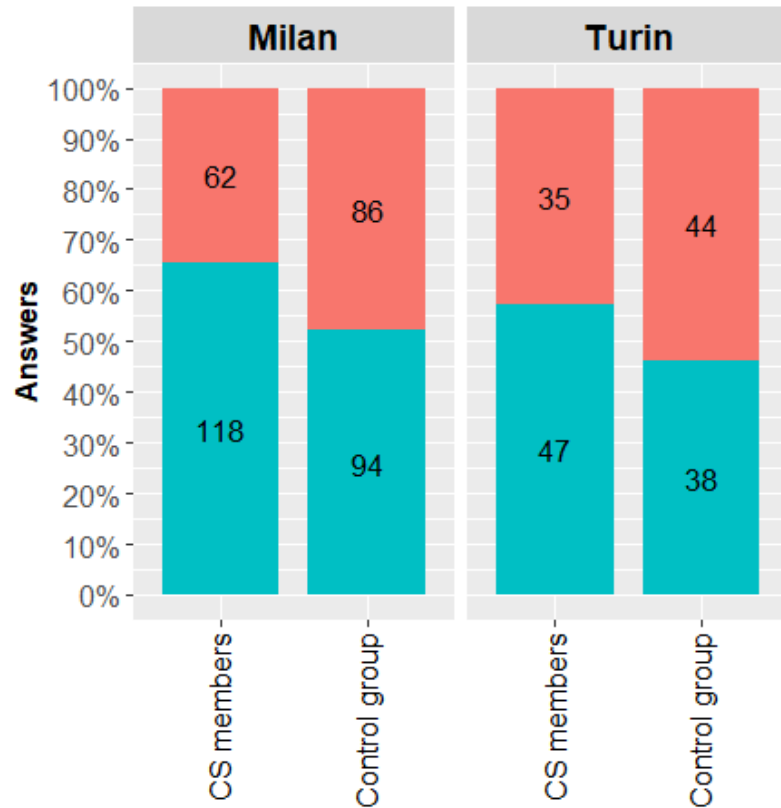
Milan (n=485)



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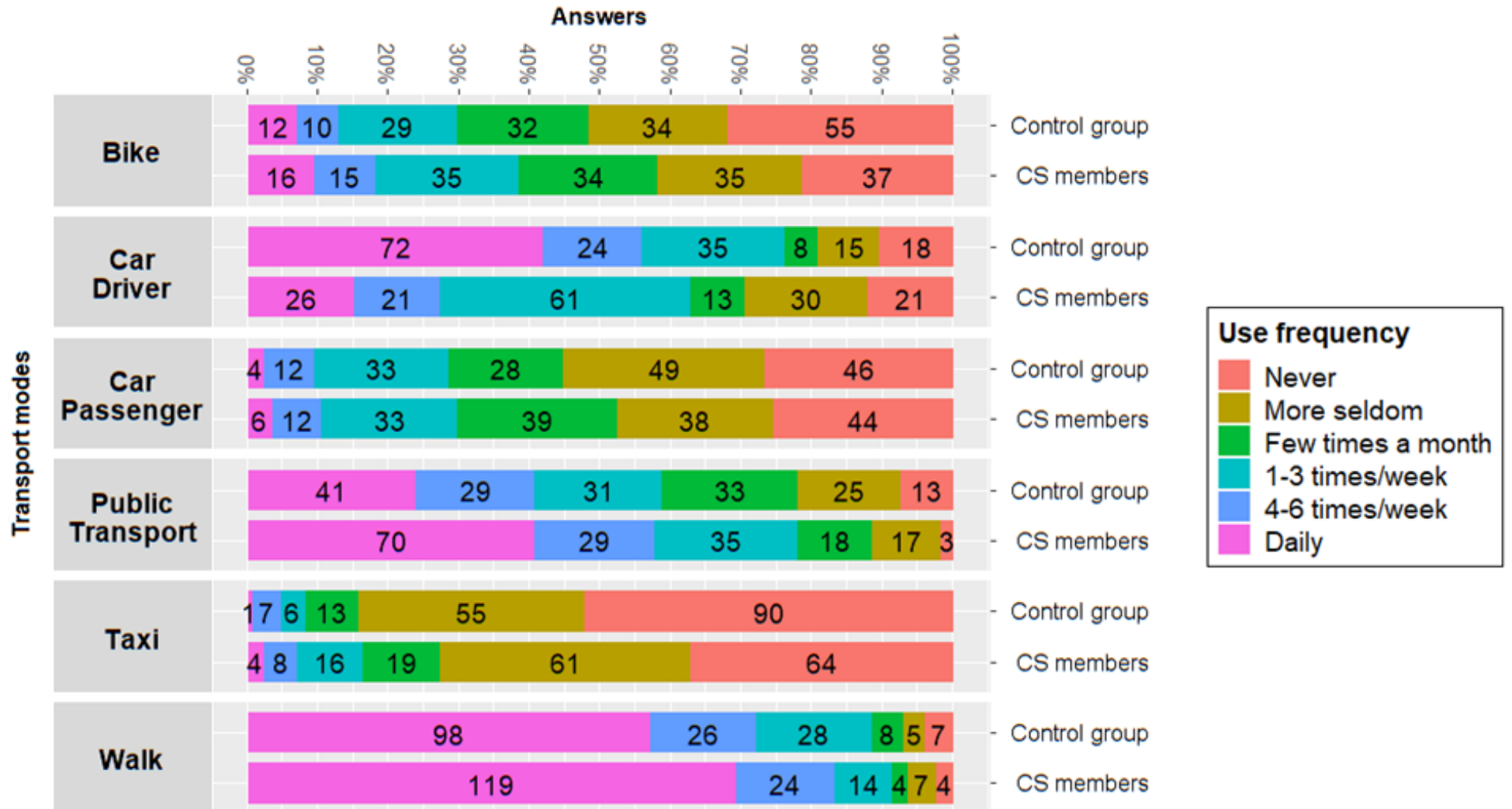
PT season ticket ownership & bike sharing membership



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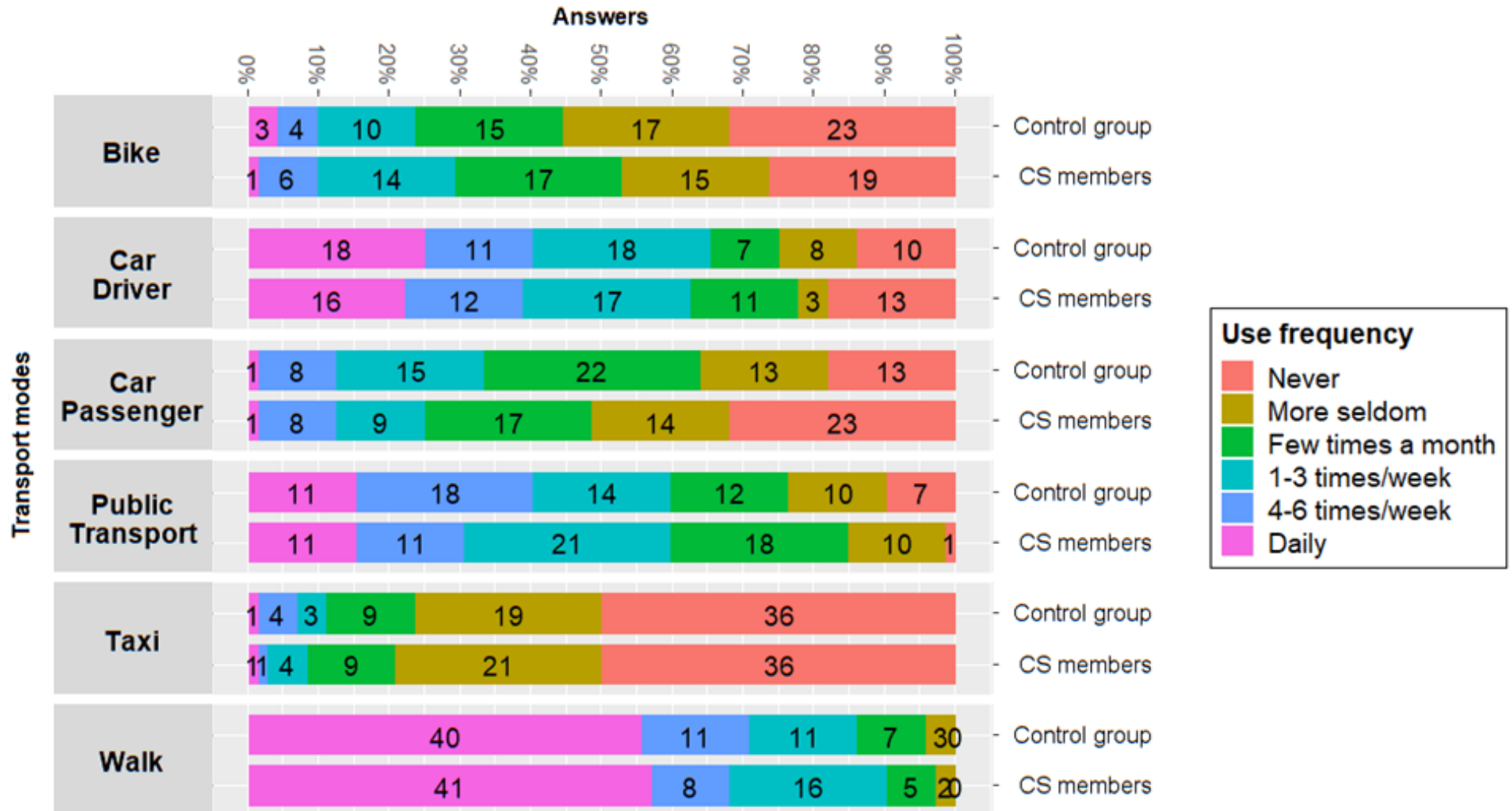
Frequencies of use of different travel modes - Milan



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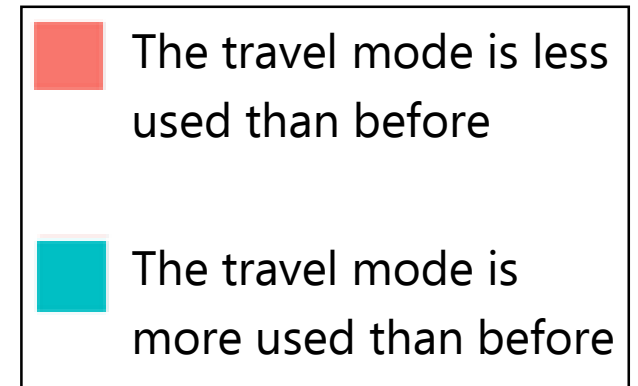
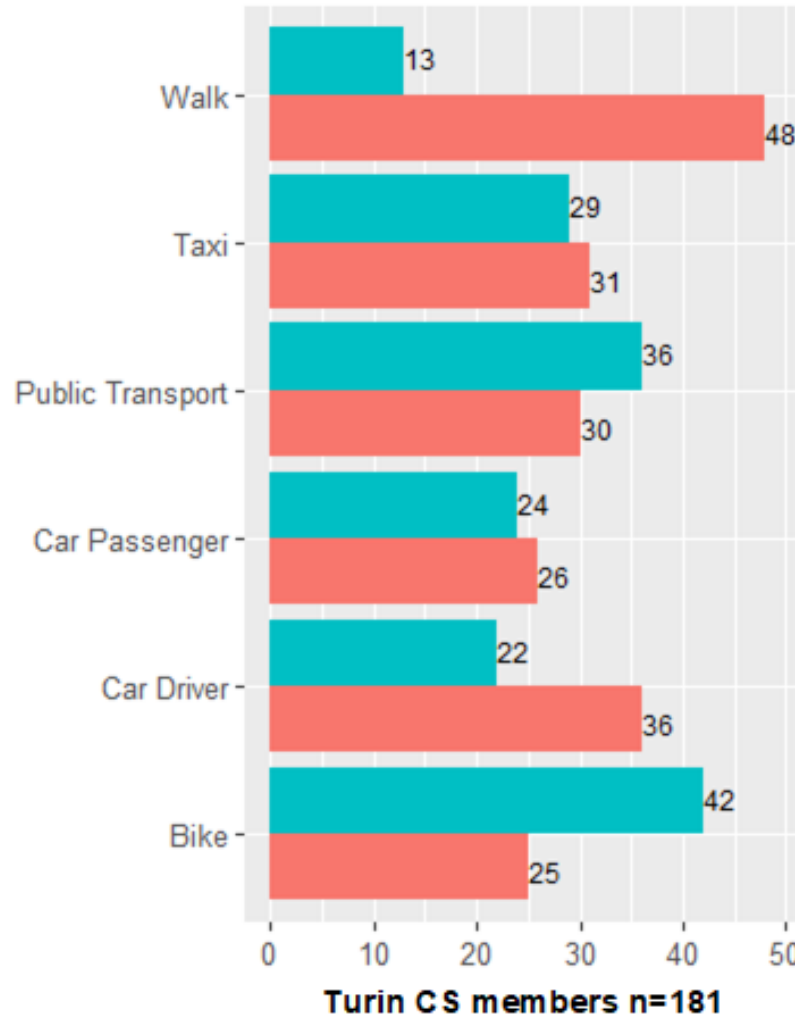
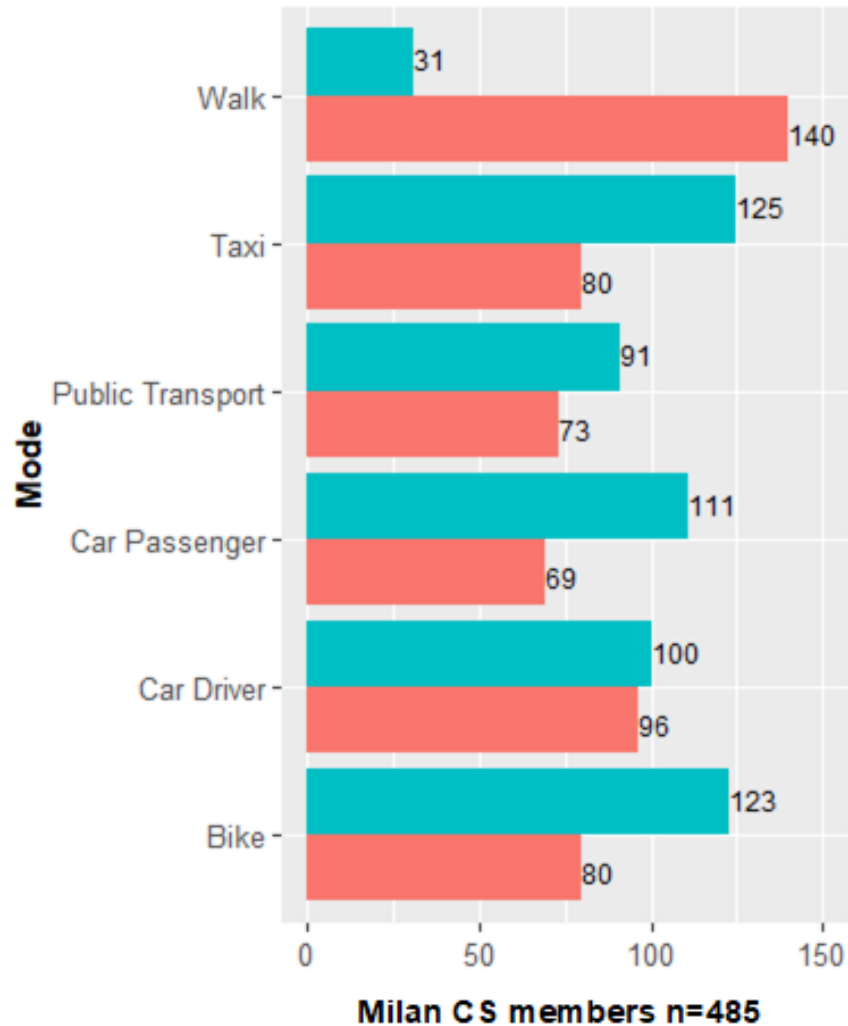
Frequencies of use of different travel modes - Turin



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Changes in travel habits after joining CS



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Trip-level analyses: daily mobility scenarios and related car sharing impacts (1/2)



- ★ To **quantify** the potential of car sharing in attracting travel demand
- ★ To clarify **substitution and complementarities** at the **individual trip level** that will potentially change the travel demand **for all competing modes**



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Trip-level analyses: daily mobility scenarios and related car sharing impacts (2/2)

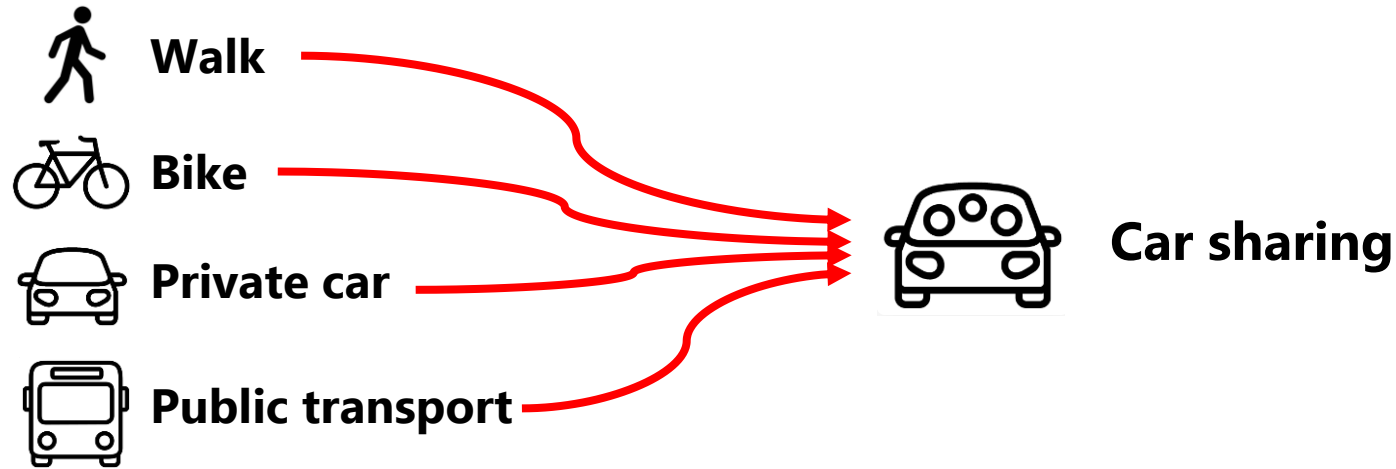
HOW?

- ★ **Switching models** to predict the potential switch from the base mode (walk, bike, car and PT) to car sharing
- ★ Generation of **mobility scenarios** from the modelling results:
 - not referred to a specific time point
 - travel demand constant across scenarios
 - public transport offer constant across scenarios



Switching models (1/2)

★ 4 main models



★ Calibrated on a large travel survey (3280 interviews) run in Turin in 2016-2017 with stated choice experiments that were missing from the STARS survey



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Switching models (2/2)

- ★ Models input: **socioeconomic characteristics** (individual and household) and **trip characteristics** (travel distance, duration, daytime, purpose of the trip...)
- ★ Models output: **probability** to switch to car sharing for a specific trip that are used to estimate the number of trips for all models



Mobility scenarios (1/2)

Five mobility scenarios have been identified:

- ★ **Business as usual scenario:** market shares of all modes are those observed in the survey, expanded to the universe, or taken from official statistics concerning car sharing
- ★ **All switch scenario:** CS market shares are the maximum possible under current conditions
- ★ **Rupture scenario:** modal market shares are those that maximise the overall car sharing benefits, only considering greenhouse (CO₂) and pollutants (NMVOC, NO_x, NH₃ and PM_{2.5}) reduction of emissions
- ★ **All electric scenario:** it is derived from the rupture scenario by using a fully electrified fleets instead of the current car sharing fleets composition
- ★ **No car sharing scenario:** market shares of all modes are those of the BAU scenario without considering car sharing and using the alternatives declared from the respondents instead



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Mobility scenarios (2/2)

For each scenario:

- ★ Estimation of the number of trips for each mode (private car, car sharing, public transport, bike and foot)
- ★ Quantification of the emissions of pollutants and greenhouse gases
- ★ Evaluation of the related external costs (European Commission (2019) Handbook on the external costs of transport, <https://doi.org/10.2832/27212>)
- ★ Evaluation of the impacts on parking demand



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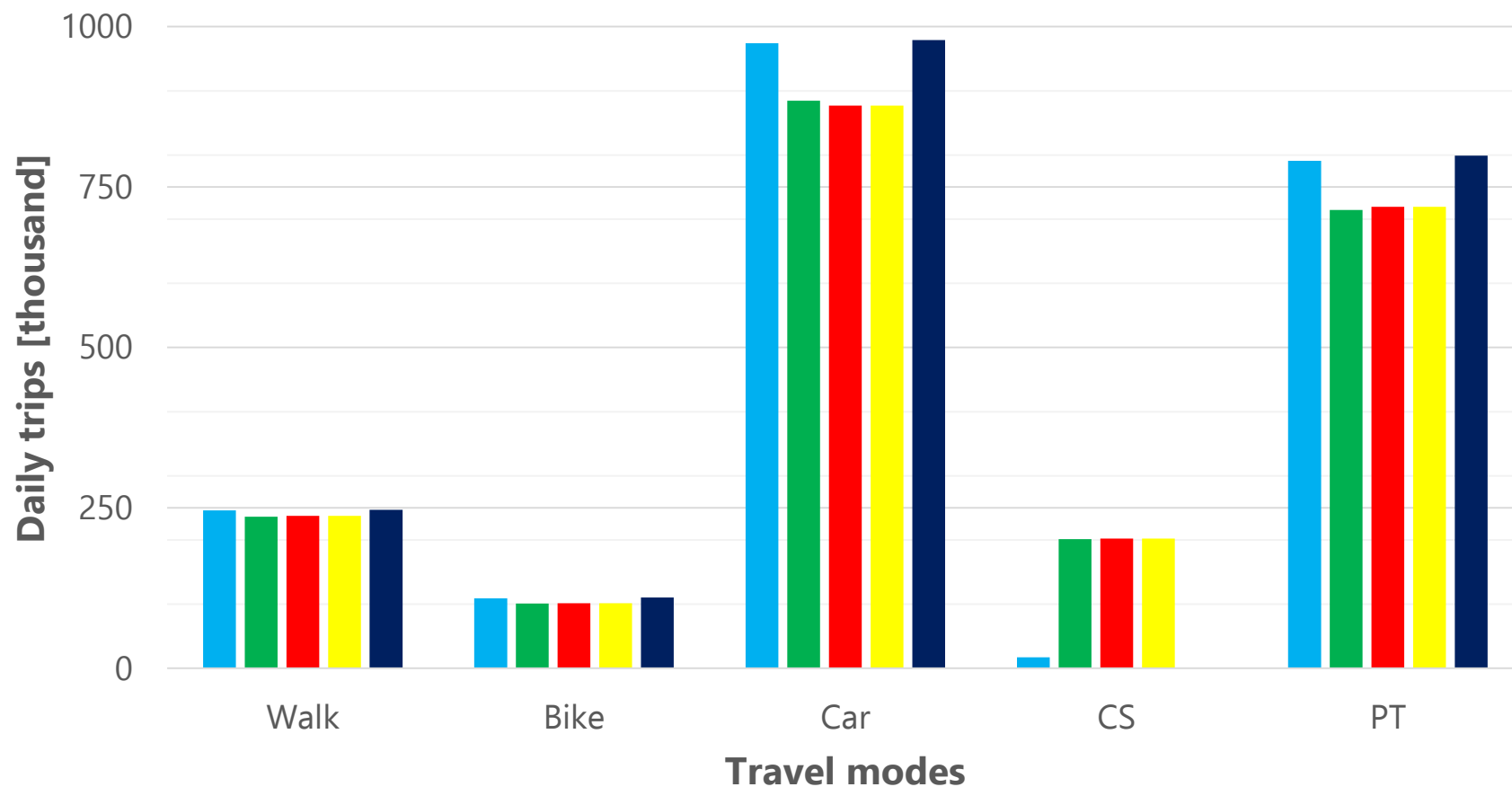


All switch versus rupture scenario

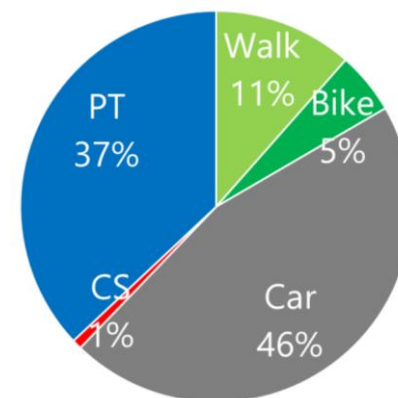
- ★ **Maximising car sharing use is not necessarily maximising its benefits**
- ★ It depends on the **switching patterns** between different modes and car sharing, where a maximisation of diverted trips from private cars and a minimisation of diverted trips from public transport and active means is desirable
- ★ **Market shares** from the all switch scenario were **changed** by **acting on car sharing fares and parking costs for private cars** (two variables that are partly in control of city administrations)
- ★ The combination of the two variables that leads to the **minimisation** of **emissions** leads to the rupture scenario



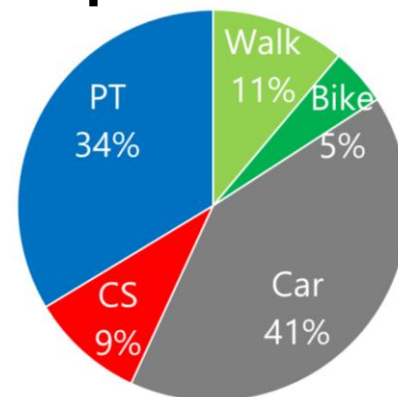
Diverted daily trips and market share in scenarios - Milan



BAU scenario



Rupture scenario



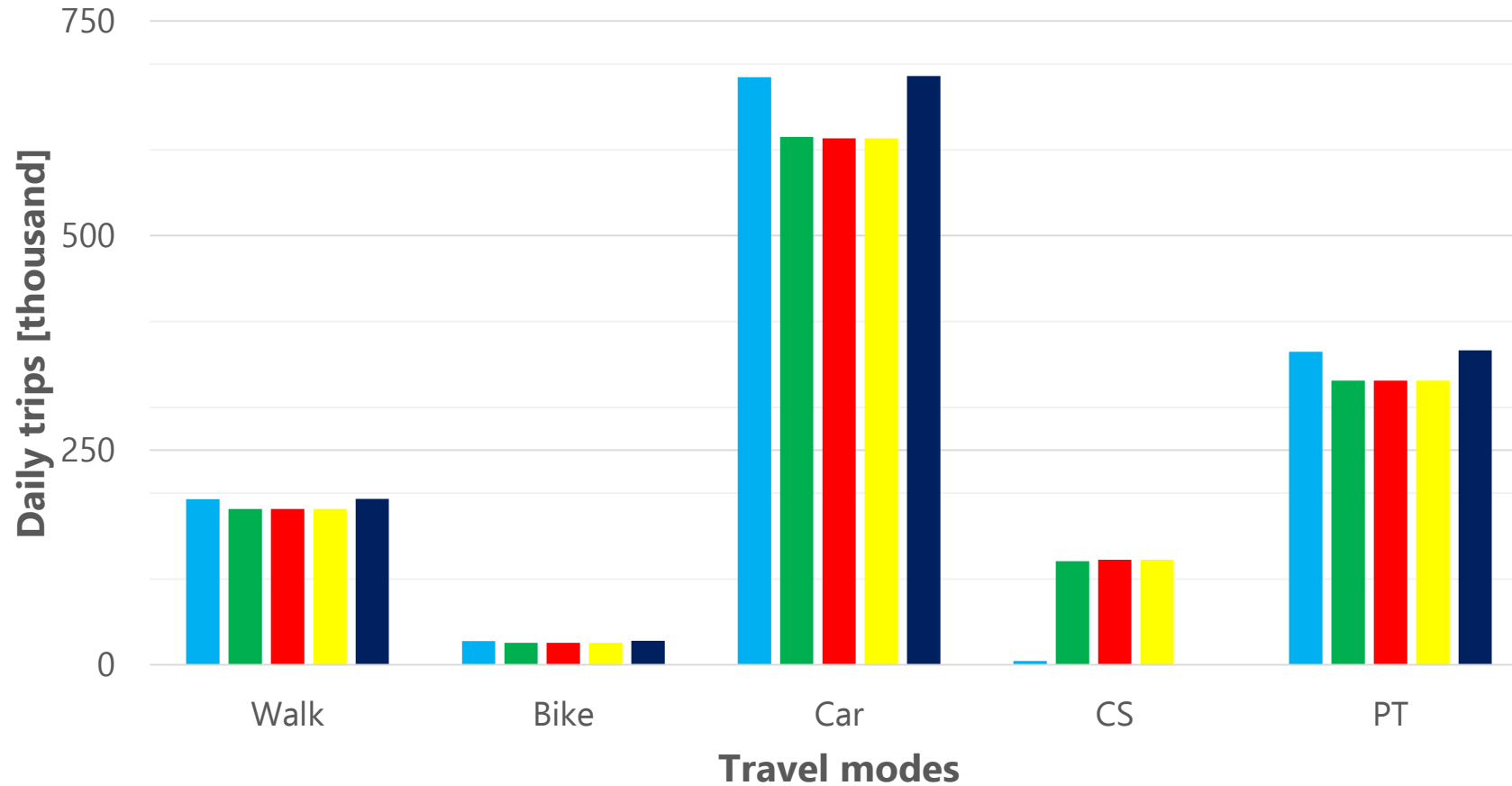
Business as usual All switch Rupture Electric No car sharing



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Diverted daily trips and market share in scenarios - Turin

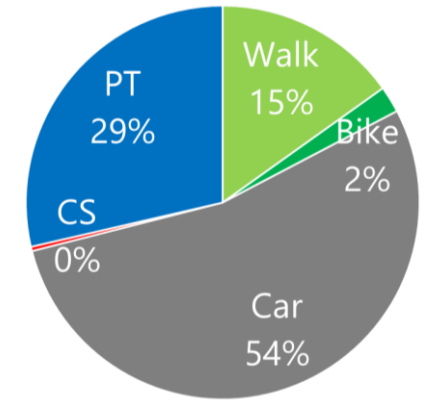


Business as usual All switch Rupture Electric No car sharing

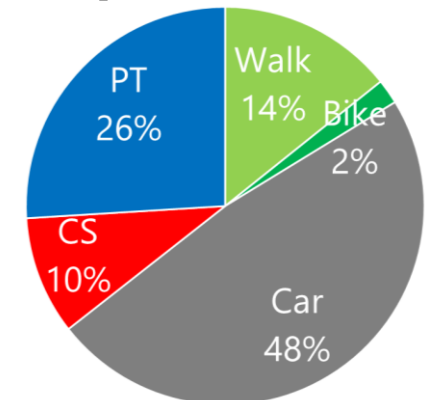


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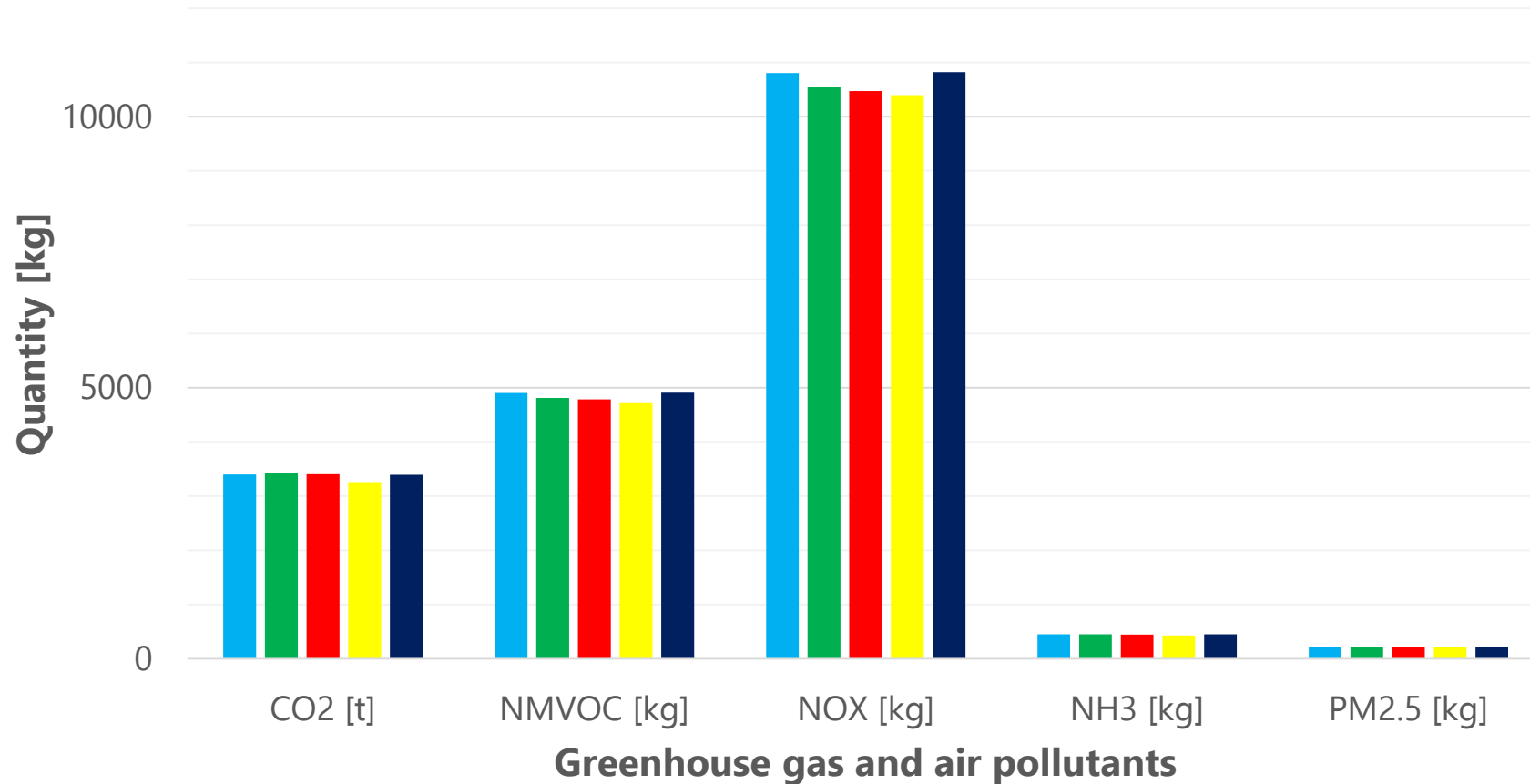
BAU scenario



Rupture scenario



Emissions of pollutants and greenhouse gas in scenarios - Milan



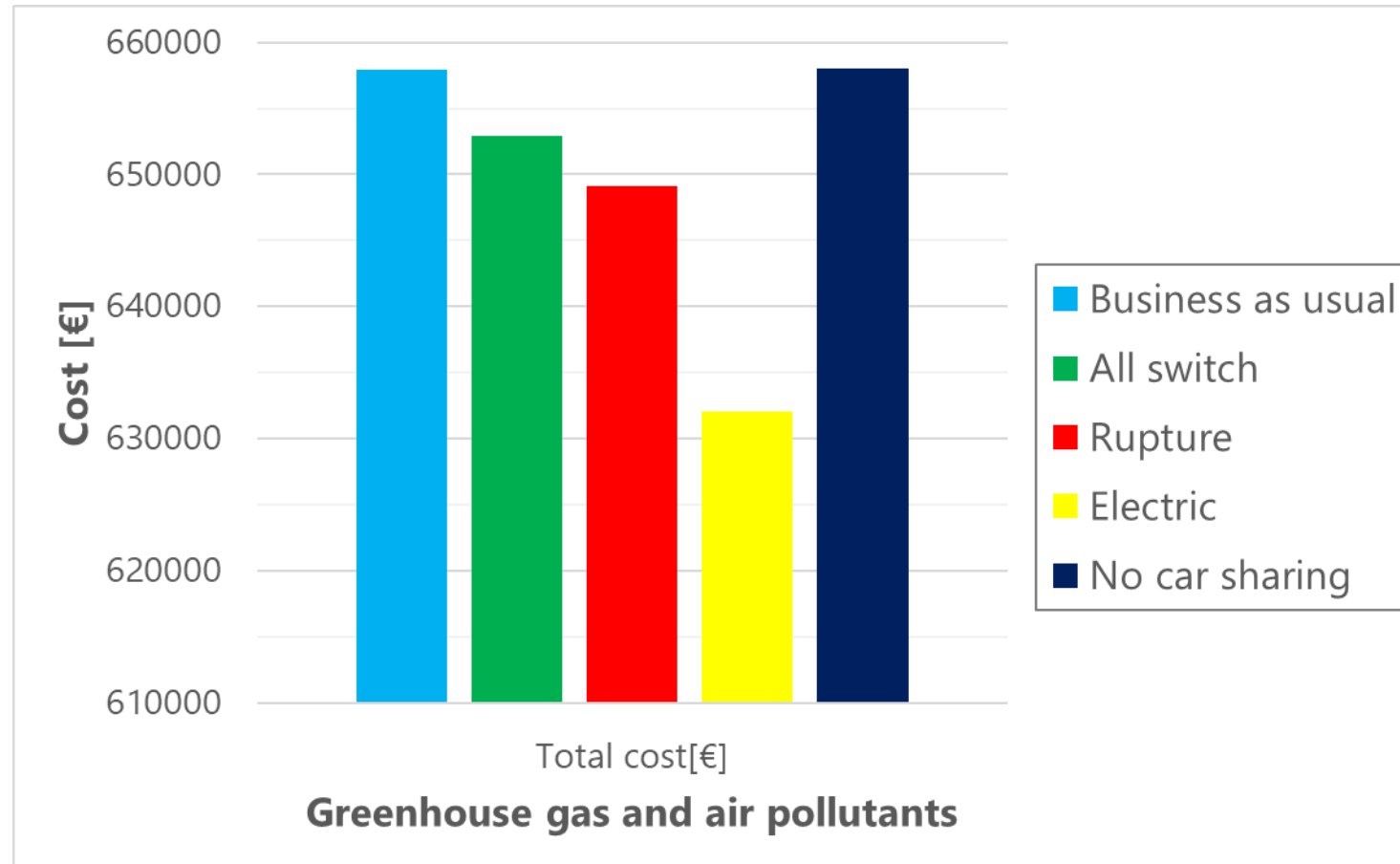
Business as usual All switch Rupture Electric No car sharing



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External costs of pollutants and greenhouse gas emissions in scenarios - Milan



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Impacts of modal diversion on public spaces

- ★ Impacts deriving from changing in car ownership are not considered here

 **trip-level parking lots occupation analysis**

- ★ **Parking events**: conceptual measurement unit that is **not equivalent** to the number of **parking spaces** (one parking space can host several events)
- ★ **Quantitative results** can be provided in terms of number of **saved parking events**, which are parking spaces not any more occupied by vehicles since the related trips were switched to car sharing
- ★ It is necessary to know where cars are parked at trip origin and destination



Quantification of impacts (only for trips diverted from private car)

Parking at the trip origin	Parking at the trip destination	Impact on parking at the origin	Impact on parking at the destination
Garage	Street	Neutral	Positive ¹
Garage	Dedicated parking area	Neutral	Positive ¹
Garage	Garage	Neutral	Neutral
Dedicated parking area	Street	Negative ²	Positive ¹
Dedicated parking area	Dedicated parking area	Negative ²	Positive ¹
Dedicated parking area	Garage	Negative ²	Neutral
Street	Street	Negative ²	Positive ¹
Street	Dedicated parking area	Negative ²	Positive ¹
Street	Garage	Negative ²	Neutral

^[1] CS cars are usually parked for less time than private cars

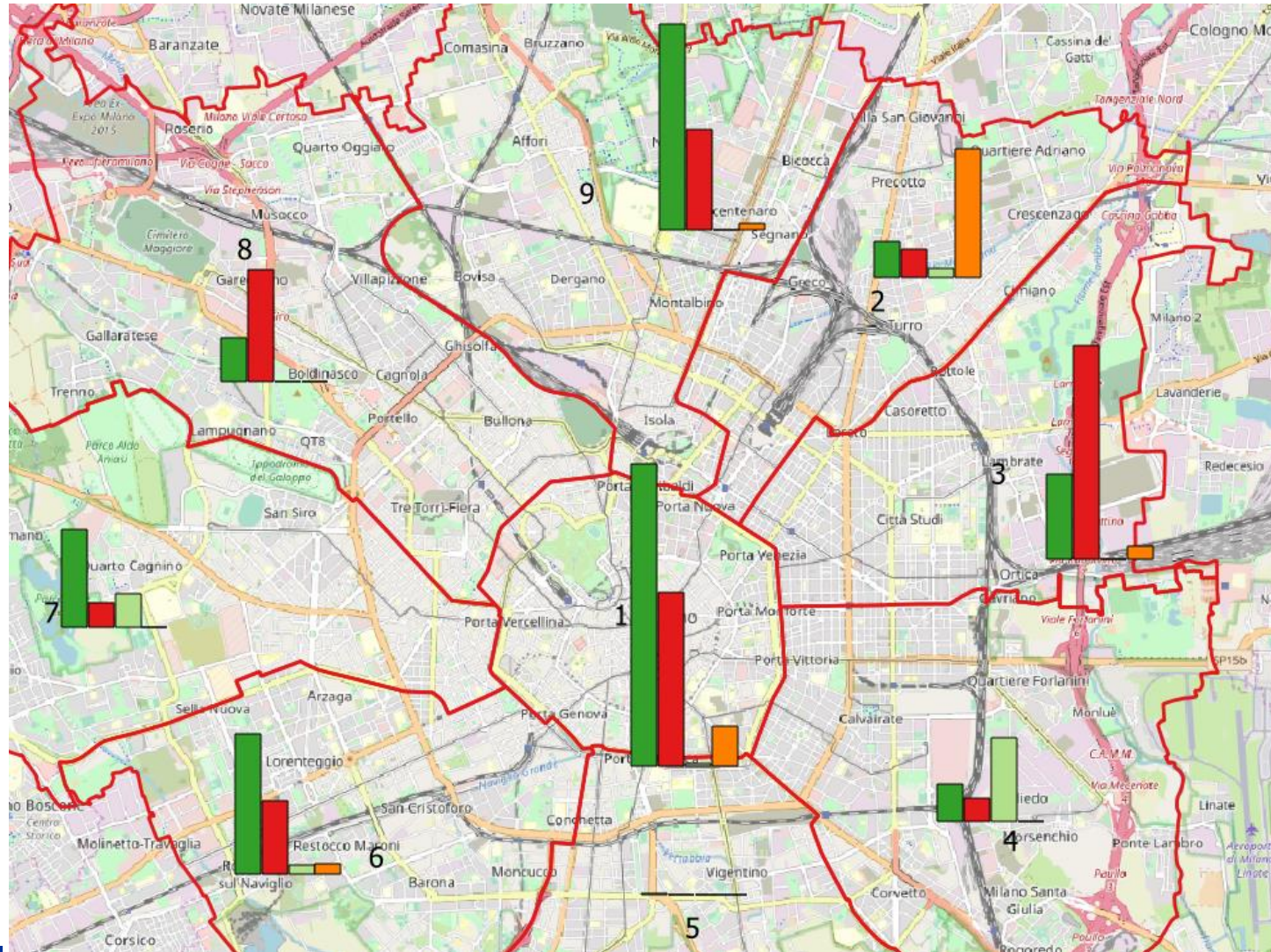
^[2] The private car is still there



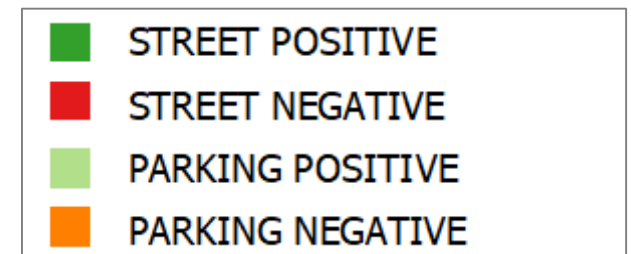
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Public spaces occupation analysis



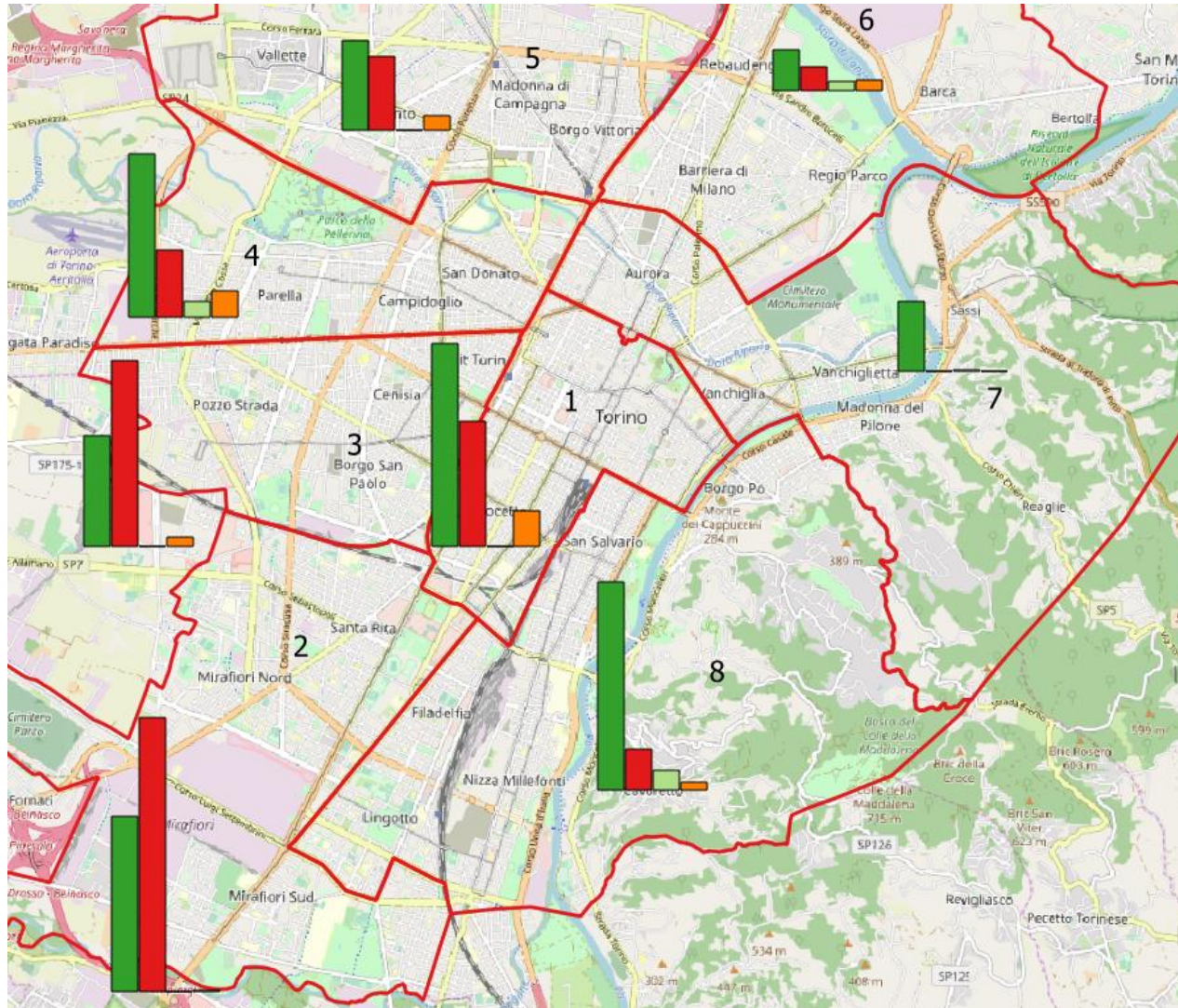
Milan Rupture scenario



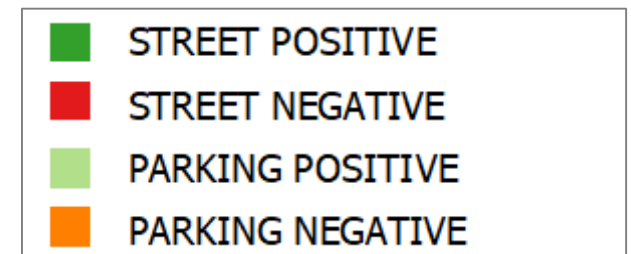
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Public spaces occupation analysis



Turin Rupture scenario



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Conclusions

- ★ CS members more frequently use active modes and public transport than non-members. They are more multimodal.
- ★ A slight increase in the number of cars owned was observed among Italian CS members. However, framing this result in the car ownership trends of the whole population, it can be noted that the growth rate of cars owned by car sharing members is smaller than that of non-members.
- ★ CS seems to have a higher impact on postponing the purchase of additional cars.
- ★ Slightly different results in PT season ticket ownership suggest that having a **dense and reliable public transport** offer is more relevant than car sharing membership.



Conclusions

- ★ The car sharing rupture scenario would produce an increase of the CO2 emissions along with a reduction of all main pollutants, which are however negligible compared to the amount currently produced.
- ★ Car sharing rupture scenario would anyway produce a saving for cities in economic terms.
- ★ Concerning the use of public spaces, car sharing might produce a positive impact on daily central areas parking events in the rupture scenario.



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General conclusions

- ★ Roundtrip and combined services seem to have a dramatic impact on car ownership compared to free-floating ones, but a lower number of members.
- ★ The aggregate impacts at the level of the overall urban area could be of the same order of magnitude
- ★ Complementarity of the different car sharing schemes may lead to an ideal situation where the maximum benefit of each system is exploited.



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Thank you

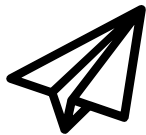
Get in touch for more information!



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All of the reports of the project will be available for download on the STARS website: **www.stars-h2020.eu**



Project coordinator: Marco Diana, Politecnico di Torino
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