Holistic Approach for Providing Spatial & Transport Planning Tools and Evidence to Metropolitan and Regional Authorities to Lead a Sustainable Transition to a New Mobility Era

D3.4 - HARMONY data: statistical and spatiotemporal analyses

Submission date: 29/04/2022

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815269

Part of:

SUMMARY SHEET

PROJECT

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DELIVERABLE

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0.1	14/03/2022	UAEGEAN – IT	ToC and brief desc.
0.2	29/04/2022	UCL	Final review

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
ABM	Activity-based model
OXS	Oxfordshire
TUR	Turin
TRK	Trikala
GZM	Katowice area
AV	Autonomous vehicle
km	kilometres
SAV	Shared Autonomous vehicle
PT	Public transportation

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EXECUTIVE SUMMARY

Deliverable 3.4 presents a part of the primary data collected during the HARMONY project. Given the different data collection efforts, conducted in different time periods of the project and the barriers in data collection effort (mainly due to the pandemic) the deliverable presents the available primary data as of April 2022. D3.4 presents analysis of the data, charts, commentary, spatial and temporal maps and a discrete choice model in the case of Katowice.

The deliverable is split into 4 main sections: The first section presents the primary data collection in Turin, discussing the representativeness of the sample, presenting responses to attitudinal questions, the habitual travel behaviour of respondents, mobility-related questions, overall sociodemographic and activity/travel data elicited through the Moby app data collection. The second section presents a short description of the drone experiments in Trikala, with the routes and the outcomes, including technical results and reporting of incidents. The third section reports on the drone SP experiment in Katowice, including attitudinal survey results, actual respondent choices and a multinomial logit model of user preferences. The final section presents the results from the COVID-19 risk mitigation measures and the impact of the pandemic in short and mid-term policy and decision making.

1. Introduction

HARMONY collects a multitude of primary data, especially regarding passenger travel behavior, focusing on two pilot cities: OXS and TUR. Collection of primary data is necessary for the development of a series of HARMONY MS sub modules and the main source of data for the Tactical Passenger simulator which deploys an activity-based model. Apart from the primary data collection which feeds the tactical passenger simulator, HARMONY also collects primary data for the following purposes: a) results of demonstrations including performance indicators of vehicles and reaction of survey

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participants; b) drone delivery games in GZM and experiment report from TRK and c) COVID-19 impact survey.

Due to delays in primary data collection, caused mainly because of difficulties and risks of collecting primary travel data during the lockdown periods, primary data regarding travel behavior is not available for OXS at the time of D3.4 deliverable and analysis is not presented in this deliverable. Additionally, the pandemic situation caused delays in the demonstrations of HARMONY, so data reports from the demonstrations will be reported at future, WP9 deliverables (D9.4 and D9.5).

Primary, travel behavior and sociodemographic data from Turin are presented in D3.4 Data is acquired from two main sources: the socio-demographic surveys, including the introductory questionnaire and the SP experiments and the Moby app travel behavior and activity data collection. The questionnaires include an introductory survey with socio-demographic data along with attitudinal, psychometric questions and habitual travel behavior. SP experiments include the mobility tool ownership survey, the mode choice survey, the remote work survey, and the dynamic travel behavior shift survey. Reports from the SP experiments are used for the development of the econometric and simulation models of WP5 and will be reported mainly in WP5 (D5.2). Results and GIS analysis from the introductory, socio-demographic survey and the Moby app data will be reported in D3.4.

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2. Primary data collection: Turin

Socio-demographic data

Table 1 presents the general socio-demographic data and a comparison with the most recent Turin census data.

Table 1 Socio-demographic data and comparison with census

Variable	Category	Sample (n=584)	Population (Census)	Census year / descr
Age (mean)		38.9	47.1	Year 2020.
Women (%)		55.5	51.8	Year 2020.
Education (%)	No formal qualifications	7.4	3.5	Year 2020. Data from Census is for >9 years old
	High school or less than high school	49.1	73.5	
	Vocational school	10	n.a	
	Undergraduate	12	11.5	
	Master's degree	11.5	11.0	
	Doctorate degree	4.4	0.5	
	Other	5.4		
Employment (%)	Full time paid employment	39.2	48.1	Year 2020. Data from Census is for >15 years old
	Part-time paid employment	14.5		
	Full time self-employment	6.6		
	Part time self-employment	3.8		
	Student	10.2	7.2	
	Unemployed and looking for work	8.7	6.0	
	Unemployed and not looking for work	1	5.3	
	Retired	5.9	25.5	
	Homekeeper	3.3	7.9	

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Variable	Category	Sample (n=584)	Population (Census)	Census year / descr
	Other	6.8		
Working schedule (% of those who work)	Fixed work schedule	36.5		Not available
	Flexible work schedule - with flexibility in finish times only	6.4		
	Flexible work schedule - with flexibility in start times only	2.3		
	Flexible work schedule - with flexibility in both start and finish times	37.2		
	Rotating shift work schedule	17.6		
Marital status (%)	Single	38.9	41.6	Year 2020. Data based on total population
	Married/Civil partnered	54.5	45.9	
	Divorced	5.8	4.7	
	Widowed	0.8	7.8	
# people who live in the household (%)	1	13.5	34.4	Year 2011.
	2	28.3	31.0	
	3	25.2	19.0	
	4	26.4	12.5	
	5	5.1	2.4	
	6	1.2	0.7	
	7	0.3		
# of children (%)	1	6.5	16.3	Year 2020. Data at regional level (calculated on total population, with or without children)
	2	7.7	11.7	
	3	0.6	2.8	
	4	0.3		
	5	0.2		
Income (% - self reported)	High	1.2	3.2	Year 2019. Data on taxpayers individuals. Assumptions in Euro/year:
	Higher middle	5.1	2.9	

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Variable	Category	Sample (n=584)	Population (Census)	Census year / descr
	Middle	52.6	27.3	high (>75,000), higher middle (50,000 - 75,000), middle (25,000 - 50,000), lower middle (15,000 - 25,000), Low (<15,000)
	Lower middle	27.5	32.4	
	Low	4.9	34.2	
	Prefer not to answer	8.7		
# of employed persons in the household (%)	0	7.8	40.9	Year 2020. Data at regional level on total households.
	1	32	33.4	
	2	47.3	25.7	
	3	10		
	4	2.3		
	5	0.6		
# of driving license holders in the household (including respondent - %)	0	4.3		Not available
	1	25.5		
	2	48.6		
	3	13.5		
	4	6.9		
	5	1.2		

Attitudinal questions

This sub-section presents the results from the attitudinal questions. All attitudinal questions answers range from 1: completely disagree with the attitude to 7: completely agree, expect a couple of psychometric questions which measure in the scale of 1 to 5. The main sub-categories are: attitudes towards autonomy, attitudes towards COVID-19 measures and the general pandemic effect, data sensitivity attitudes, remote work, travel plan change, smartphone reliance, and travel efficiency attitudes.

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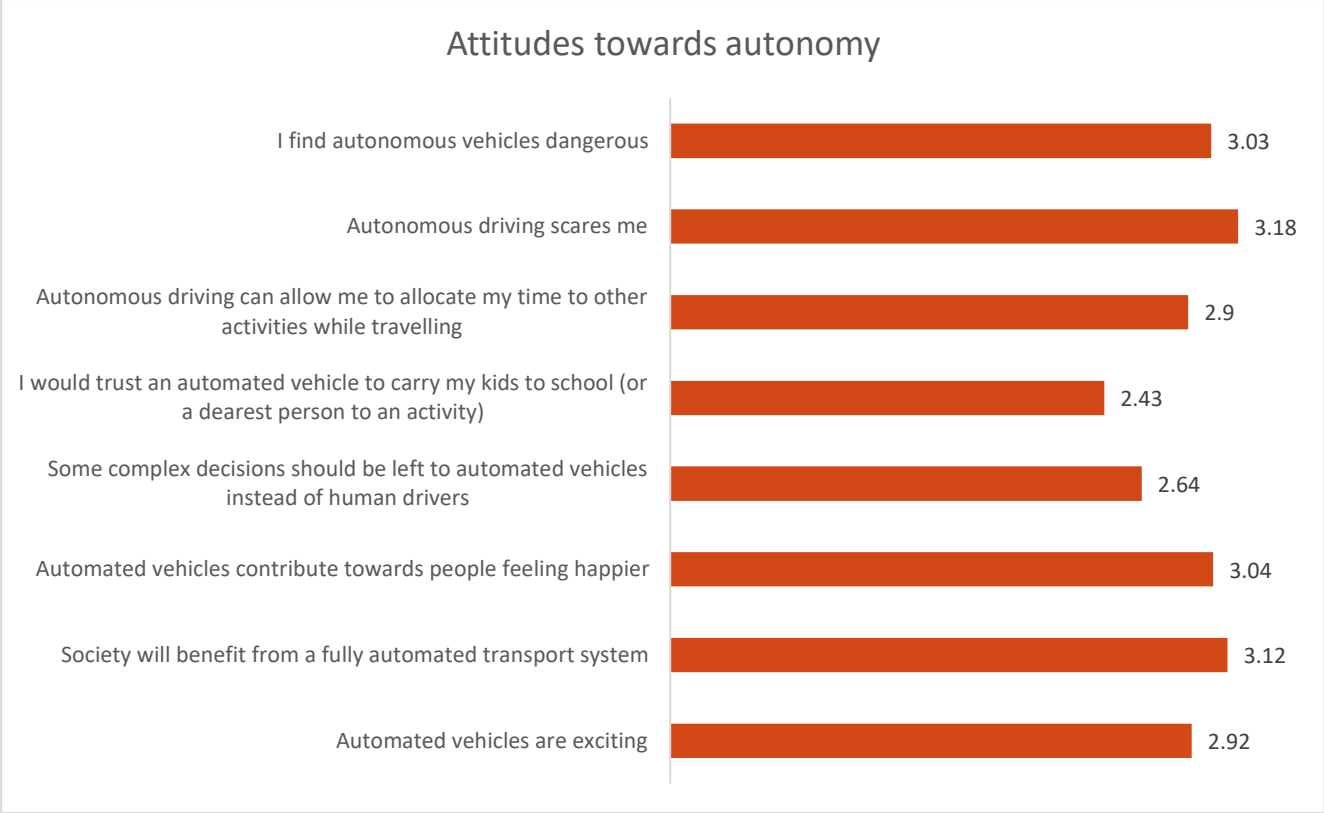

Figure 1 Attitudes towards autonomy [1:completely disagree to 5 completely agree]

The attitudinal questions regarding autonomy reveal some interesting results. The overall excitement about automated vehicles is close to 3/5, while most respondents believe that automated vehicles contribute towards people happiness and that society will benefit from a fully automated transport system. However, respondents feel that autonomous driving could scare them (3.18/5), they would not trust an AV to carry their kids to school and believe that some complex decisions should be a human decision.

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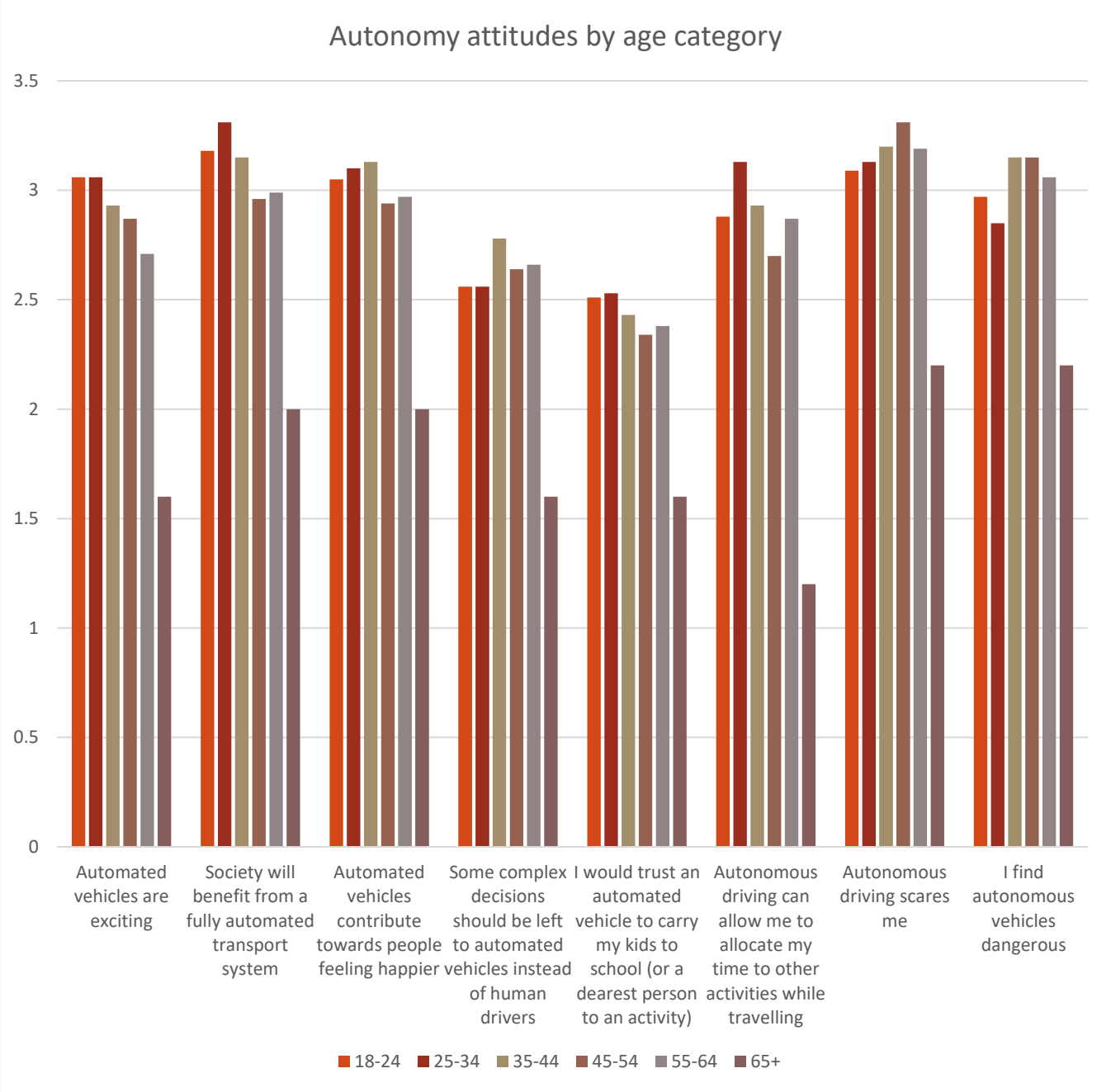

Figure 2 Autonomy attitudes by age category [Comparison of means]

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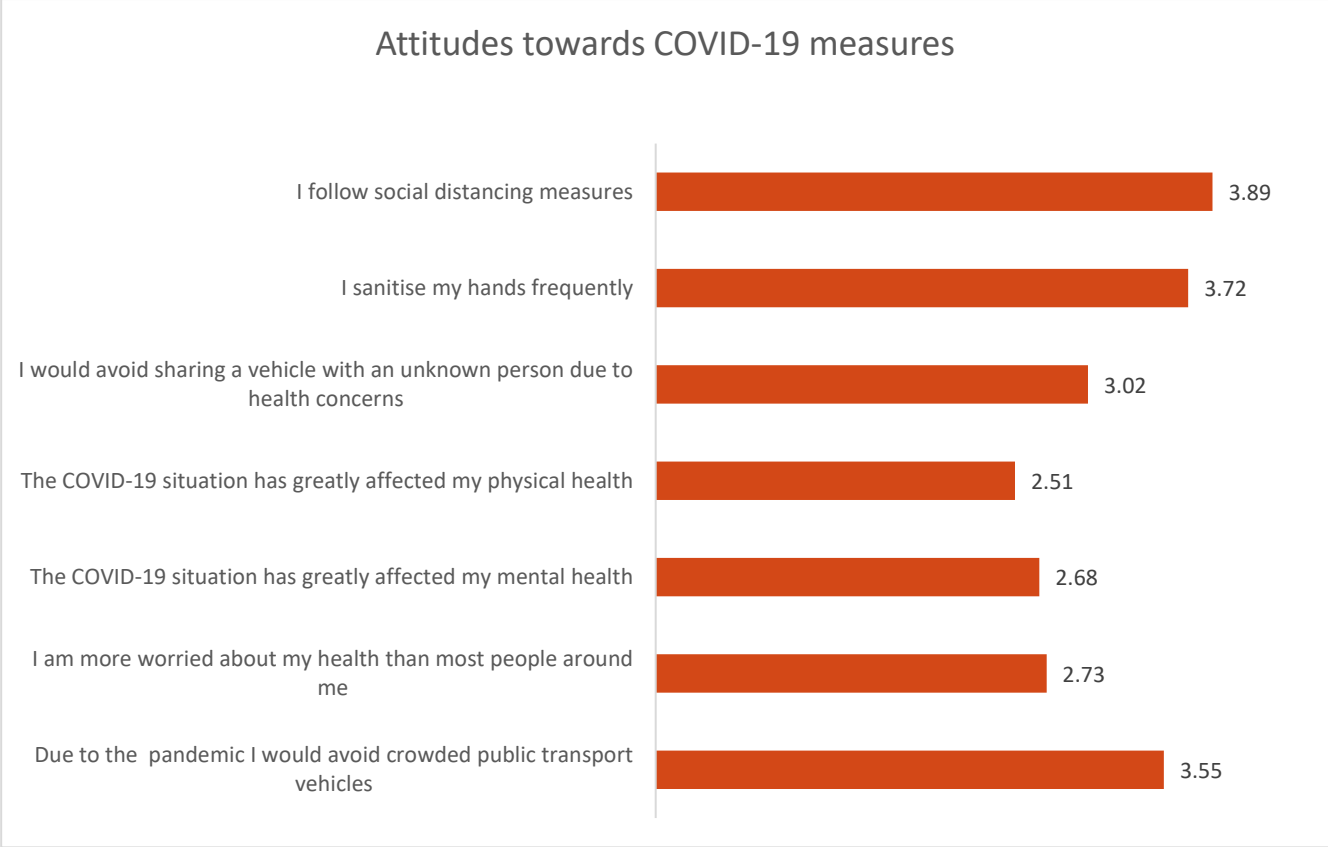

Figure 3 Pandemic attitudes [1: completely disagree to 5 completely agree]

Regarding the pandemic mitigation measures, the attitudinal survey presents some contradicting results. While respondents overall comply with the measures and take some personal steps towards minimizing the risk of spreading COVID-19, the situation has affected their mental and physical health, and tend to avoid PT and shared vehicles.

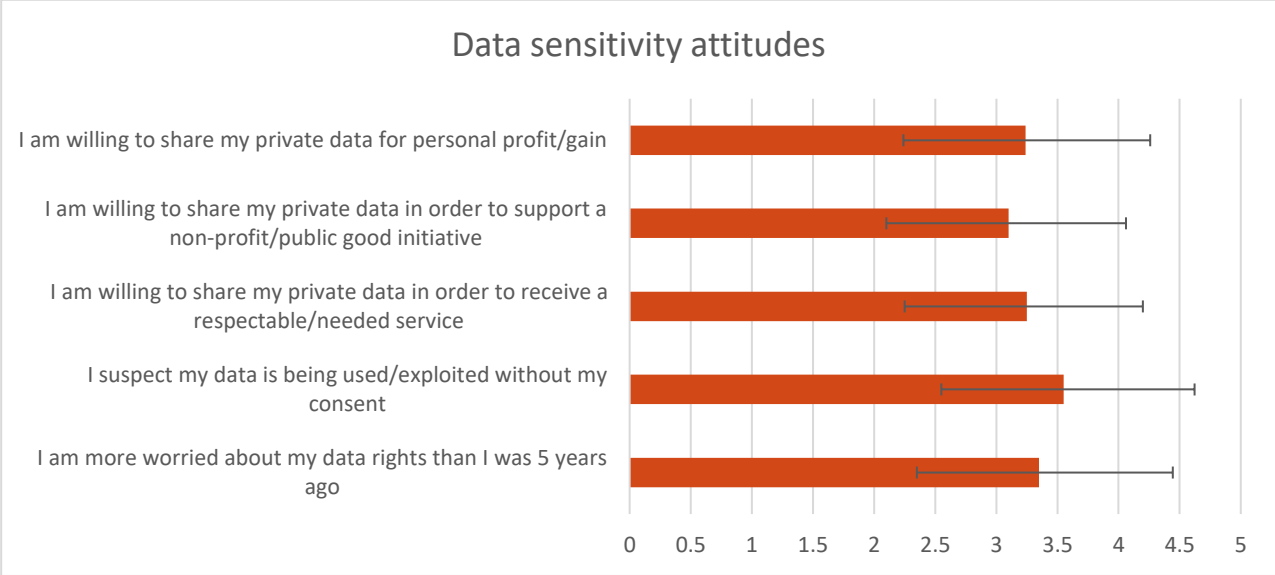

Figure 4 Data sensitivity attitudes [1: completely disagree to 5 completely agree]

Regarding sensitivity to data collection, respondents suspect that their personal data is exploited without their consent and are more worried about their data rights than in the past. On the other hand,

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there are willing to share private data to support a non-profit or public good initiative or for personal gain or profit, or to gain access to a needed service.

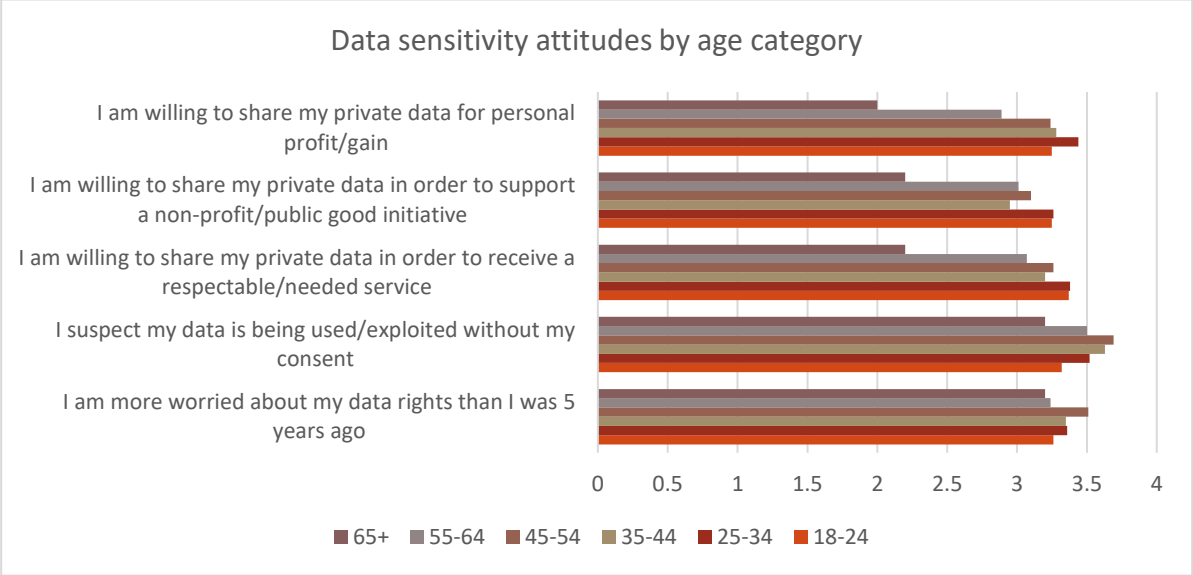

Figure 5 Data sensitivity attitudes by age category [Comparison of means]

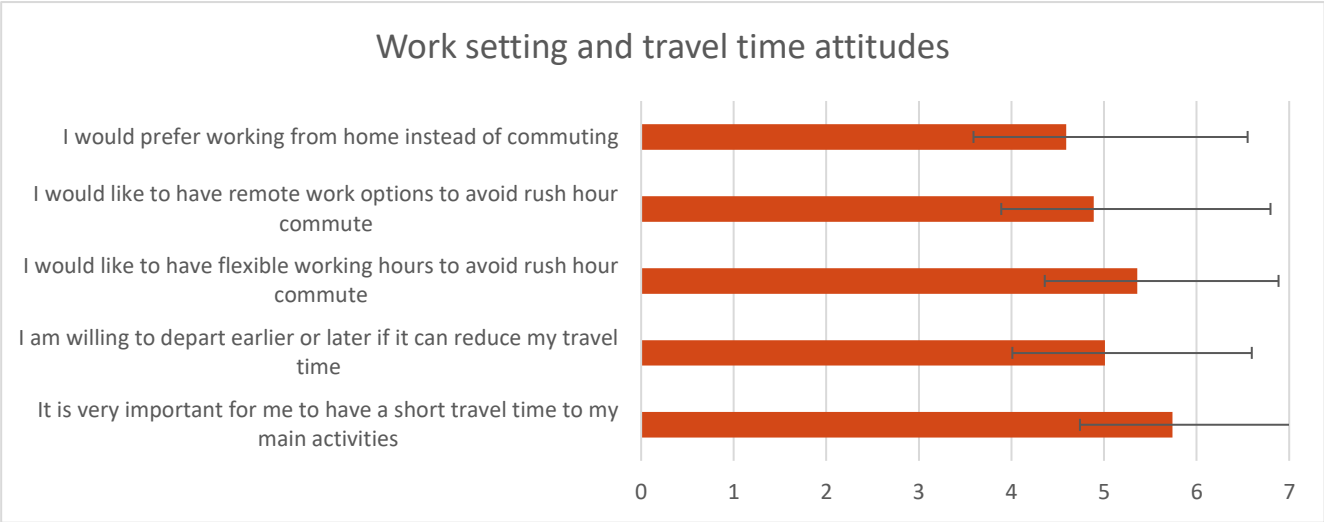

Figure 6 Remote work attitudes [1:completely disagree to 7 completely agree]

Regarding remote work, survey respondents mostly prefer to work from home to avoid commuting, rush hour commute. However, they marginally prefer flexible working hours and departing earlier or later to reduce travel time. Overall, it is important for them to have a short travel time.

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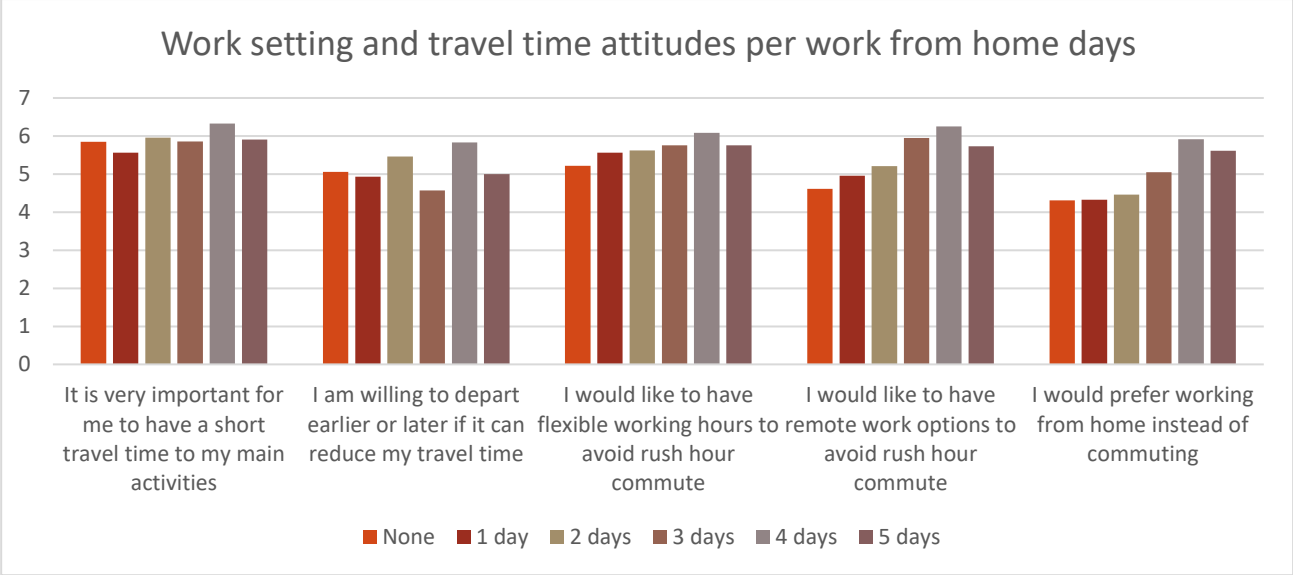

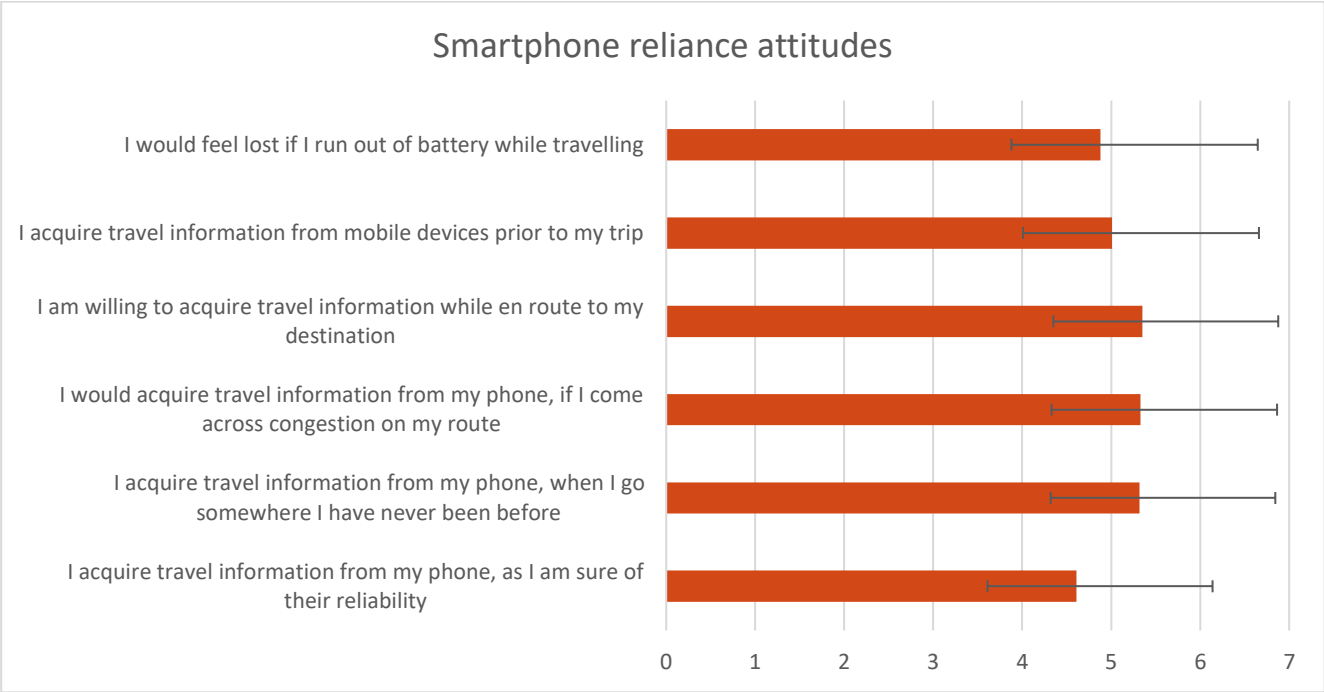

Figure 7 Smartphone reliance attitudes [1:completely disagree to 7 completely agree]

Survey respondents state that they are willing to receive travel info while en route, and would prefer to acquire such information if they come across congestion or if they travel somewhere new. Respondents also report that they would feel lost if they run out of battery while travelling and that they acquire travel information before travelling. They tend to mostly trust the reliability of the travel information accessed via their smartphone but this attitude is the lowest ranking in this group.

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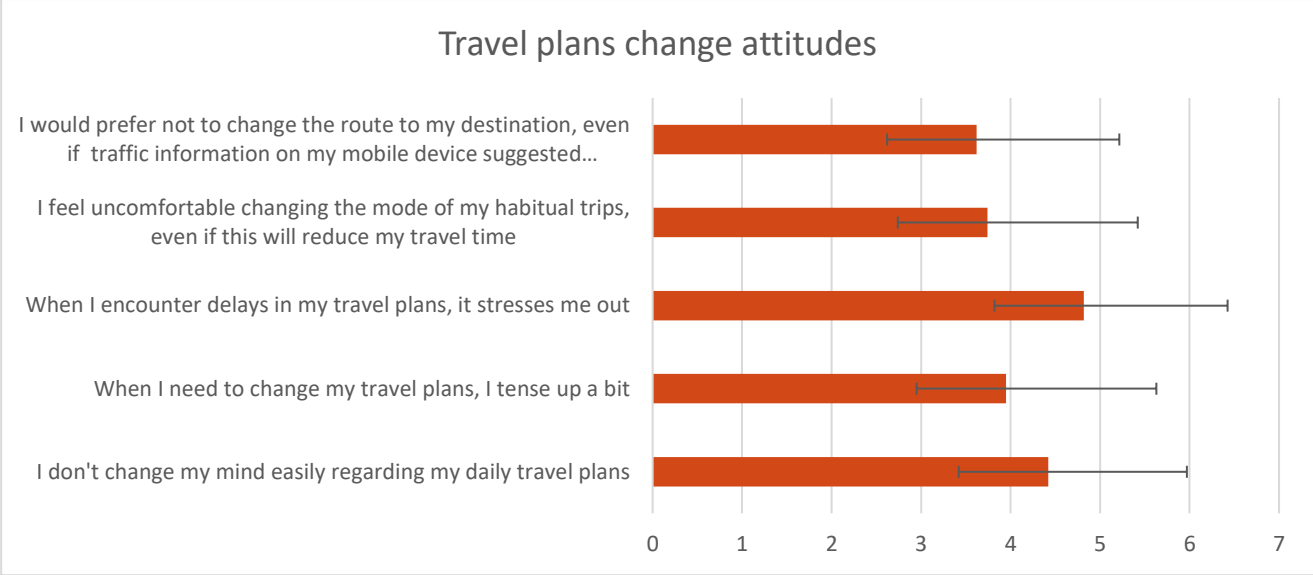

Figure 8 Travel plans change attitudes [1:completely disagree to7 completely agree]

Regarding the change of travel plans respondents replied that they tend to stress out then they encountered delays but they don't seem to tense up when they need to change their plans. Respondents also report a willingness to change route and mode if they think or acquire information that this will reduce travel time or delays.

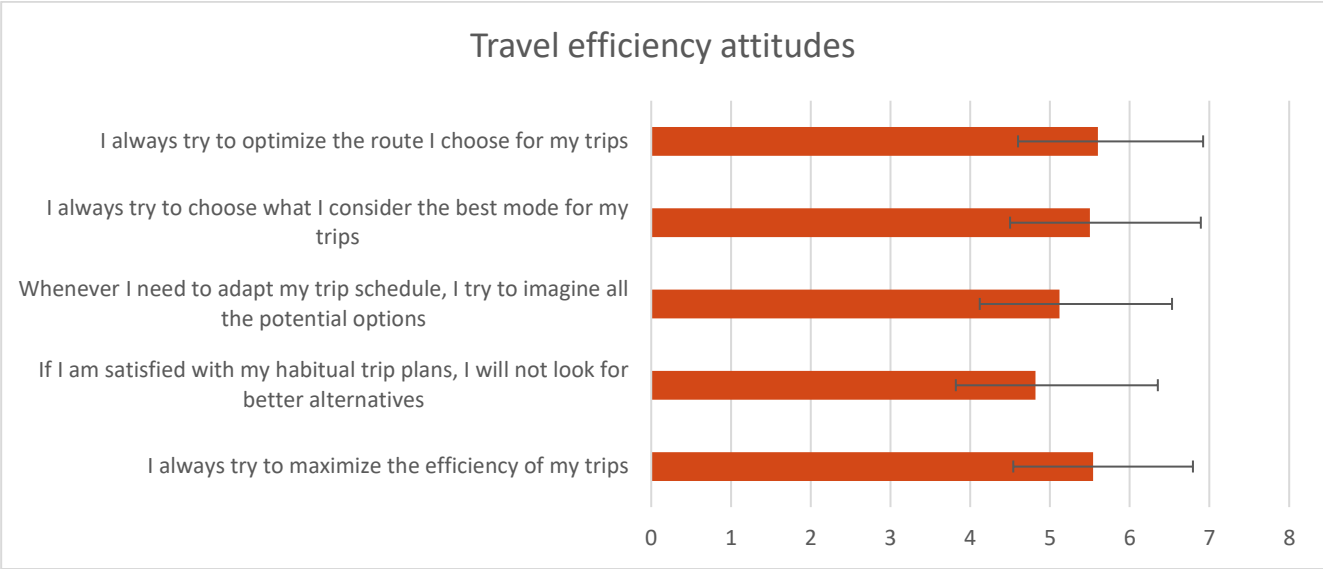

Figure 9 Travel efficiency attitudes [1:completely disagree to 7 completely agree]

Responses regarding travel efficiency attitudes reveal that is it very important for the respondents to travel efficiently. They always try to optimize their routes and choose the best mode for they trips. They also report that they try to maximize efficiency and that they will consider changing their habitual plans if better alternatives exist.

Vehicle ownership and usage data

This section presents results and charts related to vehicle ownership and usage of surveyed households.

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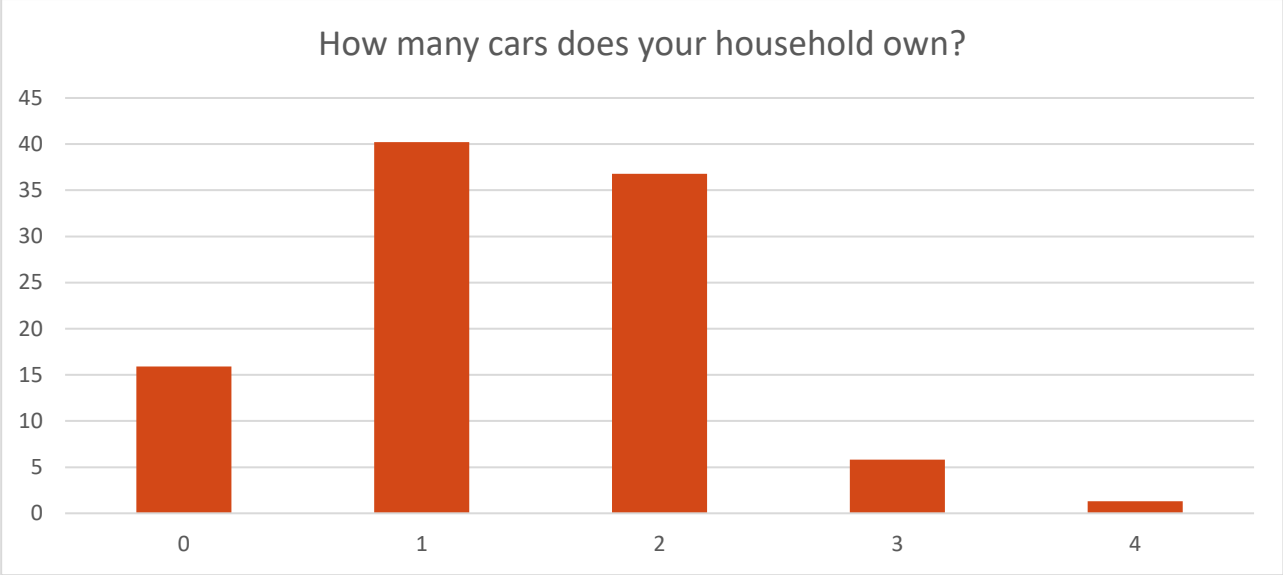

Figure 10 Number of cars in the household

Most households surveyed have either 1 or 2 owned vehicles, with a significant 15% reporting no owned vehicle.

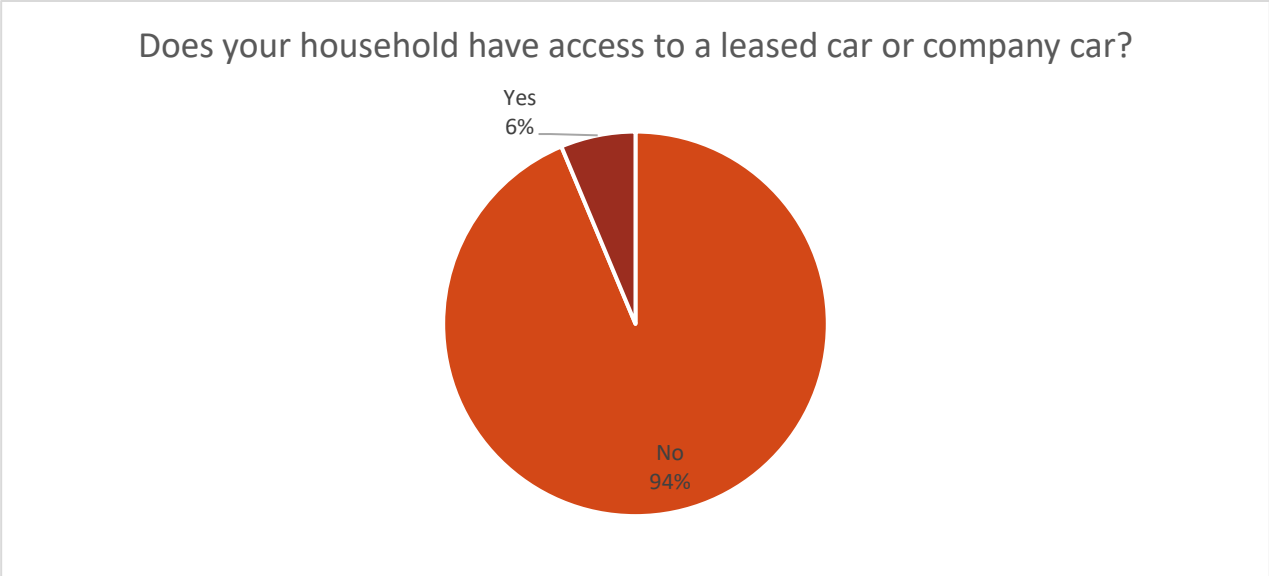

Figure 11 Company cars/leasing

Figure 11 presents a 6% of leased or company cars among households in the sample.

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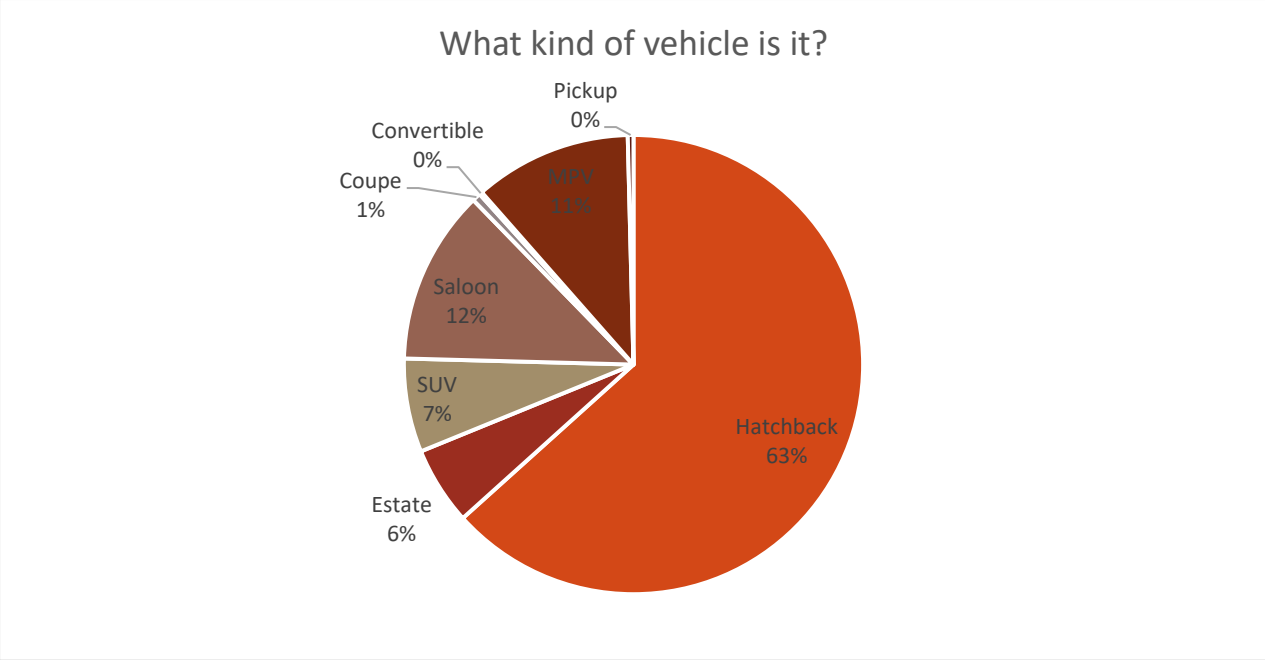

Figure 12 Type of vehicle

The vast majority of the reported vehicles in the sample is hatchback vehicles, SUVs are a small percentage (7%) while saloon kind vehicles are 12%.

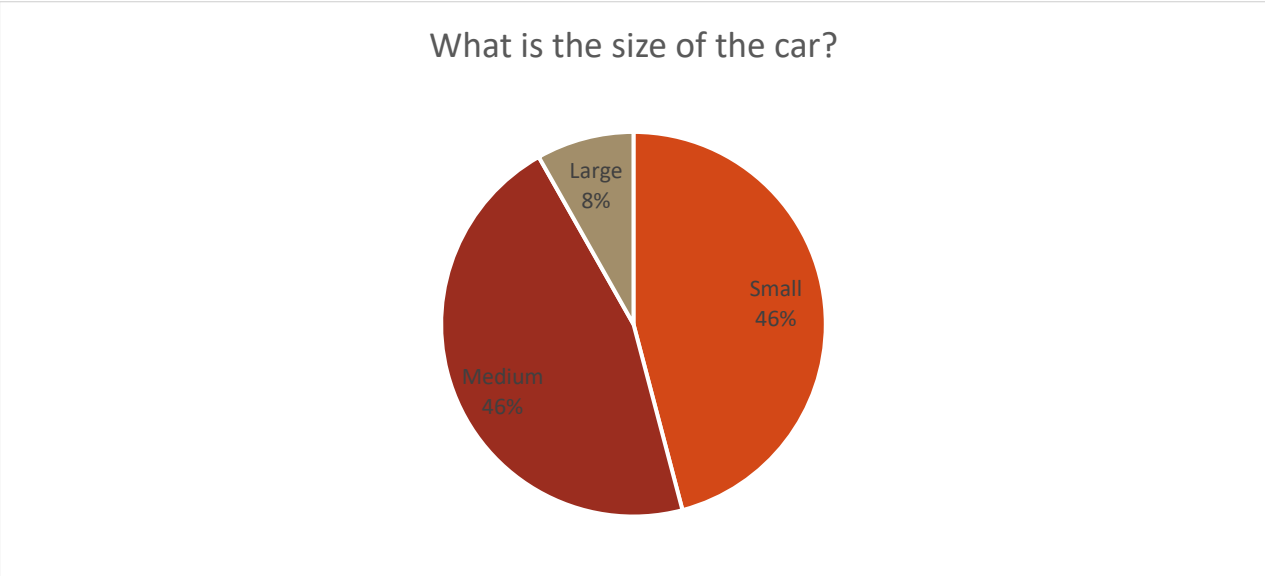

Figure 13 Size of vehicle

Most of the reported cars are either small (46%) or medium cars. Large cars are a small percentage, 8%.

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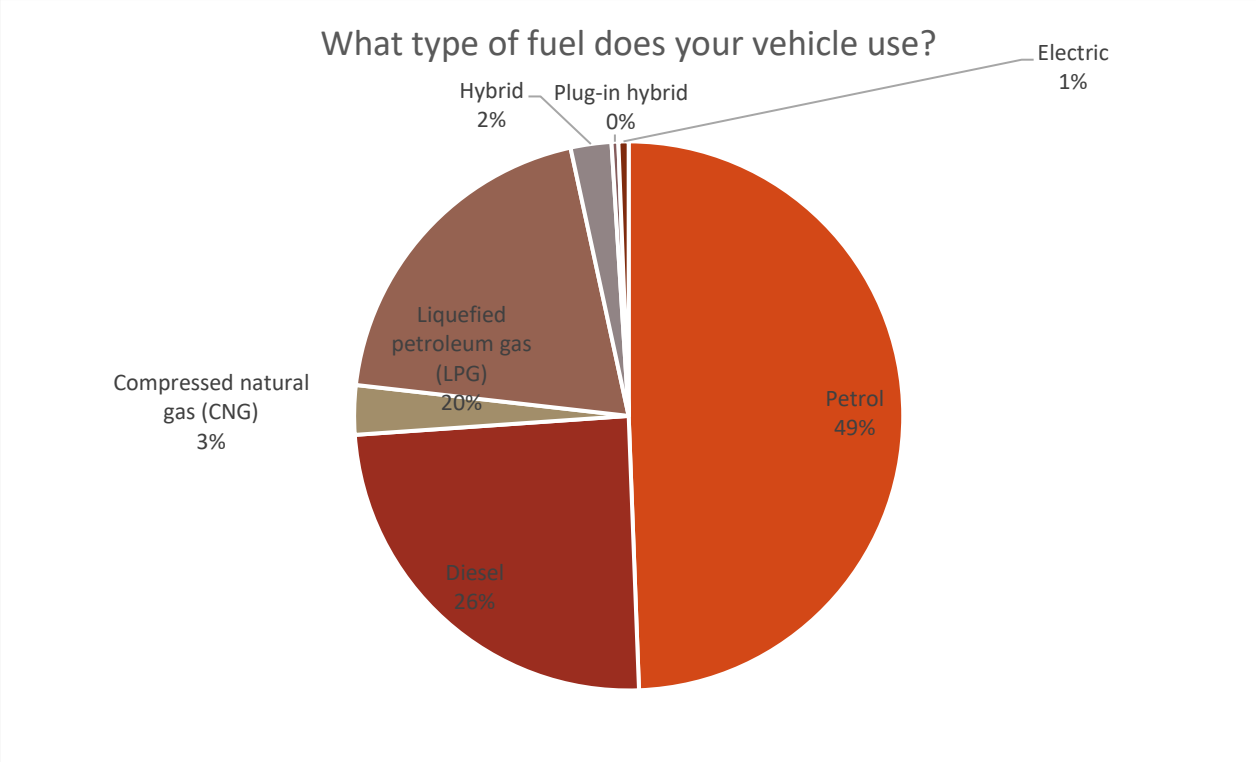

Figure 14 Type of fuel

Almost half of the reported vehicles run on petrol, while 26% of the vehicles run on diesel. There is a significant number of vehicles running either on LPG or CNG. (20% and 3% respectively). Only a small number of reported vehicles are hybrid (2%) or electric (1%)

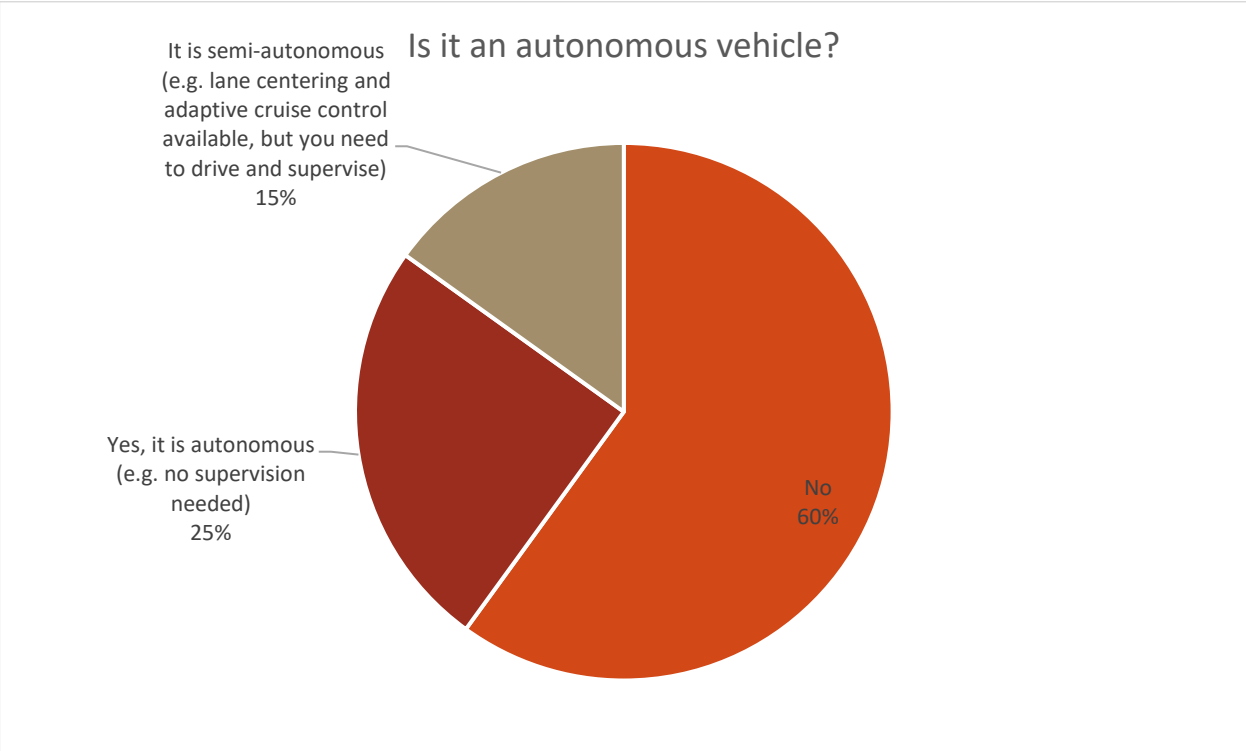

Figure 15 Level of automation

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In an interesting result, 25% of the respondents state that their current vehicle is autonomous, without need for supervision, which is most probably a misunderstanding of the attribute level in the questionnaire given the fringe existence of no supervised, autonomous vehicles in the Italian market. This finding might also be attributed to translation issues.

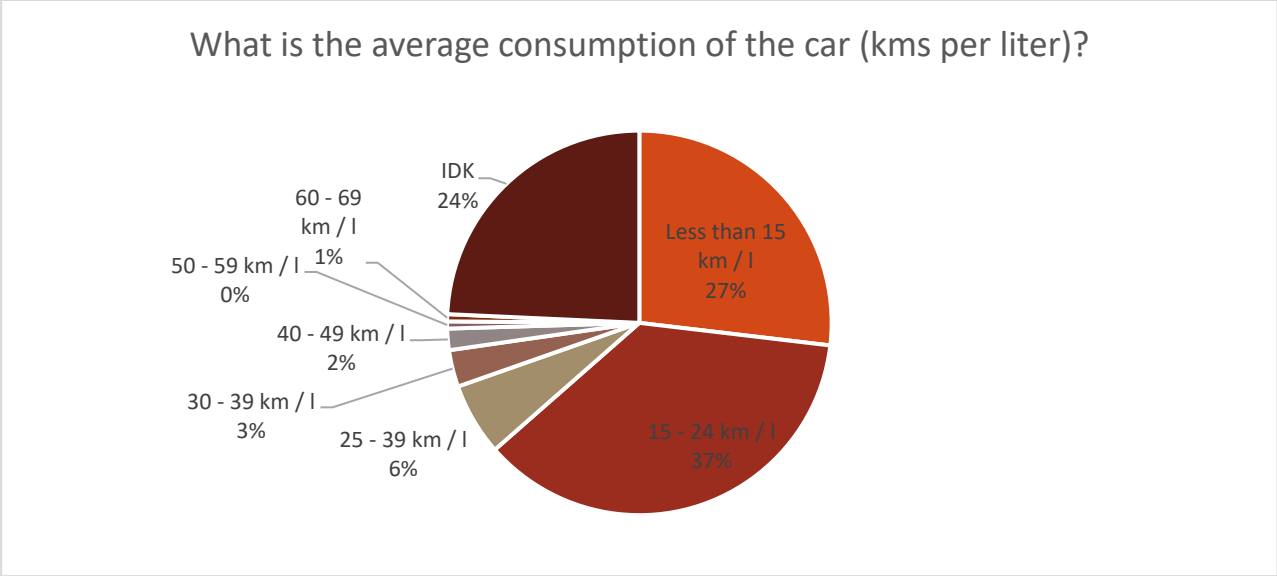

Figure 16 Average consumption

Most of the reported cars have a low average consumption with 27% of them consuming less than 15kms/l, 37% of them 15-24 kms/l and only less than 10% consuming more. It is important to report that almost ¼ of the respondents do not know the average consumption of their vehicle.

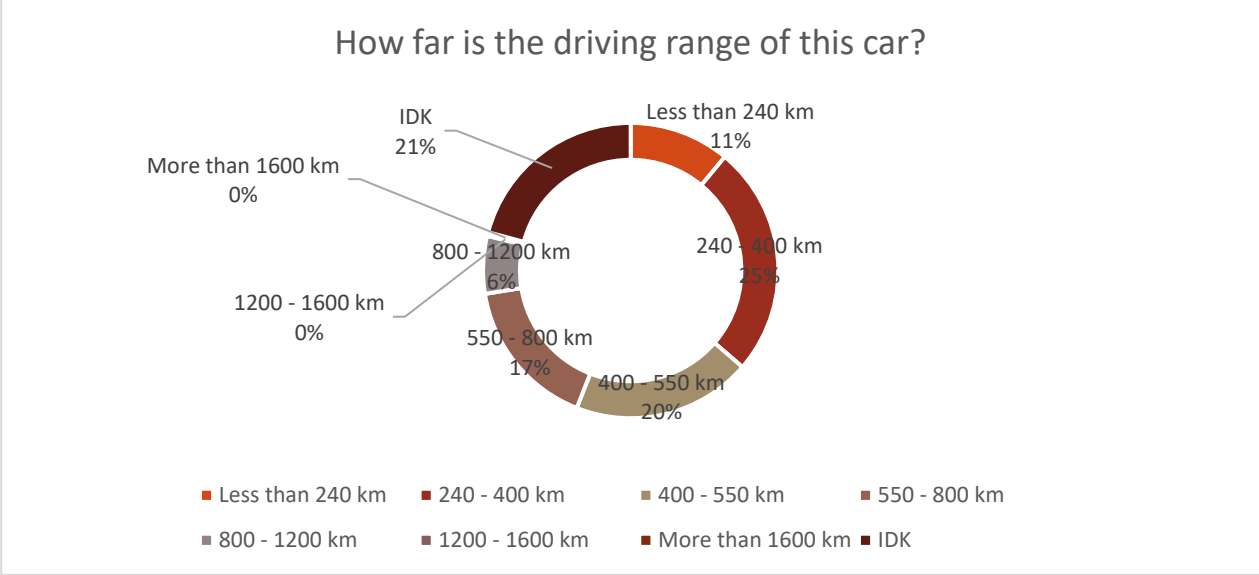

Figure 17 Driving range

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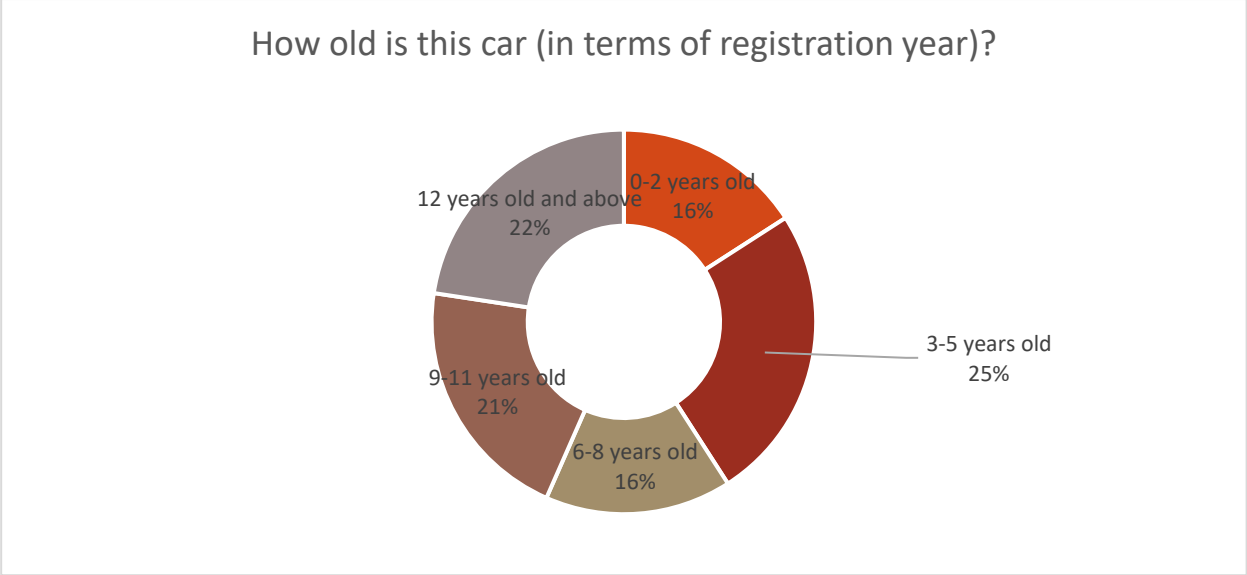

Figure 18 Registration year

Almost 44% of the reported vehicles are older than 9 years in terms of registration year. 16% of the vehicles are purchased in the last 2 years, while one quarter of the vehicles are 3-5 years old.

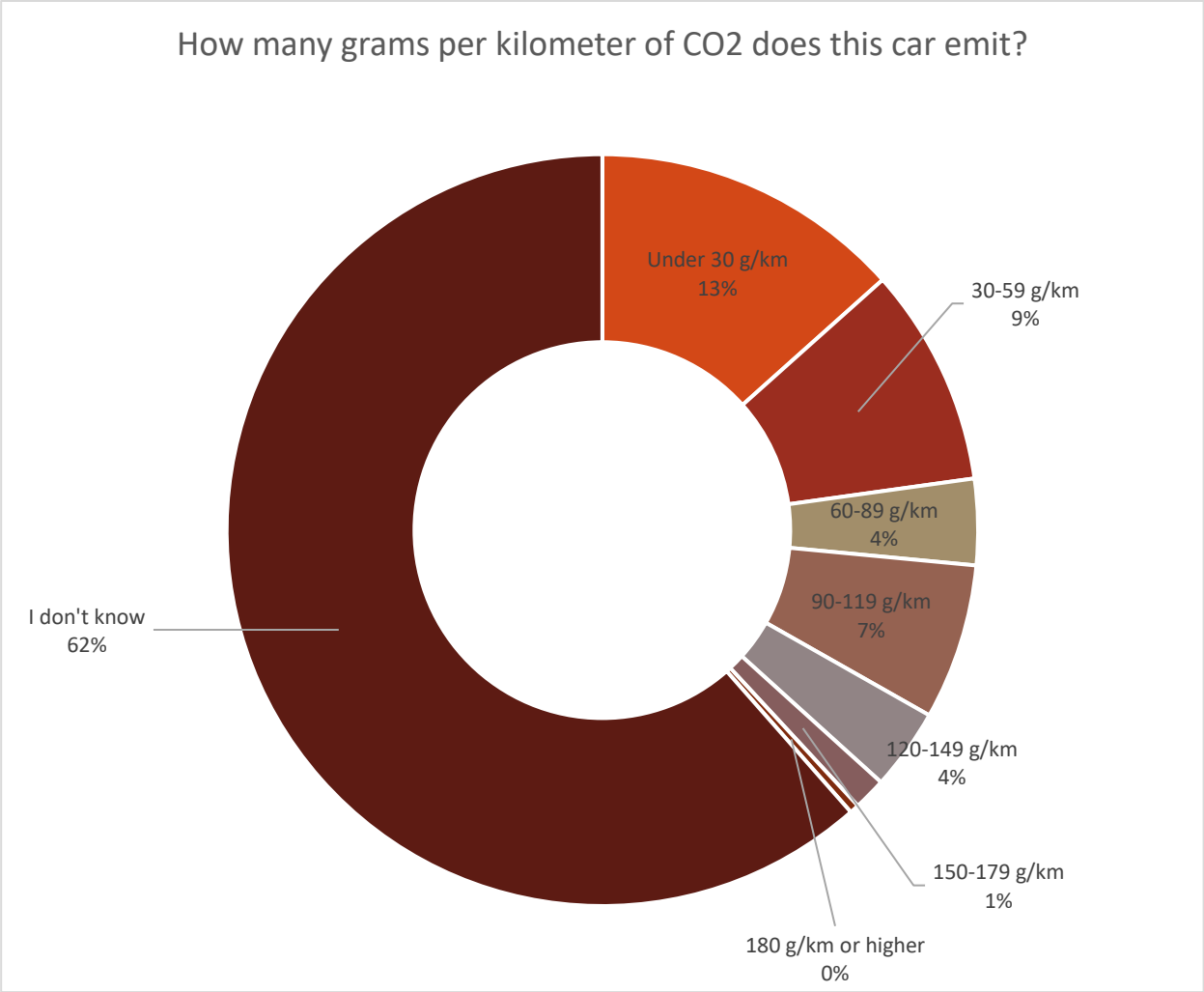

Figure 19 Vehicle emissions

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A significant part of the respondents (62%) responded that they do not know the average emissions (grams per km) that their vehicle emits. For the respondents who answered the question, only ~10% of the vehicles emit more than 10g/km, while 13% own newer technology vehicles which emit less than 30g/km.

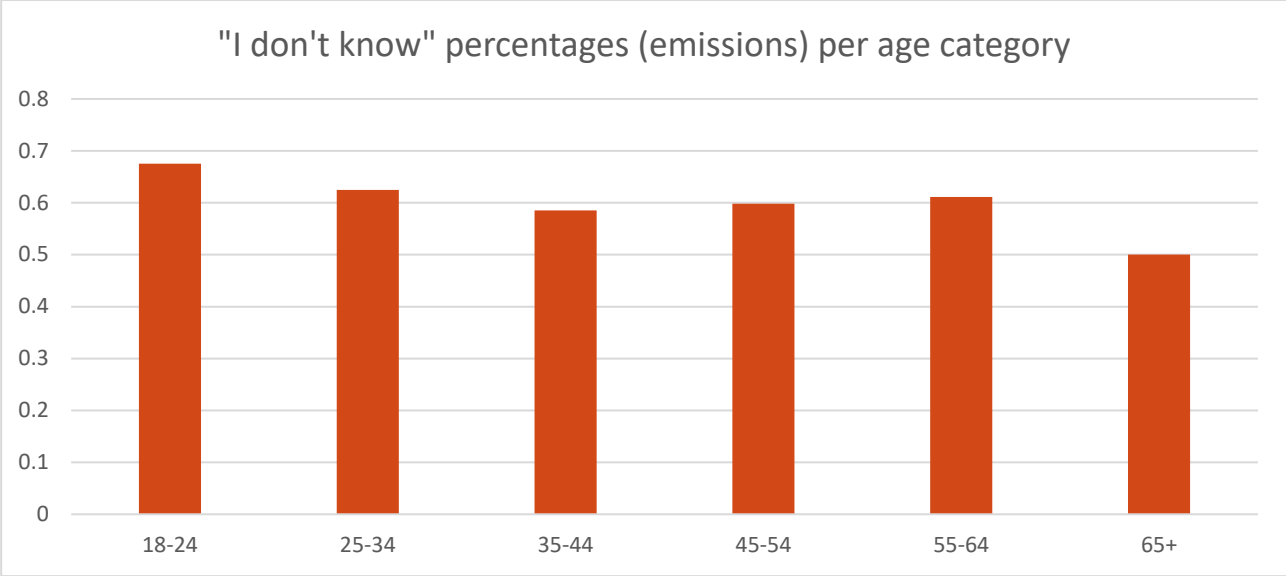

Figure 20 Analysis of the "IDK" option by age category, regarding emissions

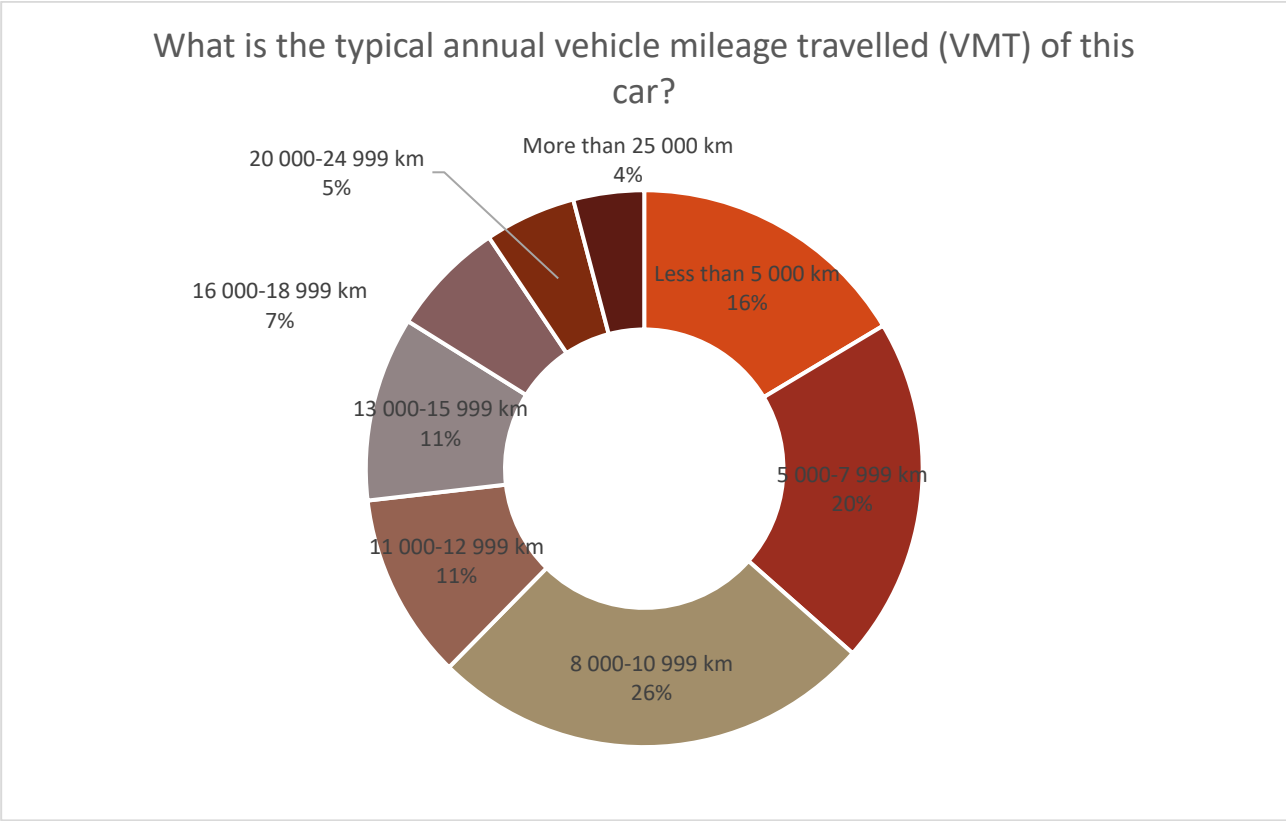

Figure 21 Typical annual mileage

26% of the respondents report that the typical annual mileage for their vehicle is between 8000 and 11000 kms. 36% reports less than this, while the rest of the sample reports more. Only 4% of the sample report driving more than 25000 kms

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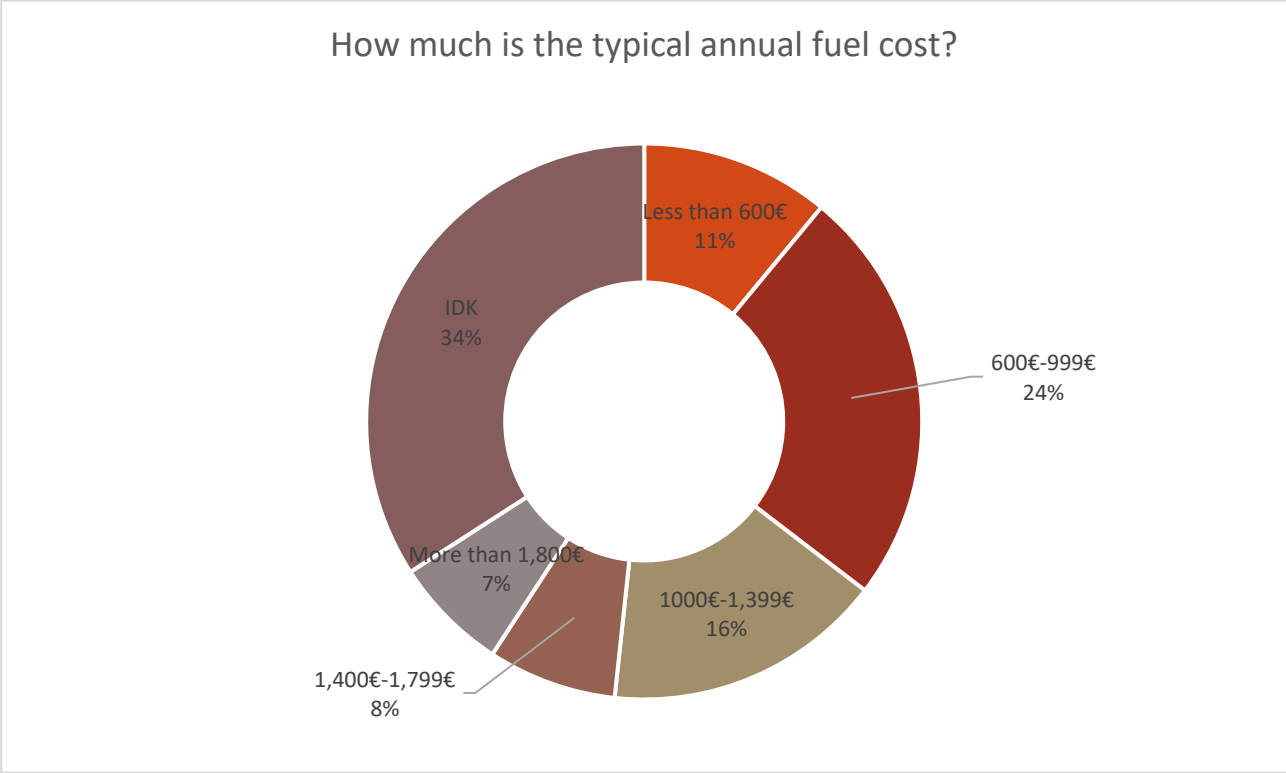

Figure 22 Typical annual fuel cost

Figure 21 presents an interesting result regarding fuel cost estimates: 34% of the respondents report that they do not know (or cannot estimate) the typical annual fuel cost. For the remaining, 11% reports a cost less than 600€, ~1/4 report a cost between 600 and 1000€, 16% a cost between 1000 and 1400 €, while the remaining 15% a cost over 1400€.

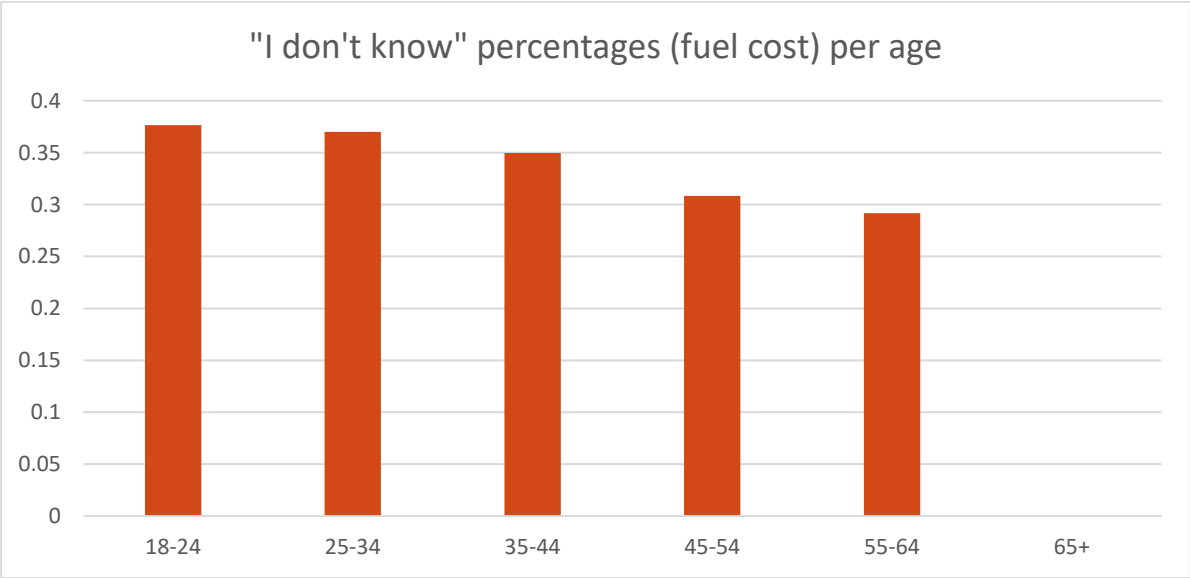

Figure 23 Analysis of the "IDK" option by age category, regarding fuel cost

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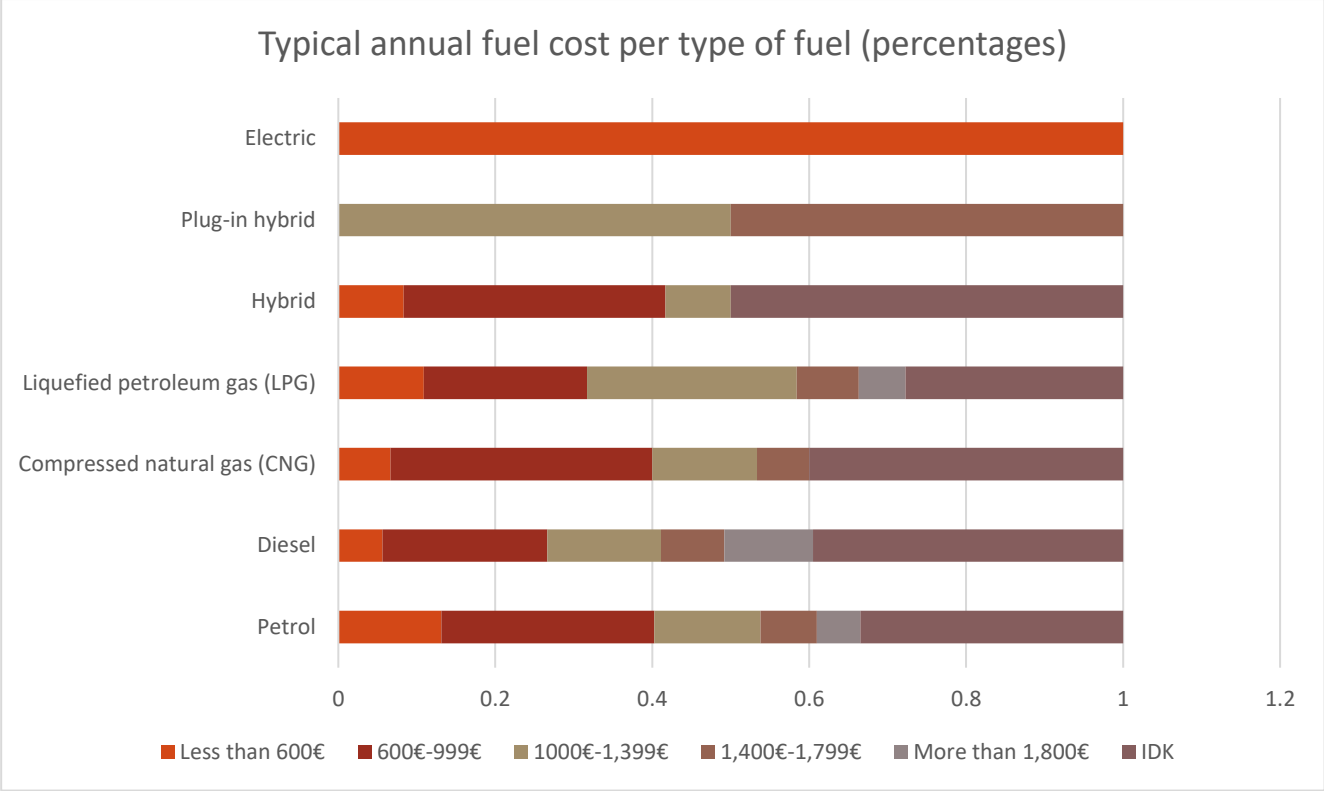

Regarding the typical annual fuel cost per type of fuel, electric is the cheaper, while a big proportion of people, again, seem to not know the exact fuel cost.

Figure 24 Typical annual fuel cost per fuel type

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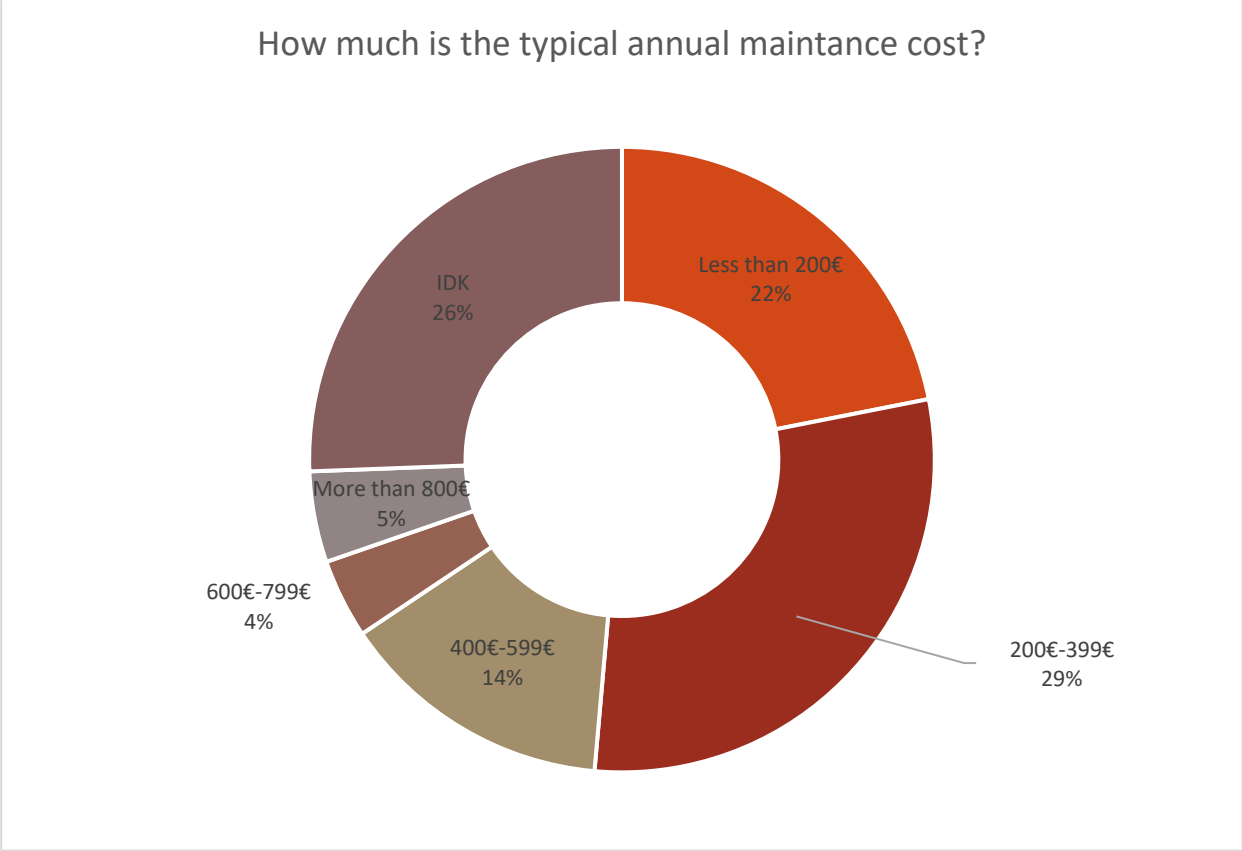

Figure 25 Typical annual maintenance cost

The same picture presents in the case of the typical annual maintained cost, where a quarter of the respondents state that they do not know the annual cost. Most respondents report a cost less than 400€, while only a small percentage report costs more than 800€.

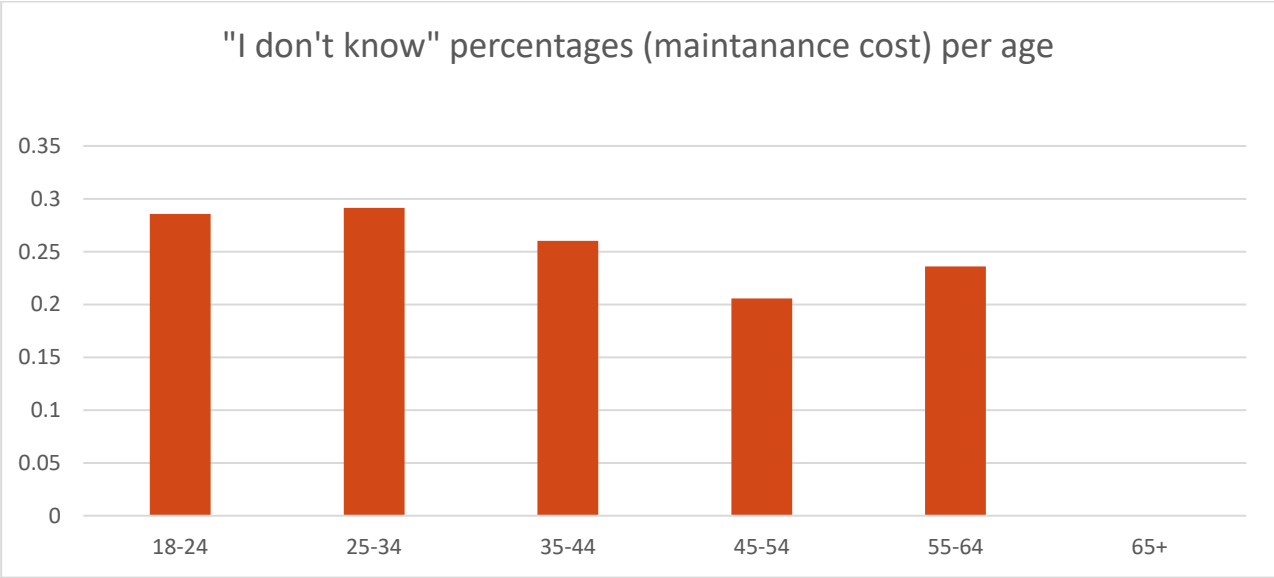

Figure 26 Analysis of the "IDK" option by age category, regarding maintenance cost

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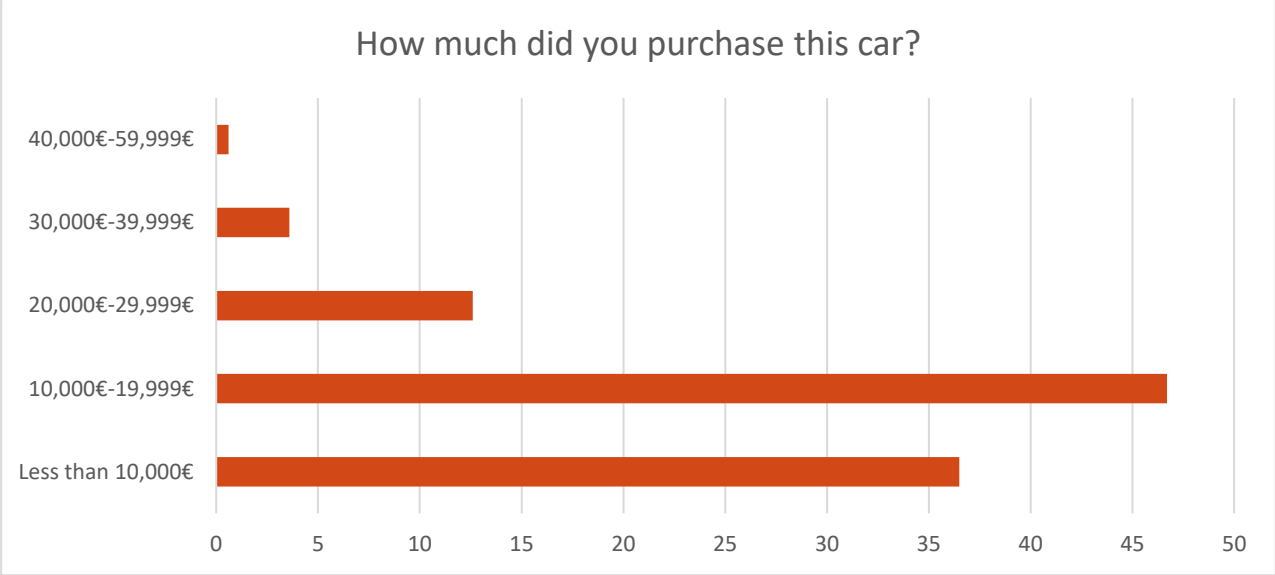

Figure 27 Cost of car purchase

Regarding the purchase cost of the car, Figure 27 presents that most of the purchased vehicles cost between 10 and 20 thousand euros or less than 10,000€

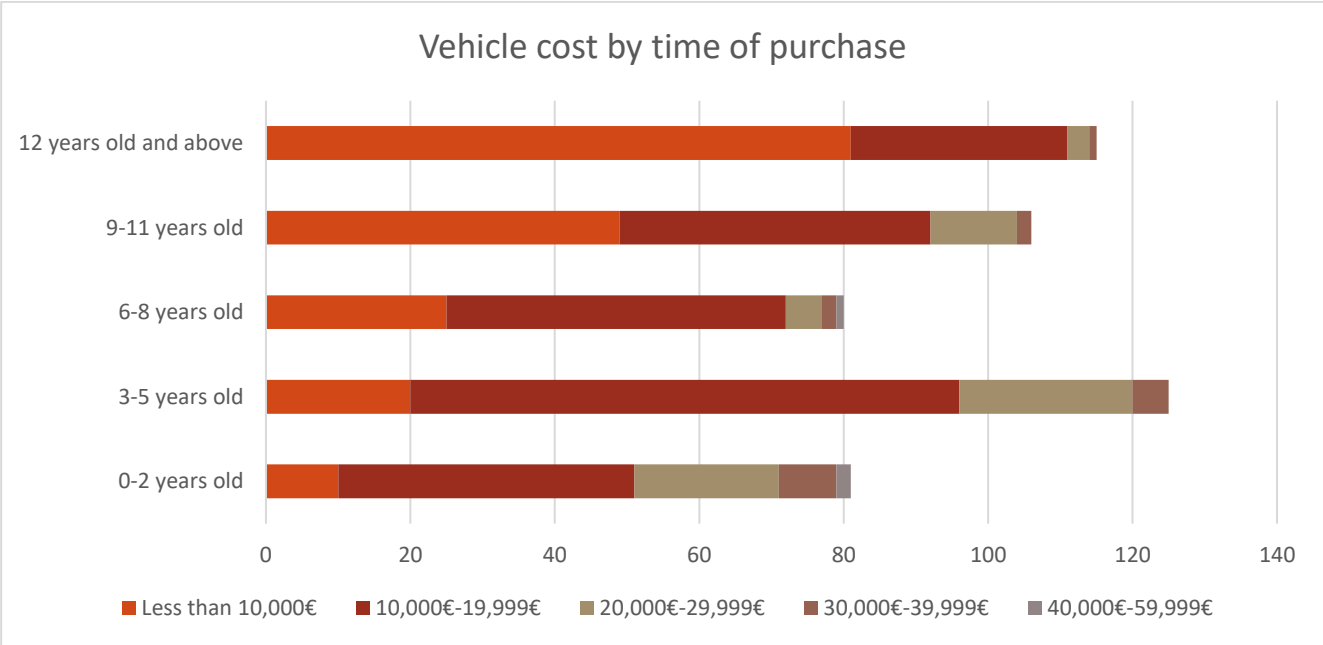

Figure 28 Cost of vehicle purchase by date of purchase

Most vehicles in the sample were purchased in the last 3 to 5 years, with a significant number (>100) being reported to be purchased more than 12 years ago. As cars keep getting more expensive this trend is also apparent in the rising purchase price for the year of purchase.

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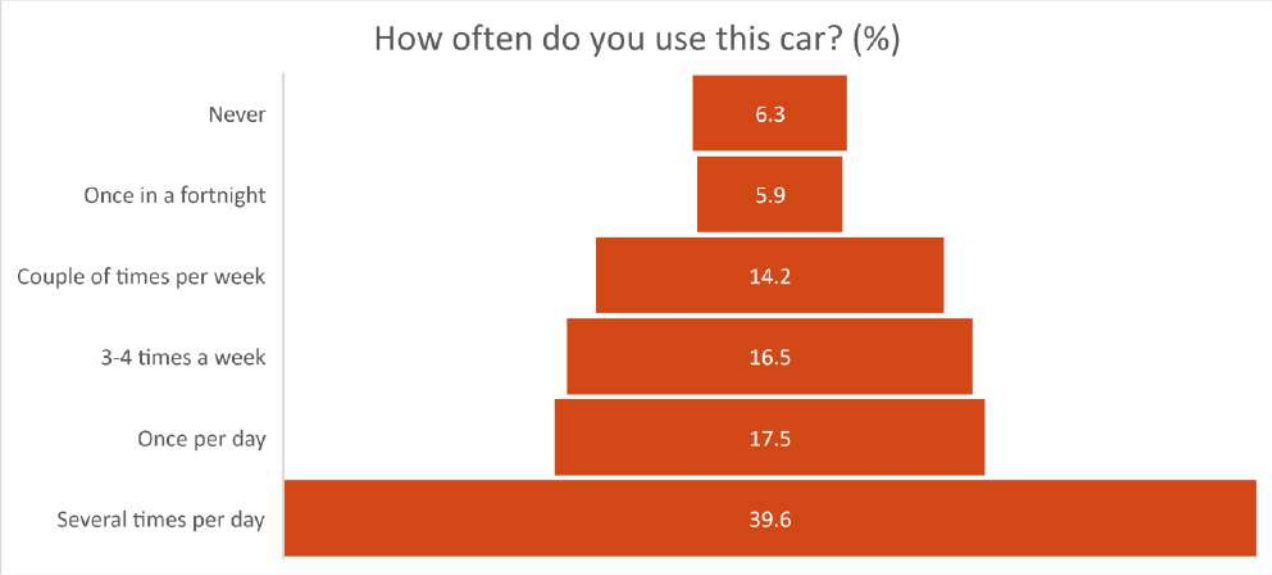

Figure 29 Frequency of vehicle usage

Almost 40% of the sample reported using their car several times per day. A significant number of respondents report that they never use their car.

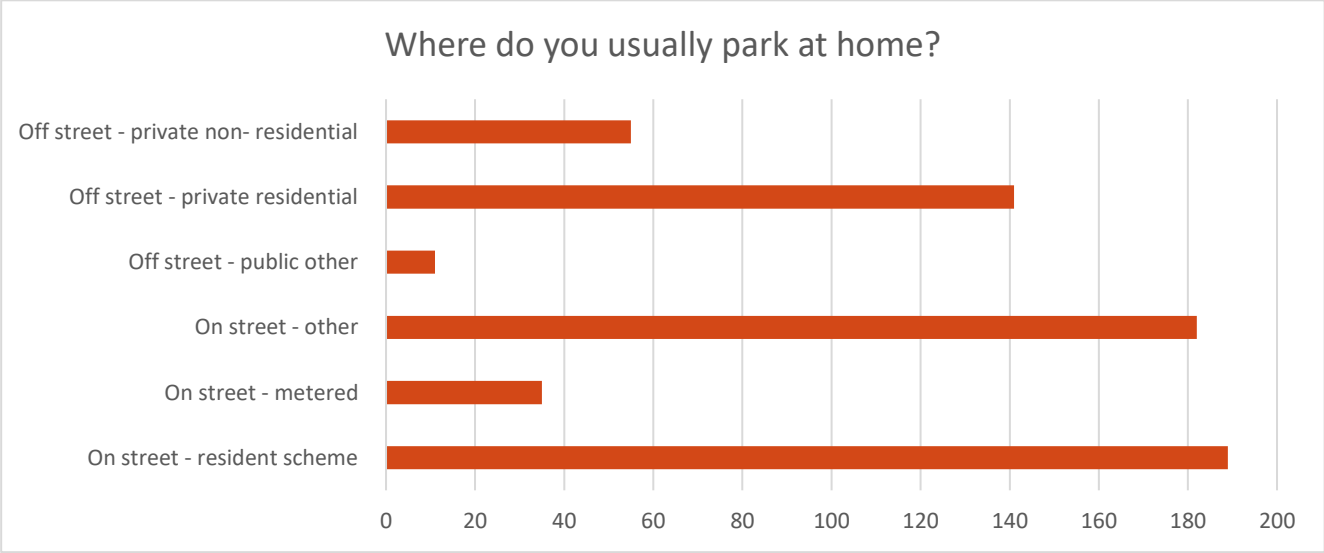

Figure 30 Usual parking location

Usual parking location includes on street parking, either by resident scheme or other, while a portion of the respondents report having private residential parking off street.

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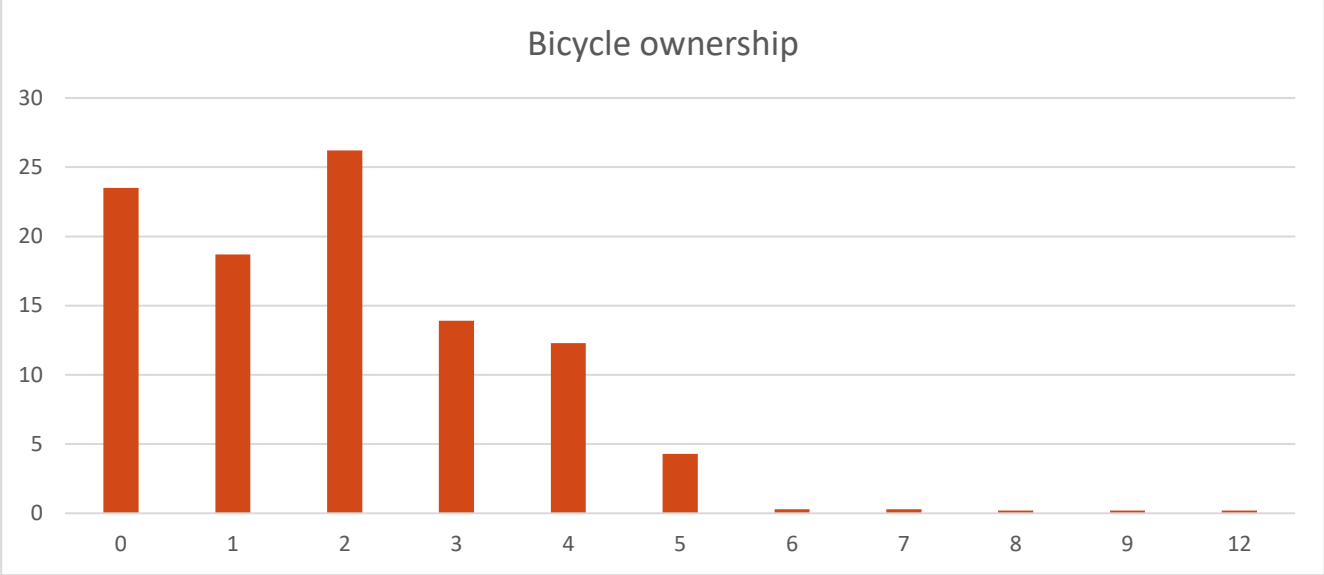

Figure 31 Bicycle ownership

25% of the sample report not owning a vehicle, which reveals an significant 75% which do own at least one vehicle, regardless of actual usage.

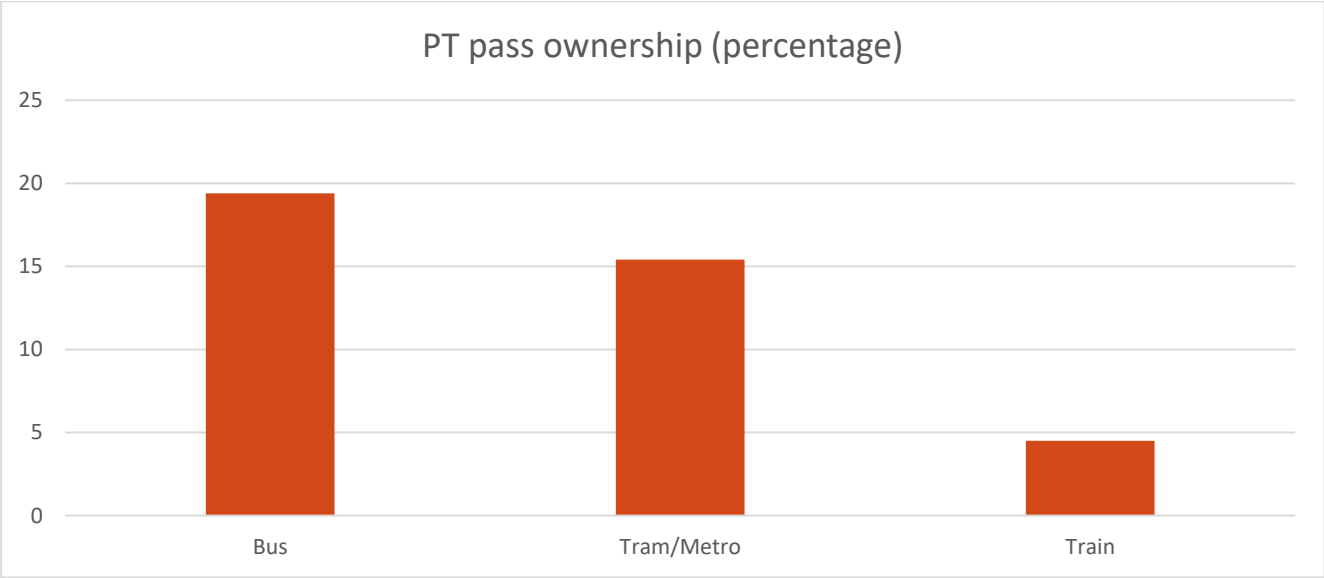

Figure 32 Public transport pass ownership (%)

20% of the sample own a bus pass, more than 15% a tram or metro pass, while less than 5% own a train pass.

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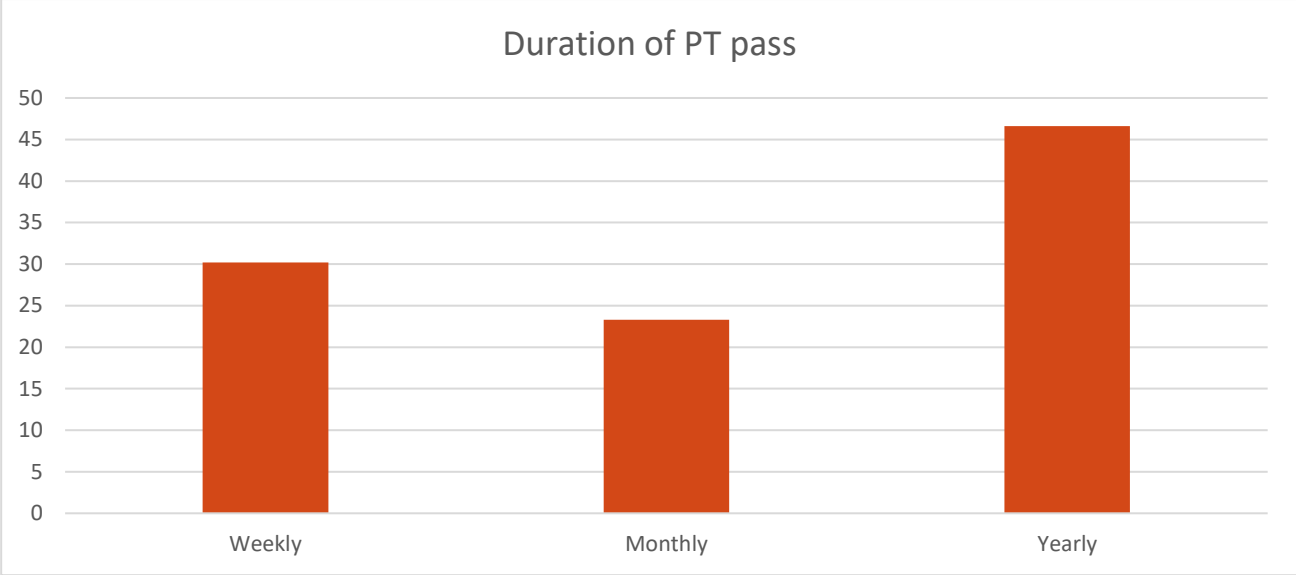

Figure 33 Duration of bus pass

The most frequent duration of the bus passes reported in the sample is yearly, revealing a long-term decision among users of public transport.

Commuting and location

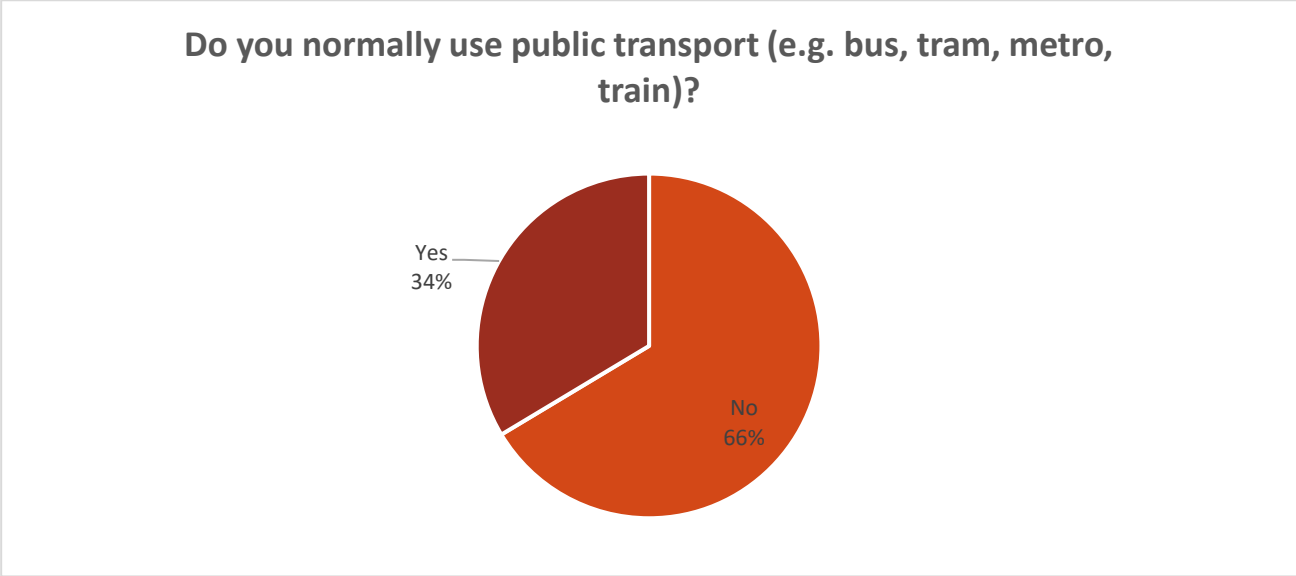

Figure 34 Overall statement of PT usage

34% of the sample reports that they normally use public transport modes, giving an indication of the potential modal split of PT in Turin, percentage which is totally in line with the number of PT subscriptions in the area.

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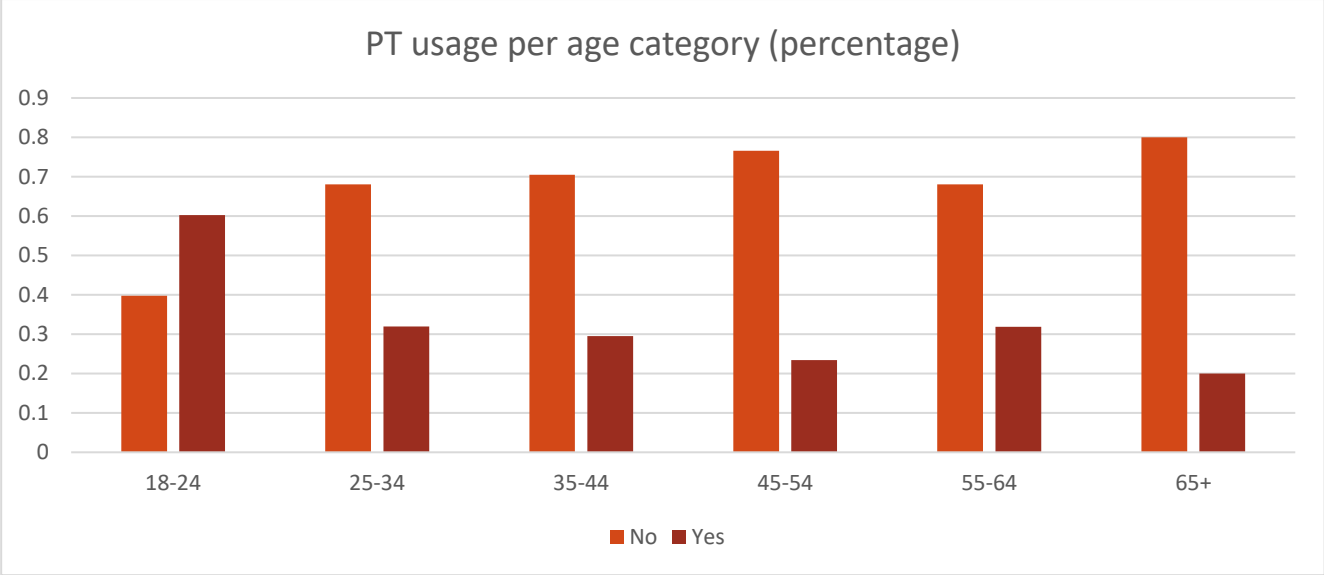

Figure 35 PT usage per age category

In most age categories, non-PT users are the majority, while in the younger category (18-24), PT users are the majority.

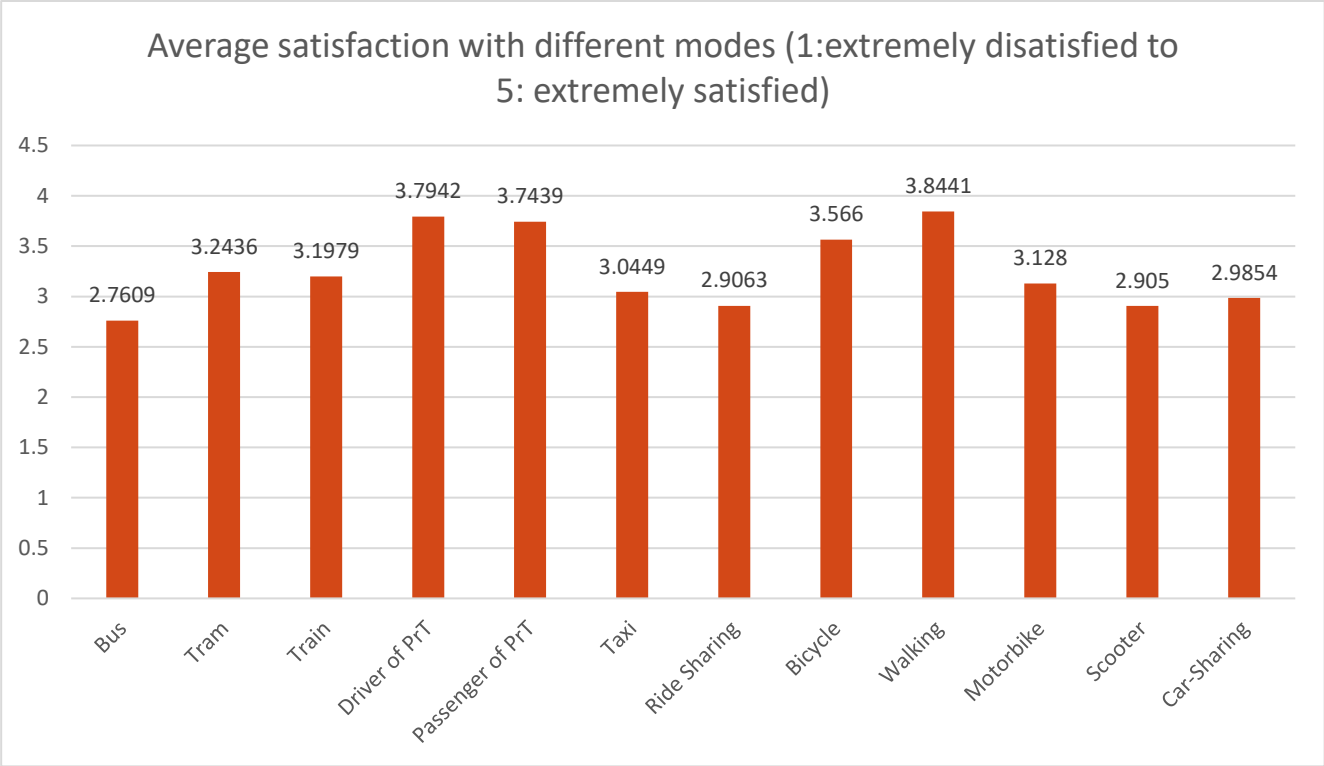

Figure 36 Satisfaction with travel modes

Average satisfaction with travel modes reveals interesting findings: Walking, cycling, driver and passenger in private cars are the modes with the best satisfaction rating, while train and tram make it over 3/5/ Bus, scooter and ride-sharing score the worst scores among all modes with bus barely making over the base of 2.5.

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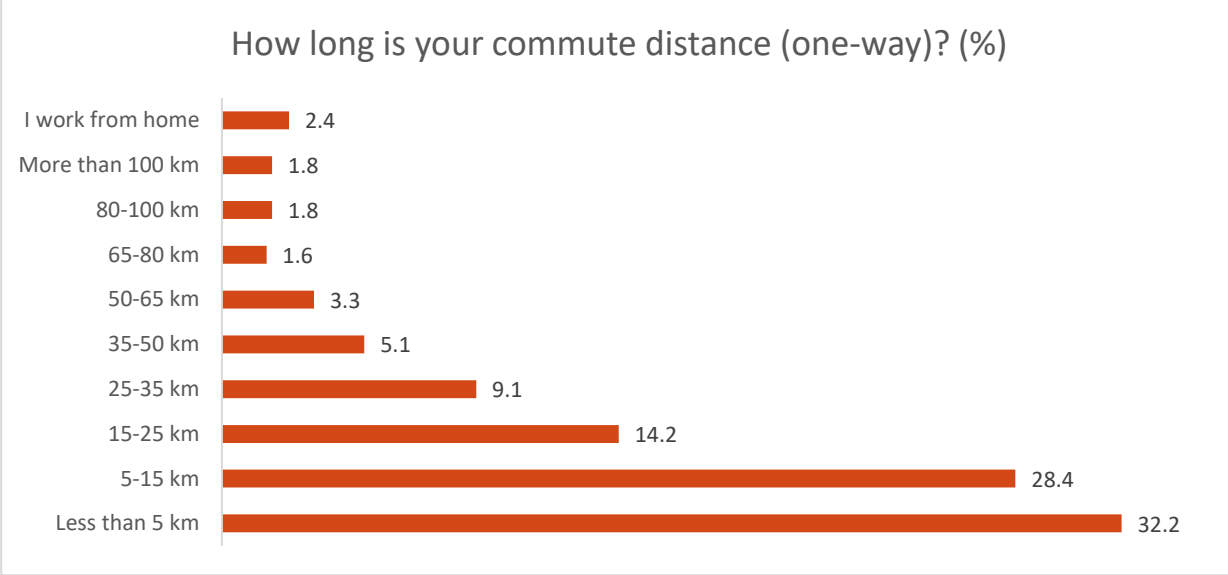

Figure 37 Commute distance

Most survey respondents report that their commute distance is less than 5kms, and most of the respondents report a distance less than 15kms. This finding is important for the modelling effort undertaken in WP5,

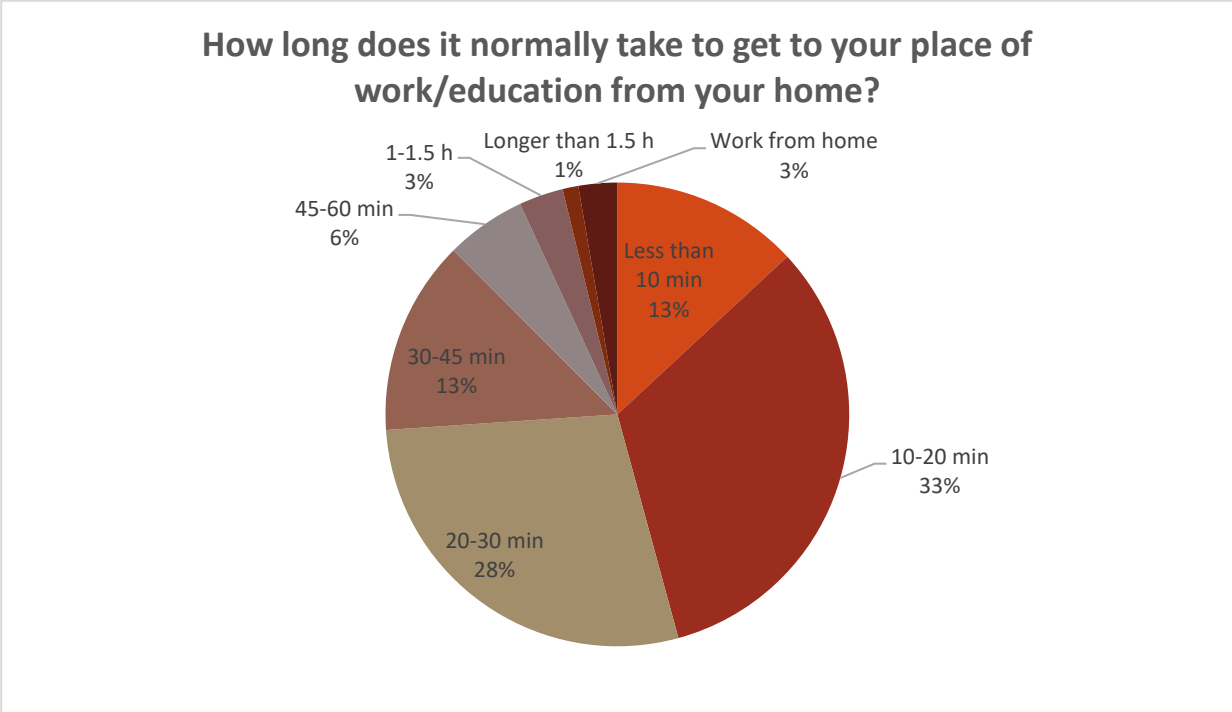

Figure 38 Travel time to main activity

Respectively, most of the respondents report a commute time less than 30 minutes, with an actual 33% reporting a 10 to 20 minutes commute (one-way). Only for a very small part of the respondents the travel time is more than an hour long.

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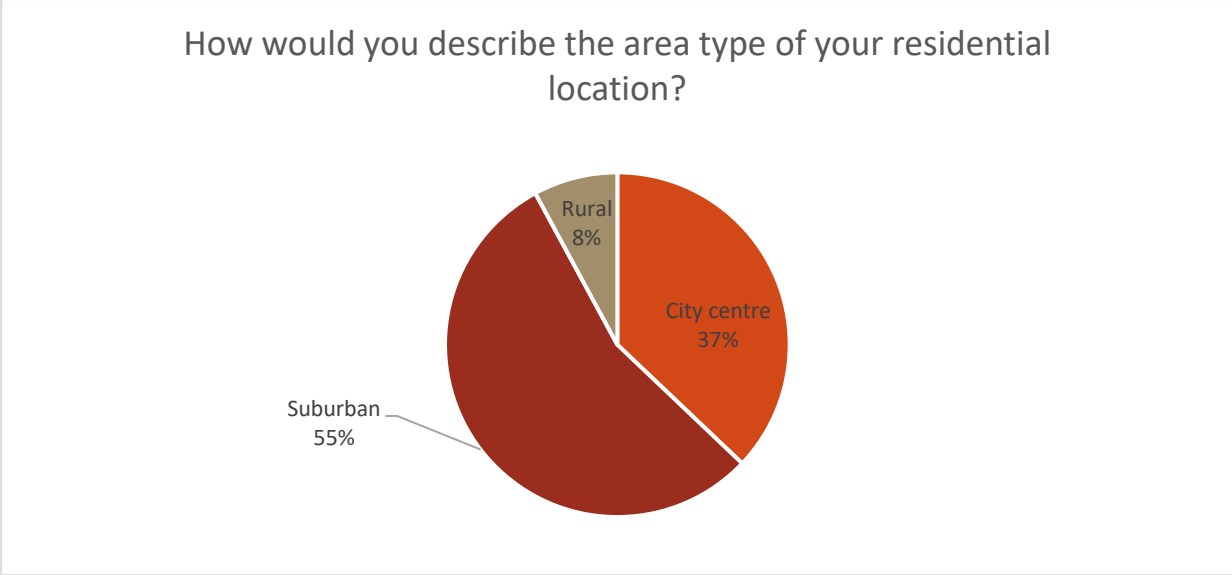

Figure 39 Residential location

37% of the respondents self-describe their residential area as “city centre”, while 55% describe it as suburban, even if the distinction between the two could be fuzzy.

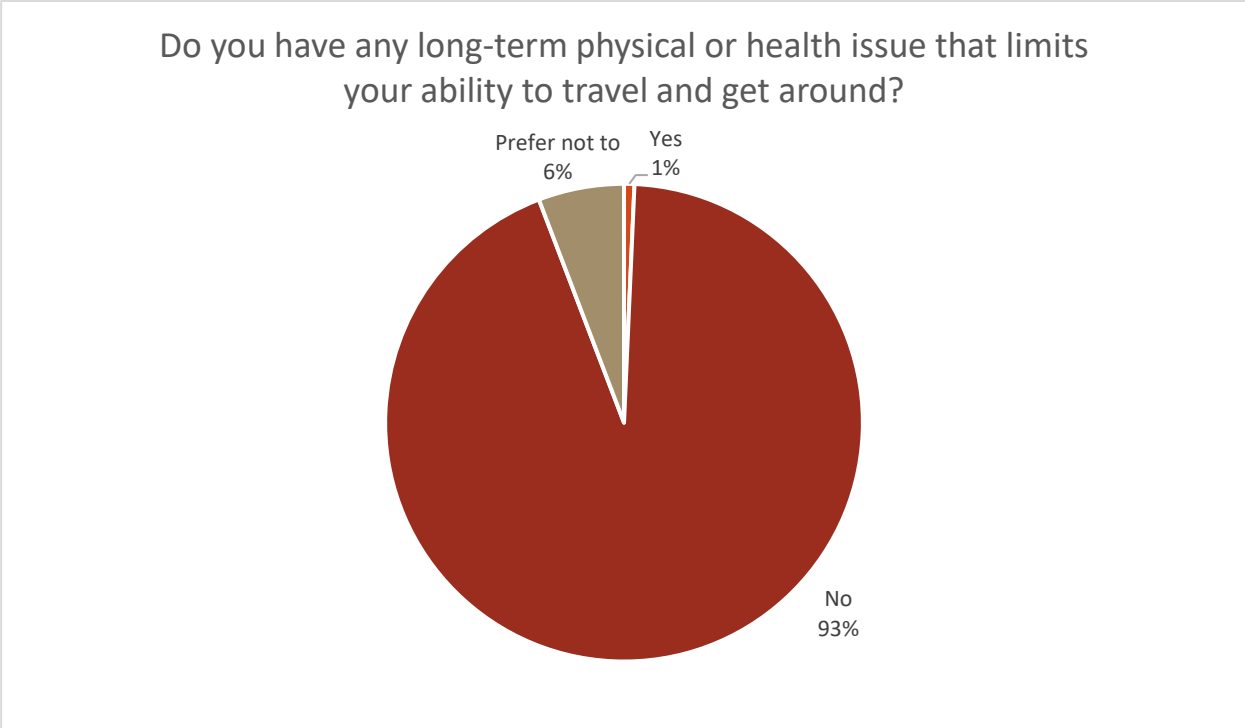

Figure 40 Health accessibility constraints

A significant part of the respondents report a long-term physical of health issue that limits their accessibility to transport services and overall mobility, findings which highlights the importance of delivering tailored, accessible services to vulnerable groups.

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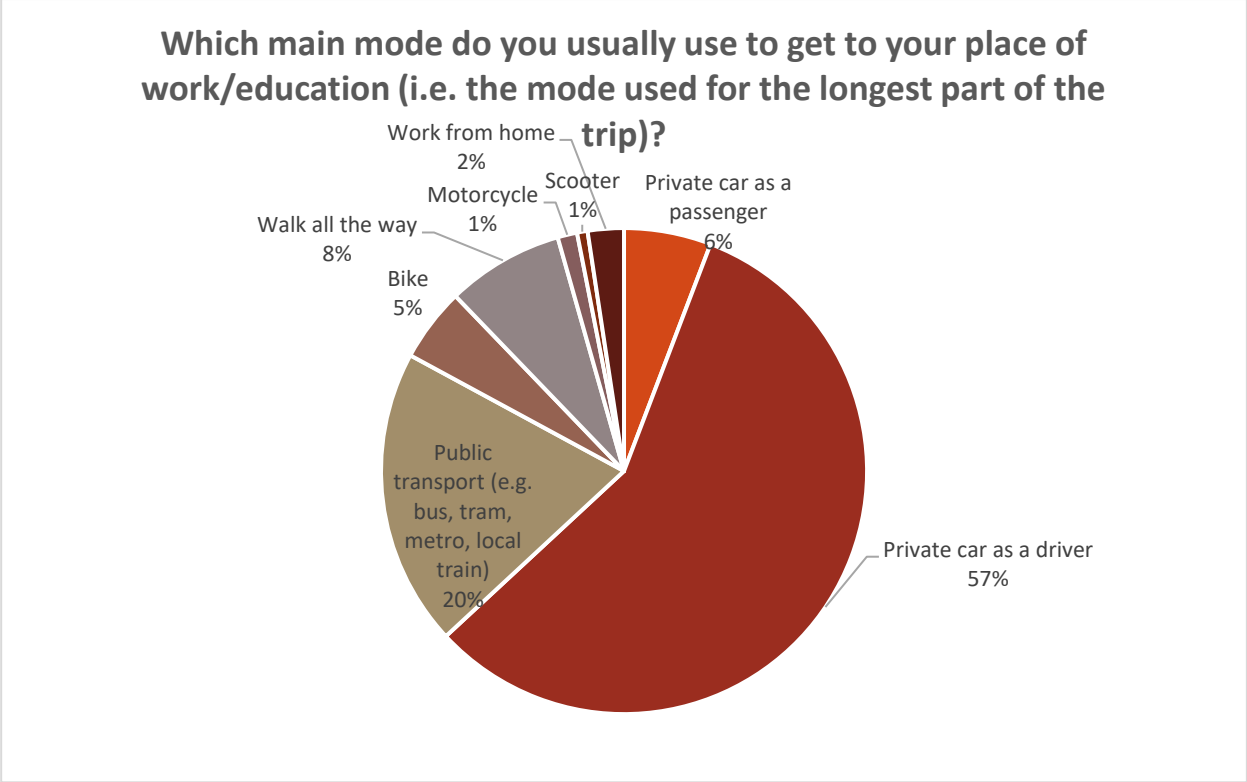

Figure 41 General mode choice

Figure 41 presents the overall, general mode choice among survey participants. Big majority of the respondents choose private car as drivers, while another 6% as passengers, summing a total of 63% of private car users. 20% of the respondents report PT as their main mode, 5% prefer cycling, an important 8% reports walking, while other modes are marginal.

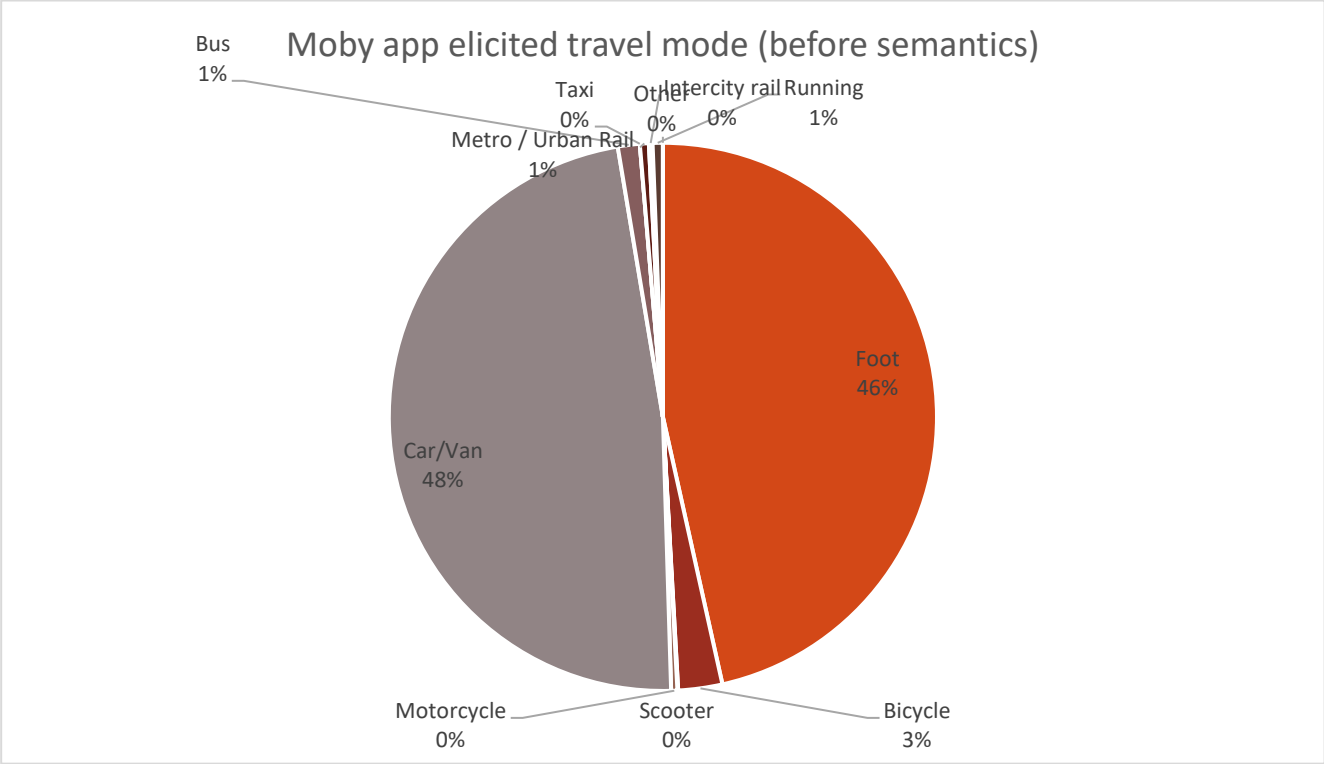

Figure 42 Moby app elicited travel mode

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Figure 42 presents the elicited travel mode from the Moby app survey, before the application of algorithms and semantics to further enhance the travel mode prediction of the survey (which will be reported as part of D5.2). The app predicts a significant part of the respondents moving by car (or van) similar but less than the reported travel mode in the survey (63% drivers and passengers), a significant part of the travel conducted by feet (this might be more accurate that the reported, as people notoriously forget and under-report short walking trips), while apart from cycling, which is mostly correctly represented, does not represent well public transport trips, mostly due to under-reporting/validation of such trips by the respondents.

Table 2 Accessibility from home location

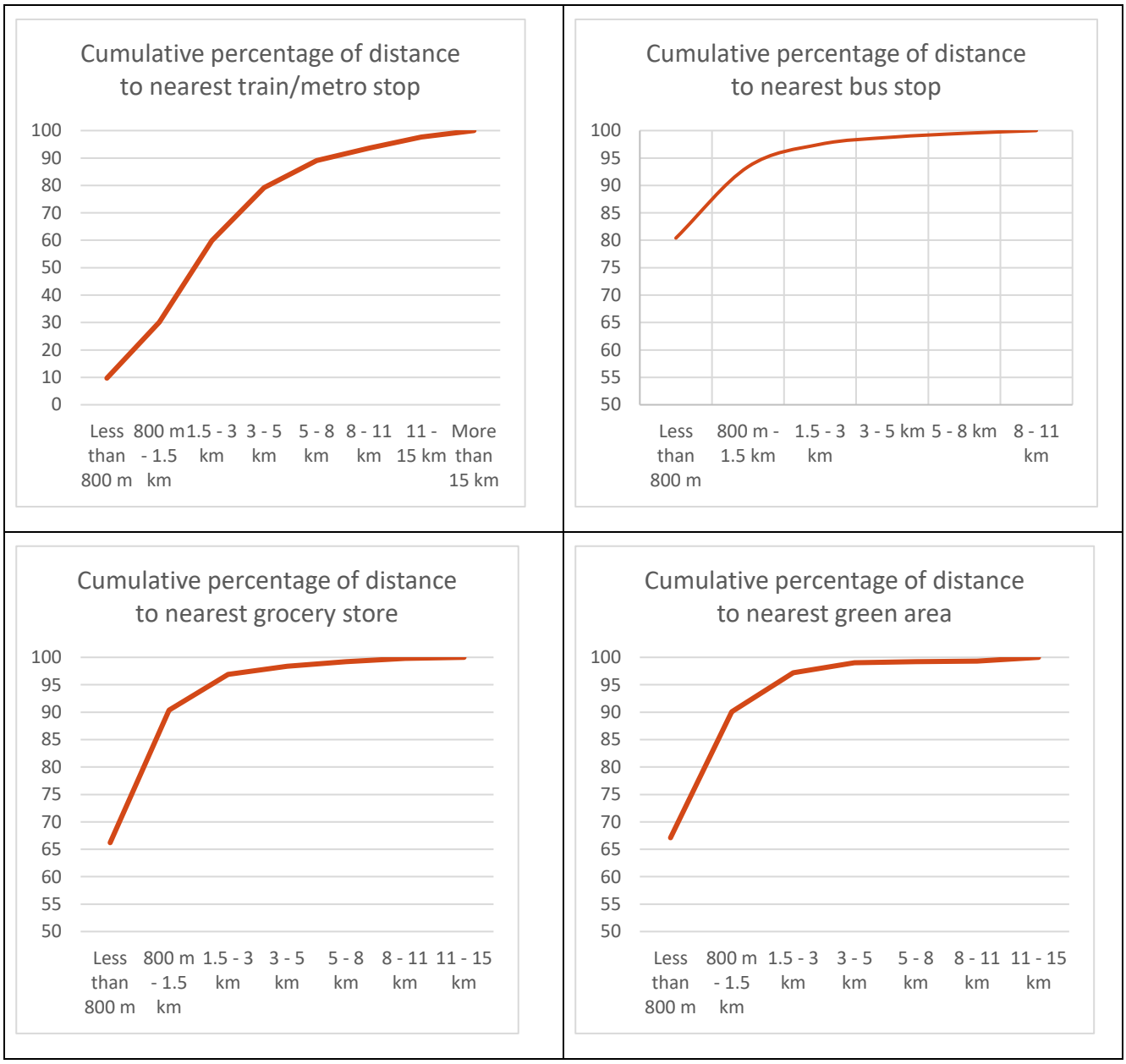

Table 2 presents a self-assessed accessibility measure from respondents' households to the nearest bus stop, train or metro stop, grocery store and green area. Over 80% of the respondents state that the nearest bus stop is less than 800m from their household, revealing a significant density of bus stops, at least as far as the sample is concerned. Over 95% of the sample reports that the nearest bus stop is within 1.5 km of their house. On the other hand, 50% of the respondents stated that the nearest train

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or metro stop is more than 1.5 kms from their home with only 10% stating that the station is within walking distance (less than 800m). In terms of nearest grocery store, 65% of the households report that the nearest store is within 1km, while only 3% report the nearest grocery store to be farther than 3 kms. Finally, almost 90% of the sample reports that the nearest green space is less than 1.5 km from their house.

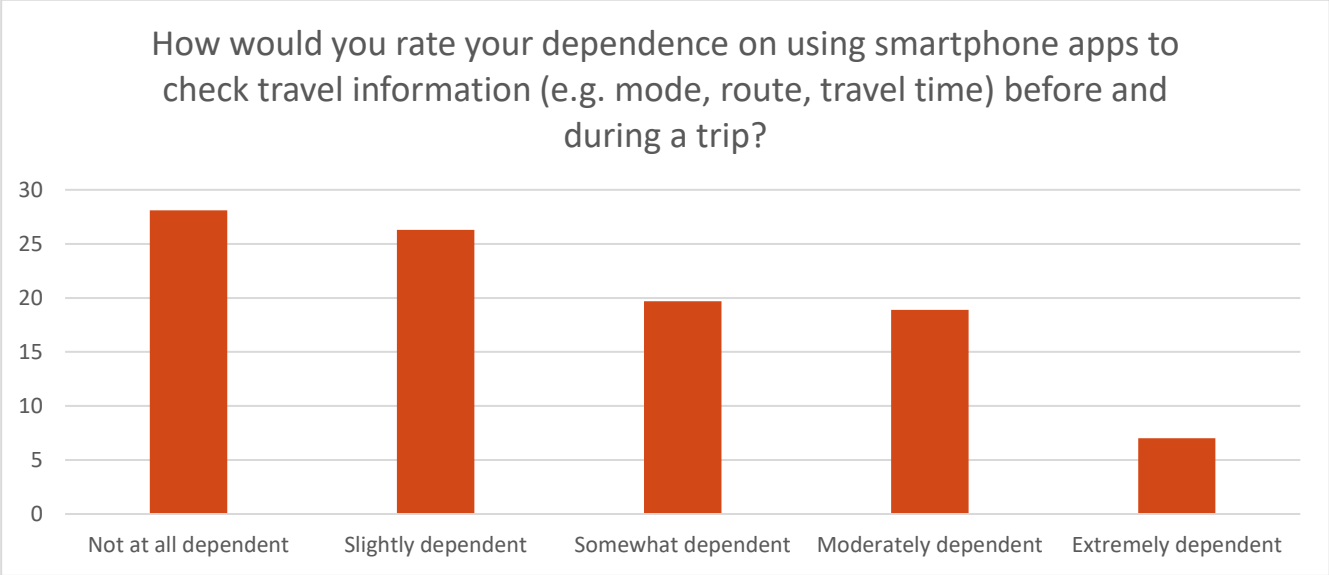

Figure 43 Dependence on smart travel apps

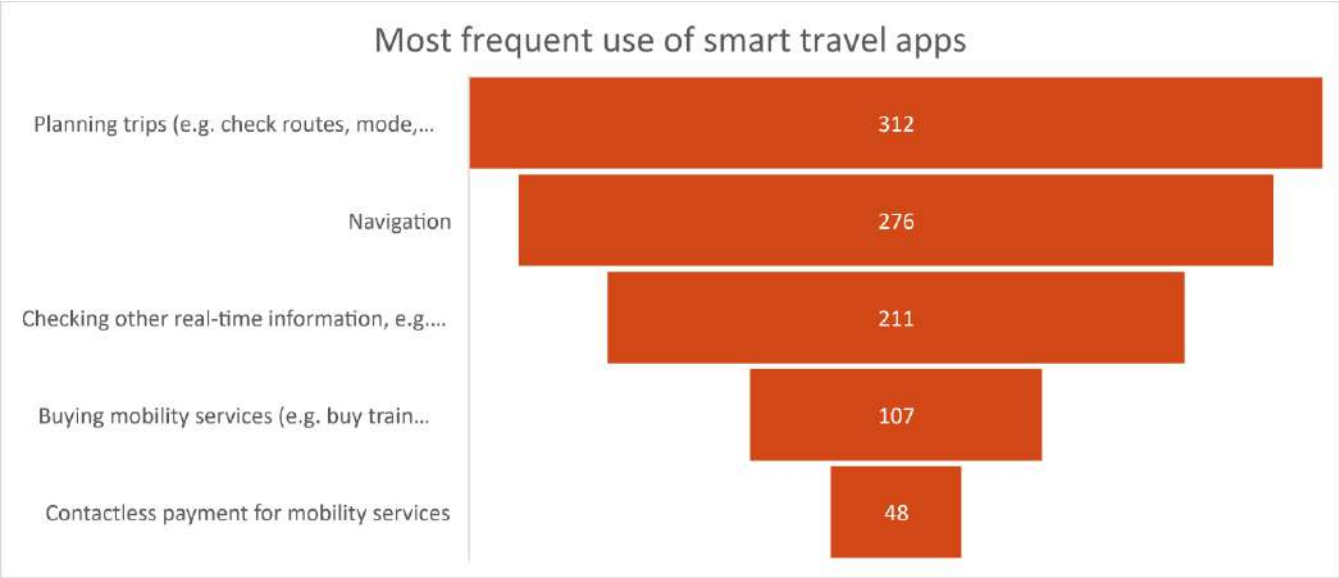

Figure 44 Usage of smart travel apps

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Work from home and work setting

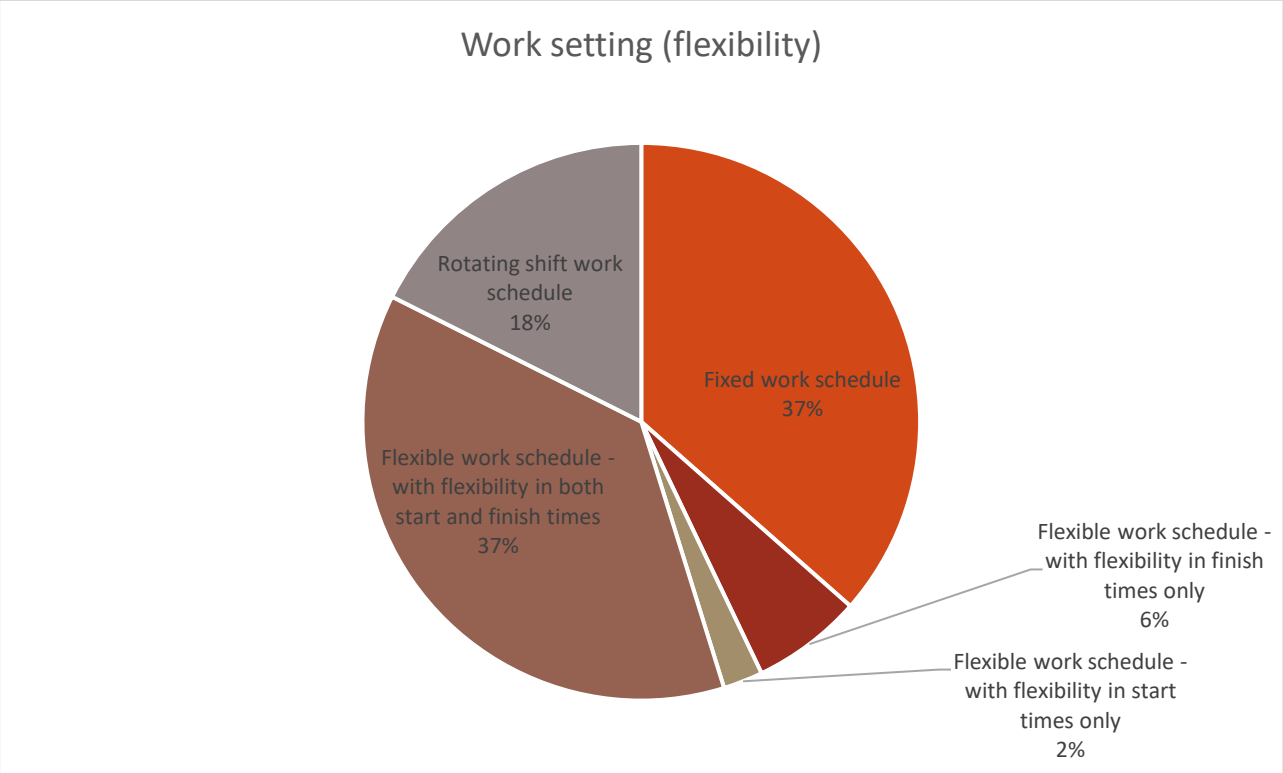

Figure 45 Work flexibility settings

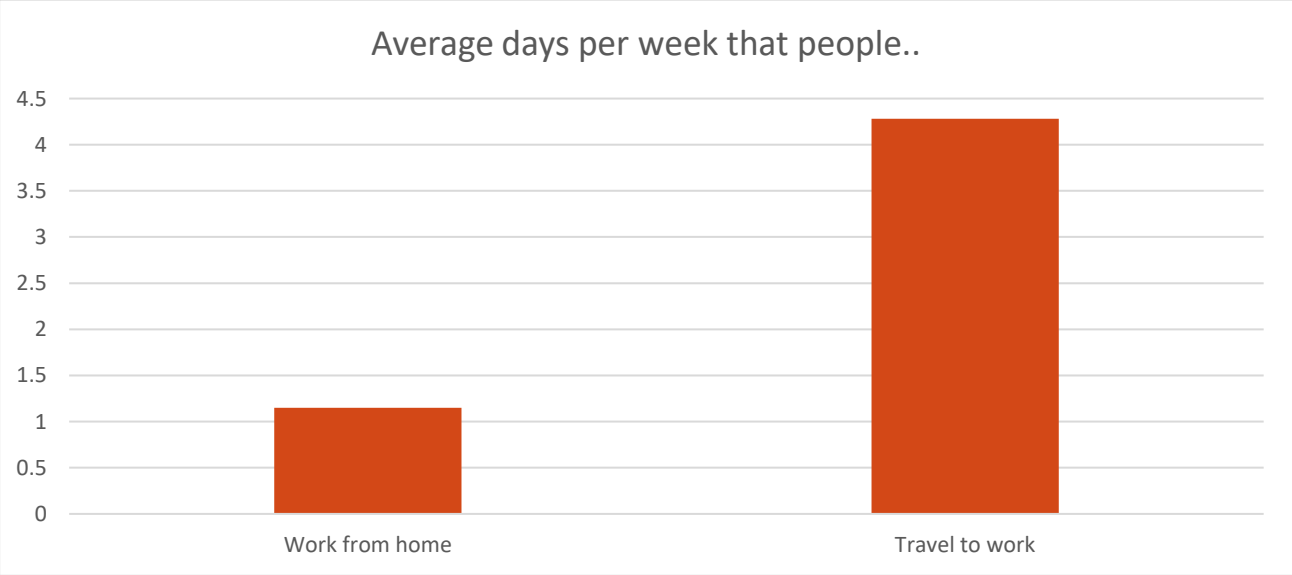

Figure 46 Average working days per work setting

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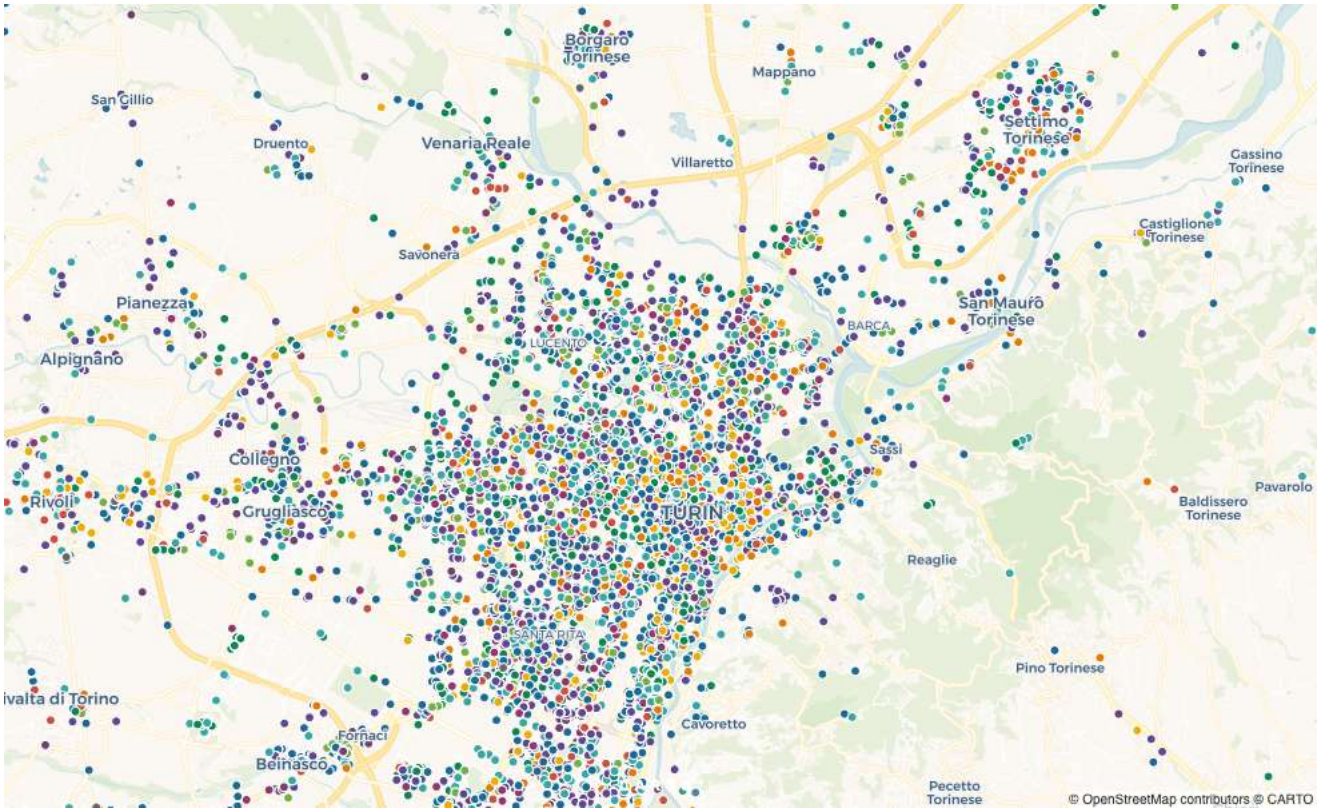
Spatiotemporal analyses



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- HOME
- -MISSING
- OTHER
- WORK/EDUCATION
- SHOPPING
- MEAL/RESTAURANT
- SOCIAL ENGAGEMENT
- PICK UP/DROP OFF
- PERSONAL ERRAND/TASK
- RECREATION/SPORTS
- DOCTOR/MEDICAL

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Figure 48 Geographic dispersion of activities elicited via moby app

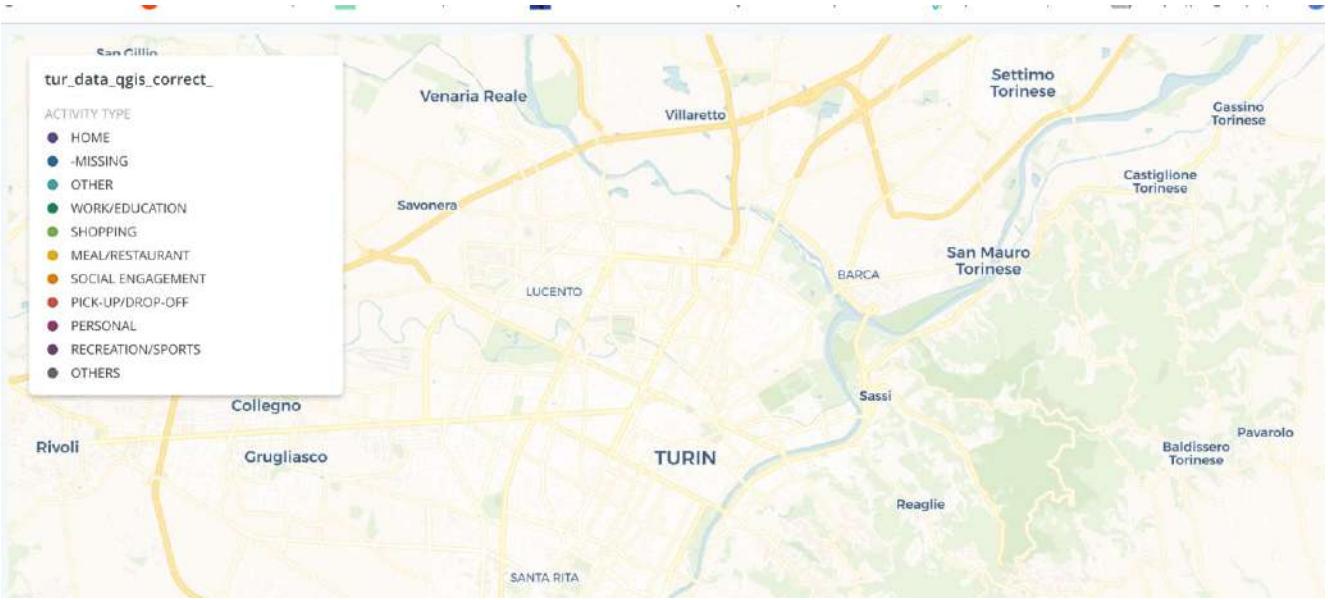

Figure 47 Timelap of activities for the duration of data collection

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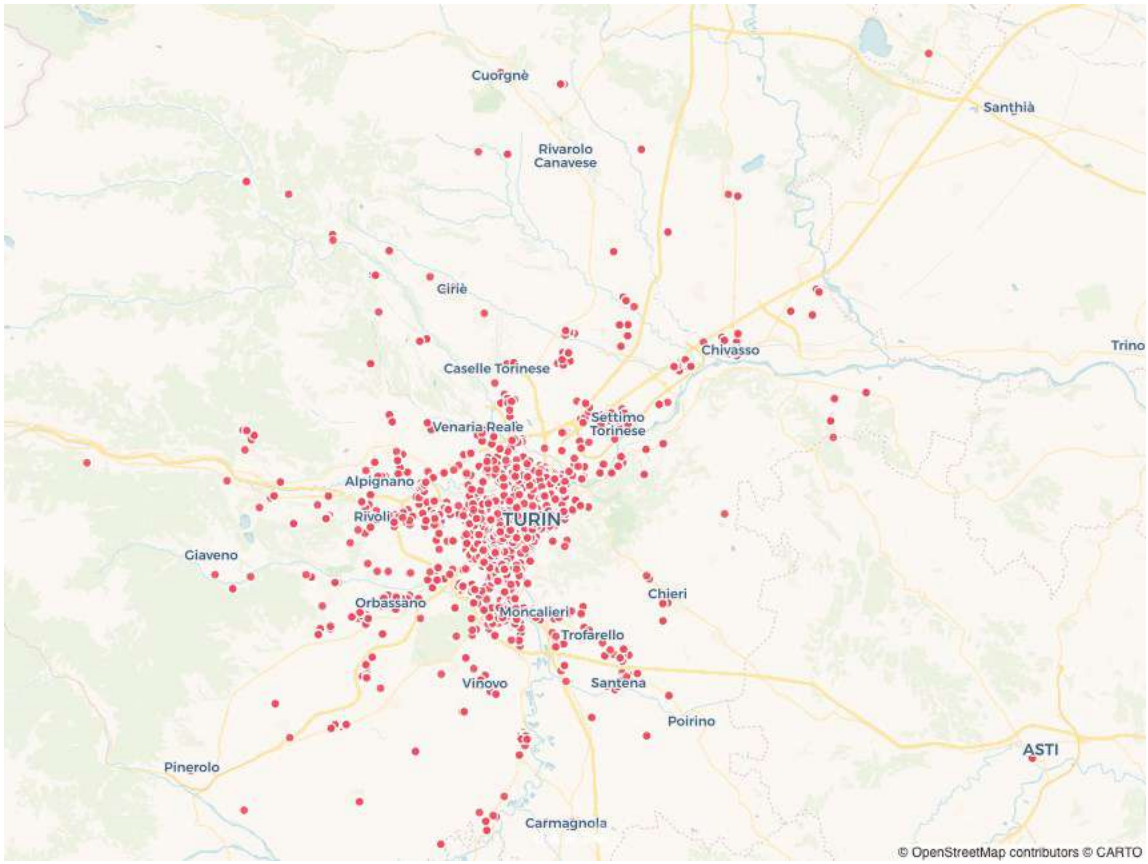

Figure 49 Location of home activities

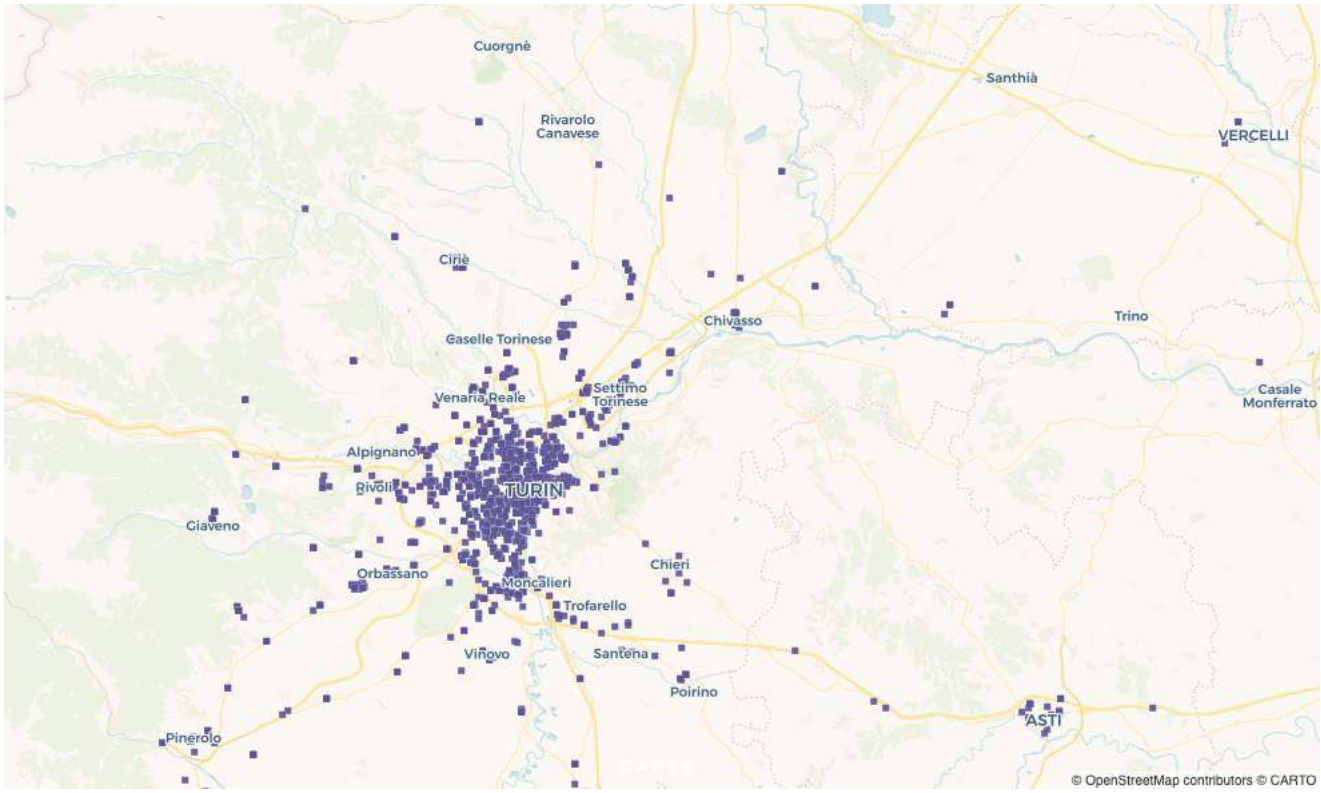

Figure 50 Location of work or school activities

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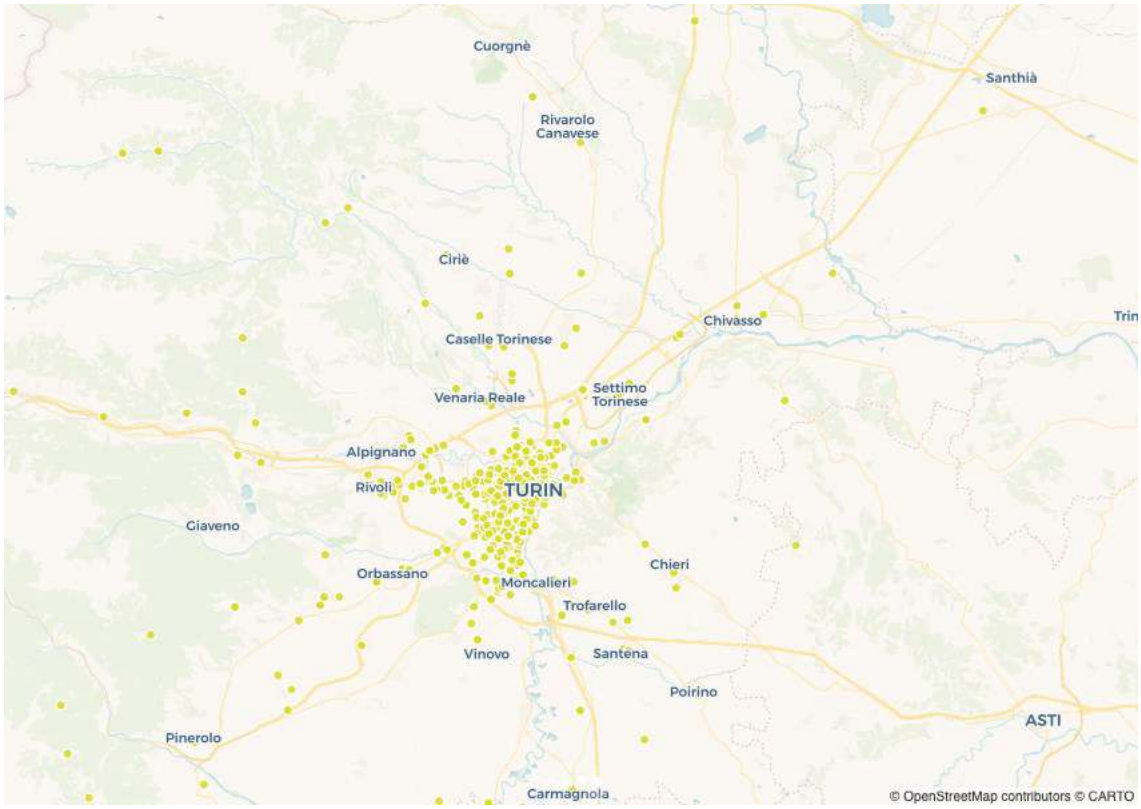

Figure 51 Location of Eating/Restaurant activities

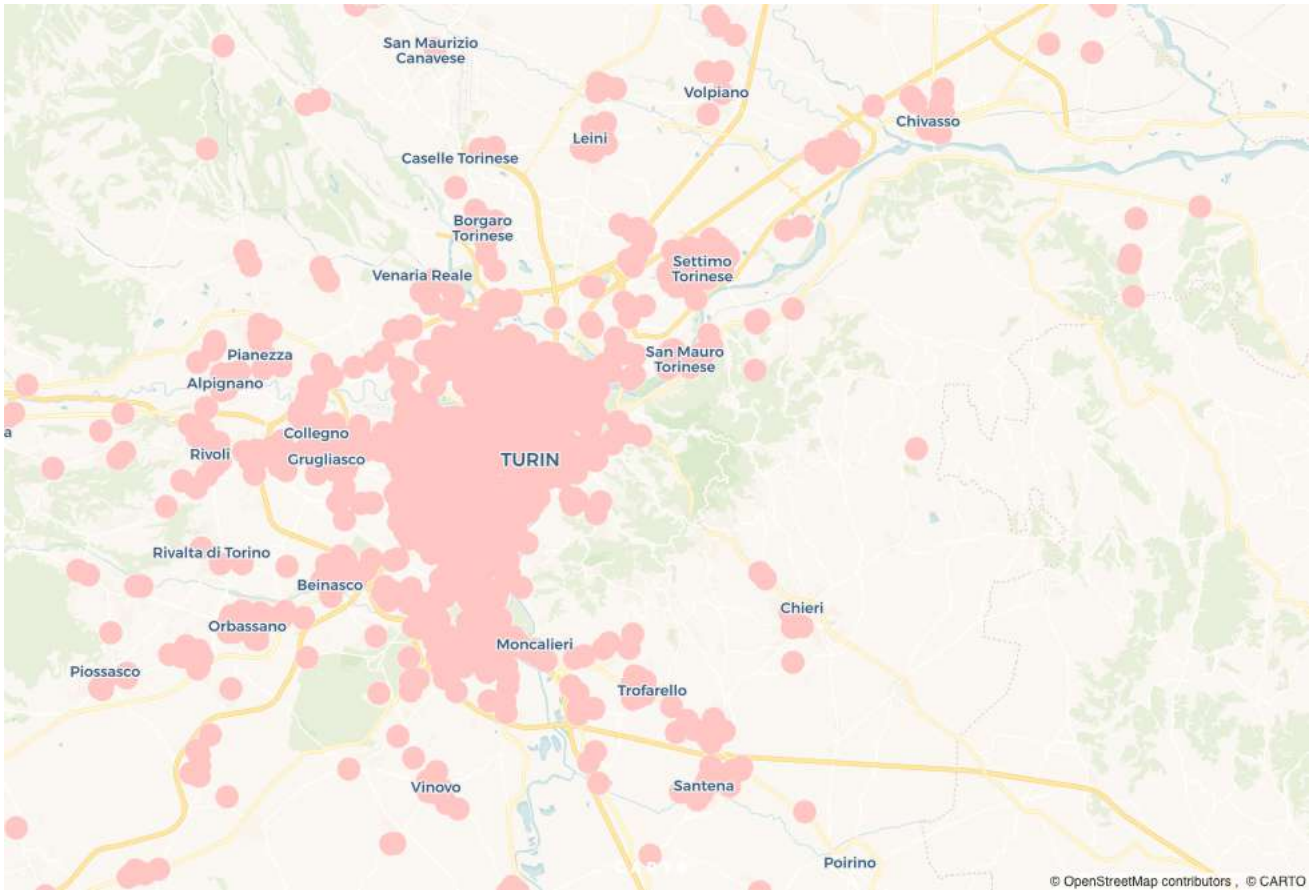

Figure 52 500m buffer from home location - geographic coverage of sample

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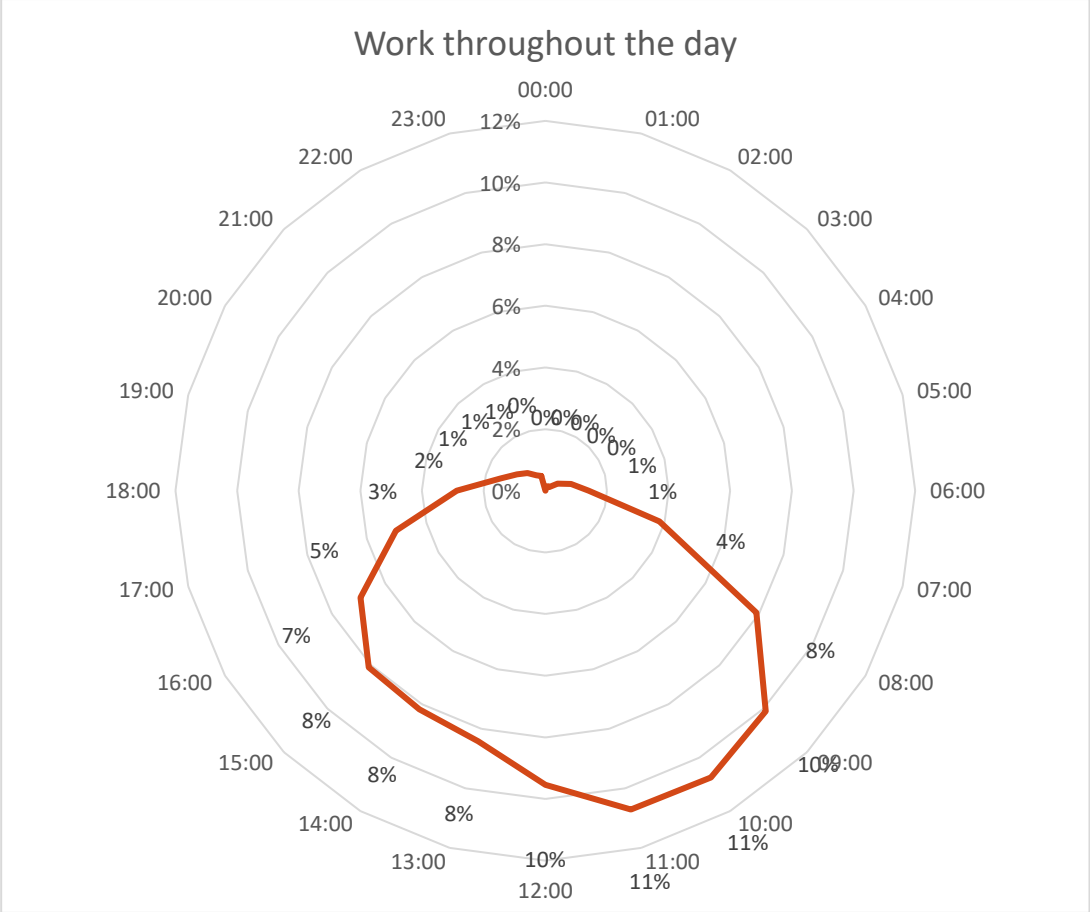

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3. Demonstrations: Trikala

Short introduction

The test flights of the European Harmony project took place in Trikala. The dispatch of the drugs by drone has been undertaken by the Drug Warehouse of the Association of Pharmacists of Trikala (SYFTA), while the respective package is received by the pharmacist of the village. For the safe and unhindered completion of the campaign, a Flight Permit was issued for the specific dates, area and altitude.

The flight was conducted from the GISEMI Hub to the three destinations Leptokarya, Mikro Kefalovriso and Megalo Kefalovriso. Prior to the flights and take off from GISEMI HUB the operational team performed all the necessary Prefight checks. The path to the final destination was already planned and uploaded to the Autopilot. All the flight paths including take-off and landing were performed automatically. For safety reasons the landing point – cargo release point was selected in manual mode with the aids of onboard FPV camera (in the UAV) and safety personnel in the area of landing – cargo release. Upon reception of the cargo the UAV continued the route and landed to the GISEMI HUB in auto mode.

Demonstration routes and maps

The demonstration routes are depicted in the maps below, as they were issued in the Flight Permit.

Figure 53 Route 1: From the GISEMI HUB to Leptokarya area

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Figure 54 Route 2: From the GISEMI HUB to Mikro Kefalovriso area

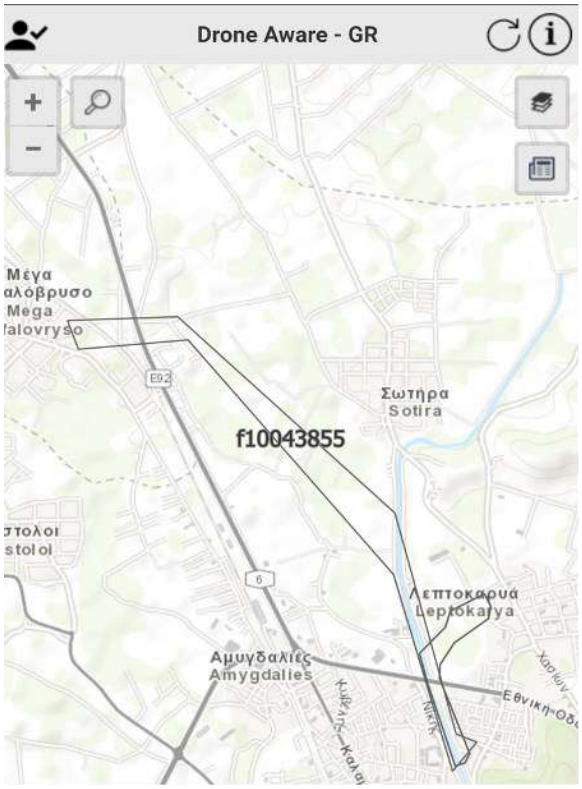

Figure 55 Route 3: From the GISEMI HUB to Megalo Kefalovriso area

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Primary data collected during demonstration

Table 3 Route 1: Data collected for Leptokaria

Flight number	Duration of flight (minutes)	Number and type of errors)	Average Ground Speed [m/s]	Maximum Altitude, Barometric [m]	Number and type of accidents	Energy consumption [Wh]
1	10	0	10	65	0	157
2	15	0	10	65	0	273
3	20	0	10	65	0	328
4	20	0	10	65	0	316
5	25	0	10	65	0	392
6	31	0	10	65	0	909
7	29	0	10	65	0	850
8	27	0	10	65	0	792

Table 4 Route 2: Data collected for Mikro Kefalovriso

Flight number	Duration of flight (minutes)	Number and type of errors)	Average Ground Speed [m/s]	Maximum Altitude, Barometric [m]	Number and type of accidents	Energy consumption [Wh]
9	29	0	10	120	0	790
10	30	0	10	120	0	888
11	31	0	10	120	0	900
12	30	0	10	120	0	890
13	29	0	10	120	0	850
14	31	0	10	120	0	905
15	30	0	10	120	0	880
16	35	0	10	120	0	1050

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Table 5 Route 3: Data collected for Megalo Kefalovriso

Flight number	Duration of flight (minutes)	Number and type of errors)	Average Ground Speed [m/s]	Maximum Altitude, Barometric [m]	Number and type of accidents	Energy consumption [Wh]
17	15	0	10	120	0	273
18	20	0	10	120	0	330
19	25	0	10	120	0	392
20	30	0	10	120	0	890
21	28	0	10	120	0	820
22	31	0	10	120	0	905
23	29	0	10	120	0	850
24	32	0	10	120	0	990

Additional data collected for all tree flights

Impact /Results/Data analysis	Leptokaria	Megalo Kefalovriso	Mikro Kefalovriso
Number of flights	8	8	8
(total) duration (Total time tested)	177 min	210 min	245 min
Average flight duration (Average time per flight)	22 min	26 min	30 min
Number of errors during the testing phase	0	0	0
Time for error fixing	0	0	0
Average speed	10 m/s	10 m/s	10 m/s
Speed variation (st. dev. of speeds)	±1 m/s	±1 m/s	±1 m/s

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Stops	1	0	0
Distance per flight	2,4 Km	5.8 Km	13 Km
Total distance	19.2 km	46,8 Km	104 Km
Freight kilometers (Ratio of the distance with cargo onboard)	19.2 km	46,8 Km	104 Km
Number of cargo transported (Average number of units of cargo transported per ride)	2	2	2
Weight and size of cargo transported (maximum size and weight that can be delivered)	100x15x50 300 g	100x15x50 300 g	100x15x50 300 g
Energy consumption	800 Wh	900 Wh	1100 Wh
Pollutant emissions/ Air quality (Air quality' is the healthiness and safety of the atmosphere which can be described by the level of pollutants in the air. The main air pollutants considered are: Sulphur dioxide (SO2), Nitrogen dioxide (NO2) and Particulate matter - PM2.5 and PM10)	Air quality is satisfactory, and air pollution poses little or no risk.	Air quality is satisfactory, and air pollution poses little or no risk.	Air quality is satisfactory, and air pollution poses little or no risk.
Noise level (The indicator 'Noise level' is used to capture the outdoor sound level caused by human activities, including transport)	40 Db	40 Db	40 Db
Accuracy (altitude, position)	±5m	±5m	±5m
Max video transmission distance in meters	20000	20000	20000
Maximum wind resistance in Km/h	50 Kph	50 Kph	50 Kph
Communication (all types)	2.4 Ghz	2.4 Ghz	2.4 Ghz
Identification	✓	✓	✓

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Failure mode	RTL,Parachute	RTL,Parachute	RTL,Parachute
Security/Cyber security	✓	✓	✓
Real time capability	✓	✓	✓
Object classification	✓	✓	✓
Interoperability (with manned aviation and other stakeholders)	✓	✓	✓
Detection	✓	✓	✓

Findings

The greatest concern in these flights routes is Safety and the insurance of Flight permits from the Hellenic civil aviation authorities HCAA. The paths of the flight were discussed and approved from HCAA. Moreover, during the flights, a member from the HCAA was present to ensure the flight safety. In addition, with the supervision and cooperation of the local government bodies all the necessarily roads and areas were evacuated for safety.

The location (usually in the centre of each village) of the pharmacies and the morphology of the ground rises a difficulty in the radio communication and the LOS (line of site) from the GISEMI HUB to Villages'.

The pharmacist has been informed via an application that is installed in a cell phone, PC or tablet that gives the position of the UAV on the map. In this manner the pharmacist can be informed when the pharmaceutical cargo will arrive in his destination. A training kit was provided to the pharmacist for approaching and using the drone.

In case the need for a Flight permit would be permanent, there is a need to create permanent spaces for landing and take-off outside residential areas. For the improvement in radio communication and LOS, a set of mesh radios would be needed.

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4. Drone survey: Katowice

A survey was designed to explore citizens' preferences for drone services. The on-line questionnaire includes a section with questions about socio-economic characteristics and attitudes towards drone services, and two stated preference (SP) experiments. One SP, where the participant is a bystander (someone else receives the service of the drone) and one SP where the participant is the recipient of the service. We followed this approach in the SPs, as citizens may be more tolerant with some aspects of the drones when they receive the service (they directly benefit from it), and less tolerant when they do not benefit from the drone service. In addition, when someone is a recipient of a drone service, more attributes are included in the choice, such as delivery time and cost; and this design is the most appropriate if it is to calculate willingness to pay.

Regarding the survey design process, the first steps included two rounds of consultations with the local authorities and stakeholders to discuss concepts and business models for drone delivery services. These consultation events resulted in a list of use cases (cases/services where drones can be used) and a list of several aspects and issues that are related to these use cases and have to further be investigated. The next steps were to translate the identified use cases along with the identified issues into a stated preference experiment to explore how citizens react towards these. Initially, a stated preference experiment was designed in the format of a table with three alternatives (two unlabeled alternatives regarding drone services and a none option), the attributes and the attributes level. However, it was identified through testings (20 individuals) that it was difficult for the participants to visualise the context. As such, it was decided to use pictures to depict the attributes and attributes levels. Graphic designers were hired to design the pictures given the combinations we provided to them (using factorial design). In a second round of testing, it was identified that the visualised experiment was much easier for the participants and it required less time to answer it. It was also identified that some attributes were still not clear and as such they were either modified or removed. After these steps, we concluded to the two experiments presented in Table 2 and Figure 1. The participants were presented with six SP tasks for the bystanders experiment and with seven for the recipients experiment.

Table 6 Attributes and levels of the two stated preference experiments

attributes	**SP for bystanders**	**SP for Recipients**
Parcel type:	Medicine; Food; Clothes; Mail; Surveillance; Illegal items; Organs/blood	Medicine; Food; Clothes; Mail; Illegal items
Registration status of the drone:	Registered; Unregistered	Registered; Unregistered
Drone operator:	Licenced; Unlicenced	Licenced; Unlicenced
Privacy:	With camera; Without camera	With camera; Without camera

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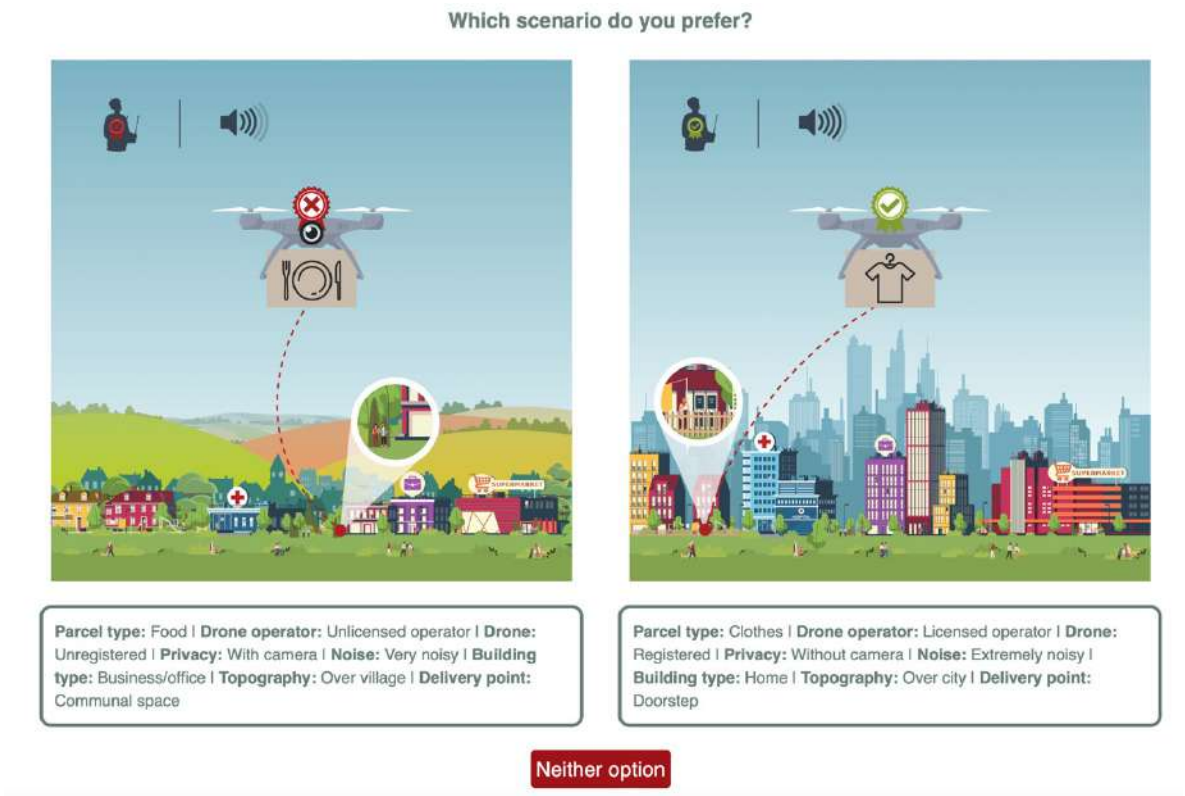
Delivery point:	Window; Doorstep; Communal space; Terrace; Open space	Window; Doorstep; Communal space; Terrace; Open space
Building type:	Hospital; Home; Business/Office; Shopping	Hospital; Home; Business/Office; Shopping
Noise level:	1=Quiet to 5=Extremely noisy	1=Quiet to 5=Extremely noisy
Area:	City; Village; Rural area	City; Village; Rural area [depending on the type of area someone lives] – *not an attribute of the SP*
Delivery cost (in local currency):	-	0, 1, 2, 3, 5, 7, 8, 10
Delivery time:	-	20min; 30min; 40min; 50min; 60min; 2h; 12h; 24h; 48h



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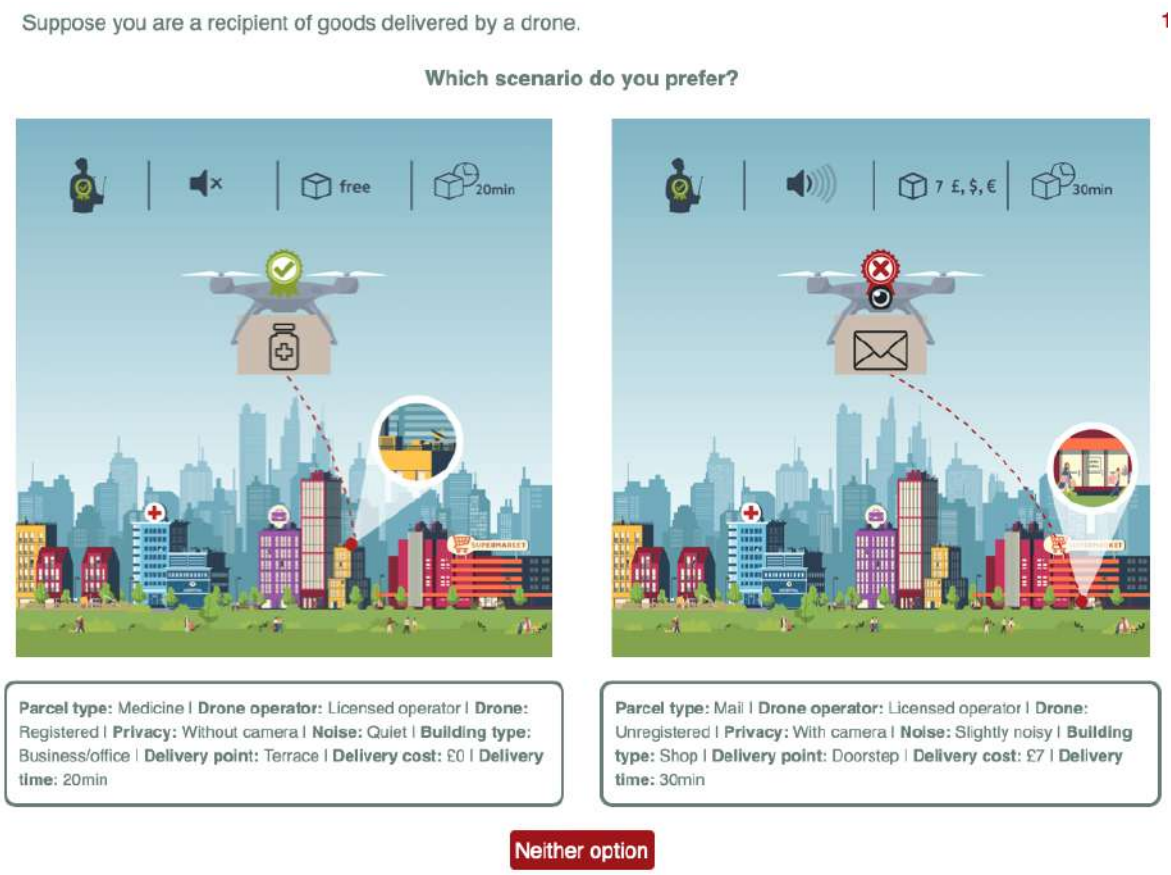

Figure 56: Examples of the stated preference experiments. Upper level: the SP for bystanders, Lower level: SP for recipients

1. Sample statistics

The survey took place between February and March 2022 and lasted two weeks. A survey company was responsible for recruiting the participants in our survey based on specific sample requirements (age, gender, and type of living area based on the census data of the GZM area) to secure representativeness of our sample. The average completion time of the survey was 6min. Table 1 presents the descriptive statistics of the sample and also provides a comparison to the census data of the GZM Metropolis (2020 National Statistics of Poland).

The majority of the participants (53%) are under 45 years old. 48.5% are males and the rest females. 68.5% of the participants are employed, while the majority (59%) live in a city.

Table 7: Sample characteristics

Variable		Sample (N=1001 obs.)	Census (2020 National Statistics of Poland)
Age	18-24	11%	10%
	25-34	19%	20%

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	35-44	23%	24%
	45-54	19%	18%
	55-64	19%	19%
	65+	9%	9%
Gender	Male	48.5%	51%
	Female	51.5%	48%
Employment status	Employed	68.5%	N/a
	Unemployed	11%	N/a
	Retired	15.5%	N/a
	Student	6%	N/a
Living area	City (more than 100,000)	59%	60%
	City/Town (5,000-100,000)	24%	22%
	Village (up to 5,000)	17%	18%

Participants and their online delivery usage

The subsequent section of the survey asked respondents to state whether they are using online delivery services, and if so, how they are using them. The findings are displayed in table 3. Most of the respondents have used online delivery services, however usually not frequently (e.g., 59% only 1-2 times per month). Roughly 23% of the participants never uses online delivery. Regarding the location, most deliveries are at home, with other delivery options used less frequently. The pick up point – post office is the second most selected delivery location. Most participants do not have a delivery subscription, and spend less than £50,- per month on online deliveries.

Table 8: Participants and their online delivery service usage

Variable		**Percentage**
Online delivery frequency	Never	23%
	1-2 times per month	59%
	2-4 times per month	15%
	More than 6 times per month	3%
Delivery location (if applicable)	Home	76%
• (Multiple options allowed)	Work	12%
	Pick up point – post office	44%
	Collect from store	17%

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	Other	15%
Delivery subscription	Yes	22%
	No	77%
Delivery costs per month	Less than £50,-	91%
	Between £51,- and £100,-	8%
	More than £101,-	1%

Participants and their familiarity with drones

Next, participants were asked to state their familiarity with drones, and attitudes regarding drone noise, privacy concerns with drones and drone safety. Most of the respondents are familiar with drones, though males are more familiar with drones than females (86% versus 81% respectively). Age is also an important factor, whereby the median age 44 for respondents familiar with drones, 48 for respondents unfamiliar with drones.

Table 9: Drone familiarity

Variable		**Percentage**
Ever seen a drone flying around?	Yes	84%
	No	16%

Considering the attitudes regarding drone noise, privacy concerns and drone safety, table 5 cross tabulates the attitudes of the respondents based on their familiarity with drones. Interestingly, noise annoyance is not a major concern for respondents, but both privacy and safety seem more of a concern. There is some variation between males and females, with males generally being somewhat less concerned on all the statements.

Table 10: Drone familiarity and noise, privacy and safety attitudes

	Familiar (1=not concerned, 5= very concerned)	**Unfamiliar (1=not concerned, 5= very concerned)**
Whether concerned about the noise levels of the drone	2.2	5
Whether concerned about my privacy regarding drones	2.8	5
Whether concerned about the safety of the drone	2.7	5

Attitudes towards drones

During the survey, participants were also asked to rate their agreement with six statements that measured their attitudes towards drones. The first three statements consider the potential purposes of drone technology, followed by two statements considering the impact of drones on the local area, and finally a statement considering whether the participant puts him/herself in exciting situations on purpose, which may be an indicator of more enthusiastic drone users (or potential adopters)

Considering the attitudes regarding potential purposes of drones, most participants see the benefits of this technology, particularly regarding goods deliveries towards remote areas. Participants also

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reported positive statements regarding deliveries to vulnerable groups. Regarding the transport of organs/blood, positive attitudes also exist, however it is notable that more respondents neither agree nor disagree.

Next, considering the impact of drones on the local area, it is notable that participants see many benefits in terms of traffic congestion alleviation. Regarding drone noises however, the views are more mixed, with a larger proportion of participants voicing concerns on the impact of drone noises (i.e., 19%). Also notable is the relatively high proportion of participants that state they neither agree nor disagree, which may suggest that they don't yet know what to expect regarding drone noises.

Finally, respondents were asked to rate their personal attitude towards exciting situations. Many respondents neither agree nor disagree, and generally tend towards disagreeing with this statement.

Table 11: Attitudes of respondents I

	Completely disagree	**Somewhat disagree**	**Neither agree nor disagree**	**Somewhat agree**	**Strongly agree**
Drones should be used to deliver goods to remote areas	3%	5%	21%	43%	27%
Drones should be used to deliver goods to vulnerable groups	3%	7%	28%	38%	24%
Drones are the best solution to transfer organs/blood	9%	15%	33%	22%	22%
Drone noises will negatively affect the wellbeing of my community	16%	32%	31%	14%	5%
Drones will contribute to traffic congestion alleviation	4%	7%	20%	37%	33%
I often put myself in exciting situations on purpose	17%	22%	40%	14%	6%

Table 12: Attitudes of respondents II

	Average score (1= completely disagree, 5= strongly agree)
Drones should be used to deliver goods to remote areas	3.9
Drones should be used to deliver goods to vulnerable groups	3.7
Drones are the best solution to transfer organs/blood	3.3
Drone noises will negatively affect the wellbeing of my community	2.6
Drones will contribute to traffic congestion alleviation	3.9

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I often put myself in exciting situations on purpose	2.7

2. Pre-estimation analysis on choice behaviour

To aid the estimation of the proposed models, several summary statistics have been derived based on the SP survey. Specifically, these summary statistics will simply look at the role of individual attributes in the choice between the two drones (or the opt out) for both SP surveys simultaneously. For each attribute studied, some cross tabulations were performed to assess whether certain socio-demographic characteristics of the respondent play a role in these choices. The criteria used are as follows:

- Type of dwelling
- Delivery frequency
- Gender
- Age
- Area type

Wherever choices seem to be different based on these characteristics, this will be mentioned for each attribute discussed.

Finally, participants wo where unlikely to choose 'drone A' or 'drone B' in any of the scenarios have been subjected to some additional analysis.

Parcel type (both SP bystander and SP recipient)

The first attribute relates to the type of goods/services that the drone provides. The following table shows the percentage of times that a drone was selected that provided the parcel/service in question.

Table 13: Parcel type for selected drone

	Bystander	**Recipient**
No drone selected	17%	22%
Medicine	15%	17%
Clothes	17%	17%
Food	13%	17%
Mail	14%	16%
Surveillance	11%	N/a
Illegal	5%	12%
Organic	8%	N/a

Regarding the bystanders, most participants selected a drone, whilst in 17% no drone was selected. It also seems that the differences between the goods/services provided by the selected drone don't vary much, though 'illegal' and 'organic' are chosen less often (which may also be due to the unbalanced SP design). Modelling is required to provide proper details on assessing whether some goods/services are more strongly preferred. Nevertheless, one could tentatively conclude that the goods/services provided may only have a limited impact. Finally, some cross tabulations were done based on the socio-demographics mentioned previously, with no obvious differences between segments.

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Regarding the recipient scenario, less parcel types are presented to recipients. It seems however that choice behaviour is similar to the SP bystander experiment, whereby parcel type does not seem to impact much on the drone selected by the participant. Only drones carrying 'illegal things' are selected less frequently (though this could be due to the design, e.g., 'illegal things' appearing less frequently in the choice tasks). Interestingly, some variation in socio-demographic factors was observed, with females somewhat more likely to select drones delivering clothing, whilst males somewhat more likely to select drones carrying illegal things. Also, participants that use delivery services frequently are also something more likely to select 'illegal things' and 'clothes'.

Licensed versus unlicensed operator (Both SP bystander and SP recipient)

Regarding the licensing of the operator that operates the drone, it seems that this has an impact on choice behaviour. Drones operated by licensed drone operators are selected more frequently by participants. This finding could indicate that bystanding participants place a relatively high value on safety. Again, cross tabulations were done based on the socio-demographic characteristics, without notable variation observed.

Table 14: Licensing of operator of the selected drone

	Bystander	**Recipient**
No drone selected	17%	22%
Operator is licensed	49%	45%
Operator is not licensed	34%	34%

Licensed versus unlicensed drone (both SP bystander and SP recipient)

As with the licensed versus unlicensed operator, the patterns are the same, with unlicensed drones not being selected as frequently. It can thus be concluded that safety concerns have a material impact on choice behaviour for bystanders, and that licensing of the operator as well as the drone could have material benefits in drone acceptance. This finding is in line with Table 5, whereby the average participant was concerned about the safety of drones.

Table 15: Licensing of the selected drone

	Bystander	**Recipient**
No drone selected	17%	22%
Drone is registered	49%	46%
Drone is not registered	34%	32%

Privacy: Drone with camera versus drone without camera (both SP bystander and SP recipient)

Regarding the cameras on drones, there are no apparent indications that this impacts on choice behaviour between drones. No significant differences are observed between bystanders and recipients. Privacy concerns may be there, but it doesn't appear to influence choice behaviour. It could thus be concluded, tentatively, that privacy concerns are less pressing than safety concerns. Interestingly, this contrasts with the statements provided in Table 5, whereby most participants were actually concerned about their privacy. It could be that the licensing regime of the drone, or operator is a mediating factor here.

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Table 16: Camera availability on selected drone

	Bystander	Recipient
No drone selected	17%	22%
Drone has no camera	42%	37%
Drone has camera	41%	41%

Delivery Point (both SP bystander and SP recipient

Regarding the bystanders, no information is available as some data points are incomplete for this attribute. For the recipient, no clear preference for the delivery point seems to exist.

Table 17: Delivery point of the chosen drone

	Bystander	Recipient
No drone chosen	n/a	22%
Window	n/a	15%
Doorstep	n/a	17%
Communal Space	n/a	15%
Terrace	n/a	15%
Open space	n/a	17%

Building type (both SP bystander and SP recipient)

The building type where the drone delivers seems to have an impact on the preferences of bystanders. Drones flying at hospitals or homes are more likely to be chosen compared to business and shopping areas. There seems to be a gender difference, whereby females are more likely to select 'hospital and home', males more likely to select 'business/office' and 'shopping area'.

In contrast, for the recipients, shopping areas are more preferred as delivery locations, whilst a much lower preference appears for hospitals.

Table 18: Building type of the selected drone

	Bystander	Recipient
No drone chosen	17%	22%
Hospital	29%	12%
Home	25%	24%
Business/office area	15%	17%
Shopping area	15%	24%

Noise levels of the drone (both SP bystander and SP recipient)

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Respondents were provided with an indication of the noise levels generated by the drone. Noise levels were visualised using a noise symbol which represented different noise levels (see figure 1). It appears that noise levels on the extreme end have a material impact on choice behaviour for bystanders, with noise level 4 being selected far less compared to the other noise levels. Interestingly, there is some evidence that males are less sensitive to noise levels compared to females in the bystander SP.

In contrast, for the recipients, higher levels of noise don't deter recipients from selecting a particular drone.

Table 19: Noise level of the selected drone

	Bystander	**Recipient**
No drone selected	17%	22%
Noise level 0	18%	16%
Noise level 1	20%	17%
Noise level 2	17%	16%
Noise level 3	16%	15%
Noise level 4	11%	15%

Area: SP bystander only (this is not an attribute for the SP recipient)

Regarding the areas in which the selected drone flies, cities are selected more often compared to villages and rural areas respectively. However, this attribute is unbalanced, with less choice tasks providing 'rural' as an option. Based on the share of scenarios in which 'rural', 'city' and 'village' are presented in the choice tasks, it cannot be concluded that any of them have a material impact on the selected drone.

	Recipient
No drone selected	17%
City	37%
Village	33%
Rural	13%

Willingness to pay (SP recipients only)

The willingness to pay attributes were only included in the SP recipient survey. It appears that more expensive drone deliveries are less likely to be chosen, in particular deliveries costing more than 8 złotys.[1] Some cross tabulations have been made to assess the impact of socio-demographics. It appears that females somewhat more likely to choose cheaper delivery options, whilst males are more likely to select expensive delivery options. Age seems to have a small effect too, with lower ages being associated with more expensive deliveries. Finally, in cities, participants are somewhat more likely to select cheaper drone deliveries. Given that most participants spend less than £50,- per month on deliveries, it was to be expected that most of them prefer cheaper delivery options.

[1] 1 Poland złoty = 0.18 GBP as of 20/4/2022

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Table 20: Cost of the selected drone delivery

	Recipient
No drone selected	22%
Free delivery	14%
1 zł	13%
2 zł	11%
3 zł	9%
5 zł	8%
7 zł	9%
8 zł	7%
10 zł	6%

Delivery time (SP recipients only)

The delivery time attribute was only provided for the SP recipient survey. The choice patterns suggests that longer delivery times are not preferred, however up to 60 minutes there is a limited effect. There is probably a relationship between time sensitive goods and non-time sensitive goods being delivered. Indeed, when the delivery is a food parcel, participants are more likely to choose lower delivery times.

Table 21: Delivery time of the selected drone

	Recipient
No drone selected	22%
20 minutes	11%
30 minutes	9%
40 minutes	9%
50 minutes	9%
60 minutes	10%
120 minutes	7%
360 minutes	7%
720 minutes	7%
1,440 minutes	5%
2,880 minutes	6%

Characteristics of participants who did not choose drones in choice scenario's.

Finally, after discussing the role of the attributes in choice behaviour, it is interesting to pay closer attention to participants who are less likely to select drones in the choice tasks. The following table provides information on how many participants did not choose a drone, or 'opted out'. It becomes clear that it is uncommon that no drone is selected, with most participants (59%), selecting a drone in each of the choice tasks, whilst 16% opted out once. Only 4% of the participants never selected a drone in any of the choice tasks.

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Table 22: Number of times recipients 'opt out'

	Bystander	Recipient
Never	59%	55%
Once	16%	12%
Twice	9%	7%
Three times	6%	6%
Four times	3%	7%
Five times	3%	4%
Six times	4%	3%
Seven times	N/a	6%

- i.e, 0 means, the share of respondents choosing 'no drone' in none of the choice task, etc.
- i.e., 6 means, the share of respondents that choose 'no drone' in all choice tasks (for bystanders).

To assess whether any socio-demographics may play a role here, the socio-demographics and attitudes of participants selecting 'no drone' at least three times, were contrasted with the socio-demographics and attitudes of participants selecting 'no drones' less than three times for both the SP bystander and SP recipient. Some interesting patterns subsequently arise. For both SP surveys, age seems to be an important factor, whereby the median age is 48 for participants unlikely to select drones, whilst participants likely to select drones have a median age of 44. Another factor that seems to impact is the frequency of delivery usage, whereby respondents not using delivery services are more likely to choose 'no drone' for scenario's (e.g., 35%-44% don't use deliveries for respondents choosing no drones in at least 4 of the choice tasks). Finally, participants who did not tend to choose drones in at least 2 of the choice tasks, seem to have differing attitudes regarding drone noise (I selected this variable, as this seems most interesting in terms of measuring 'positive attitudes' or 'negative attitudes' relating to drones). Interestingly, they are not more likely to be negative in their attitudes, but simply more likely to state that they 'neither agree nor disagree'. This could suggest a degree of unfamiliarity with drones (see tables below).

Table 23: Attitudes of participants unlikely to choose drones in any of the choice tasks

Drone noise will negatively affect the wellbeing of my community	
Completely disagree	11%
Somewhat disagree	18%
Neither agree nor disagree	50%
Somewhat agree	14%
Strongly agree	8%

Table 24: Attitudes of participants likely to choose drones in the choice tasks

Drone noise will negatively affect the wellbeing of my community	
Completely disagree	17%
Somewhat disagree	35%

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Neither agree nor disagree	28%
Somewhat agree	15%
Strongly agree	5%

To verify this hypothesis, cross tabulations of 'having ever seen drone flying around' and the share of respondents not choosing drones has been inspected. For respondents choosing 'no drone' for 5 or 6 of the choice tasks, there is indeed a higher share of respondents that have not experienced drones (roughly 25% versus 14% respectively).

3. Preliminary model estimation results

A preliminary multinomial choice model has been developed using the data from the SP for bystanders. The preliminary model includes as variables only the attributes of the SP and not any other explanatory variables (i.e. socio-demographic characteristics). The final model as well as the model for the recipients will be presented in the full paper. The final models will be mixed multinomial choice models to account also for taste heterogeneity. The model was estimated using Python Biogeme (Bierlaire, 2017).

Table 25: Preliminary model estimation results for bystanders (basic MNL model)

Variable	Coef.	t-stat
Constant (specific to none alternative)	1.760	15.6
Parcel type: clothes	-0.382	-5.21
Parcel type: illegal items	-1.330	-14.4
Parcel type: mail	-0.114	-1.65
Parcel type: medicine	0.129	1.39
Parcel type: organs	-0.086	-0.698
Parcel type: surveillance	-0.084	-0.908
Registration status of the drone: unregistered	-0.526	-14.4
Drone operator: unlicenced	-0521	-14.2
Privacy: no camera	0.131	2.49
Noise (continuous)	-0.149	-9.06
Area: rural	0.419	0.554
Area: village	0.115	2.17
		N. obs.: 6006
		R^2: 0.138
		Initial Log likelihood: -6598.265
		Final Log likelihood: -5690.991

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The elaboration of the preliminary results shows that citizens prefer drone services when it is to be used for medicines deliveries, while they do not prefer drones to be used for surveillance and clothes, illegal items, mail, and organs deliveries. However, the coefficients and the t-stat are quite low for the organs deliveries and surveillance, and this may change in the final model. As noise increases, citizens tent to not prefer drone services. The same applies when the drone is unregistered, or the operator of the drone is unlicenced. Participants seem to accept drone services when the delivery areas are rural or villages.

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5. COVID-19 survey

This section presents the findings from the data analysis. It starts by presenting the authorities' priority planning objectives before the Covid-19 outbreak and during the 2020/2021 Covid-19 lockdowns. It elaborates on the actions and planning approaches the authorities took to implement the prioritised objectives during the Covid-19 lockdowns, as well as the reasons/driving forces behind these actions. Then, the gaps that authorities have in emergency planning are discussed.

Planning objectives before and during the 2020/2021 Covid-19 lockdowns

The results of the survey indicate that there has been changes in the planning priorities that authorities targeted before and during the outbreak of the pandemic. Respondents of the survey were given a list of 13 planning objectives, and they were asked to rank the 5 most important objectives for their area for the period before and for the period during the 2020/2021 Covid-19 lockdowns (section 2 of the questionnaire). Respondents had the option to specify additional planning objectives if not already in the given list, and they could also skip answering for the period during the Covid-19 lockdowns, meaning that the planning objectives remained the same. Figure 1 illustrates the frequencies of the selected objectives for the two time-periods.

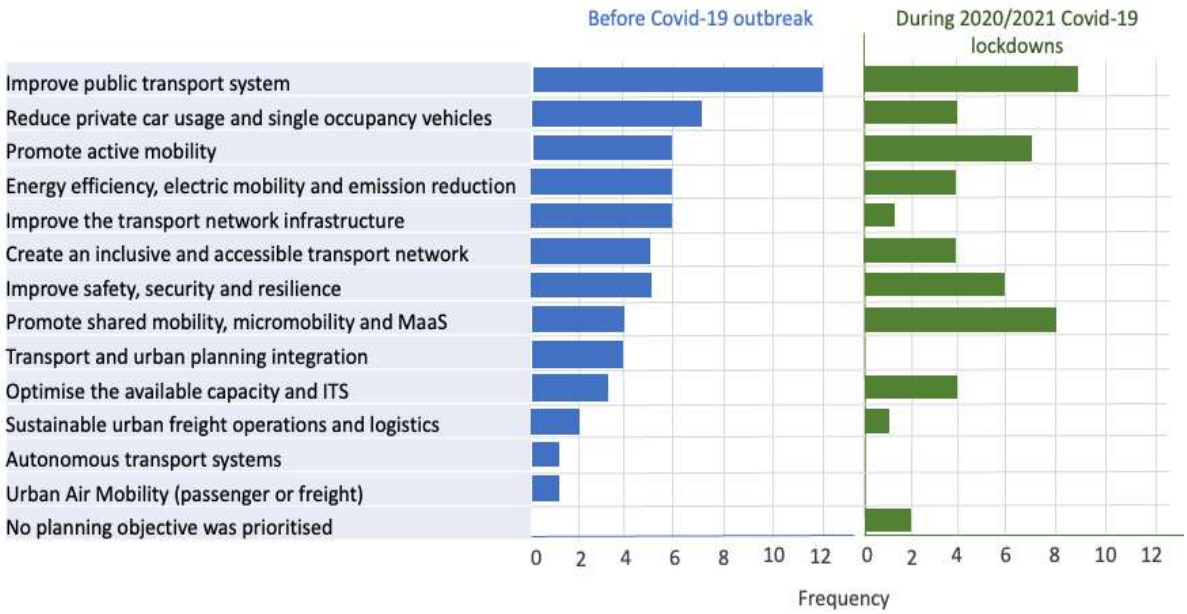

Figure 1: Selected planning objectives before) and during Covid-19 outbreak [ITS= Intelligent Transport Systems]

In the "Before Covid-19" period, the objective that was selected the most is to "Improve public transport system"; selected by all but one authority. "Reduce private car usage and single occupancy vehicles" objective was the second most popular. In the third place there are three objectives -all selected by six authorities-, which are to "Improve the transport network infrastructure", "Promote active mobility" and "Energy efficiency, electric mobility and emission reduction". All planning objectives listed in this question were selected by at least one authority confirming the relevance of objectives to the planning practice.

In the period "During the 2020/2021 Covid-19 lockdowns", the objective "Improve public transport system" remains the most popular one; but this time was selected three times less (9 authorities selected it); although the use of the public transport modes had been reduced during this period (Marra et al., 2021; Marsden et al., 2021; Nundy et al., 2021; Rothengatter et al., 2021; Vickerman et al., 2021), this finding is plausible, as this survey focuses on authorities and one of their responsibilities is the operation and resilience of the public transport systems. The objective, "Promote shared mobility,

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micromobility and MaaS" comes second (selected by 4 times more), while "Promote active mobility" comes third (selected by one more authority). "Improve safety, security, and resilience" comes in the fourth position, and "Optimise the available capacity and ITS" comes in the fifth place. "Integration of transport and urban planning", "Autonomous transport systems", "Urban Air Mobility" are the only planning objectives that were not selected at all. This indicates that authorities preferred to allocate all their resources on solutions that were already operational, instead of looking to solutions that have high uncertainty for the public and for all the stakeholders. Two authorities stated that no planning objectives were prioritised which highlights the diversity among planning mechanisms (or even existence of barriers) regardless of common needs.

The most noticeable change concerns the objective "Promote shared mobility, micromobility, and MaaS". Given the Covid-19 situation in 2020 (when vaccines were not available yet), citizens were reluctant to use public transport modes fearing of their safety (Song et al., 2021). The authorities anticipated these concerns and as such, they looked for alternatives to the second best option, this of shared mobility, micromobility and MaaS, trying as such to also refrain people from using private vehicles:

- *"If public transport is not ready for some general changes, then we could get support from external shared mobility operators and we feel that it could help us...They are more flexible for the changes [needed during Covid-19]. So, this was like a good opportunity to use these services [MaaS]."* [Katowice, POL; Large urban area; without SUMP]
- *"During Covid-19 we are working to create alternative solutions [to public transport] and one solution is to use shared mobility [e-scooter or cycling]."* [Turin, IT; Large urban area; with SUMP]

Another noticeable change, is the drop of the objective "Reduce private car usage and single occupancy vehicles" in the during 2020/2021 Covid-19 lockdowns, selected three times less for this period. It is anticipated that by prioritising other objectives like active transport, shared mobility, micromobility and MaaS, the authorities try indirectly to also reduce private vehicle usage.

A further analysis among small or medium sized areas (50,000-500,000 inhabitants) and large areas (>500,000 inhabitants) reveals different priorities for the period during the 2020/2021 Covid-19 lockdowns (Figure 2). Large areas focused a lot on "Promote shared mobility, micromobility and MaaS", while smaller areas focused on "Promote active transport". This is mainly due to the fact that the smaller areas do not have satisfactory transport mode alternatives (see Table 2) to direct citizens, and as such active mobility options are the most promising ones. The second most frequently selected objective was to "Improve public transport system" for both smaller and larger areas.

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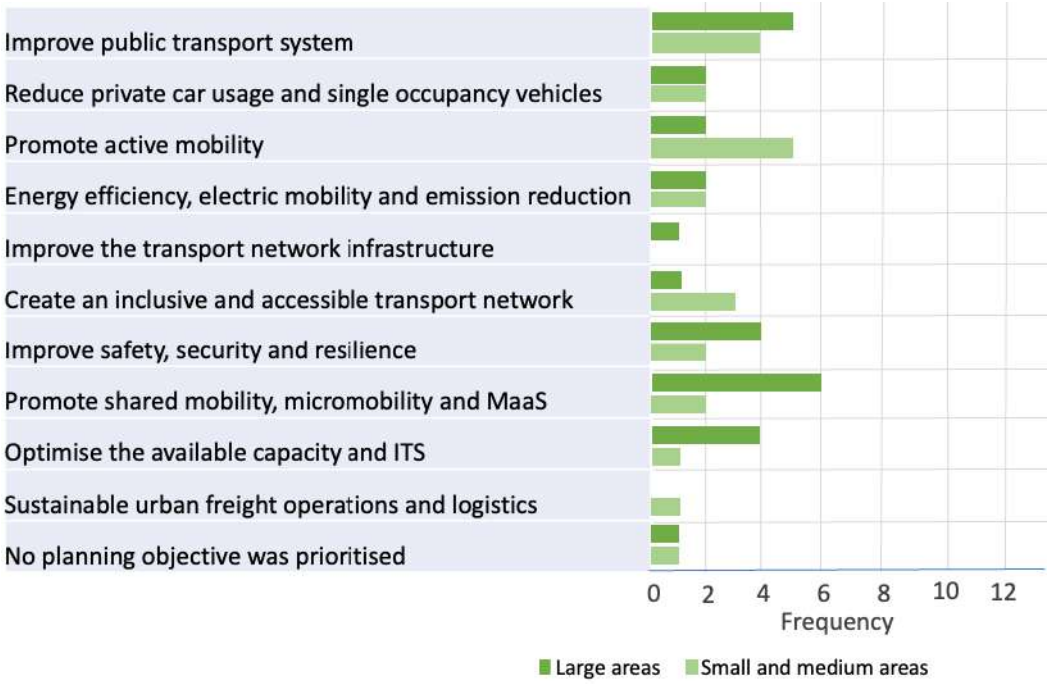

Figure 2: Planning objectives during the Covid-19 outbreak in large and small/medium areas

The comparison of the ranking of planning objectives between the period before and during the 2020/2021 Covid-19 lockdowns, results in the disclosure of the prioritised objectives (the planning objectives that were prioritised during the 2020 lockdowns), or the ones introduced for the first time (Figure 3). In total 9 planning objectives were prioritised or introduced out of the 13 presented in the given list. It is remarkable that almost half of the public authorities introduced or prioritised "Promote shared mobility, micromobility and MaaS". It is also revealed that "Promote active mobility" and "Improve safety, security and resilience" objectives have been ranked higher for the period during Covid-19, reflecting the need for securing public health, while at the same time promoting active travel which enables more keeping social distancing measures.

Another interesting finding is related to the objective "Create an inclusive and accessible transport network for all", which although selected by fewer authorities in the period during the 2020/2021 Covid-19 lockdowns, it was ranked higher by three authorities. This period of time, it was important for the authorities to act in a way that vulnerable population groups (i.e. elderly, disabled etc.) were not opted out from travelling when they needed to. Moreover, "Sustainable urban freight operations and logistics" objective was only prioritised once, although selected twice for the period during Covid-19. This fact contradicts with the increase of freight movements in urban areas which aim to make up for the reduced movements of people and market restrictions during the 2020-2021 lockdowns.

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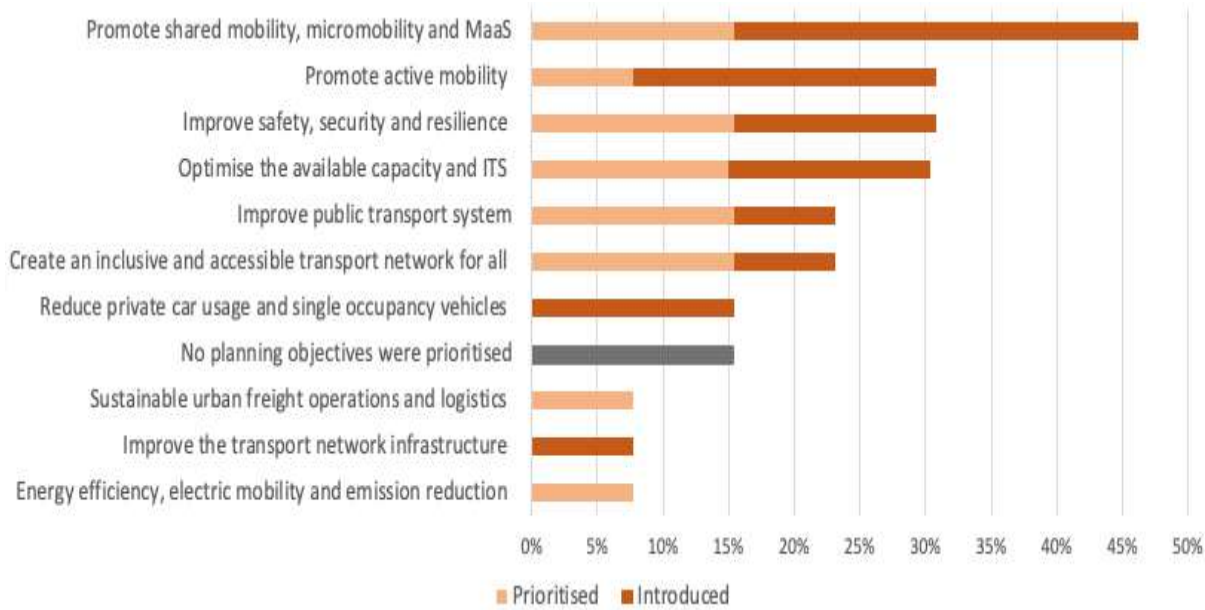

Figure 3: Prioritised or introduced planning objectives during Covid-19 lockdowns

Planning actions to implement the prioritised objectives and driving forces behind

This section explores the actions taken to implement the prioritised planning objectives (as presented in the previous section) and the driving forces behind them answering as such RQ2.

The respondents of the survey prioritised or introduced in total 9 planning objectives as presented in the given list (Figure 3). For each one of the prioritised objectives, the authorities specified one to three actions they took to achieve them, as well as the driving forces behind implementing these actions (Table 3). Looking to Table 3, it is interesting the variety of the actions the authorities implemented to achieve the same objectives. For example, in order to promote shared mobility, micromobility and MaaS, some areas tried to increasethe supply of these services, while others found the opportunity to initiate e-scooter trials. There are also several similar actions that the authorities implemented to achieve their objectives. For example, in order to improve safety, several authorities imposed the installation/provision of sanitisers, the increase in the frequency of cleaning the vehicles, as well as wearing a mask on board (that applies to all transport modes). Social media was also widely utilised for the authorities to inform and engage the public.

However, it is also noticed that several of the implemented actions can achieve more than one objective. For example, by imposing traffic restrictions for private cars to improve safety or to promote active transport, at the same time the objective “Reduce private car usage and single occupancy vehicles” is also achieved. Similarly, by installing ITS (digital ticketing, real time information, digital counting) the authorities achieve both the optimisation of the available capacity, but also the improvement of the public transport system.

- *"Safety is one of the driving forces that has to be the focus right now, because somehow we have to gain trust from the passengers to make sure that they understand that public transport vehicles are not dangerous or not more dangerous than visiting shops or markets."..."safety issues remain important also after Covid-19, because people will not think from one day to the other 'OK, it's over now we can get back to normal'."* [Aachen, DE; Large urban area; with SUMP]

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- *"ITS system (mobile app) was created in order for people to know if the bus is full or not full (to know the occupancy)."..."Another measure to protect safety is the separate lanes for cyclists with lowering the maximum speed for cars, where lanes are common between cars and bikes."* [Turin, IT; Large urban area; with SUMP]
- *"A priority is given right now to active mobility, walking and cycling, since it is regarded as a safer solution and there has been a discussion to pedestrianise even more streets in the city for promoting and making safer and easier active mobility modes; so have more pedestrian roads, more cycling lanes and less cars."* [Trikala, GR; Small urban area; without SUMP]

Prioritised objectives	Planning actions implemented	Driving forces / Wider objectives
Promote shared mobility, micromobility, and MaaS	Increase the supply of shared mobility services *[Turin, IT; Katowice, POL]*	PH, ECON
	Mobility credits scheme* extended *[West Midlands, UK]*	ENV, ECON, SE
	Initiate e-scooter trials *[Middlesbrough, West Midlands, UK]*	PH, ENV, ECON
Promote active mobility	Promote active transport via local and social media *[Athens, Trikala, GR; London, West Midlands, Oxford, Middlesbrough, UK; Graz, AU]*	PH, ENV
	Public engagement through social media campaigns *[Athens, GR; Oxford, West Midlands, UK; Graz, AU]*	PH, ENV
	Temporary traffic restrictions to support active travel; Pedestrianisation *[Trikala, GR; Katowice, POL]*	PH, ENV
	Widening footpaths *[Middlesbrough, UK; Katowice, POL]*	PH, ENV
Improve safety, security and resilience	Prioritise public transport at traffic lights to reduce travel times *[Turin, IT]*	PH
	Introduce telehealth instead of physically travel to the doctors/medical centres/hospitals *[London, Oxford, West Midlands, UK]*	PH, SE, ENV
	Switching off all buttons for pedestrians at traffic lights to prohibit people touching interfaces *[Katowice, POL]*	PH
Improve public transport system	Increase the level of safety on board by installing sanitisers, increasing the frequency of cleaning, making masks compulsory *[Graz, AU; Flanders, BE; Athens, GR; Turin, IT; London, Oxford, West Midlands, UK]*	PH

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	Increase number of buses to increase occupancy and satisfy social distancing measures *[Aachen, DE; Athens, GR; Middlesbrough, UK]*	PH
	Introduction of demand responsive bus service *[Athens, GR; West Midlands, UK]*	PH, ECON
	Improve public transport accessibility *[Athens, GR; West Midlands, UK]*	SE, PH
	Increase speed of rail-based public transport, enhance headways *[Athens, GR]*	PH
Optimise the available capacity & ITS	Digital ticketing, digital passenger information systems, digital communication, Digital counting infrastructure at PT *[Aachen, DE; London, West Midlands, Oxford, UK; Athens, GR; Turin, IT]*	PH, ECON, ENV
Create an inclusive and accessible transport network for all	Introduce more bus platforms and accessible buses *[Athens, GR; Middlesbrough, UK]*	PH, SE
	Subsidised the PT tickets for vulnerable population and key workers *[London, UK]*	SE, PH
	Secured grocery delivery slots for disabled and elderlies (one slot every week) [*Oxford, West Midlands, Middlesbrough, UK*]	PH, SE
Reduce private car usage and single occupancy vehicles	Introduction of bus rapid transit *[Athens, GR; West Midlands, UK]*	PH, ENV
	New bus lanes (car lanes dedicated to buses) *[Katowice, POL]*	PH, ENV
	Reopening of rail stations that closed in the past *[West Midlands, UK]*	PH, ECON
	Cooperation with shared mobility providers and ridehailing companies for free trips for medical staff *[Katowice, POL; Oxford, West Midlands, UK]*	PH, ECON
Improve the transport network infrastructure	Roadworks, fix potholes, improve roadside infrastructure (it was an opportunity to fix potholes as the traffic on the roads was too low) *[Oxford, UK]*	ECON, SE
	Improved and updated the operation of traffic lights *[Oxford, Middlesbrough, UK]*	ECON

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	Strengthened collaboration with other authorities for maximising transport assets *[London, UK]*	ECON, ENV
Energy efficiency, electric mobility and emission reduction	Installing more EV charging points and incentivised electromobility *[Trikala, GR; West Midlands, UK]*	ECON, ENV, SE
	Roll out of 300 electric buses through a leasing scheme *[Athens, GR]* *Roll out of electric buses [West Midlands, UK]*	ENV, ECON
Applies to all objectives	Covid-19 support funds *[Aachen, DE]*	PH, ECON, ENV, SE
PH: Public Health, ECON: Economy, ENV: Environment, SE: Social equity *Residents with an older, polluting car can exchange their car for £3000 of mobility credits. The credits can be spent on public transport, and other transport services such as car clubs, bikeshare, taxis and on-demand bus services. The credits are loaded in a pre-paid Debit card		

Table 3: Actions adopted to accommodate prioritised planning objectives

Out of the 29 actions specified (Table 3), it was stated that 19 were defined before the Covid-19 outbreak indicating that the pandemic has worked as an accelerator of objectives and measures already in place. As discussed during the interviews, the Covid-19 outbreak has favoured the promotion of sustainable transport modes (active and shared mobility, micromobility and MaaS), and related actions came forward, using this crisis as an opportunity to implement them.

- *"All these directions were already discussed by the municipality before, but maybe they were accelerated by the pandemic."* [Trikala, GR; Small urban area; without SUMP]
- *"We're looking to try and jump on at the back of the Covid-19 pandemic opportunities that are available in terms of getting people around sustainable transport modes..."* [Oxford, UK; Small urban area; with SUMP]
- *"Covid-19 is an opportunity to bring forward some of the ambitions [related to the transport system] that had been around beforehand"…"It's more trying to probably accelerate some of the measures like active travel measures… "… "Covid-19 has sort of reinforced the importance of MaaS...is a good opportunity to bring people back to those services, or to use for new people."* [London, UK; Large urban area; with SUMP]
- *"Micromobility remains obviously important during Covid-19, because it's socially distanced mode of transport...there was a significant policy change in the micromobility trials which became available now … so we sort of took the opportunity."* [West Midlands, UK; Large urban area; with SUMP]

The driving factors or the wider objectives for authorities changing their priority in planning objectives vary. Taking into account all the objectives that were prioritised during the lockdowns, it is found that the main reasons for prioritising specific objectives was public health and safety (35% of the prioritised objectives), followed by reducing environmental impact (27%), support economic recovery (21%) and secure social equity (15%). As it can be seen in Table 3, the implementation of most of the actions had as a driving force the protection of public health. However, the authorities tried to make sure that the actions, can cross at the same time and other reasons, such as the economic recovery, the protection of the environment, and social equity.

- *"The focus of whatever we do is, well, public health and safety."* [Oxford, UK; Small urban area; with SUMP]

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- *"We've had to look at alternative sustainable options of how we can get people around based on supporting the local economy. So, we have basically commenced an electric scooter trial."* [Middlesbrough, UK; Small urban area; with SUMP]

Emergency planning

The analysis continues with exploring if the authorities have been prepared for dealing with emergency situations and if emergency planning is part of their strategic planning (the Sustainable Urban Mobility Plan). The results reveal that emergency planning for a pandemic and any emergency situation in general, is not part of the planning mechanisms and the strategic frameworks (SUMP) of the authorities. Five of the participant authorities stated that there is no emergency planning, and the other five were unsure about the existence of any. Only the UK authorities mentioned that there is emergency planning for the public transport system in the case of terrorism incidents (e.g. evacuation etc.). Two authorities mentioned that emergency scenario planning exists for other sectors, such as business continuation plans for dealing with terrorist attacks. Just one authority mentioned that since the Covid-19 breakout, they created an official synergy with stakeholders to adopt tools and techniques from other sectors' emergency scenario planning as a response to the Covid-19 crisis.

- *"No, we haven't had an emergency planning before. I'm pretty sure that on a city level there is…but not focusing on our sector [transport]. "…"I don't think that there has been a detailed or focused analysis on what to do in crisis situations."* [Aachen, DE; Large urban area; with SUMP]
- *"We have developed something during the pandemic, that is the regional Transport Coordination Centre...We bring together a lot of different agencies to look at live situations that are happening on the network, but also plan ahead."* [West Midlands, UK; Large urban area; with SUMP]

The lack of emergency planning, has led to a situation where all the authorities followed reactionary approaches. At the same time, six authorities stated that they were sharing knowledge with other cities or areas to fill knowledge gaps about how to respond towards the Covid-19 lockdowns.

- *"It was very much local knowledge as opposed to a strategy…it was the opinions and the thought process of the local people as opposed to a strategy that came. Place for that is very reactionary."* [Oxford, UK; Small urban area; with SUMP]
- *"Covid-19 is being very reactionary, so if anything, there's been no real strategy behind it. It's been kind of local knowledge and thought processes that have got into it, but no real strategy as such."* [Middlesbrough; UK; Small urban area; with SUMP]
- *"We are doing more ad hoc actions now, looking at the requirements that we see in the horizon."* [Aachen, DE; Large urban area; with SUMP]
- *"We have counselled with other cities to get insights about their reactions …to start thinking how to do it in a similar way and we realised that cities are not ready…haven't thought about it previously."* [Katowice, POL; Large urban area; without SUMP]

Authorities stated that it is somehow impossible to think about introducing emergency scenario planning during the lockdowns. However, they mentioned the need to include it in the next iteration of their strategic documents either as a reference to resilience or as lessons learned from the pandemic, or to include it in the scenarios specification (to define emergency scenarios).

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6. Conclusions

Deliverable 3.4 presents analysis of primary data sources available so far in HARMONY. Data from the primary data collection effort (socio-demographic survey and Moby app activity tracking) are presented in Chapter 2, experiment description along with experiment data from drone demonstration in Trikala is presented in Chapter 3, SP survey from the drone experiment in Katowice is presented in Chapter 4, while pandemic-related questionnaire results are presented in Chapter 5.

Primary data analysis from Turin reveals that the sample is sufficiently representative of the local population. Chapter 2 presents some interesting findings of the analysis, such as the big percentage of the sample who state they do not know specifics regarding the CO2 emissions of their vehicle, their annual mileage or fuel/maintenance cost, verifying the long-standing perception in travel behaviour analysis that the cost of using a private car is severely miscalculated by passengers/owners. Regarding the attitudinal questions, respondents generally seem eager to accept autonomous vehicles, though reluctant to trust them to carry their kids to their activities, not so suspicious of data sharing where there is a clear gain/incentive and seem to overcome certain barriers faced during the pandemic. In terms of remote work, a significant portion of the respondents worked remotely during the pandemic and a part of them are planning to continue working remotely, at least partially.

Data from the drone experiment in Trikala, revealed that the experiment was conducted in a successful and safe way, without any major unforeseen events and disruptions. Additional exploring of the stance of citizens towards drones is conducted in the survey presented in Chapter 4. Main results indicate that citizens prefer drone services when it is to be used for medicines deliveries, while they do not prefer drones to be used for surveillance and clothes, illegal items, mail, and organs deliveries. Participants seem to accept drone services when the delivery areas are rural or villages, which is more or less the experiment conducted in Trikala.

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