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Public perception towards electric light vehicles: an empirical look across six European cities

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List of Acronyms

Abbreviation / acronym	Description
AMT	Azienda Mobilità e Trasporti (“Mobility and Transport Company” in Italian language)
AQI	Air Quality Index
AVE	Average Variance Extracted
BEV	Battery Electric Vehicle
CNG	Compressed Natural Gas
CO	Carbon monoxide
CR	Composite Reliability
EC	European Commission
EL-V	Electric L-category Vehicle

Abbreviation / acronym	Description
EMT	Empresa Malagueña de Transportes ("Málaga City Transport Company" in Spanish language)
EU	European Union
EV	Electric Vehicle
FUTs	Flagstaff Urban Trails
GHG	Greenhouse Gas
ICEL-V	Internal Combustion Engine L-category Vehicle
ICEV	Internal Combustion Engine Vehicle
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LTZ	Limited Traffic Zones
NMNL	Nested Multinomial Logit Model
NO_2	Nitrogen dioxide
O_3	Ozone
PCA	Principle Component Analysis
PHEV	Plug-in Hybrid Electric Vehicles
PM	Particulate matter
PM10	Coarse particulate matter
PM2.5	Fine particulate matter
ppb	parts per billion
PT	Public Transport
REEV	Range Extend Electric Vehicle
SO_2	Sulphur dioxide
SUMP	Sustainable Urban Mobility Plan
TCO	Total Cost of Ownership
TAM	Technology Acceptance Model
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology
ZSL	Zona Sosta Limitata ("Restricted Parking Zones" in Italian language)
ZTL	Zona a Traffic Limitato ("Limited Traffic Zones" in Italian language)

Executive Summary

The development of sustainable, smart mobility has been accelerated by the arrival of innovative technologies. With the paradigm shift towards transport electrification, Electric Light Vehicles (EL-Vs) represent a low-cost, most promising pathway to smart urban mobility. Despite this, the current market penetration of EL-Vs is relatively low compared to that of conventional vehicles or other e-powered vehicles such us e-bikes or cars. A major hindrance in wide market deployment of EL-Vs is the users' low awareness of their existence.

By deploying and demonstrating this kind of vehicles in six different European cities (Rome, Genoa, Bari, Málaga, Trikala and Berlin), the EU-funded ELVITEN project aimed at proposing innovative schemes to boost EL-V usage.

This research work has been carried out in the context of better understanding the prior attitude of the population towards EL-Vs, identify potential user groups, and exploring if infrastructure-related aspects (such as parking and charging facilities) are more relevant than other factors considered by the literature (such as policy incentives, congestion levels, weather conditions, topography or population density, age and education).

A comprehensive template was created as a data collection guideline for demonstration cities, in order to highlight their demographic characteristics and mobility features. By a state-of-the-art survey the factors affecting EL-V adoption were identified. City profiles were then created for each of the demonstration cities using a qualitative analysis on current mobility patterns and underlying conditions from existing city data. A cross-city comparison provided a deeper understanding of the contextual environment surrounding EL-V usage, which can be used as a basis for future EL-V city deployment.

Prior attitudes towards EL-Vs were examined through a wide online questionnaire survey, and on-site interviews. Online questionnaires were distributed in all demonstration cities in the national language. The statistical analysis was based on a total of 6,753 responses received via an online platform (standard multiple-choice questionnaire offered in five languages), identifying perceptions of EL-V use and attitudinal barriers that may inhibit adoption. By analysing a limited series of on-site or telephone interviews with fleet owners and stakeholders - including fleet managers and drivers respectively – additional attitudes towards EL-Vs were observed.

The general results from the surveys indicated that positive perceptions for aspects such as comfort, capacity, and safety increase with the number of wheels, whereas aspects such as parking and affordability decrease with the number of wheels of EL-Vs. Perceived attitudes towards using shared or rented EL-Vs as well as using EL-Vs as part of a multimodal journey were positive in all cities. In contrast, perceived attitudes towards using these vehicles for all trip purposes (e.g. work, shopping, and leisure) are more neutral.

The most favourable measures to promote EL-Vs usage identified were to provide sufficient charging infrastructure, followed by incentive schemes, allowing use of bus lanes, and sufficient secured parking. For fleet operators and drivers, dedicated delivery spaces on streets, low costs for maintenance, and possible access to Limited Traffic Zones were categorised as advantages in order to encourage use of EL-Vs.

A model was also applied exploring whether three moderators (gender, age and occupation) hold a direct influence on eight a-priori perceptions and attitudes (indicators) towards EL-V usage: Willingness to use per trip purpose, Willingness to use as a part of a multimodal trip, Ease of parking, Comfort, Safety, Luggage capacity, Charging convenience and Affordability.

In sum, the insights gained from the outcomes of this study provided a comprehensive picture of the EL-V environment in each demonstration city as well as people's attitudes towards EL-Vs. Based on such findings, a preliminary guide for EL-V policymaking is put forward, including six usage schemes for EL-Vs city roll-outs, and in addition 40 operational, policy and ICT requirements.

Resumen Ejecutivo

El desarrollo de una movilidad sostenible e inteligente se ha visto acelerado por la llegada de tecnologías innovadoras. Con el cambio de paradigma hacia la electrificación del transporte, los vehículos eléctricos ligeros representan una vía de bajo coste y muy prometedora para la movilidad urbana inteligente. A pesar de ello, su penetración en el mercado es relativamente baja en comparación con la de los vehículos convencionales u otros vehículos eléctricos, como las bicicletas o los coches eléctricos. Uno de los principales obstáculos para su implantación en el mercado es el escaso conocimiento de su existencia por parte de los usuarios.

Mediante el despliegue y la demostración de este tipo de vehículos en seis ciudades europeas (Roma, Génova, Bari, Málaga, Trikala y Berlín), el proyecto ELVITEN, financiado por la UE, ha propuesto planes innovadores para impulsar el uso de los vehículos eléctricos ligeros.

Este trabajo de investigación se enmarca en el contexto de comprender mejor la actitud previa de la población hacia los vehículos eléctricos ligeros, identificar grupos de usuarios potenciales y explorar si los aspectos relacionados con la infraestructura (como las instalaciones de aparcamiento y recarga) son más relevantes que otros factores considerados por la bibliografía (como los incentivos políticos, los niveles de congestión, las condiciones meteorológicas, la topografía o la densidad de población, la edad y la educación).

Para ello se ha utilizado una plantilla exhaustiva para la recogida de datos de las ciudades piloto, con el fin de destacar sus características demográficas y sus características de movilidad. Mediante una encuesta sobre el estado de la cuestión, se han identificado los factores que afectan a la adopción de los vehículos eléctricos ligeros por parte de los ciudadanos. A continuación, se han estudiado el perfil de cada una de las ciudades piloto utilizando un análisis cualitativo sobre los patrones de movilidad actuales y las condiciones subyacentes a partir de los datos disponibles. La comparación entre las distintas ciudades ha proporcionado una comprensión más profunda del entorno contextual que rodea el uso de los vehículos eléctricos ligeros, y puede utilizarse como base para el futuro despliegue de vehículos eléctricos ligeros en entornos urbanos.

Las actitudes a priori hacia los vehículos eléctricos se han examinado mediante un amplio cuestionario en línea (*online*) y mediante entrevistas in situ. Los cuestionarios en línea se distribuyeron en todas las ciudades de demostración en el idioma nacional. El análisis estadístico se ha basado en un total de 6.753 respuestas recibidas a través de una plataforma digital (cuestionario estándar de opción múltiple ofrecido en cinco idiomas), identificando las percepciones sobre el uso de los vehículos eléctricos ligeros y las barreras que pueden inhibir su adopción por parte de los usuarios. Mediante el análisis de una serie limitada de entrevistas in situ o telefónicas con propietarios de flotas y otros agentes interesados - como gestores de flotas y conductores profesionales - se han explorado actitudes adicionales hacia los vehículos eléctricos ligeros.

Los resultados generales de las encuestas han mostrado que las percepciones positivas de aspectos como la comodidad, la capacidad y la seguridad aumentan con el número de ruedas del vehículo eléctrico ligero, mientras que aspectos como el aparcamiento y la asequibilidad disminuyen con el número de ruedas de los vehículos. Las actitudes percibidas hacia el uso de vehículos eléctricos ligeros compartidos o alquilados, así como hacia el uso de vehículos eléctricos ligeros como parte de un viaje multimodal, han sido positivas en todas las ciudades. Por el contrario, las actitudes percibidas hacia el uso de estos vehículos para todos los propósitos de viaje (por ejemplo, trabajo, compras y ocio) son más neutras.

La medida más favorable para promover el uso de los vehículos eléctricos ligeros identificada ha sido proporcionar una infraestructura de recarga suficiente, seguida de la puesta en marcha de planes de incentivos, permitir el uso de carriles bus y la disponibilidad de un aparcamiento seguro suficiente. Para los operadores de flotas y los conductores, los espacios de carga y descarga dedicados en las calles, los bajos costes de mantenimiento y el posible acceso a las Zonas de Tráfico Limitado han sido categorizados como ventajas para fomentar el uso de los vehículos eléctricos.

También se ha aplicado un modelo para demostrar si tres moderadores (sexo, edad y ocupación) influyen directamente en ocho percepciones y actitudes a priori (indicadores) hacia la utilización de este tipo de vehículos: predisposición a su uso según el motivo de viaje, predisposición a su utilización como parte de un viaje multimodal, facilidad de aparcamiento, comodidad, seguridad, capacidad de carga de equipaje, comodidad en la recarga eléctrica y asequibilidad (precio).

En resumen, los resultados del trabajo ofrecen una imagen completa del potencial de los vehículos eléctricos ligeros en cada una de las ciudades piloto, así como de la actitud de los ciudadanos hacia los mismos. Sobre la base de estos resultados, se ha elaborado una guía preliminar para la formulación de políticas en materia de vehículos eléctricos ligeros, la cual incluye seis esquemas de uso para el despliegue de estos vehículos en ciudades y, además, 40 requisitos operativos, políticos y de tecnologías de la información.

1 Introduction

1.1 Purpose of the research

Mobility of people and goods is a major sculptor of the urban environment, profoundly impacting the aesthetics, resiliency, sustainability of cities and the urban quality of life. Smart mobility planning within the context of smart cities may lead to a mobility future likely to differ in significant ways from today's transport systems. Electric Vehicles (EVs) have received enormous attention worldwide as one of the solutions to reducing greenhouse gas emissions associated with road transport. Most of this attention has focused on electric cars and buses or in e-bikes regulated by the EU Machinery Directive (pedal-assisted e-bikes, with power up to 250 W and maximum speed of 25 km/h with electric engine) [1].

L-category Vehicles (L-Vs) being smaller and lighter than passenger cars account for a significant percentage of urban trips, since one expects reduced trip time, reduced fuel consumption and less time needed to find a parking place in the city centre. Especially motorcycles are very common in the Mediterranean countries, for example in the City of Genoa there exist around 24 motorcycles per 100 inhabitants while there are 28,186 trips by motorcycles in the time slot 7:30-8:30 a.m., compared to 46,965 trips by car, as highlighted by Frincu *et al.* (2017) [2]. L-Vs are used in bigger cities also, for example Halsted (2020) remarks that in London there are 28 million transport trips per day, of which 0.2 million are estimated to be done via L-Vs [3]. The City Changer Cargo Bike project (2022) also estimated that in an average European city with 240,000 inhabitants there are about 100,000 delivery trips per day [4].

However, L-category vehicles with more power available are increasingly available in electric form, known as EL-Vs. According to Regulation (EU) No 168/2013 [5], EL-Vs comprise powered two-, three- and four-wheel vehicles, including powered cycles, two- and three-wheel mopeds, two- and three-wheel motorcycles, motorcycles with sidecars, light and heavy on-road quads, and light and heavy quadri-mobiles.

Electrified L-category Vehicles (EL-Vs) are a further step towards an even more sustainable urban mobility, as they further reduce emissions and noise. According to Frincu *et al.* (2017) EL-Vs have potential for daily commuting, home-school and delivery trips, which account for around 470,000 daily trips in an urban area with 1 million inhabitants [2].

However, and despite emerging technological advancements, the market penetration of EL-Vs is still quite marginal. Three issues for this hindrance are addressed in this research, including users' low awareness about EL-V vehicles' performance and functionalities, consumers' concerns about costs and charging range, and inadequate mobility planning for EL-Vs due to a lack of consistent knowledge and information.

Additionally, there is a lack of consistent knowledge and information needed by planning authorities to prepare an adequate traffic and charge infrastructure for EL-Vs and therefore to achieve their integration in the transport and electricity networks. For example, little is known on how such vehicles are used and how much basic infrastructure is required in terms of parking spaces and type and location of charge facilities.

For EL-Vs to enter the market in significant numbers, all the above challenges should be tackled. Adequate usage schemes, support services and ICT tools should be designed and offered to the private and professional users, to increase their direct experience and awareness about EL-Vs performance. Real usage data of EL-Vs and users' perceptions and opinions before and after experiencing such vehicles in real conditions should be collected and analysed. This will provide substantial information for the new generation of such vehicles and for planning and provisioning appropriate infrastructure and policies for the optimal integration of such vehicles into Sustainable Urban Mobility Plans (SUMPs).

The research has addressed these issues using a holistic approach in six demonstration cities in the framework of the EU-funded ELVITEN project [6]: Bari, Genoa and Rome in Italy, Trikala in Greece, Berlin in Germany and Málaga in Spain.

The PhD work takes a close look at the key factors influencing the adoption of EL-Vs, explores the demonstration cities' mobility features, and carries out surveys into the a-priori attitudes of people from these cities as well as from other stakeholders towards such vehicles. By examining the cities' mobility features, their comprehensive background is presented to help designing the usage schemes that seem of better application for each city. The investigation of people's attitudes towards and perceptions of EL-Vs identifies positive and negative aspects of relevant technologies and infrastructure, potential user groups and possible policy incentives.

Based on the findings of the work recommendations are given at a city-level; they also allow to define the most suitable usage schemes for EL-V city deployments, and in addition propose the most relevant operational, policy and ICT requirements applicable.

1.2 Structure of the research study

This piece of research is structured as follows:

Chapter 2 presents an overview of EL-Vs as a vehicle sub-category in the EV market.

Chapter 3 reviews the existing literature covering the most relevant factors influencing EL-V adoption.

Chapter 4 describes the methodology used in the study of mobility characteristics of six demonstration cities and in the survey of people's attitudes towards and perceptions of EL-Vs.

Chapter 5 presents the main features and findings as regards the mobility characteristics of the six demonstration cities. Detailed information per city is presented in Annex B. Comparisons of mobility features between demonstration cities are outlined and city profiles are created for EL-V related features.

Chapter 6 presents the results of a large scale, online, anonymous survey addressing public attitudes and perceptions of EL-Vs. Comparisons are also given at the end of this section.

Chapter 7 validates the measurement model defined in Chapter 4 and tests the hypotheses set to extract outcomes regarding the a-priori users' acceptance of EL-Vs.

Chapter 8 discusses a series of fleet operator interviews held in the demonstration cities aiming to collect additional information on perceptions, barriers and opportunities from fleet managers and drivers.

Chapter 9 summarises the overall survey conclusions and a summary of conclusions per city.

Chapter 10 proposes a tentative guide for EL-V policymaking based on the survey findings, including six usage schemes for EL-Vs city rollouts, and in addition 40 operational, policy and ICT requirements.

Chapter 11 hints a series of future research lines connected to the research topic analysed.

Annexes include: (A) city data collection templates, (B) additional city mobility data, (C) city profile of factors influencing EL-V adoption, (D) a public perception questionnaire, (E) profiles of the public perception questionnaire respondents (factual background data), (F) an interview survey for fleet operators (managers), and (G) an interview survey for fleet drivers.

2 An overview of Electric Light Vehicles (EL-Vs)

With the development of global economy, air pollution and global warming (CO_2) issues are attracting much attention. The main air pollution sources are from factory, agriculture, residential heating, and on-road vehicles including cars, trucks, and buses. The NO_x emissions from on-road vehicles make a great contribution to the air pollution, being approximately 35% of the total emission. NO_x emissions from on-road vehicles are mainly caused by traditional internal combustion engine vehicles (ICE-Vs), especially for urban area where vehicle density is high and road congestion happens regularly. Road congestion in urban area significantly increases vehicle exhaust emission factors; and it deteriorates fuel economy as well, resulting in high CO_2 emission. Electric vehicles (EVs) are free of tailpipe emissions, e.g. CO_2, NO_x, CO, PM; in addition, energy efficiency is high even under congested road conditions. As indicated by the International Council on Clean Transportation in 2018 [7], EVs are considered to have low emissions over their life cycle of manufacturing, fuel cycle and use, compared to ICE-Vs. However, Pierpaolo *et al.* (2015) studies how EVs generate more human toxicity and eutrophication than ICE-Vs [8]. Hawkins *et al.* (2013), Ma *et al.* (2012) and Sharma *et al.* (2013) underline EVs can effectively alleviate the air pollution pressure in urban area although the emissions comparisons between EVs and ICE-Vs are still in debate [9][10][11].

Most of the attention on EVs is currently focused on electric cars and buses, although L-category vehicles are increasingly available in electric form. EL-Vs have many special characteristics such as small size and light weight, which means low on-board energy requirement and small batteries, which allows lower costs and faster recharge. EL-Vs can be used for commuting, first-and-last mile deliveries, tour and sightseeing operations. In addition, EL-Vs can also effectively alleviate congestion situations in urban areas, benefited from their smaller size; further, decreasing traffic emissions and energy consumption.

However, there are several issues during their utilization preventing the popularisations of EL-Vs, such as concerns of battery performance, inadequate infrastructure, safety for both electric vehicle users and vulnerable road users, and so on. The detailed issues for individual types of EL-Vs reported by previous studies will be reviewed in this section. It will also provide the evidence for improving the travel characteristics of EL-Vs and address the need to further investigate the potential issues for users and non-users.

2.1 Electric two wheelers

Weinert *et al.* (2008) describe electric two wheelers is a category of EL-Vs that includes two-wheel bikes propelled by human pedalling supplemented by electric power from a storage battery (bicycle-style), and low-speed scooters propelled almost solely by electric power (scooter-style) [12]. Due to convenience and the relative low price compared with conventional vehicles, electric two wheelers are gradually becoming popular in many regions. The electric two wheelers however have some issues in real-world utilization, which may prevent the popularizations of these vehicles. Electric two wheelers can be used for various purposes and in different countries, which may lead to the differences in issues. This section reviews the issues reported in published materials and are further classified. Figure 1 is part of the electric two-wheeler type, whose issues during utilisation were addressed in studies such as Rose (2012) [13].

Figure 1: Electric two wheelers from published report (Rose, 2012)

2.1.1 Technical issues

There are several major technical issues related to electric two wheelers, including battery performance issues, speed issue and short running distance, which were reported by previous studies.

2.1.1.1 Battery performance issues

As the power of the electric two wheelers, battery encounters many problems in real-world use. As highlighted by Selvi (2017), batteries have two main impacts on the electric two wheelers' ease of use: they add to the weight of the vehicle and their energy capacity places a cap on the distance [14]. To make the battery applicable to electric two wheelers, the size should be small, which would limit the energy capacity. In addition, battery capacity is significantly affected by temperature. For example, Patil (2009) indicates that the capacity drops to a relative low value in winter although some technologies are applied to prevent the drop [15].

Regular charging is necessary for electric two wheelers, which are completely different from conventional bicycles. However, it usually takes long time, and the charging frequency is high if electric two wheelers are used as a travel mode by commuters, as studied by Huang (2015, 2017, 2020) [16][17][18].

Table 1 below shows the specifications of the batteries used in electric two wheelers. Patil (2009) indicates that the time taken for rapid charging of these batteries is 4.5 hours [15]. Huang (2017) remarks that frequent charging would also shorten lifetime of battery and further increases the replacement frequency of battery, which in turn would add financial burden on the users because it is the most expensive part for the electric two wheelers [17].

Table 1: Specifications of electric bike batteries (Patil, 2009)

Model No.	Size	Capacity (A•h)	Maximum Discharging Current (A)	Rapid Charge Current (mA)	Rapid Charge Time (h)
HFR-60DP7000	D	7	21	2,100	4.5
HFR-60DP8000	D	8	24	2,400	4.5
HFR-60DP9000	D	9	27	2bee,700	4.5
HFR-90DP12000	F	12	36	3,600	4.5
HFR-90DP13000	F	13	39	3,900	4.5

2.1.1.2 Speed issue

Low speed is one of the major technical issues reported by the respondents. According to an exploratory research based on customers perception towards electric two wheelers conducted by Rajiv and Kavitha (2016), 14% of respondents among the 100 submitted comments, believed that electric two wheelers have low speed, which is one of the factors that prevents people from making the decision to purchase the electric two wheelers (Table 2) [19]. Meanwhile, Deekshu (2008) found that the maximum number of customers feel the speed of the electric two wheelers to be very low and were not satisfied with the current speed of the electric two wheelers [20]. This situation may change in different regions, for example, the speed limit of a city road is much lower than the value of maximum speed of electric two wheelers. As supported by the data in Table 3: Comparison of selected E-bike regulations in different regions (Rose, 2012), which includes the limitations of the electric two wheelers such as the power limitations and maximum speed limitations for different types of electric two wheelers in various regions, the maximum difference for speed limitations was found to be about 12 km/h [13].

Table 2: Factors preventing the decision to purchase electric two wheelers (Rajiv and Kavitha, 2016)

Factors	Percentage (%)
Expensive	27
Lack of awareness	12
Low speed	14
Non availability	22
Few benefits	25

Table 3: Comparison of selected E-bike regulations in different regions (Rose, 2012)

Country	Power limit	E-PB allowed?	E-PAB allowed?	Max. speed under power assistance
USA	750 W	Yes	Yes	32 km/h
Canada	500 W	Yes	Yes	32 km/h
EU	250 W	No	Yes	25 km/h
Japan	250 W	No	Yes	24 km/h
China	-	Yes	Yes	20 km/h
Australia	200 W	Yes	Yes	Not specified

(Note: E-PB: electric powered bicycles; E-PAB: electric power assisted bicycles)

2.1.1.3 Short running distance

The electric two wheelers are not an effective commuting mode for medium to long distance travel. The running distance of the electric two wheelers is mainly dependent on the battery capacity. In order to make the electric two wheelers light for use, however, battery size generally is small and correspond capacity is low. Accordingly, the short running distance for many users is another issue that they must face.

Based on the survey conducted in the RESOLVE project, it was found that electric two wheelers are "*not suitable for long distance*", which can prevent the frequent use of electric two wheelers [21]. The same opinion was obtained in a study by Wei *et al.* (2013) where the response was "*Travel distance of electric two wheelers concentrate on 1 to 20 km range, the reason to decide travel distance is the capacity of battery*" [22]. Figure 2 shows the travel distance of the electric two-wheeler users. Figure 2 emerges from the work of Wei *et al.* (2013) and reveals that more than half of the trips distance was shorter than 5 km, which mainly resulted from the short running distance of electric two wheelers [22]. Additionally, Jaguemont *et al.* (2016) remark that the running distance would be shortened in winter due to lower temperature [23]. In fact, the importance ranking of this issue might vary with the purpose of using electric two wheelers. For example, the running distance is an issue for commuters, but it is not an issue for the non-regular shoppers.

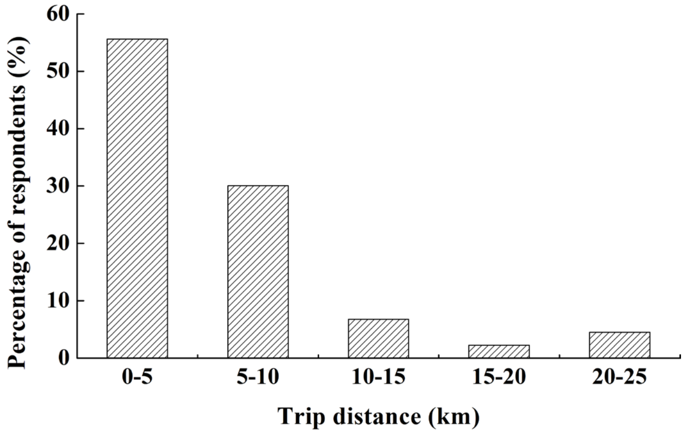


Figure 2: Single trip distances of electric bike users (Wei *et al.*, 2013)

2.1.2 Infrastructure issues

Several respondents from a survey conducted by the City of Flagstaff in the U.S. in 2019 indicated a need to improve bicycle infrastructure [24]. Crucial bike lane segments are missing, and where they exist are often blocked by snow or covered with cinders and debris. On many streets, bicyclists feel compelled to use the sidewalk because the street does not feel safe. The main infrastructure issue of electric two wheelers included in the previous projects are the lack of battery charging stations, electric two-wheeler lanes, and parking spaces.

2.1.2.1 The lack of battery charging stations

The lack of battery charging stations is a big issue that limits the adoption of electric two wheelers. Electric two wheelers are mainly used for short distance travel. Most of the time, people spend their time either at home or in the workplace. Therefore, charging stations at home or workplace are very important. Pierini *et al.* (2015) underline the issues related to homeplace- and workplace charging, as shown in Figure 3 [21]. The results show that for the homeplace charging, 39% of respondents hold the opinion that they had homeplace charging problems, while about 56% respondents stated that they had workplace charging problems. Improvement of home charging and workplace charging would significantly promote the adaption of electric two wheelers.

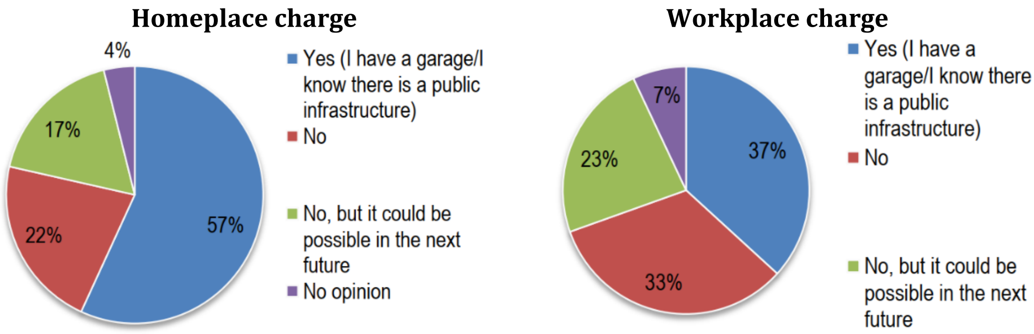


Figure 3: Responses to the question "Is it possible for me to charge at..." (Pierini *et al.*, 2015)

2.1.2.2 The missing of electric two-wheeler lanes

Cherry (2007a, 2010), Dill *et al.* (2012), Haworth (2012) and Weiner *et al.* (2007b) emphasise that the mixing of electric two wheelers and conventional bicycles on bike lanes or paths is a concern because of differences in their speeds [25][26][27][28][29]. Electric two wheelers operate faster than conventional bicycles, but their speed is lower than cars, so they cannot safely fit into either lane, as underlined by Cherry (2007a) [25]. Certainly, the lack of specific lanes for electric two wheelers would cause the electric two wheelers mixed in traffic, which would have road safety implications from the perspective of the individual users and non-users of electric two wheelers. Cherry (2007b) explored the safety of E-bikes and estimated fatality rates per million vehicle kilometres travelled (VKT) from two provinces in China [30]. The fatalities per million VKT for E-bikes and for conventional bicycles are 0.023 and 0.013, respectively, indicating that E-bikes had slightly higher fatality rates than conventional bicycles. Figure 4 shows the most important factors affecting E-bike users, as underlined by Weinert *et al.* (2007b) [29]. Among these factors, pedestrians and other bikes are dominant for most of the respondents. These issues, usually caused by sharing the lane with pedestrians and four wheelers, can be effectively decreased if separate lanes are provided for electric two wheelers.

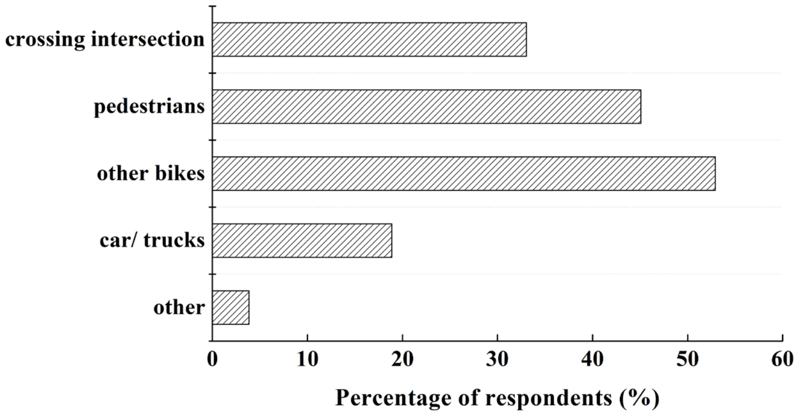


Figure 4: Most important factors affecting E-bike users (Weinert *et al.*, 2007b)

2.1.2.3 Parking problem

A lack of parking infrastructure causes parking difficulty of electric two wheelers, which leads to often parking on sidewalks, and thus causes problems with sidewalk obstruction and the visual clutter of short-term rental scooters, which is caused by parking of electric two wheelers on sidewalks. According to a survey conducted by the City of Flagstaff in 2019 [24], part of the responses from electric two-wheeler users are as follows:

- *Crucial bike lane segments are missing, and where they exist are often blocked by snow or covered with cinders and debris.*
- *We need to create the infrastructure that allows these "last mile" forms of transportation. I've used both e-bikes and e scooters and they do have a place in the community.*
- *Our downtown sidewalks are already crowded and there is little bike parking as is. Bikes have no place on downtown sidewalks, let alone bikes with motors of any sort.*

2.1.3 Comfort issues

Compared with the conventional vehicles, although electrical two wheelers are convenient for short travel, they may have comfort issues due to poor weather protection and less electronic devices.

2.1.3.1 Poor weather protection

Following a survey, Weiner *et al.* (2007b) found that one of the reasons for not choosing electric two wheelers as people's main travel mode is the lack of weather protection, as shown in Figure 5 [29]. The main reason of more than 50% electric two-wheeler users who gave up using electric two wheelers is due to the bad weather. Consequently, the improvement of weather protection could improve the adoption rates of electric two wheelers. The descriptions from parts of survey response are as following:

- "Protection from the weather is poor" is an issue remarked by the EU-funded RESOLVE project (2015) [21]. The users also highlighted the need for weather protection and usability in cold winters.
- Electric two-wheeler users would mostly use a bus or bicycle in the absence of electric two wheelers. Electric two wheelers appear to be acting as a near-term remedy for people who are under served by public transportation. As indicated by Weinert *et al.* (2007b), many users however still rely on bus transit instead of electric two wheelers as their travel mode in case of bad weather [29].

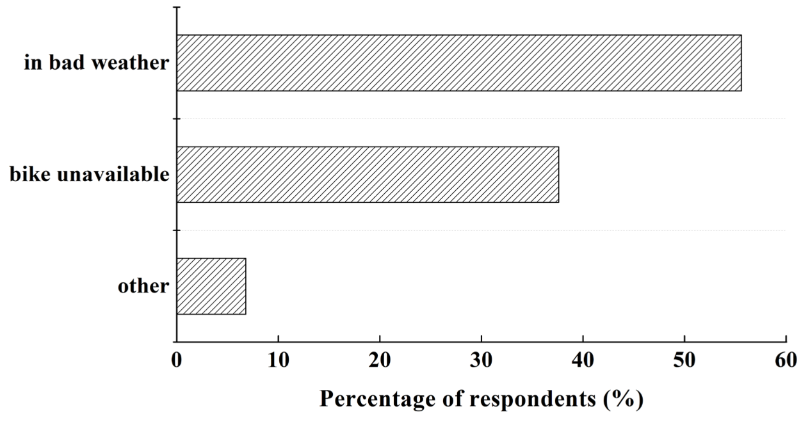


Figure 5: Reasons for not using electric two wheelers (Weinert *et al.*, 2007b)

2.1.3.2 Less electronic devices

Due to the simplicity of their structure electric two wheelers provide much convenience for use. However, Zuev (2018) stresses that the simple structure also limits the applications of advanced technologies, such as GPS, navigation map, air conditioner, or heater [31]. These issues may disappoint the electric two-wheeler users, such as 'last mile deliveries', who are dependent on GPS and navigation system to carry out their work efficiently.

2.1.4 Other issues

Other issues were also reported by Cherry *et al.* (2009), González *et al.* (2015) and Pierini *et al.* (2015) in previous projects for electric two wheelers [32][33][21], such as low capacity for goods and passengers, and limited access to motorways and pathways. The issue of low capacity was indicated in a survey led by Pierini *et al.* (2015) [21], where respondents were willing to use electric two wheelers to transport people and goods. The concern was also expressed in another choice experiment by Cherry *et al.* (2009) [32], where the cargo-carrying capacity was found to be an important factor that affects the decision to buy electric two wheelers. However, it is illegal to carry people and goods using electric two wheelers in some countries, such as the UK. Therefore, it was not the case in the UK. In addition, the speed of electric two wheelers is usually faster than bicycles and lower than cars, such that the electric two wheelers do not have any access to motorways and pathway for most of the regions, as shown by the work of the City of Flagstaff (2019) [24] and the RESOLVE project (2015) [21].

2.2 Electric three wheelers

The characteristics of electric three wheelers are different from electric two wheelers, such as the size, battery capacity, speed, and applications, which lead to the difference in issues between electric two wheelers and electric three wheelers. The types of electric three wheelers reported by other studies such as Rose (2012) are shown in Figure 6 [13] and related issues of electric three wheelers reported by published data are also presented in this section.

Figure 6: Electric three wheelers from published report (Rose, 2012)

2.2.1 Technical issues

2.2.1.1 Battery performance issues

Similarly to electric two wheelers, electric three wheelers also have battery performance issues under low temperature conditions. Table 4 lists the battery capacity of the electric three wheelers with various low temperatures, as described by Pierozynski (2011) [34]. It was found that the electricity capacity of the battery dropped significantly with temperature, such that it was only 74% of the maximum electricity capacity over temperature of -20 °C, which may happen in winter for several parts of north European countries. This issue was also reported in PRO-E-BIKE project, where the electric three wheelers are mainly used for post, social car service, and waste collection [33]. The reported issues are different because there is significant difference in temperature of various countries and regions.

As electric three wheelers are primarily used for goods delivery, the load of electric three wheelers is much higher than electric two wheelers. The capacity of electric three-wheeler battery is also usually high leading to long charging time. Holms *et al.* (2010) and Moulin (2018) accentuate that various studies have reported that the owners of three wheelers have anxiety about the charging time of electric three wheelers [35][36]. Due to the frequent charging, the battery of electric three wheelers has a short lifetime, as stressed by Hayashi *et al.* (2014), which significantly disappoints the customers [37].

Table 4: The effect of temperature on battery capacity (Pierozynski, 2011)

Temperature	Percentage of maximum battery capacity
Room temperature/ ~15 °C	96%
-20 °C	74%
-30 °C	58%

2.2.1.2 Short running distance

Many electric three wheelers are used for delivery and the heavy load leads to faster consumption of energy stored in the battery. This highlights the short running distance of the electric three wheelers. In the PRO-E-BIKE project, e-cargo tricycles were provided in two pilot sites (Valencia and Ibiza, in Spain), where the users were slightly disappointed by the short running distance [33]. Some electric tricycles need to be recharged 1-3 times a day, with about one third needing to be charged more than three times for dispatchers, indicating low efficiency in some tricycles. The results (Table 5) were reported by Zhang *et al.*, based on a survey where the respondents are dispatchers in Beijing, China [38]. In this survey, more than half of the dispatchers would like their electric tricycles able to run around 100 km for one-charge, which is far beyond the capacity of the current electric tricycles. However, this may not be the issue for other users as larger batteries can be installed on the electric three wheelers due to their bigger size as compared to electric two wheelers.

Table 5: The preference in electric three wheelers of logistics dispatchers (Zhang *et al.*, 2017)

Variable	Value	Sample Number	Percentage (%)
Average mileage (km/day)	0-50	19	8.6
	50-80	81	36.5
	81-120	94	42.3
	121-150	14	6.3
	>150	14	6.3
Average daily recharging times	1	90	40.5
	2	65	29.3
	≥3	67	30.2
Ideal one-charge mileage (km/day)	50-80	40	18.0
	80-100	73	32.9
	100-120	79	35.6
	120-150	14	6.3

Variable	Value	Sample Number	Percentage (%)
	>150	16	7.2

2.2.1.3 Safety issues

The running speed of electric three wheelers is much higher than electric two wheelers due to their capability of high-power output; however, advanced technologies highlighted by Dizo *et al.* (2018) such as an anti-lock braking system (ABS), automatic collision avoidance system, and sensors [39], can significantly decrease the probability of an accident are missing under emergency situations. In the WEEVIL project, safety issues of electric three wheelers were addressed with significant efforts invested, to improve the driving safety of electric three wheelers [40]. The speed of electric three wheelers and road conditions may cause an issue with the safety of the electric three wheelers. Table 6, based on the work of Dižo and Blatnický (2019), presents the contact status between wheel and roadway over various scenarios [41]. Accidents could happen if the contact is under bad situations. Even when the speed is lower than 30 km/h, electric three wheelers still have some contact problems over bad road situations.

Table 6: The safety problem over different driving speeds (Dižo and Blatnický, 2019)

Driving speed	Wheel	Very good cement concrete	Good asphalt concrete	Medium asphalt concrete	Medium pavement	Bad pavement
10 km•h^{-1}	Front	√	√	√	√	√
	Rear right	√	√	√	√	√
	Rear left	√	√	√	√	√
15 km•h^{-1}	Front	√	√	√	√	√
	Rear right	√	√	√	√	√
	Rear left	√	√	√	√	√
20 km•h^{-1}	Front	√	√	√	√	√
	Rear right	√	√	√	√	√
	Rear left	√	√	√	√	√
25 km•h^{-1}	Front	√	√	√	√	√
	Rear right	√	√	×	×	×
	Rear left	√	√	×	×	×
30 km•h^{-1}	Front	√	√	√	√	×
	Rear right	×	×	×	×	×
	Rear left	×	×	×	×	×

(Note: Individual wheels are still in contact with the roadway (sign "√") or they lose contact (sign "×"))

2.2.2 Infrastructure issues

2.2.2.1 Inadequate charging stations and service networks

The lack of public charging stations was highlighted in the literature by Holms *et al.* (2010) and Moulin (2018), who identified that most respondents expressed a preference for public charging infrastructures [35][36]. This issue was also reported in a survey by Tang *et al.* (2004) where it was found that the users of electric three wheelers suffered significantly due to insufficient charging stations and service networks around their community [42]. The users also have the problem with home charging. For the electric three-wheeler users who do not have a garage or community charging station, the heavy battery needs to be moved into their home for charging. This can be an especially difficult work for the frequent charging users.

Holms *et al.* (2010) and Moulin (2018) also highlight that users in a survey report that, due to the small amount of electric three-wheeler users, service network around their community is quite limited, which makes the maintenance difficult to reach [35][36]. In addition, less maintenance will lead to shorter lifetime, which adds more financial burdens on electric three-wheeler users.

2.2.2.2 Parking problem

The size of electric three wheelers is much bigger than bicycles such that the conventional bicycle parking spots are not suitable for electric three wheelers. In addition, there are no specific parking spots available for electric three wheelers, which makes the user difficult to find a safe parking spot. This problem was also reported in the PRO-E-BIKE project, where the users mainly used the electric three wheelers for post, social care service, and waste collection [33]. The electric three wheelers are usually parked in improper spots, which may cause some problems for other road users along with other safety issues. Home parking is also an issue such that the electric three wheelers cannot be taken into the home, in case of lack of garages, due to their large size and heavy mass.

2.2.3 Comfort issues

Due to the simplicity of electric three wheelers compared with conventional vehicles, less accessories are available for electric three-wheeler users, such as air conditioning, radio and GPS. This results in losses in terms of recreation and comfort of users during travelling. The electric three-wheeler users also suffer a lot during winter and rainy days because of lack of protection, which was reported in the PRO-E-BIKE project [33]. Additionally, the suspension system of electric three wheelers is hard compared to conventional vehicles and the jounce of the electric three wheelers over bad road situations is serious.

2.2.4 Other issues

The speed of electric three wheelers is much higher than bicycles and lower than cars, thus the lanes for cars are not shared with electric three wheelers, which was blamed by electric three-wheeler users who used electric three wheelers for delivery. Zhang *et al.* (2017) comment that the survey was conducted in Beijing, China, with 222 respondents [38]. In order to popularise electric three wheelers and decrease the accidents caused by electric three wheelers, part of the car lanes with low-speed limitations should be shared with electric three wheelers.

2.3 Electric L- category four wheelers

The types of electric L-category four wheelers in the market differ a lot according to Weinert *et al.* (2008), as shown in Figure 7 [12]. Although the size of electric L-category four wheelers is small, the charging time for electric L-category four wheelers is long, and the running distance of one-charge is shorter than the small conventional cars. These issues reported by electric L-category four-wheeler users may change with the type of the electric L-category four wheelers.

Figure 7: Electric L-category four wheelers (Weinert *et al.*, 2008)

2.3.1 Technical issues

2.3.1.1 Lack of advanced devices

The STEVE project demonstrated that electric L-category four wheelers face significant challenges as they are not equipped with advanced braking system and electronic stability control [43], which makes electric L-category four wheelers perceived as less safe than conventional cars according to Einwögerer (2018) [44]. However, respondents state that an anti-lock braking system (ABS) can be included in the future designs.

2.3.1.2 Short driving distance

A survey by Langbroek *et al.* (2019) conveyed that 37% of the respondents experienced range limitations having an influence on perceived mobility [45]. Results also showed that there seemed to be a positive relation between range anxiety and total distance travelled; for example, participants who felt that the battery of the electric L-category four-wheeler was not sufficient for the trips they wanted to make, travelled over a significant longer distance. Table 7 shows the specification of small electric L-category four wheelers. Adrian (2013) stressed that the running distance for these vehicles is less than 150 km, which is much shorter than the distance a conventional car can reach [46]. In other studies, such as in Pierini *et al.* (2015), respondents from the survey also indicated that the vehicle range cannot meet their journey requirements [21].

Table 7: Specifications of electric L-category four wheelers (Weinert *et al.*, 2008)

	Company	
	Incalcu EV	**Shiwei EV**
Range (km)	80-120	100-150
Speed (km/h)	45	45-60
Power (kW)	3	3

	Company	
	Incalcu EV	**Shiwei EV**
Dimensions (l,w,h) (m)	3.1×1.6×1.5	-
Weight (kg)	650	750
Battery	VRLA, 48 V, 9 kwh	VRLA, 48 V (120 Ah, 12 V modules)

In the STEVE project, the average travel distance for the respondents is presented in Figure 8 [43]. The average travel distance (using shared cars) for the respondents is longer than 50 km which is in the range of the running distance for most of electric L-category four wheelers. However, many respondents usually travel more than 100 km, which is out of the range of the running distance for most electric L-category four wheelers.

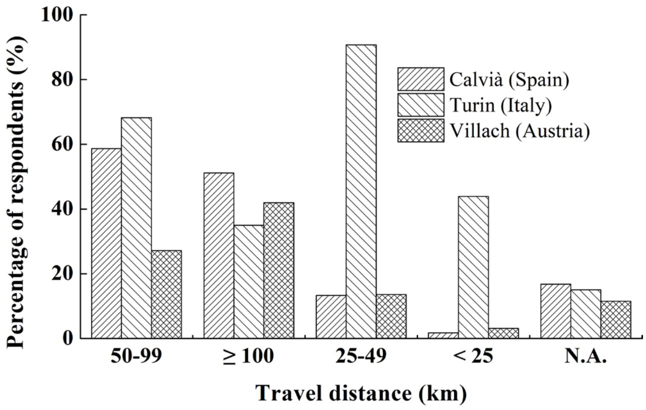


Figure 8: The average travel distance of respondents (STEVE project, 2018)

(Note: N.A.: not available)

2.3.1.3 Long charging time

The capacity of electric L-category four wheelers is much higher than electric two wheelers and three wheelers, and many electric L-category four wheelers are also used for long distance travelling. The charging duration for electric L-category four wheelers is around 1 hour even for fast charging (to 80% of capacity), and it is more than 5 hours for slow charging for the current commercial vehicles (such as Smart EQ fortwo coupe[1] and Renault Zoe[2]). Re-charging halfway is necessary for long distance journeys, and it takes much time. Other studies also show user complaints due to long recharging time. In the RESOLVE project users prefer fast charging stations [21]. Moreover, Lindgren *et al.* (2016) remark that charging time is significantly affected by ambient temperatures, as shown in Table 8 [47]. The charging time over ambient temperature of -10 °C is twice more than that of 20 °C ambient temperature.

[1] Source: Electric Vehicle Database (2018), Smart EQ fortwo coupe, https://ev-database.uk/car/1132/Smart-EQ-fortwo-coupe [Accessed 18 December 2022].
[2] Source: Renault Retail Group Renault Zoe, https://www.renaultretail.co.uk/new-renault-cars/renault-zoe/?gclid=EAIaIQobChMI67D3meqG6wIVWe7tCh2p2gk1EAAYAyAAEgJ6xPD_BwE&gclsrc=aw.ds. [Accessed 18 December 2022].

Table 8: Average charging time for electric vehicles over different ambient temperatures (Lindgren and Lund, 2016)

Ambient temperature (°C)	-10	0	10	20	30	40
Charging time (minutes)	166.4	110.5	75.3	65.0	74.7	85.1

2.3.2 Infrastructure issues

2.3.2.1 Lack of charging infrastructure

The development of charging infrastructure is relatively slow, which is key reason to refrain people from adopting an electric vehicle as highlighted by Franke *et al.* (2013) and Langbroek *et al.* (2019) [48] [45]. As shown in Figure 9, Todts (2020) remarks that the number of public charging points are about 1/10 to 1/5 of the number of electric vehicles for more than half of the EU countries [49]. It should be noted that the vehicle number includes conventional electric cars and electric L-category four wheelers. Considering the long charging time for electric vehicle even during fast charging, the number of public charging points are not sufficient. The users from the RESOLVE survey hoped the problems caused by lack of adequate charging infrastructure could be solved [21]. The results of this questionnaire indicated that many users suggested that home charging could be feasible in their current home position, while lower percentages showed their lack of workplace charging. More than 90% of responses agree and strongly agree that they preferred the availability of charging infrastructures in the surroundings.

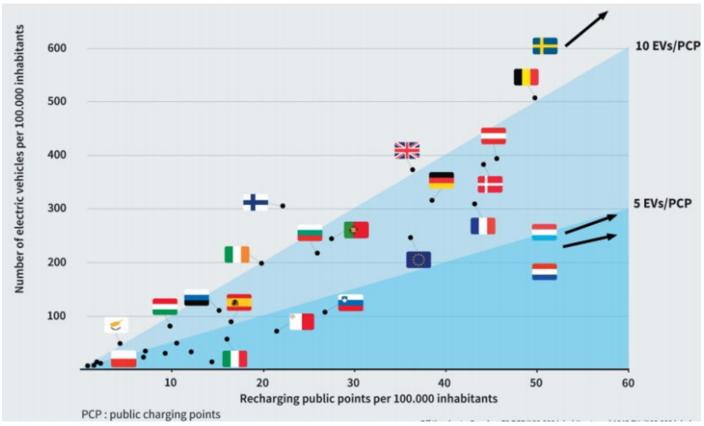


Figure 9: Current supply overview of EVs and public chargers across the EU countries (Todts, 2020)

For the commuter using electric L-category four wheelers, it is important to address home charging and workplace charging. Most of the respondents in a survey by Zuidema (2020) indicated that home charging is not a problem for them; however, more than half of the respondents have charging problem at workplace for four countries (Germany, Belgium, UK and France) (Figure 10) [50]. Similar studies related to charging infrastructure have also been done. In one from Ulrich (2020), the following comments are obtained from the respondents in terms of charging [51]:

- *"I live in a charger desert", He said it wasn't practical to drop a car at a station, make his way home by other means, then fetch it when the battery was full, with perfect timing to avoid hogging the charger space.*
- *I can't go miles from my home and then do nothing for several hours.*
- *It is (charging) not just a New York problem but a global, urban problem.*

- *Unless there is a charger at work or your apartment, or damn close to it, it's not practical to buy an EV.*
- *I have a house, so it's easy for me, but if I lived in an apartment, I'd be constantly worried about charging the car or where I'm going to leave it.*

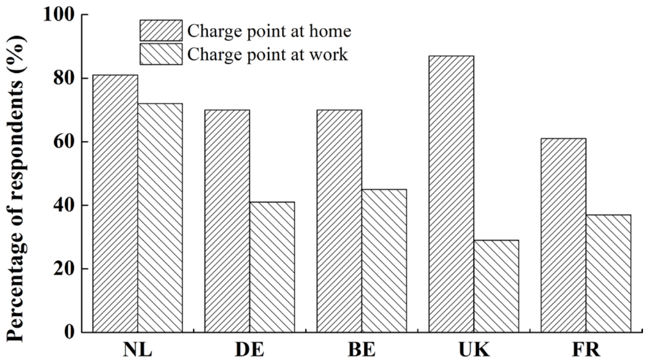


Figure 10: Percentage of people who have a charge point at home or at workplace (Zuidema, 2020)

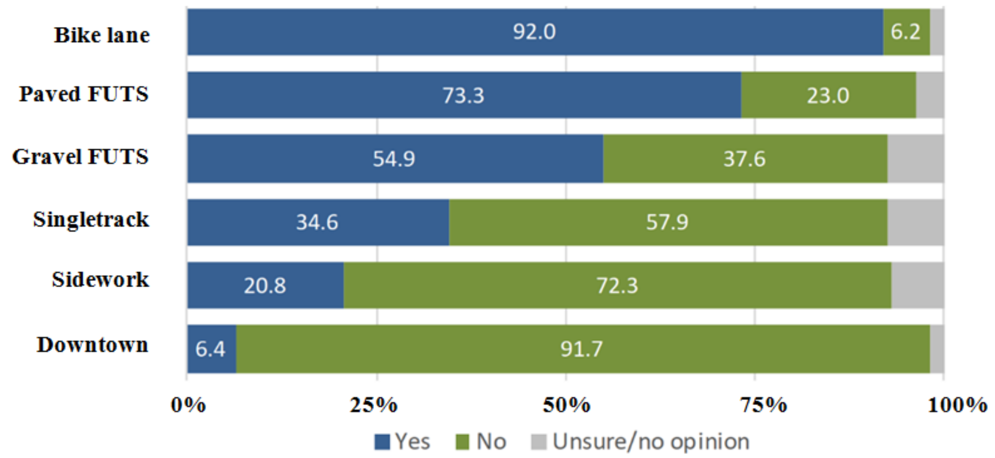
(Note: NL: Netherlands; DE: Germany; BE: Belgium; UK: United Kingdom; FR: France)

2.4 Non-users of electric L-category vehicles (EL-Vs)

Compared with the respondents of electric two, three and L-category four-wheeler users, the available data for non-users is very few. In addition, the reported issues can be related to electric two, three and L-category four wheelers; however, the users only reported their corresponding vehicles in the above sections. The issues mentioned by the non-users mainly focused on their safety, bad city/ town traffic situations caused by electric L-category vehicles (EL-Vs). Because non-users do not have any experience of electric two, three and L-category four wheelers, they do not report any problems of utilisation. Moreover, as non-users are mainly affected by electric two wheelers rather than three and L-category four wheelers, most of the issues are related to electric two wheelers.

2.4.1 Safety issue

Safety issue reported by non-users is mainly caused by using mixed lane and fast speed. Figure 11 shows the opinions of non-users about sharing lanes with electric two wheelers. Most respondents hold the opinion that bike lanes may be shared with electric two wheelers, while the single track, sidewalk, and downtown should not be shared with electric two wheelers. The report from the City of Flagstaff expresses a concern about potential conflicts between electric two wheelers and pedestrians and other vulnerable users [24]. Concerns about the safety of pedestrians or others on the sidewalk are also included. Part of responses are as follows:



Should the electric two wheelers be allowed on sidewalks, downtown sidewalks, bike lanes, paved FUTS (Flagstaff Urban Trails), gravel FUTS, and single-track trails?

Figure 11: Survey results about the lane sharing with electric vehicles (City of Flagstaff, 2019)

- *I was constantly annoyed and worried that I would be hit by someone using electric two wheelers. It was very unpleasant!!*
- *The totally self-propelled scooters and bicycles have proven to be problems in cities larger than ours and without four seasons. Pedestrians should not have to deal with another fast, wheeled vehicle that can approach from behind and is almost totally silent.*
- *I have seen people riding on sidewalks run into pedestrians and that is a concern.*
- *I feel these machines are more in-line with mopeds and motorcycles than a bicycle. To me the speed gets too high to be on the same recreational trails as bicycles and walkers/ runners.*

2.4.2 Parking related problems

Problems with sidewalk obstruction caused by electric two wheelers were reported in the City of Flagstaff report [24]. Electric two wheelers were found to be left everywhere, which makes the city more crowded. Part of the responses about this issue are the following:

- *Scooter parking needs to be controlled, otherwise they will be left anywhere and everywhere.*
- *I really dislike that the vehicles can be left anywhere. It would make much more sense if they had to be returned to a charging station and the station would be placed in a good out of the way location.*
- *They are littering the city. People are disrespectful of them and will ride on sidewalks. It will be a huge eyesore and headache.*

2.5 Summary of reported issues of EL-Vs

Many issues related to electric two-, three- and L-category four wheelers during their utilisations were reported by previous studies. Table 9 summarises both reported and potential issues. As can be seen, battery performance issues and short running distance were reported by all the electric vehicle users, and the battery was found to be the main aspect that significantly affects the decision of buying electric L-category vehicles. The running distance can be a factor that influences traffic mode choice when travelling. Electric two-wheeler users reported most of the issues compared with three and L-category four-wheeler users, which might be caused by more users of electric two wheelers in the past. Lack of traffic signs/ light were never reported by the users. Least issues were reported by the non-users, which was an important aspect addressed in the online survey described in Chapter 6.

Table 9: Summary of the reported issues

Issues	Electric two wheelers	Electric three wheelers	Electric L-category four wheelers	Non-users
Long charging time	√	√	√	×
Short battery lifetime	√	√	√	×
Bad performance over low temperature	√	√	√	×
Speed issue	√	×	×	√
Short running distance	√	√	√	×
Lack of battery charging stations	√	√	√	×
Lack of service network	×	√	×	×
Missing of electric two/ three/ L-category four-wheeler lanes	√	√	×	×
Safety issues due to mixing of different road users	√	×	×	√
Safety issues due to technical problem	×	√	×	×
Parking problem	√	√	×	√
Poor weather protection	√	×	×	×
Less electronic devices	√	√	×	×
Low capacity/ passengers	√	×	×	×
Limited access to motorways/ pathway	√	×	×	×
Lack of traffic signs/ lights	×	×	×	×
Problem with trucks	×	×	×	×

(Note: √: Reported; ×: not reported; N.A.: not applicable)

3 Review of factors influencing EL-V adoption

3.1 Introduction

EL-V adoption is influenced by a wide variety of factors, as briefly described in the section above. In this section a literature review of key factors is carried out using studies of electric vehicles, of which EL-Vs is a subcategory. Based on this review and mobility characteristics from each city, a city profile will be created to clarify common city features relating to EL-V market potential.

3.2 Policy incentives

In Sang *et al.* (2015), Hardman *et al.* (2017), Mersky *et al.* (2016), and Vassileva *et al.* (2016), government incentives, such as purchase subsidies, tax reductions or exemption, are identified as an important factor for EV preference [52][53][54][55]. A comprehensive study by Yong *et al.* (2017) has qualitatively compared aspects of government policy and environmental factors affecting the adoption of electric vehicles as summarised below [56]:

- Government is the main driving force in the early stage of the EL-Vs industry development. Public policies are developed to encourage the adoption of EL-Vs.
- Policies are divided into monetary incentives and non-monetary incentives. The monetary consists of purchase incentives, purchase tax exemptions and electricity cost subsidies. Non-monetary incentives consist of road toll exemptions and free public charging.
- Policy support schemes, such as tax benefit and subsidy payment, are most influential to the spread of electric vehicles (e.g. Iceland, Norway and Sweden).
- Environmental factors, economic level and status of electric vehicle charging stations, also affect EV deployment and use.
- High economic status and charging infrastructure alone cannot lead to diffusion of EVs (e.g. Luxembourg).
- Economic incentives help initial market creation in early stages. To maintain the market demand, there must be policy changes from monetary to non-monetary support, such as deregulation.
- A mix of policies is much more effective than a single policy in the promotion of electric vehicles.

However, how effective these incentives are in encouraging EV adoption differs between cities. Results from different EV studies vary greatly.

Liao *et al.* (2017) studied five different policies [57]. The results of this study are summarised below:

- Regarding one-time price reduction policies, reducing purchase tax is significant in all cases, while reducing purchase price is only significant 2 out of 4 times.
- For usage cost reduction policies, annual tax reduction seems to be the only significant policy, while free parking and toll reduction are not significant in any case.
- The only non-financial policy tested, the effectiveness of giving EV access to HOC (high-occupancy vehicle) lanes, remains ambiguous.

The undergoing European Union efforts are also remarkable in order to increase the penetration of EVs. Several EU policies have been introduced in the context of clean and energy efficient road transport. Nanaki *et al.* (2016) highlight that the "European Strategy for Competitive, Sustainable and Secure Energy 2020" states that the creation of market conditions which stimulate more low carbon investments into key technologies for electro-mobility are needed [58].

As contributing stakeholders, the automobile industry and utility providers should work closely together with urban concept planners and city governments to accelerate the business service environment around electromobility and EV market take-up.

Nanaki *et al.* (2016) underline that gaining a major market share for electric vehicles will probably require technology advances to reduce cost and improve performance, but early market deployment efforts running in parallel to technological advancements often lead to earlier mass adoption than if market development waits until technological progress is finished [58].

3.3 Environmental factors

The key environmental factor where EL-Vs have an impact is the reduction in greenhouse gas (GHG) emissions in the mobility sector. The mobility sector is overall responsible for 24.6% of the EU-28's GHG emissions; from that percentage, a 71.7% is produced by road transportation [59]. The European Commission has accordingly set several targets to try to reduce these emissions [55]. Not only the European Commission has acted on this topic; regional municipalities have also developed incentives to reduce emissions, following the increased social concern towards the environment and possible outcomes from its decadence. This has resulted in a growing emergence of low-carbon and free-carbon technologies such as EL-Vs.

Nanaki *et al.* (2016) state that the deployment of alternative fuels and electromobility could create a low carbon city contributing to the energy and climate change policies addressed by European Union [58]. Nevertheless, to reach such a scenario, technology needs higher acceleration in the coming years. Not only technology is a barrier to achieve this objective, but there are also political and economic barriers which need a specific plan to be overcome.

Vassileva *et al.* (2016) highlight EL-Vs are one of the most effective alternatives to Internal Combustion Engine Vehicles (ICEVs) to reduce CO_2 emissions and allow countries increase their sustainability performance [55]. From an efficiency point of view, in average ICEVs reach a 28-30% conversion efficiency while electric motors can achieve up to 95%.

Nevertheless, battery production is considered as the most critical component, not only because of its cost but also because its environmental impact. This impact is caused by the type of materials needed for the manufacturing.

Nanaki *et al.* (2016) highlight an important factor which is that EVs do not produce tailpipe emissions but the energy they consume could produce them, depending on the energy source it comes from [58]. Considering this, the role of the energy regulators and utility companies becomes even more important because if the energy mix is mostly renewable, EVs could reduce even further their emissions during usage.

3.4 Social factors, population density, age and education

Li *et al*. (2017) carried-out panel data studies across 14 countries to assess the impact of renewables and socioeconomic factors on electric vehicle demand [60]. The conclusions of this study are summarised below:

- They quantified a total of seven factors, four of which have positive effects. These factors were: percentage of renewables in total electricity production, charger density, percentage of adults with college educations, and population density.
- Their econometric model revealed that EV demand is directly related to population density, with 1% increase in the population density resulting in a significant increase in demand.
- Policy makers should combine three factors (i.e. charging stations, population density and education levels), with charging stations near areas of college educated populations and car sharing programmes to encourage multiple drivers to own "community EVs and charge stations".

Zubaryeva *et al*. (2012) identified a set of factors grouped into five categories (i.e. demography, environment, economy, energy and transport) based on a literature survey [61]. This factor set was then verified and assessed by a panel of experts representing key stakeholders with different scientific and technical backgrounds at the European level. They found that population density has received a high weighting for EVs, indicating that it would be a crucial factor for lead market assessment. Among different age demographics, young and middle-aged groups show a higher intent to adopt EVs.

Potoglou and Kanaroglou (2007) developed a nested multinomial logit (NMNL) model to estimate household demand and willingness to pay for clean vehicles [62]. They found that individuals consider vehicle costs and performance characteristics as very important when choosing their next vehicle. Also, they found that segmentation variables including gender, age, education level, and household size and type were significant, revealing differences in preference between segments.

Education level is also believed to be a significant factor in influencing preferences towards adoption of cleaner vehicles. Carley *et al*. (2013) found that although overall stated intent to purchase or lease electric vehicles is low, consumers who express early interest in adopting electric vehicles are typically highly educated and environmentally sensitive [63].

Li *et al*. (2017) carried out a study to examine the effects of education levels across 14 countries [60]. The results show that a 1% increase in education level (college or higher), EV demand increases by 19%.

In this case it is also important to consider social influence. The so-called 'neighbour effect' affects the willingness to adopt an EV. It means that if in a given region people start to use EVs on a daily basis, non-users would start to desire to use one only because they are seeing more people using them, an effect that eases EVs penetration, as highlighted by Vassileva *et al.* (2016) [55].

Lin *et al.* (2018) carried out a literature review where they studied the theory of planned behaviour (TPB) in user's willingness to purchase EL-Vs [64]. TPB is frequently used to predict the intentions of consumers. It assumes that the decision is based on a rational evaluation of stimuli, and that human action is guided by behavioural beliefs, normative beliefs, and presence factors. Consumer behaviour is directly predicted by intentions and intentions can be predicted by the sum of possible consequences of behaviour. Literature shows that various business models have been established based on TPB.

In short, research shows that demographic variables such as age, gender, education level and income may influence EL-V adoption. Charging infrastructure may also influence the perceived behavioural control and it is certainly one of the major challenges faced by EL-Vs, as a degree of charging infrastructure that is perceived as sufficient might help reduce range anxiety.

3.5 Technology factors

Technology factors of EL-Vs are related to driving range. charging time, battery deprecation and technology cost. These factors can be obstacles to EL-V adoption and diffusion. These factors are described and summarised below:

- A study by Lieven *et al.* (2011) highlights that, from the participants' perspective, cruising range is most important factor for an all-day operation of an EV [65]. Based on a nation-wide discrete choice experiment among 711 potential car buyers, the driving range factor was further studied by Hackbarth and Madlener (2016), who concluded that limited driving range was one of the main barriers in the purchasing decision [66].
- Electric vehicles take longer to charge than internal combustion engine vehicles (ICEVs) take to be filled up with fuel. EVs require an average 30 minutes at a fast-charging station, whereas most ICEVs can refuel in roughly 4 minutes. In comparison, electric bike's batteries charge in 3.5 hours on a 400Wh and 4-5 hours on a 500Wh battery from flat[3]. This is much longer than that of electric cars and could be considered as one of the technical barriers for limiting the adoption of EL-Vs.
- Battery deprecation is a factor highly influencing EL-V adoption, as EL-Vs need batteries with high efficiency and energy capacity and these performance factors are lost with usage. Statharas *et al.* (2019) state the factor which influences the most is the reduction of battery costs [67]. High reduction implies a high share of EL-Vs, irrespective of the intensity of other factors. A low reduction implies that even if other factors are at their maximum intensity, market share of EL-Vs remains lower than in the case of a high reduction of costs.
- Liao *et al.* (2017) also highlight performance, brand and diversity (model range) as relevant technology factors [57]. Performance is represented by engine power, acceleration time or maximum speed. It is obvious consumers generally prefer a better performance in their vehicles. However, acceleration time is found to be insignificant since preferences among the population may cancel each other out: males have a significant preference for faster acceleration while females prefer slower acceleration. In brand and diversity, the study found that people prefer brands from certain countries and the preference order differs between countries. It was further stated that having more EV models available on the market increases the probability of choosing an EV. It can be seen as an indicator of EV market maturity and hence influence people's perception of uncertainty.

[3] Source: E-bikeshop News (2017), Electric Bike Charging Times: Bosch Yamaha & Shimano eBikes, https://www.e-bikeshop.co.uk/blog/post/electric-bike-charging-times-bosch-yamaha-shimano-ebikes [Accessed 18 December 2022].

3.6 Financial factors

Liao *et al.* (2017) define financial attributes as those which refer to various types of monetary costs of vehicle purchase and use [57]. Purchase price is the direct cost of the car when buying it; this factor is included in all the literature. A pivoted design is used for this attribute: price levels are customised and pivoted around the price of a reference vehicle stated by each respondent. Purchase price was found to have a negative and highly significant influence on the EV utility. This is explored as a linear relationship, with rare exceptions.

Liao *et al.* (2017) also underline that price preferences also vary among populations, as there is an income effect, namely that people with high incomes are less price-sensitive than others [57]. In other words, customer heterogeneity is particularly high when the price of EV is much higher than ICE vehicles.

Operation costs are every cost related with the usage and operation of the vehicle. The most important cost is energy cost, which can be shown as cost per 100 km or both fuel efficiency and fuel price. Also, regular maintenance costs should be included as an operation cost. These all negatively affect the decision to purchase a car, which gives EV an edge over ICE vehicles, because of their lower operation costs.

Hagman *et al.* (2016) state that one of the main factors which slows the integration of EVs is vehicle costs. Nevertheless, users usually focus on purchasing cost without looking to the real cost of ownership [68]. The total cost of ownership includes the purchasing cost and operating and capital cost. It is important to provide users an easy model to calculate the Total Cost of Ownership (TCO) for them to easily compare between ICE vehicles and EVs. This would certainly contribute to the market take-up of EVs.

TCO is defined as the true cost of buying a good or service from a specific supplier. It is a useful calculation for consumers to assess the direct and indirect cost associated with a purchase. TCO analyses have found that EVs can be both cheaper or more expensive to own compared to their ICE vehicle competitors depending on cost assumptions and time scales. The electric power train has lower service and maintenance costs, better fuel economy (energy is cheaper than fuel) and lower taxes compared with ICE vehicles, but their purchasing price is higher.

Developing a TCO model which properly shows every factor involved in owning a vehicle is challenging, especially when estimating the individual cost factors and when applying data available to consumers. Some of the vehicle cost factors are predictable and relatively stable over time, such as interest, insurance, maintenance and repair, taxes and subsidies. The challenging factors to estimates are depreciation and fuel. Depreciation is affected by an untold number of factors and can change over the length of the ownership. Fuel price change daily so making a proper estimation is difficult and not possible in the long-term.

Applying a proper TCO model, Hagman *et al.* (2016) show a discrepancy between the purchasing price and TCO [68]. This highlights the importance of spreading a TCO model for users to being able to understand that the purchasing price is an important factor, but it should not be the only key factor leading their decision-making process. Considering indirect and direct costs would help them realise that EVs are often a good option nowadays because their operational costs are lower than ICE vehicles.

3.7 Charging infrastructure and power transmission and distribution grid

Wu *et al.* (2017) underlines that the existence of charging stations plays a critical role to guarantee EVs running normally [69]. In some countries, charging infrastructure is built into policy incentive programmes, as indicated by Zubaryeva *et al.* [61]. Wu *et al.* (2017) stress that the limited number of charging stations generates 'range anxiety' among users of electric vehicles and makes them fearful of not reaching their destination [69]. According to Li *et al.* (2017), an increase in charging infrastructure positively affects EV adoption [70].

Liao *et al.* (2017) also highlight that availability of charging infrastructure has a significantly positive effect, possibly because more charging facilities save time and search cost for users as well as relieving their range anxiety [57]. Charging posts in different activity locations are preferred by certain groups; for example, long distance commuters value chargers in workplaces significantly more than others, and in addition prefer a higher density of charging stations.

An important factor to consider is the charging time of the charging post. Differentiating between fast and slow charging points is crucial to fully understand how it affects to consumers. Nevertheless, this factor does not show up in the literature consulted.

It is also important to consider the impact that different EV penetration levels will have on the power system. Vassileva *et al.* (2016) remark that a large penetration of EVs would not affect the power transmission and distribution systems, for as long as they are managed as active components of the whole power grid [55].

To minimise the impact on the power system and avoid investment on new-generation and transmission capacity, several scenarios of EV penetration were analysed with controlled and optimised charging in different power systems, demonstrating the potential benefits of Smart Charging. Smart Charging refers to the EV or the charging station it is connected to communicating with the network operator.

3.8 Weather conditions, topography and congestion level

No research evidence has been found as of yet to indicate that weather conditions and topographic have a direct influence on EV preference. However, a study on EV energy consumption by Sierzchula *et al.* (2014) suggests that temperature affects battery performance [71]. Thus, the inference is that temperature conditions may have a positive effect on technology factors, such as drive ranging and charging time, and subsequently may have an indirect influence on the EV preference, as indicated in the Green Car Reports (2013) [72]. According to the study by Sierzchula *et al.* (2014), battery performance worsens with extreme temperatures [71]; Li *et al.* (2016) and Yuksel *et al.* (2015) stress that a 40% decrease in driving range was seen both on cold and hot days as compared to achievable maximum range [73][74].

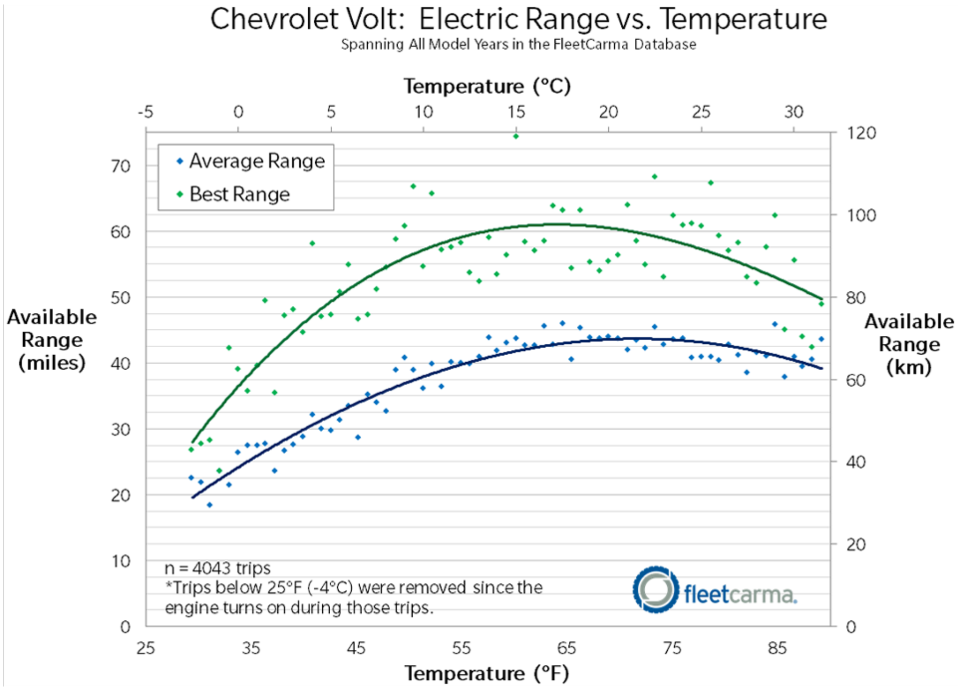


Figure 12: Example of electric range vs. temperature (Green Car Reports, 2013)

Based on previous studies by Egede *et al.* (2015) and Sierzchula *et al.* (2014), topography is also mentioned as a significant factor affecting energy consumption of EVs [75][71]. Like temperature, it may be indirectly related with EV preference. High variation in altitude results in a high consumption in energy and therefore affects both the drive range and charging time.

Congestion levels influence EV preference in a similar way to topography. Egede *et al.* (2015) underline that increasing the level of congestion increases the overall energy consumption of EVs, as vehicles in high-level congestion conditions must decelerate and accelerate often to cope with variations in speed [75].

Last but not least, and having described above different factors influencing the adoption of EL-Vs, it is important to highlight as well that these factors influence with a different degree of intensity depending on the region the consumers come from, as stressed by Ghann *et al.* (2018) [76].

4 Research Model, Design and Method

4.1 Generic theories and models

A predominant theory on the adoption process for innovations is the **Theory of the Diffusion of Innovations**. According to Rogers (1995), there are four main elements in the diffusion of innovations: the innovation, the communication channels, time and the social system [77].

Regarding **innovation**, the first factor is its' relative advantage', i.e. that the innovation is perceived as better[4] than the idea it supersedes. A second aspect is 'compatibility', i.e. the degree to which an innovation is perceived as being consistent with existing values and needs of potential adopters[5]. 'Complexity' is a third characteristic. Complexity is the degree to which the innovation is perceived as difficult to understand and use. The more complex a product, the slower the rate of adoption can be expected to be. 'Trialability', i.e. the degree to which an innovation may be experimented with, will also affect the diffusion of the innovation as will 'observability', i.e. the degree to which the results of an innovation are visible to others. The easier it is for individuals to see the results of (the use of) an innovation, the more likely they are to adopt it. However, the diffusion of an innovation is affected also by aspects that are not technical.

Communication patterns and the channels used for communication play important roles. For instance, most individuals adopt or reject an innovation based on the subjective evaluations of to what degree so called 'peers' have adopted the solution.

Time is a third element in the diffusion process. The time dimension is affected by the decision process by which an individual pass from first knowing about the innovation through to adopting (or rejecting) it. Knowledge of the innovation and its functions is a prerequisite for adoption, but the individual must also form a positive attitude towards the innovation. A positive attitude may lead the individual to decide on adopting or rejecting the innovation. One cannot, however, speak about adoption until the individual has put the innovation into actual use. The innovativeness of an individual will also have an impact on time. Five categories are proposed: (i) innovators, (ii) early adopters, (iii) early majority, (iv) late majority, and (v) laggards. The innovators are the first to adopt a new idea, while laggards are the last. There are several differences between the five groups according to Rogers (1995) [77]; they differ in socio-economic status, personality values, as well as communication behaviour. For instance, innovators are usually younger than later adopters, have more years of formal training, have a higher social status (influenced by income, level of living etc.), and have a higher degree of 'upward social mobility'. Early adopters are also described as having greater empathy than later adopters, as being less dogmatic, as being more able to deal with abstractions as well as with uncertainty, and they are furthermore more favourable towards changes. Finally, early adopters have more social participation than later adopters, they have more interpersonal networks, greater exposure to mass media, and are also more active in seeking information on innovations. Rogers (1995) concludes that the individuals "… who most need the benefits of the new idea are generally the last to adopt an innovation. …" (p. 275) [77].

It is in addition important to acknowledge that diffusion occurs in a **social system** and the social structure of that system will affect the innovation's diffusion. Again, communication is an important factor, as

[4] 'Better' should be understood as providing an advantage in economic terms, but also in social prestige, convenience or general satisfaction. This may also include so called hedonic benefits.

[5] An idea that is incompatible with the values and norms of a particular social system will not be adopted as rapidly as an innovation that is compatible.

are the existing norms (e.g. cultural or religious) of the system. Opinion leaders play an important role in enhancing or deterring changes.

Another group of theories can be determined intention-based models. An example is the **Theory of Reasoned Action** (TRA), described by Ajzen and Fishbein (1980) and Fishbein and Ajzen (1975) [78] [79]. According to TRA, a person's performance of a special behaviour (such as adopting new technology) is determined by his or her **behavioural intention** to perform the specific behaviour. The behaviour intention is jointly determined by the **person's attitude,** i.e. the individual's positive or negative feelings about performing the target behaviour, and **subjective norm** concerning the behaviour in question. A person's attitude is determined by the individual's salient beliefs about the consequences of performing the behaviour multiplied by the evaluation of those consequences. An individual's subjective norm is determined by his/her normative beliefs, i.e. perceived expectations of specific referent individuals or groups, and his/her motivation to comply with these expectations[6]. According to the theory, other factors that may influence behaviour do so by indirectly influencing the individual's attitude towards the behaviour, subjective norm or their relative weights. To Rogers (1995) this means that the characteristics of the innovation [77], the user characteristics, the nature of the development and implementation process, etc. will all fall into a category which Fishbein and Ajzen (1975) refer to as **'external variables'** [79].

The **Technology Acceptance Model** (TAM) (Davis, 1993) is an adaptation of TRA, originally tailored for modelling user acceptance of information system but later used also in other, related domains [80]. As the focus of TAM is to explain why a technical system may be unacceptable to users, the purpose is to provide a basis for tracing the external factors which have an impact on internal beliefs, attitudes, and intentions in order to be able to design a system which has the highest probability for 'success'. Using TRA as a theoretical basis, TAM concludes that **perceived usefulness** and **perceived ease of use**[7] are of primary relevance for acceptance behaviours, influenced by **external variables** (such as demographic variables), as highlighted by Kaasinen (2005) [81].

Perceived usefulness is defined as the prospective user's subjective probability that using a specific system will increase his or her (job) performance within a certain context. Perceived ease of use refers to the degree to which the prospective user expects the system to be free of effort. These factors shape the individual's attitude towards using and the attitude affects in turn the individual's behavioural intention to use the new technology. TAM does not include TRA's subjective norm as a determinant of the individual's behavioural intention. The TAM model has been tested and the empirical results conclude that perceived usefulness is the major determinant of people's intention to use computer while perceived ease of use if a secondary determinant. e.g., Davis (1993) and Davis *et al.* (1989) [80] [82].

There has been an increasing concern about the appropriateness and comprehensiveness of TAM (and similar theories). The model has been criticized for being too parsimonious and incomplete, and appropriate in an organizational context but less so in other contexts. For instance, Rogers (1995) highlights many **individual differences** in terms of gender, age, education etc. play a more important role in users' adoption of new technology in their everyday, private, life [77], even though some studies contradict this assumption, e.g. a study on users' adoption of mobile phones by Kwon and Chidambaran (2000) [83]. Related to individual differences is the importance of **social pressure** or social norm where some individuals may search to gain social status by adopting the innovation, but this impact does not

[6] Culture sets values and norms which in turn determine our behaviours, decisions, actions and knowledge. Culture and cultural differences should thus be important factors to consider in people's adoption of new technology. However, specific studies investigating the role of culture in user uptake are scarce.

[7] Perceived ease of use is the degree to which a person believes using a particular system will be free from effort. Perceived ease of use is at first based on external factors (attitude, information from peers etc.). In actual use, perceived ease of use is increasingly affected by the user's own experiences of using the system in different contexts.

appear to be direct. One example of a development of TAM is the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh *et al.*, 2003) [84].

The latter explains behavioural intention to use a technology and/or technology as being determined by the following constructs:

a) ***Performance Expectancy****, "the degree to which a technology will provide benefits to consumers in performing certain activities",*
b) ***Effort Expectancy****, "the degree of ease associated with consumers' use of technology",*
c) ***Social Influence****, "the extent to which consumers perceive that important others believe they should use a particular technology",*
d) ***Facilitating conditions****, "which refer to consumers' perceptions of the resources and support available to perform the behaviour".*

In 2012, Venkatesh *et al.* [85] expand UTAUT by adding three new constructs, which are:

e) ***Hedonic Motivation****, "the fun or pleasure derived from using a technology",*
f) ***Price Value****, "the consumers' cognitive trade-off between the perceived benefits of the applications and the monetary cost for using them" and*
g) ***Experience****, that "reflects an opportunity to use a technology and is typically operationalised as the passage of time from the initial use of a technology by an individual", and* ***Habit****, "the extent to which people tend to perform behaviours automatically because of learning".*

The first six are theorised to influence **behavioural intention** to use a technology, while behavioural intention, experience and habit determine **behaviour use**. Individual difference variables (age, gender) are theorized to moderate various relationships in the model.

4.2 Research design and methodology

A methodology must be designed to address the research objectives of this work, which attempts to take a closer look to **a-priori behavioural intention towards the adoption and utilisation of EL-Vs**.

While a mixed quantitative and qualitative research model should be used in the case of exploring ex-post, based-on-experience behavioural intention towards EL-Vs following real life demonstrations (for instance resorting to trip data loggers recording location, speed, acceleration, trip duration, etc. of the vehicles, while at the same time collecting opinions and attitudes from the users with questionnaires and surveys), an a-priori research on acceptance, attitudes and willingness to use of a given technology is of **qualitative** nature.

The key characteristics of qualitative research are that this kind of research, according to Creswell (2014) [86]:

- takes place in the natural setting,
- relies on the researcher as the instrument for data collection,
- employs multiple methods of data collection,
- is both inductive and deductive,
- is based on participants' meanings,
- includes researcher reflexivity, and
- is holistic.

With the above in mind, the research design proposed can be broken down into three main steps:

i. **Analysis of city mobility characteristics** in each demonstration city (including a city cross-comparison).

ii. **Analysis on people's attitudes towards and perceptions of EL-Vs** (by means of citizen surveys).

iii. **Interviews with fleet owners and fleet drivers**, to collect more specific data on barriers and perceptions.

With the help of the tools above, the research methodology proposed aims at responding whether A) **gender**, B) **age** and C) **occupation** (*moderators*) have a direct influence on the following a-priori perceptions and attitudes (indicators) towards potential EL-V usage:

1. Willingness to use per trip purpose,
2. Willingness to use as a part of a multimodal trip,
3. Ease of parking
4. Comfort,
5. Safety,
6. Luggage capacity,
7. Charging convenience,
8. Affordability.

4.3 City Mobility Characteristics

4.3.1 Mobility Characteristics in demonstration cities

An understanding of city characteristics and mobility features is required to promote effective usage schemes when introducing EL-Vs into target cities. In the case of the six cities covered by the ELVITEN project, the work started by identifying factors that may affect the integration of EL-Vs into existing transportation systems. Similarly, Mohd Shariff *et al.* (2008) remark that there are many factors that affect mobility demand, including environment, infrastructure, time, and cost [87]. These factors have been identified via literature review and include demographics, trip characteristics, transport types, travel costs, and shared mobility. A comprehensive template was then created for each group of factors to support data collection from the cities. The template was formatted in Microsoft Excel spreadsheets (also included in Annex A), as follows:

Table 10: Template for City Characteristics

Characteristics	Genoa		Rome			Bari		Trikala		Berlin		Málaga		
	City	Metro	District IX	City	Metro	City	Metro	Municipality	Regional	City	Metro	District I	City	Metro
Size (km^2)														
Population														
Persons in employment														

Persons in full time education:														
Age 16-18														
Age 19 and over														
Population/nationality:														
% nationals of that country														
% nationals of other EU countries														
% from non-EU countries														
Weather/Climate:														
Average daytime temperature														
in hottest month of year (°C)														
in coldest month of year (°C)														
Average days of rain														
in driest month														
in wettest month														
Topography: approximate %:														
% of area flat or nearly flat														
% of area slightly hilly														
% of area very hilly														
Pollution and air quality:														
NO_2: Min_value														
NO_2: Avg_value														
NO_2: Max_value														
NO_2: No_observations														
SO_2: Min_value														
SO_2: Avg_value														
SO_2: Max_value														
SO_2: No_observations														
Comments area:														

Table 11: Template for Travel Costs

(City only, not metro-area)	Genoa	Rome	Bari	Trikala	Berlin	Málaga
Local public transport (bus, metro or tram):						
Single ticket cost for an average journey in the city						
Monthly ticket cost for unlimited travel within the city						
Car or motorcycle:						
Average local cost per litre of unleaded petrol						
Average local cost per litre of diesel						
Average local cost for 1h on-street parking in central area						

Average local cost for 4h in off-street public car park						
Description of any restrictions on petrol/diesel vehicles entering the city centre (types of vehicles banned or restricted and when)						
Costs for permit or right to drive in city in the case of restrictions (Eco-tax, limited traffic zone, congestion charge, etc.)						
Comments Area:						

Table 12: Template for Trip Characteristics

Trips per average weekday		Genova		Rome			Bari		Trikala		Berlin		Málaga		
		City	Metro	District	City	Metro	City	Metro	Municipa lity	Regional unit	City	Metro	District I	City	Metro
By Purpose	Home Based Non-Work														
	Non-Home Based														
	Light Goods Delivery														
	Other purposes														
By Mode *(no. of trips to, from, through or within the area)*	Bus														
	Tram														
	Metro/underground														
	Rail														
	Car or van (driver)														
	Car or van (passenger)														
	Taxi or ride sharing service														
	Motorcycle														
	Moped/scooter														
	Cycle														
	Walk														
	Other (specify, e.g. funicular, ferry, etc.)														
Average vehicle occupancy	Bus -peak periods														
	Bus -off-peak periods														
	Tram or metro -peak periods														
	Tram or metro -off-peak														
	Car or van -peak periods														
	Car or van -off-peak														
	Taxi -peak periods														
	Taxi -off-peak														
Comments															

Table 13: Template for Transport System

Characteristics	Genova		Rome		Bari		Trikala		Berlin		Málaga	
	City	Metro	City	Metro	City	Metro	Municipality	Regional	City	Metro	City	Metro
Car or van												
Public transport												
Motorcycle												
Bicycle												
Other (specify modes)												
Road length (km):												
Motorways												
Principal roads												
Other/Local roads												
Bus lanes (km/dir)												
of which bicycles allowed												
of which scooters allowed												
Separate bicycle lanes (km/ direction)												
No. *of vehicle-km* *per average weekday within the area*												
Cars												
of which electric vehicles												
L-category vehicles												
of which electric L-Vs												
Light goods vehicles												
Trucks												
Motorcycles												
of which electric ones												
Bicycles												
Buses and coaches												
Traffic Issues: Average traffic volume -hourly												
Average traffic volume												
Average traffic flow rates (vehicles/hour)												
Average daily road capacity of (vehicles/day)												
Mean travelling speeds (km/h)												
Characteristics	Genova		Rome		Bari		Trikala		Berlin		Málaga	
	City	Metro	City	Metro	City	Metro	Municipality	Regional	City	Metro	City	Metro
Public transport network(km) (bus/tram/rail/metro)												
Length of bus network												
Length of tram network (if any)												

Length of metro network (if any)												
Length of suburban rail network												
No. of PT lines freq. daytime >= 15 min.												
No. of PT lines with daytime freq. between 15 min. and hourly												
Public transport quality												
Average waiting time at bus stop												
Average frequency of metro on weekdays												
Average frequency of tram on weekdays												
Congestion, EV facilities and parking												
Traffic congestion: Congestion Level (increase in overall travel times when compared to a Free Flow situation.)												
Traffic congestion: Extra Travel Time: (extra travel time during peak hours vs. an hour of driving during Free Flow situation)												
No. of urban policies and bonuses to promote virtuous behaviours and e- or e-light vehicle use (e.g. use of bus lanes, discounts for PT, access to LTZ)												
Please indicate what are the policies												
No. of public charging points for EVs (individual poles, so there might be 2 or more at the same location)												
No. of public charging locations for EVs (a location might include two or more charging points, or only one)												
Public off-street parking (car park) spaces												
No. of parking places reserved for light vehicles, of which for e-light vehicles;												
No. free at all times												
No. charged for												
No. *of on street parking spaces*												
No. free at all times												
No. charged for or need permit for												
Comments Area:												

Table 14: Template for Shared Mobility

(City only, not metro-area)	Genoa	Rome	Bari	Trikal a	Berlin	Málaga
Car sharing (self-service, not traditional rental):						
No. of companies						
Names of companies						
Total no. of cars for sharing in cities						
No. of these which are electric or hybrid cars						
No. of car pick-up points in city						
No. of charging stations for shared EVs						
Car sharing usage:						
No. of persons subscribed (all operators)						
Average no. of rentals per car per week						
Average km driven per car per week						
LV Sharing (self-service, not traditional rental):						
No. of companies						
Names of companies						
Total no. of LVs for sharing in cities						
No. of these which are EL-Vs						
No. of LV pick-up points in the city						
LV sharing usage:						
No. of persons subscribed (all operators)						
Average no. of rentals per car per week						
Average km driven per car per week						
Bike Sharing (self-service):						
No. of companies						
Names of companies						
Total No. of bicycles for sharing in cities						
No. of docking stations in city						
No. of free-floating cycles (no docking station)						
No. of these which have electric assistance						
Bike sharing usage:						
No. of persons subscribed (all operators)						
Average No. of rentals per car per week						
Average km driven per car per week						
Comments Area:						

Ideally, data was sourced from 2016, but other years were also acceptable depending on their availability. Each city followed a uniform format when presenting data. However, as data availability varied between cities, the level of detail given for each city also varies. Thus, the main findings of each city are given in Chapter 5 while the detailed analysis is given in Annex B. By analysing city-specific features, important factors in understanding cross-city mobility differences are identified for comparison.

4.3.2 City Profile of Factors Influencing EL-V Adoption

Using the factors identified in the previous section, city profiles have been created using the data provided by each city. The results were represented in diagrams, wherein all factors were displayed in the same format and by the same measure for each city, in order to provide a suitable basis for comparison of otherwise heterogeneous data. Moreover, factors with complete data were selected and visualized in radar charts to gain a further insight into the factors affecting EL-V adoption in each demonstration city. The detailed analysis was included in Chapter 5.

4.4 Survey of Attitudes and Perceptions

4.4.1 Online Survey

To collect and examine the views and perceptions of the public towards the use of L-Vs/EL-Vs and to identify the main barriers (and potential barriers) that deter the usage of these vehicles, an online questionnaire template (also available in Annex D) has been created with the use of SurveyMonkey online platform and distributed through the demonstration cities' channels (websites, social media etc.):

Table 15: Citizen questionnaire with coding for analysis

Q. No.	Question	Column	Response format	Explanation
	ID	**A**	Number	
	Language	**B**	English, German, Greek, Italian, Spanish	Version of questionnaire answered (irrespective of city)
	Country	**C**	Country name (text)	
1	Demo city	**D**	Bari, Berlin, Málaga, Rome, Trikala, z Other	Use “z Other” if not a demo city so that it comes at the end of the list if sorted
	If other	**E**	Name of city	If not a demo city
2	For the following bicycles, please specify which one(s) you use or own? *(several responses possible)*	**F**	1 Blank	Pedal cycle own No
		G	2 Blank	Pedal cycle shared No
		H	1 Blank	Electric cycle own No
		I	2 Blank	Electric cycle shared No
3	For the following vehicles, please specify which one(s) you own or use *(several responses possible)*	**J**	1 Blank	2-wheel petrol own No
		K	2 Blank	2-wheel electric own No
		L	3 Blank	2-wheel petrol share No
		M	4 Blank	2-wheel electric share No
		N	1 Blank	3-wheel petrol own No
		O	2 Blank	3-wheel electric own No
		P	3 Blank	3-wheel petrol share No
		Q	4 Blank	3-wheel electric share No
		R	1 Blank	4-wheel petrol own No
		S	2 Blank	4-wheel electric own No
		T	3 Blank	4-wheel petrol share No
		U	4 Blank	4-wheel electric share No

4	How often do you travel for work or education?	**V**	1 2 3 4	4 days a week or more At least once a week Less often Rarely or never *(these people were not asked Q5 and 6)*
5.	What is the average one-way distance for your trips to work or education?	**W**	1 2 3 4 Blank	Up to 5 km 6-15 km 16-25 km 26 + km Rarely or never travels for this purpose
6.	Which is your main mode of travel for your trips from home to work or education?	**X** For cross-analysis, group: 1 2, 3 4, 5, 6, 7, 8, 9 10, 11, 13 12	0 1 2 3 4 5 6 7 8 9 10 11 12 13 Blank	Other *(do not count in analysis)* Walking Pedal bicycle Electric bicycle 2-wheel petrol 2-wheel electric 3-wheel petrol 3-wheel electric 4-wheel petrol 4-wheel electric Diesel, petrol or hybrid car or van Fully electric Public transportation Taxi or ride-sharing Rarely or never travels for this purpose *(do not count in analysis)*
		Y	Other (text)	
7.	How often do you travel for shopping?	**Z**	1 2 3 4	4 days a week or more At least once a week Less often Rarely or never *(these people were not asked Q8 and 9)*
8.	What is the average one-way distance for your trips for shopping?	**AA**	1 2 3 4 Blank	Up to 5 km 6-15 km 16-25 km 26 + km Rarely or never travels for this purpose
9.	Which is your main mode of travel for your trips for shopping?	**AB** For cross-analysis, group: 1 2, 3 4, 5, 6, 7, 8, 9 10, 11, 13 12	0 1 2 3 4 5 6 7	Other *(do not count in analysis)* Walking Pedal bicycle Electric bicycle 2-wheel petrol 2-wheel electric 3-wheel petrol 3-wheel electric 4-wheel petrol

			8 9 10 11 12 13 Blank	4-wheel electric Diesel, petrol or hybrid car or van Fully electric Public transportation Taxi or ride-sharing Rarely or never travels for this purpose *(do not count in analysis)*
		AC	Other (text)	
10.	How often do you travel within your city for leisure, entertainment and visits (family/friends)?	**AD**	1 2 3 4	4 days a week or more At least once a week Less often Rarely or never *(these people were not asked Q11 and 12)*
11.	What is the average one-way distance for your trips within your city for leisure, entertainment and visits (family/friends)?	**AE**	1 2 3 4 Blank	Up to 5 km 6-15 km 16-25 km 26 + km Rarely or never travels for this purpose
12.	Which is your main mode of travel within your city for leisure, entertainment and visits (family/friends)?	**AF** For cross-analysis, group: 1 2, 3 4, 5, 6, 7, 8, 9 10, 11, 13 12	0 1 2 3 4 5 6 7 8 9 10 11 12 13 Blank	Other *(do not count in analysis)* Walking Pedal bicycle Electric bicycle 2-wheel petrol 2-wheel electric 3-wheel petrol 3-wheel electric 4-wheel petrol 4-wheel electric Diesel, petrol or hybrid car or van Fully electric Public transportation Taxi or ride-sharing Rarely or never travels for this purpose *(do not count in analysis)*
		AG	Other mode (text)	
13.	If there was a sharing scheme for these kinds of light electric vehicles in your local area would you consider using it?	**AH**	1 2 3 4 5 6 Blank	Yes, frequently Yes, occasionally Maybe No, I would prefer to buy my own one No, I would not use such a vehicle I don't know Exclude from analysis of this question

14.	In the future, would you consider using one of the following vehicles?	**AI**	1 Blank	Work/education bicycle No
		AJ	2 Blank	Work/education 2-wheel EL-V No
		AK	3 Blank	Work/education 3-wheel EL-V No
		AL	4 Blank	Work/education 4-wheel EL-V No
		AM	1 Blank	Shopping bicycle No
		AN	2 Blank	Shopping 2-wheel EL-V No
		AO	3 Blank	Shopping 3-wheel EL-V No
		AP	4 Blank	Shopping 4-wheel EL-V No
		AQ	1 Blank	Leisure bicycle No
		AR	2 Blank	Leisure 2-wheel EL-V No
		AS	3 Blank	Leisure 3-wheel EL-V No
		AT	4 Blank	Leisure 4-wheel EL-V No
16.	Travelling with it is comfortable irrelevant of the weather conditions	**AU**	1 2 3 4 5 Blank	2W I strongly disagree 2W I rather disagree 2W I rather agree 2W I strongly agree 2W I don't know Exclude from analysis of Q16
		AV	1 2 3 4 5 Blank	3W I strongly disagree 3W I rather disagree 3W I rather agree 3W I strongly agree 3W I don't know Exclude from analysis of Q16
		AW	1 2 3	4W I strongly disagree 4W I rather disagree 4W I rather agree

			4 5 Blank	4W I strongly agree 4W I don't know Exclude from analysis of Q16
17.	Parking is easy and secure	**AX**	1 2 3 4 5 Blank	2W I strongly disagree 2W I rather disagree 2W I rather agree 2W I strongly agree 2W I don't know Exclude from analysis of Q17
		AY	1 2 3 4 5 Blank	3W I strongly disagree 3W I rather disagree 3W I rather agree 3W I strongly agree 3W I don't know Exclude from analysis of Q17
		AZ	1 2 3 4 5 Blank	4W I strongly disagree 4W I rather disagree 4W I rather agree 4W I strongly agree 4W I don't know Exclude from analysis of Q17
18.	I would feel safe during the trip	**BA**	1 2 3 4 5 Blank	2W I strongly disagree 2W I rather disagree 2W I rather agree 2W I strongly agree 2W I don't know Exclude from analysis of Q18
		BB	1 2 3 4 5 Blank	3W I strongly disagree 3W I rather disagree 3W I rather agree 3W I strongly agree 3W I don't know Exclude from analysis of Q18
		BC	1 2 3 4 5 Blank	4W I strongly disagree 4W I rather disagree 4W I rather agree 4W I strongly agree 4W I don't know Exclude from analysis of Q18
19.	Charging is convenient	**BD**	1 2 3	2W I strongly disagree 2W I rather disagree 2W I rather agree

			4 5 Blank	2W I strongly agree 2W I don’t know Exclude from analysis of Q19
		BE	1 2 3 4 5 Blank	3W I strongly disagree 3W I rather disagree 3W I rather agree 3W I strongly agree 3W I don’t know Exclude from analysis of Q19
		BF	1 2 3 4 5 Blank	4W I strongly disagree 4W I rather disagree 4W I rather agree 4W I strongly agree 4W I don’t know Exclude from analysis of Q19
20.	It is affordable to use and operate	**BG**	1 2 3 4 5 Blank	2W I strongly disagree 2W I rather disagree 2W I rather agree 2W I strongly agree 2W I don’t know Exclude from analysis of Q20
		BH	1 2 3 4 5 Blank	3W I strongly disagree 3W I rather disagree 3W I rather agree 3W I strongly agree 3W I don’t know Exclude from analysis of Q20
		BI	1 2 3 4 5 Blank	4W I strongly disagree 4W I rather disagree 4W I rather agree 4W I strongly agree 4W I don’t know Exclude from analysis of Q20
21.	It has sufficient luggage capacity for my needs	**BJ**	1 2 3 4 5 Blank	2W I strongly disagree 2W I rather disagree 2W I rather agree 2W I strongly agree 2W I don’t know Exclude from analysis of Q21
		BK	1 2 3	3W I strongly disagree 3W I rather disagree 3W I rather agree

			4 5 Blank	3W I strongly agree 3W I don't know Exclude from analysis of Q21
		BL	1 2 3 4 5 Blank	4W I strongly disagree 4W I rather disagree 4W I rather agree 4W I strongly agree 4W I don't know Exclude from analysis of Q21
22.	Do you or would you consider using one of these kinds of electric vehicles as a part of multi-modal journey, with for instance public transport?	**BM**	1 2 3 4 Blank	I already do so I would consider using one No I don't know Exclude from analysis of Q22
23.	What in your opinion are the most necessary measures to encourage greater use of these kinds of electric vehicles? Please select up to three from the list.	**BN**	1 Blank	Sufficient secure parking No
		BO	2 Blank	Sufficient electric charging infrastructure No
		BP	3 Blank	Offer sharing schemes for such vehicles No
		BQ	4 Blank	Integrated payment or card for sharing such vehicles and public transport No
		BR	5 Blank	Allow use of bus and cycle lanes by 2- or 3-wheel electric vehicles No
		BS	6 Blank	Navigation services aimed at electric light vehicles No
		BT	7 Blank	User assistance (rescue, information or training services) No

		BU	8 Blank	Incentive schemes for purchase or renting No
		BV	Other ideas (text, optional)	
24.	Do you have a driving licence?	**BW**	1 2 3 4 Blank	Type A Type B Type A+B None Exclude from analysis of Q24
25.	Are you:	**BX**	1 2 3 or blank	Female Male Prefer not to say or no answer (Exclude from analysis of Q25)
26.	Please tell us your age:	**BY**	1 2 3 4 5 Blank	Under 18 18-29 30-59 60-74 75 and more Exclude from analysis of Q26
27.	What is your current occupation?	**BZ**	1 2 3 4 5 6 Blank	In education/student Full-time employment Part-time employment Unemployed Retired Other Exclude from analysis of Q24

The online questionnaire was available in five languages, namely English, German, Greek, Italian and Spanish. The creation process of the questionnaire was mainly focused to the direction of making an inventory of expectations and experiences towards the public mobility and the (potential) use of L-Vs/EL-Vs, in order to answer to the proposed hypotheses in Chapter 7. It was not intended as a census of current trip behaviour (the survey respondents might not be representative of the city's population), but rather to gather information on perceptions and to correlate this with current trip behaviour. The questionnaire was related to urban and suburban trips only.

By means of the online questionnaire, and based on the review of factors influencing EL-V adoption explored in Chapter Three, the following topics were mainly addressed:

1. Attitudes towards the use of EL-Vs (in terms of safety, comfort, travelling, luggage capacity);
2. Characteristics of responders' journeys within the urban environment, as part of their work/education, shopping and leisure activities;
3. Incentives that may boost the diffusion of EL-Vs and the responder's propensity to consider EL-Vs as an alternative mode of transport.

4.4.2 Onsite interviews with fleet owners and stakeholders

The onsite interviews with users in the participating cities were conducted by the local representative partners of each city, in national language. The interviews were directed toward a twofold aim: to investigate the attitude and perceptions of the interviewed people and to increase the awareness towards the upcoming use of L-Vs/EL-Vs. The selected individual interviewed candidates were:

- The Fleet managers or supervisors (responsible for fleet acquisition, trip planning, etc.)
- Drivers (employees)

The interviews were conducted either face-to-face or by telephone. In case several people from the same organisation were supposed to be interviewed, each person was interviewed separately and privately. If managers were worried that their drivers would criticise them or give the “wrong” responses, it was clearly explained that there are no right or wrong responses and the questions are not about the employees’ satisfaction or behaviour. It is about their opinions on different types of vehicles and the infrastructure in their city. In all cases, a set of pre-interviewed informative steps were used when a company was contacted. More in detail, the interviewers:

- explained what the survey was about;
- explained which types of staff we want to interview (manager responsible for the vehicle fleet and drivers);
- explained how long each interview would take (around 15 minutes);
- explained that our survey is non-commercial and that results would be anonymous (we collected the name of the company, but we will not report the responses by company; only by city and by kind of respondent (large or small company, manager or driver);
- got the name of a fleet manager that could be interviewed;
- agreed a time for a telephone call (or for you to visit their premises).

Pre-defined uniform document templates for interviews (Interview sheets) (one for Fleet managers and one for drivers were developed (Annex F and Annex G respectively). Interview sheets were printed out and responses were written on them, by pen, by the interviewer during the discussion. At the end of the interview period, the responses from the interview forms were entered into an Excel spreadsheet file in English. The main onsite interview findings per city are given in Chapter 8.

5 Mobility demand in demonstration cities

5.1 Bari

5.1.1 General City characteristics

The City of Bari has a medium density of population, a Mediterranean climate with mild winters and hot and dry summers (see Figure 13) and from a geomorphologic point of view its territory is almost completely flat.

In detail, as reported in Table 16, the city has a **population** of about 326,344 inhabitants, in 2016, over 117 km^2. The inhabitants younger than 18 years are 17.2% of the population compared to pensioners (> 65 years old) who number 23.0 %. As regarding the education, the inhabitants having a level of education equal or below high school are 227,243 that correspond to about 69.6%. The citizens that attended college/university and higher level of education (e.g. PhD, professor etc.) are about 17.6%. According to urban migration studies in Bari, migration to urban areas is higher than migration from urban areas.

Table 16: Demographic Characteristics in Bari for 2016

Characteristics	**Bari Metropolitan** N=1,263,820		**Bari City** N=326,344	
	n	%	n	%
Population				
Male	616,198	48.7	156,480	47.9
Female	647,622	51.3	169,864	52.1
Age group				
< 18	240,997	19.0	56,279	17.2
18-65	766,632	60.6	195,147	59.8
> 65	256,191	20.4	74,918	23.0
Education				
< High School	928,854	73.7	227,243	69.6
College/university	126,237	10.0	46,100	14.1
> College	28,334	2.2	11,748	3.5
Employment				
Employment	573,774	45.4	154,034	47.1
Unemployment	690,046	54.6	172,310	52.9
Nationality				
Italian	1,222,738	96.7	313,849	96.1
Other EU Countries	21,807	1.7	4,045	1.2

Characteristics	Bari Metropolitan N=1,263,820		Bari City N=326,344	
	n	%	n	%
Non-EU Countries	19,275	1.6	8,450	2.7

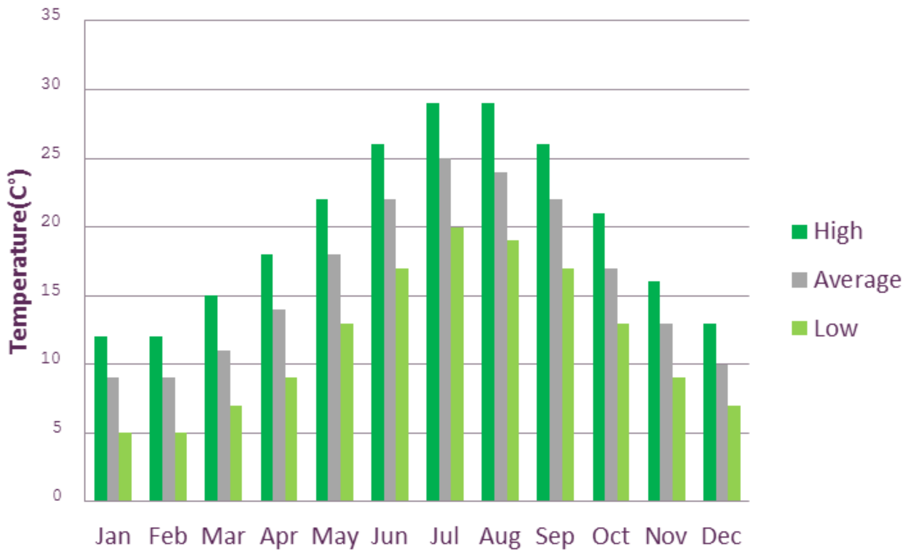


Figure 13: Monthly Average/low/high temperature in Bari [8] in 2016

Air quality data in Bari has been obtained from WeatherBug[9], a website that combines from data including governmental monitoring stations, satellites, traffic conditions, and air dispersion models. The data given is collected in real time, which means that actual values will fluctuate depending on environmental conditions throughout the day. The overall air pollution level is considered Fair at 34 units on the AQI scale, taking both concentration and time into account as a measure of the dosage. Main pollutants include PM2.5 (20.8μg/m^3), PM10 (33.1μg/m^3), O_3 (27.1ppb), NO_2 (34.7ppb), SO_2 (0.29 ppb) and CO (306ppb). As can be seen from the data, the partial pressure of CO is significantly higher than that of the other gaseous pollutants, suggesting that CO is one of the main contributors to low air quality.

5.1.2 Transport characteristics

The analysis of the Regional Transport Plan[10] for 2015-2019 of the Puglia Region and "Piano Urbano della Mobilità Sostenibile[11]" show that:

- The **main transport mode** (see Figure 14) for trips used by citizens is the car or van (52%), followed by motorcycle (22%), by public transport (18%) and finally by bicycle (5%). In detail, there were 88,818 trips made for study and work within the municipality of Bari. The analysis

[8] Source: https://www.holiday-weather.com/bari/averages [Accessed 20 December 2020].
[9] Source: https://www.weatherbug.com/ [Accessed 20 December 2020].
[10] Source: http://mobilita.regione.puglia.it/index.php/component/k2/item/11575-piano-regionale-dei-trasporti-e-il-piano-triennale-dei-servizi [Accessed 20 December 2020].
[11] Source: https://www.cittametropolitana.ba.it/istituzione/struttura-e-organizzazione/servizi/servizio-pianificazione-territoriale-generale-demanio-mobilita-e-viabilita/27-territorio/331-piano-urbano-di-mobilita-sostenibile-pums-della-citta-metropolitana-di-bari-procedura-vas.html [Accessed 20 December 2020].

of modal split shows that 61,312 trips (or 69%) were made by car, just over 20% made by public transport (train and bus), and only 3% made by bicycle (see Figure 15).

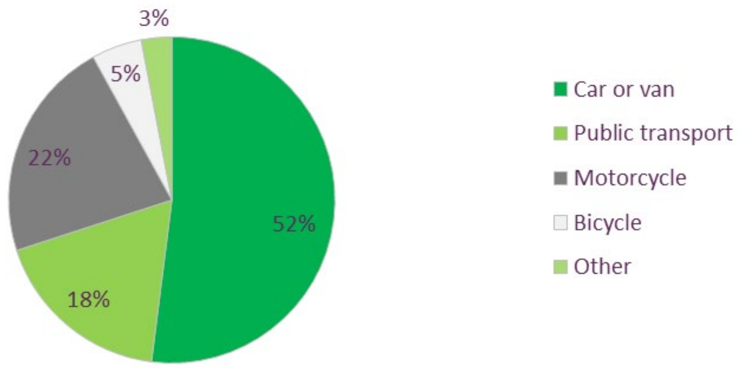


Figure 14: Modal share in Bari

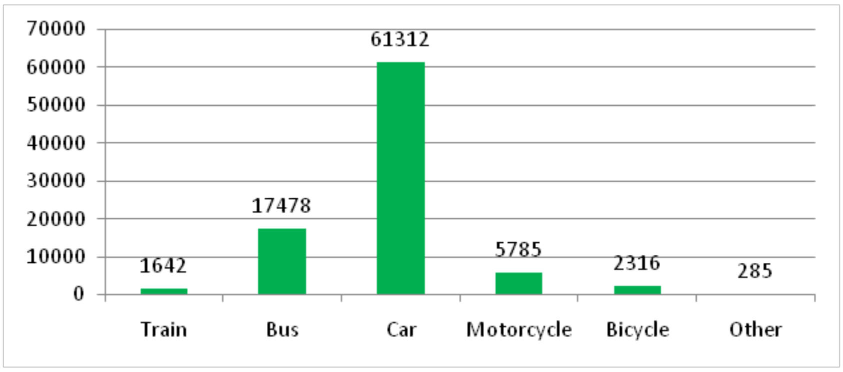


Figure 15: Trips by mode within the city of Bari for study and work

- Data regarding the fleet of vehicles (Figure 16) show the high number of cars circulating in the metropolitan area of Bari. In more detail, there are over 65,000 cars, followed by motorcycles (<10,000), trucks and other vehicles. Furthermore, in Bari there are 53 vehicles/100 inhabitants, less than the Italian average value (that is 58 vehicles/100 inhabitants) and higher than the European average value (that is 49.1 vehicles/100 inhabitants).

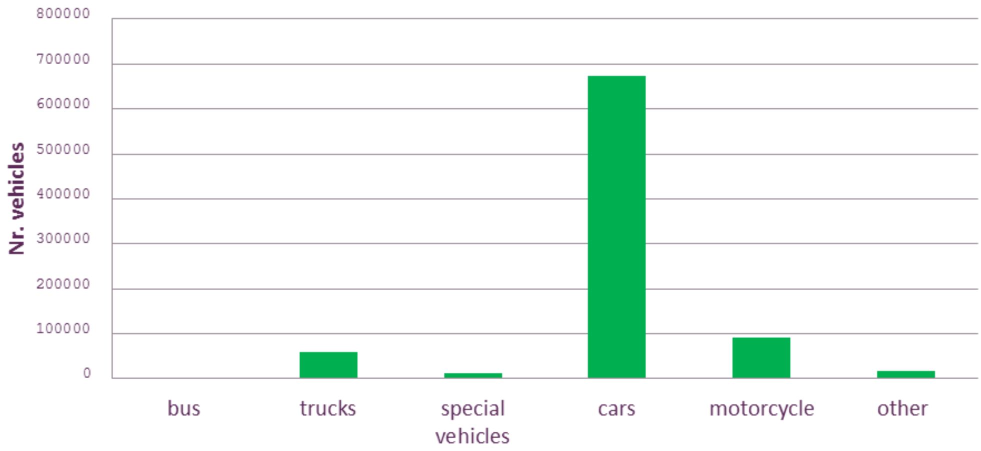


Figure 16: Fleet of vehicles in the metropolitan area of Bari (2014)

5.1.3 Travel characteristics

According to the leading document cited in the previous paragraph, the following main points can be highlighted:

- The systematic mobility for study and work amounts to a total of 223,221 trips (one way) per day, of which around 140,657 start from Bari and 82,564 are trips from other cities to Bari (Table 17).

Table 17: Trips for work and study, Bari

Trips	Bari	Other cities	Total
Bari	124,120	16,537	140,657
Other cities	82,564	-	82,564
Total	206,684	16,537	223,221

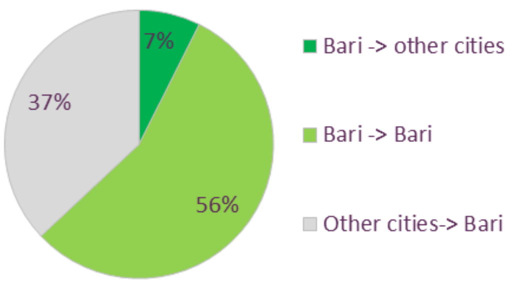


Figure 17: Trips for work and study, Bari

- Each vehicle in circulation makes an average 4.28 trips/day with an average distance of 21.1 km/day (Table 18). Furthermore, each inhabitant spends 0.55 hour per day for trips. In the Bari city, the average trips per vehicle are 5.54 with an average travelled distance of 23.48 km and average speed of 22.5 km/h.

Table 18: Travelled trips by car for the Metropolitan area of Bari and the city of Bari

	Bari metropolitan				Bari City			
	Total	Average values per trips	Average values per inhabitant	Average values per vehicle	Total	Average values per trips	Average values per inhabitant	Average values per vehicle
Trips	753,621	1	2.33	4.28	2,762,538	1	2.94	5.54
Travel times (hours)	162,577	0.22	0.50	0.92	520,119	0.19	0.55	1.04
Travelled distance (kms)	3,716,115	4.93	11.51	21.10	11,711,683	4.24	12.47	23.48
Average speed (km/h)	22.9	22.9	22.9	22.9	22.5	22.5	22.5	22.5

- As regards the public transport system and road infrastructure, Table 19 and Table 20 show the different public lines in Bari, discriminated by bus, rail and metro. In particular, and in relation to road infrastructure and density of population, the city does not offer many bicycle lanes. In detail, bicycle paths are 0.2 km for every 10,000 inhabitants, far below the Italian average value (which is 3 km/10,000 inhabitants). Also, the limited traffic zones (ZTL in Italian, "Zona a traffic limitato") are approximately less than 2.5 m2/inhabitants, while the Italian average value is 5 m2/inhabitants[12].

Table 19: Public Transport in Bari

Transit	Bus	Rail	Metro
network length(km)	621	38.6	20.5
Lines	45	6	1
Vehicles	241		
No. of lines with frequency <15min	4		
No. of lines with frequency >15min	31	4	
No. of lines without a fixed frequency	10		
Average peak time frequency (min) on weekday	15-20	15	
Average waiting time(min)	20		
Single ticket cost for an average journey in the city (€)	1.0		
Monthly ticket cost for unlimited travel within the city (€)	35		

[12] Source: Osservatorio Mobilità Sostenibile in Italia, Euromobility, https://www.osservatorio50città.it [Accessed 20 December 2020].

Table 20: Road length in Metropolitan area of Bari

	Motorways/ Expressway (km)	Principal (km)	Local roads/ streets (km)	Travelled roads by public transport (km)	Bicycle lines (for Bari city) (km)	Railway network (km)
Metropolitan area of Bari	78	1816	412	1293	24	1232

5.1.4 L-V/EL-V Use

No data on light vehicle and electric light vehicle usage is available. The only data on electric vehicles regard the electric shared cars. In detail GIRACI[13], that is the car sharing service in Bari until 2017, reported a summary of the electric car usages in Bari for 2017 (Table 21). 23 electric Nissan Leafs became available, which could be recharged either at existing Enel posts in the city or at additional charging stations that were to be provided by the company Aci Global in the future. Cars enjoyed unlimited access to the Limited Traffic Zone (ZTL in Italian) and could park for free in blue-striped parking lots.

Table 21: Electric sharing vehicles in Bari in 2017

Charging information	
No. of public charging points	26
No. of public charging locations	14
Sharing scheme	
Number of electric sharing vehicle	23
Number of pick-up points in city	14
Monthly average trips for E-CAR	12
Travelled km for car	612 km/year
Average travelled km for trip	5.0 km
Average time for trip	36 min
Nr. people registered to the car sharing service	564

5.2 Berlin

5.2.1 General City Characteristics

Berlin is the largest city of Germany and since the German reunification in 1990 it is also the capital of the Federal Republic of Germany again. Besides Bremen and Hamburg, Berlin is one of the three German city states. It is a global city of culture, media and science. With an annual amount of approximately 12.7 million visitors, the touristic branch is one of the supporting pillars of Berlin's

[13] Source: https://giraci.com/it/bari/guide [Accessed 10 December 2019, now discontinued], https://www.aciglobal.it/media-room/news/giraci-il-car-sharing-aci-global-parte-a-bari/ [Accessed 20 December 2020].

economy. The city has a population of 3,671,000 registered inhabitants[14] in an area of 892 km^2. About 13% of Berlin's population is younger than 15 years old, while about 19% is older than 65 (see Figure 18)[15]. The average age is 42.8 years[16] compared to the national average of 44.25 years. 81.6% of the population[17] is of German nationality, in contrast to 6.75% EU foreigners and 11.65% non-EU foreigners[18]. Berlin has the largest Turkish community outside Turkey with 176,730 people. 1,892,000 people in Berlin are in employment, while the unemployment rate[19] is at 8.7%. In 2017, 180,235 students were registered at Berlin universities and community colleges[20].

Berlin's climate is classified as a maritime temperate climate, but with larger temperature differences between the seasons due to its inland position. In another climate classification, it is also classified as a temperate continental climate. The hottest month is July with an average temperature of 25 degrees Celsius, while the coldest month is January with an average of 3.3 degrees Celsius. The driest month is October and the rainiest one is June[21].

Berlin is located in a low-lying area, in the middle of the Northern European Plain, which stretches from France to Russia. Berlin city area is mostly flat. Since 2015, the highest elevation is the Arkenberge hills (122 metres) based in Pankow, which occurred through the dumping of construction debris. There are also several hills made of rubble from ruins of the Second World War. The Müggelberge at 114.7 metres is the highest natural elevation[22].

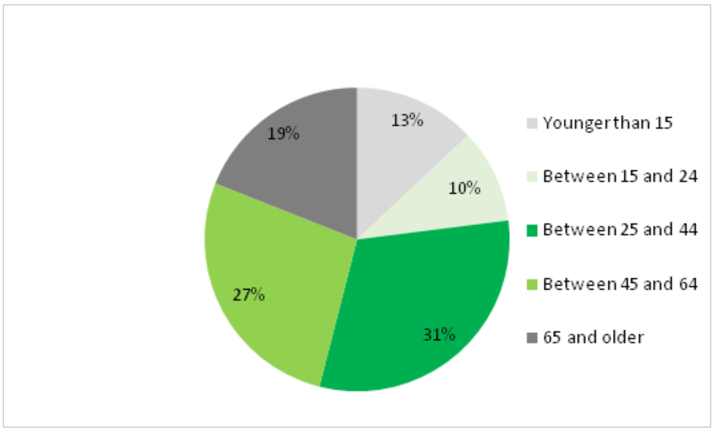


Figure 18: Age of population in Berlin

The city has, compared to most metropolises, problems with air pollution. The legal limit for particulate matter (PM10) and Nitrogen dioxide (NO_2) are exceeded many times a year. The limits for PM10 and NO_2 are at 40µg and are exceeded 35 and 18 times respectively on average per year[23]. The city council

[14] Source: https://www.statistik-berlin-brandenburg.de/publikationen/stat_berichte/2018/SB_A01-07-00_2016m12_BE.pdf [Accessed 20 December 2020].
[15] Source: https://www.statistik-berlin-brandenburg.de [Accessed 20 December 2020].
[16] Source: http://www.businesslocationcenter.de [Accessed 20 December 2020].
[17] Source: https://de.statista.com/statistik/daten/studie/723069/umfrage/durchschnittsalter-der-bevoelkerung-in-deutschland-nach-staatsangehoerigkeit/ [Accessed 20 December 2020].
[18] Source: https://www.rbb24.de/panorama/beitrag/2017/11/ein-fuenftel-der-berliner-auslaender-auslaenderanteil-berlin.html [Accessed 10 December 2019, now discontinued]
[19] Source: https://statistik.arbeitsagentur.de [Accessed 20 December 2020].
[20] Source: https://www.statistik-berlin-brandenburg.de/BasisZeitreiheGrafik/Bas-Hochschulen.asp?Ptyp=300&Sageb=21003&creg=BBB&anzwer=4 [Accessed 20 December 2020].
[21] Source: https://worldweather.wmo.int/016/c00059.htm [Accessed 20 December 2020].
[22] Source: https://www.tagesspiegel.de/berlin/bezirke/pankow/das-ist-die-hoehe-arkenberge-der-hoechste-berg-von-berlin-ist-neuerdings-in-pankow/11406254.html [Accessed 20 December 2020].
[23] Source: https://www.berlin.de/senuvk/umwelt/luftqualitaet/de/messnetz/grenzwerte.shtml [Accessed 20 December 2020].

is aware about this problem. Actions include reduced speed limits and the so-called *Berlin Mobility act,* which aims to increase the usage of electric vehicles and bicycles[24].

Air quality data in Berlin has been obtained from WeatherBug, a website that combines from data including governmental monitoring stations, satellites, traffic conditions, and air dispersion models. The data given is collected in real time, which means that actual values will fluctuate depending on environmental conditions throughout the day. The overall air pollution level is considered Fair at 31 units on the AQI scale, taking both concentration and time into account as a measure of the dosage. Main pollutants include PM2.5 (18.9µg/m^3), PM10 (34.8µg/m^3), O_3 (36.7ppb), NO_2 (31.1ppb), SO_2 (0.05ppb) and CO (242ppb). As can be seen from the data, the partial pressure of CO is significantly higher than that of the other gaseous pollutants, suggesting that CO is one of the main contributors to low air quality.

5.2.2 Transport Characteristics

Excluding walking, 41% of all trips in Berlin are made by car, van or motorcycle. 40% are made by the public transport system, which includes rail, metro, bus and tram. The last 19% of the trips are made by bicycle (see Figure 19)[25].

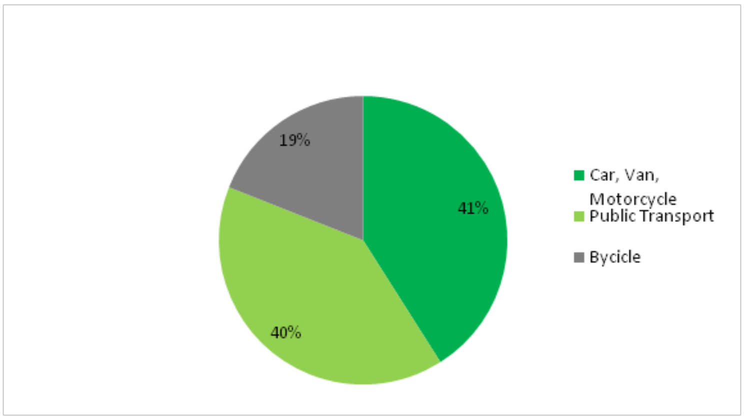


Figure 19: Modal share in Berlin

Berlin is known for its well-developed public transportation system. The metro system has a total length of 146.5 kilometres[26], the rail 331.5 kilometres[27], the tram 193.6 kilometres[28] and the bus system is the largest with a total length of 1675 kilometres Table 22[29]. On an average working day, the frequency of buses, tram and rail are at least every ten minutes, while the metro is at least every five minutes.

Table 22: Public Transport in Berlin

Transit	Bus	Tram	Rail	Metro
Network length (km)	1,675	196.6	331.5	146.6
Lines	152	22	16	10

[24]Source: https://www.berlin.de/senuvk/verkehr/mobilitaetsgesetz/ [Accessed 20 December 2020].
[25]Source: http://www.berlin.de/senuvk/verkehr/politik_planung/zahlen_fakten/mobilitaet_2013/ [Accessed 20 December 2020].
[26]Source: https://www.berlin.de/tourismus/infos/nahverkehr/1742343-1721041-ubahn.html [Accessed 20 December 2020].
[27]Source: https://www.s-bahn-berlin.de [Accessed 20 December 2020].
[28]Source: https://stadtplanberlin360.de/strassenbahn-plan-berlin#.Wq_YHyjwZaQ [Accessed 20 December 2020].
[29]Source: https://www.morgenpost.de/printarchiv/berlin/article104990991/Trotz-Millioneninvestitionen-fahren-Bus-und-Tram-langsamer.html [Accessed 20 December 2020].

There are 1,195,149 cars registered in Berlin, of which are 1,668 fully electric vehicles and 8,400 hybrids. The road system has a total length of 5,413 kilometres, with 76 kilometres of federal motorways ("Autobahn"). Cycle paths have a length of 1,671 kilometres. Some lanes remain reserved for buses and have a length of 101 kilometres. In the whole city there are more than 80,000 public parking management zones and about 26,600 bike stands. With 628 charge points, Berlin is the city with the most charge points in Germany.

The extra travelling time due to congestion per day through traffic is at 28 minutes and 107 hours per year. Especially during the morning peak (8:00-9:00 am) and during the evening peak (5-6 pm), there is a lot of traffic due to the commuters.

A federal restriction prohibits diesel fuelled cars classified EURO3 and lower to enter most parts of the city centre. The fine for car owners violating that law is 80 euro. Some German city councils are considering a general ban on diesel fuelled cars, with Berlin currently discussing this possibility.

The following table (Table 23) gives an overview of the costs of mobility in Berlin.

Table 23: Mobility costs in Berlin

Mobility Costs	Price (€)
Single ticket cost for an average journey in the city[30]	2.80
Monthly ticket cost for unlimited travel within the city[31]	81.00
Average local cost per litre of unleaded petrol[32]	1.37
Average local cost per litre of diesel[33]	1.20
Average local cost for 1h on-street parking in central area	2.00
Average local cost for 4h in off-street public car park[34]	10.00

5.2.3 Travel Characteristics

For trips of a length of 3 km and longer, public transport is the favourite choice of Berlin's citizens. It is more convenient than using a car. In the range from 1 to 3 km, cycling is the most used mode of transport, which is quite noticeable for a city with such a well-developed public transport infrastructure (Figure 20).

For shopping, leisure and education, walking is the leading means of transport. Most commuters to work in Berlin use public transport. Motorized vehicles are not the most used means for any urban trip purpose (Figure 21, Figure 22).

The average trip length for shopping, leisure and education is relatively short with a length of less than 4 kilometres (Figure 23) [35].

[30]Source: https://shop.bvg.de [Accessed 10 December 2019].
[31]Source: https://shop.bvg.de [Accessed 10 December 2019].
[32]Source: https://de.statista.com/statistik/daten/studie/1690/umfrage/preis-fuer-einen-liter-superbenzin-monatsdurchschnittswerte/ [Accessed 10 December 2019].
[33]Source: https://de.statista.com/statistik/daten/studie/1691/umfrage/preis-fuer-einen-liter-diesel-monatsdurchschnittswerte/ [Accessed 20 December 2019].
[34]Source: https://difu.de/sites/difu.de/files/bericht_lk_argus_parkgebuehrengestaltung.pdf [Accessed 20 December 2019].
[35]Source: http://www.berlin.de/senuvk/verkehr/politik_planung/zahlen_fakten/download/SrV_2013_Berlin_Steckbrief_innere.pdf [Accessed 20 December 2020].

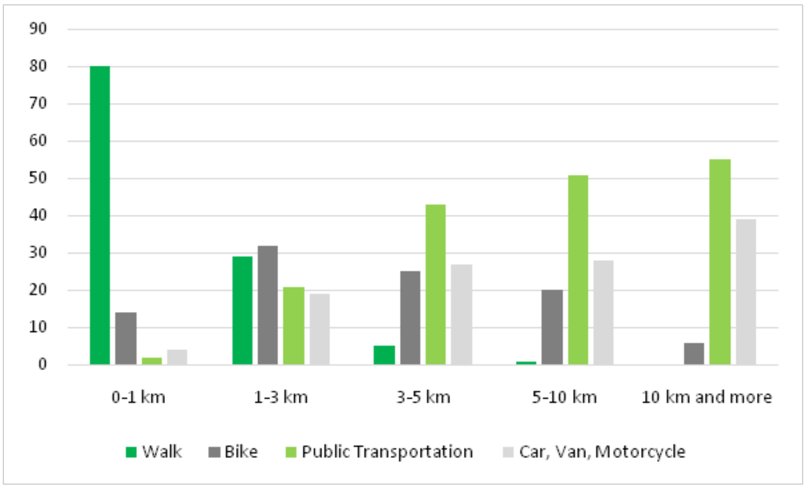


Figure 20: Means of transportation regarding to distance, Berlin

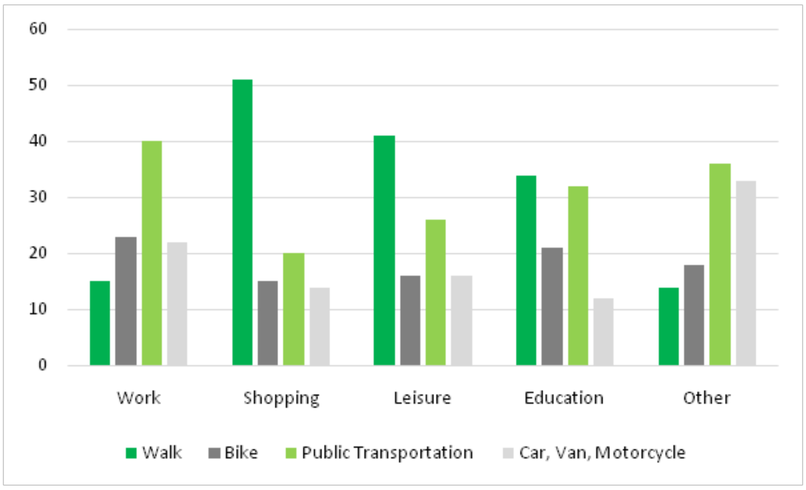


Figure 21: Purpose of Trips by mode, Berlin

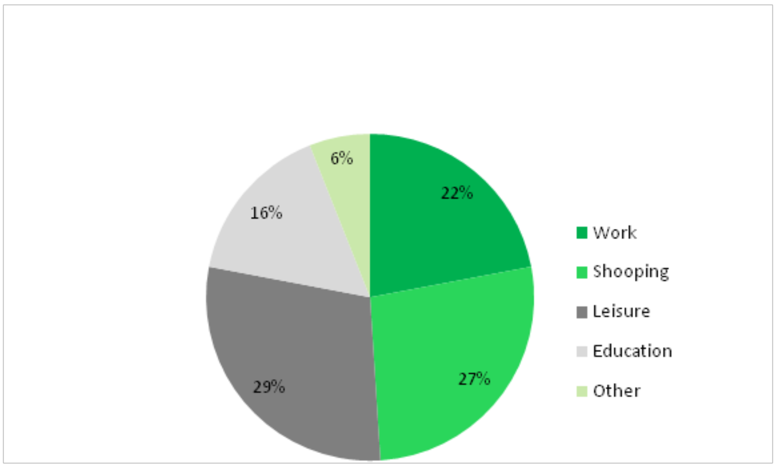


Figure 22: Purpose of Trips, Berlin

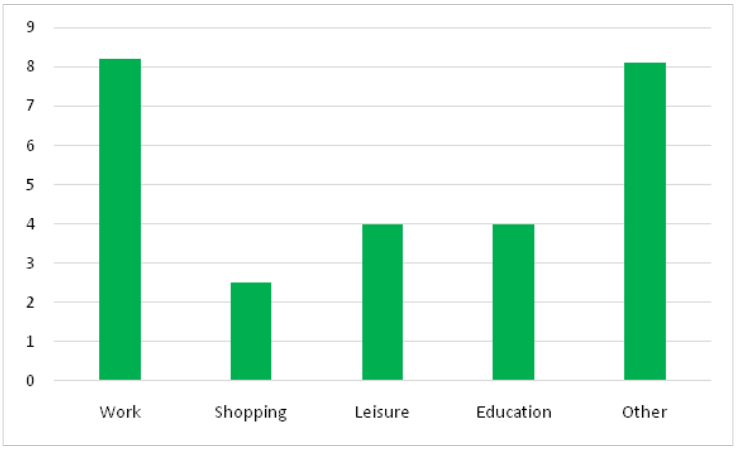


Figure 23: Average Distance of Trips, Berlin

5.2.4 L-V/EL-V Use

Berlin is one of the leading cities in Europe regarding the sharing offers for EL-Vs, but also for vehicles in general. Besides the big car sharing companies like car2go and DriveNow, there are also companies specialized on EL-Vs[36]. These include Coup and Emmy, both of which offer electric scooters. Coup supplies about 1,000 scooters and is a daughter company of Bosch. Emmy is a Berlin start-up and supplies about 800 scooters[37].

The parcel delivery service DHL, a subsidiary of the German Post Office, uses 600 e-bikes and 232 e-trikes in Berlin. The vehicles are manufactured by Streetscooter, which was also taken over by the German post office[38] in 2014.

Additionally, there are more than 100,000 e-bikes in the city, but through a lack of registration, it is not possible to say, how many of them are classified as L-vehicles[39].

5.3 Genoa

5.3.1 General City Characteristics

The city of Genoa lies in a narrow area between the Apennines Mountains and the Ligurian Sea, along a seaside of about 40 km from the West (Voltri/Crevari) and the East part (Nervi/Capolungo) and two main valley expansions in Bisagno and Polcevera valleys.

The territory of the Genoa Municipality is completely characterized by hills and just narrow alluvial flats along the main rivers/brooks, and it is considered by ISTAT (the Italian National Institute of Statistics) as "coastal mountains". Similar situation characterizes the entire Liguria Region, which is completely hilly (34.9%) and mountainous (65.1%).

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[36]Source: https://www.tagesspiegel.de/wirtschaft/carsharing-in-berlin-auf-kurzen-strecken-flexibel-und-teuer/20519084.html [Accessed 20 December 2020].
[37]Source: http://getmobility.de/20170322-coup-vervielfacht-seine-gogoro-flotte-berlin/ [Accessed 20 December 2020].
[38]Source: https://ecomento.de/2017/06/30/elektro-post-streetscooter-jetzt-auch-in-berlin-unterwegs/ [Accessed 20 December 2020].
[39]Source: https://www.bz-berlin.de/berlin/immer-mehr-berliner-e-biken-durch-die-hauptstadt [Accessed 20 December 2020].

The entire Municipality has got 583,601 inhabitants[40] with a density of about 2,431 inhabitants per km^2 and it is the sixth biggest city in terms of population in Italy. Its territory has an extension of ~240 km^2, of which ~40% is covered by built-up territories. About 50% of the urban population is concentrated in the central part of the city and in its historical centre, where there is the highest density of population.

Furthermore, Genoa is the capital of Città Metropolitana, the former Province, with 850,071 inhabitants and an extension of 1,839 km^2 [41].

Although the activities linked with the port, one of the largest in Italy for goods moved (~51 million tonnes[42] in the year 2016), and its good position for Padana Valley and the larger urban areas of Milan and Turin, the city of Genoa and its Province in the last 25 years has been characterized by a decrease of population. The demographic trend of Genoa is also characterised by an increasing share of elderly people (over 65), 28.4% of the total population of the Municipality[43].

About 90.4% of the population is of Italian descent. The largest nationality group of not Italian-origin people come from Ecuador (~14,000 people). In total, the immigrants, in 2016, are 55.071 people[44].

Table 24 synthesises the main data about the demographic characteristics in Genoa.

Table 24: Demographic Characteristics in Genoa

Characteristics	Genoa Metropolitan N =850,071		Genoa City N=583,601	
	n	%	n	%
Population				
Male	403,271	47	275,090	47
Female	446,800	53	308,511	53
Age Group				
<18	117,542	14	80,722	14
18 - 65	500,803	59	344,042	59
>65	231,726	27	158,837	27
Education				
<=High School	707,329	83	477,110	82
>=College	113,030	13	85,340	15
Employment				
Employment	~325,000	63	~235,000	64
Unemployment	~190,900	37	~132,200	36
Nationality				
Italian			528,530	91
Other European Countries			16,133	6
Non-European Countries			34,599	3
Not defined			4,339	1

[40] Source: ISTAT (1/1/2017), https://www.istat.it/en/ [Accessed 20 December 2019].
[41] Source: ISTAT (2017) https://www.istat.it/en/ [Accessed 20 December 2019].
[42] Source: "Relazione annuale 2016 Porto di Genova", Ports of Genoa.
[43] Source: ISTAT (1/1/2017), https://www.istat.it/en/ [Accessed 20 December 2019].
[44] Source: Municipality of Genoa, Statistics Department (2016).

Regarding the climate, Genoa has a Mediterranean climate and the thermal excursions are contained by the mitigating marine action. August is the hottest month in Genoa with a range of daytime temperature between 23 and 28°C and the coldest[45] is January at 5-10°C.The rains are concentrated in the autumn months, October in particular, with an average of 160mm of rain[46].

Regarding the pollution and air quality, for each of the 11 air quality monitoring stations managed by ARPA Liguria (Regional Agency for Prevention and Environmental Protection) in Genoa, in the year 2016 the most frequent events in which the emissions exceed the threshold concern Ozone (O_3) during the summer months (hourly and 8-hour moving average).

Another measure for **air quality** has been obtained from WeatherBug, a website that combines from data including governmental monitoring stations, satellites, traffic conditions, and air dispersion models. The data given is collected in real time, which means that actual values will fluctuate depending on environmental conditions throughout the day. The overall air pollution level is considered Fair at 40 units on the AQI scale, taking both concentration and time into account as a measure of the dosage. Main pollutants include PM2.5 (24.7μg/m^3), PM10 (24.9μg/m^3), O_3 (42.6ppb), NO_2 (3.29pb), SO_2 (1.23ppb) and CO (151ppb). As can be seen from the data, the partial pressure of CO is significantly higher than that of the other gaseous pollutants, suggesting that CO is one of the main contributors to low air quality.

5.3.2 Transport Characteristics

Genoa is among the "greenest" cities in Italy, with an average of about 48 cars per 100 inhabitants. The city is also characterized by a good Public Transport (PT) demand (250 passengers per inhabitant), being the 6th city in which buses and underground are most used[47].

Analysing the modal share in Genoa (Figure 24), by taking into consideration the total of the daily trips in the Municipality, the satisfying level of the PT use is quite clear. In this light, the public transport system (bus/underground + train) is used for ~27% of the trips but the private car is still prevalent, for ~37% of the trips.

Only 0.1% (~1,000) of the total of the daily trips in Genoa are carried out by bicycle. When used, the bike appears more useful for getting to work (~250 daily trips of the bike trips) and for occasional purposes (~170). This low bike modal share can be justified by the geographic situation of the city (hilly and often narrow streets) and the absence of cycle paths.

[45] ARPAL (Agenzia Regionale per la Protezione dell'Ambiente Ligure).
[46] Source: www.holiday-weather.com/genoa/averages [Accessed 20 December 2019].
[47] Source: Euromobility on data ISTAT (2013).

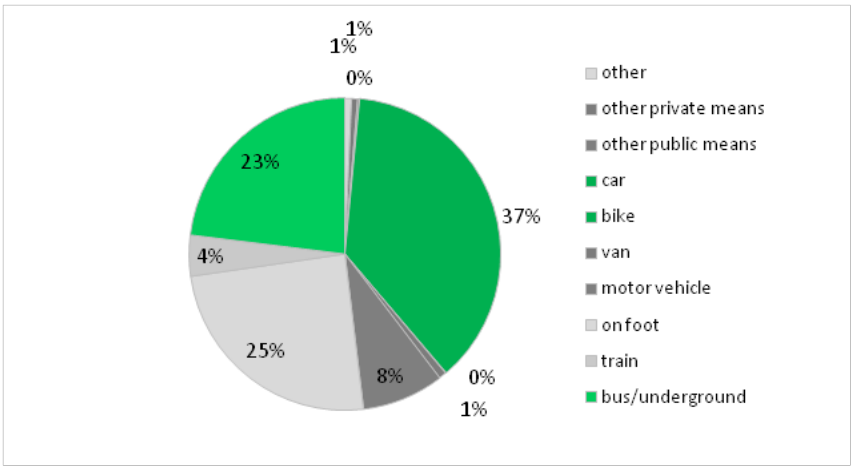

Figure 24: Modal share in Genoa

The total vehicle fleet in Genoa consists of ~429,400 vehicles[48] (including cars, buses, motorcycles, trucks) of which 61% cars and 31% motorcycles. According to the 2014 data, in Genoa 17 e-cars are circulating.

Furthermore, Genoa is the largest city in Italy with the highest use of motorcycles (23.7 vehicles/100 inhabitants, while the Italian average[49] is 14 and the EU one is still much lower and equal to 6.9).

Regarding motorcycle fleet, the preponderant share concerns petrol vehicles (~92%) and then "other and not defined types" (~8%) follows, while the rate of the electric ones is less than 0.1%. According to the Italian Driver & Vehicle Licensing Agency (end of 2014 data), the total number of e-motorcycles in Genoa is equal to 48, now increased to ~100, thanks to the initiatives, activities and facilitations carried out (e.g. ZTL access and new charging points).

The analysis of the traffic volume monitored in 15 urban sections in Genoa, of which 13 two-way, points out the higher level of vehicle traffic is located in the main access points from/to West and East and the centre of Genoa. The daily vehicle flow per direction of the 6 most important sections is between ~800 and ~1,150.

In the territory of Genoa, the complex PT network (managed by the public company named AMT-Azienda Mobilità e Trasporti) allows citizens and tourists to move using trolley and traditional buses, horizontal and vertical public lifts, cable ways, cog and traditional railways and small buses for peripheral areas.

The bus network covers the entire built-up area in the Municipality including the hilly districts, with more than 900 km of lines (Table 25).

On the other hand, the underground line is quite short, ~7 km, connecting the central part of the city.

All the main lines along the most important routes have a high frequency (every 5 and 10 minutes) during the daytime of a working day. Other lines, e.g. for hilly and peripheral areas, have lower frequency in consideration of the specific demand needs to satisfy.

The customer satisfaction survey[50] of the year 2014 pointed out an adequate appraisal of the users, by achieving a global rating of 6.2/10. It is obvious there are a significant improvement to be done, mainly

[48] Including cars, buses, motorcycles, trucks.
[49] Source: Euromobility on data ACI and ISTAT (2012).
[50] Source: AMT (Azienda Mobilità e Trasporti).

on specific issues, such as the average age and crowding of the vehicles and the lack of more improved systems like tramways, light-rail, and a wider trolleybus network.

The main characteristics of the urban Public Transport in Genoa are synthesised in the following table.

Table 25: Genoa Public Transport characteristics

Transit	Bus	Trolley bus	Metro	Ferryboat	Cableway -lift	Cog railway
network length(km)	925.4	14.3	7.2	12	2.5	1.1
Lines	155*	1	1	1	14	1
Vehicles	701		21			2
No. of lines with frequency (morning rush hour)						
<5min	4	1				
between 5-10min	29		1			
between 10-35min	51					
>35min	8					1
without a fixed frequency				1	15	
Average waiting time(min)	8.8	5	3.7	n.a	n.a	n.a
Single ticket cost for an average journey in the city (€)	1.50	1.50	1.50	3.00 / 1.60 (only for residents)	1.50 / 0.90 (single journey on lifts)	1.50
Monthly ticket cost for unlimited travel within the city(€)	46.00					
* Including the so-called "servizi integrativi" in low-demand areas						

The current system of fee parking in Genoa includes 21,357 parking places charged for or need permit for. In the fee parking system, the parking of vehicles for residents is not expensive thanks to the possibility of annual or temporary flat-rate subscription that allow discounted rates in the relevance areas of residence.

In Genoa there are 17 public charging locations for EVs and each location includes two or more charging points. In addition, there are some private e-charging points in the city of Genoa (e.g. IKEA parking area).

Within the City, specific restrictions about the access to the city centre exist ("ZTL-Zona a traffico limitato" in Italian, Limited Traffic Zones" in English) and they have been defined by 5 Sectors and 11 Gates. The access and the transit in the LZT can be undergone to a fee.

In Genoa also more ZSL-"Zona Sosta Limitata" (Restricted Parking Zones) are located in the city centre. They are parking areas reserved for private vehicles of residents.

The Genoa Municipality has activated economic incentives for the purchase of bicycles and/or electric motorcycles. Adult citizens residing in the Municipality of Genoa may be beneficiaries of the incentives from 15 December 2017 to 31 May 2018. They can get € 400 for the purchase of an electric bike (500 in the case has an old scrap) and € 800 for the purchase of an electric motorcycle (€ 1000 in case there is an old bike to be scrapped). Private companies, including vehicle dealers, are excluded from the contribution.

In the Municipality area, there are the following incentives for electric or hybrid vehicles:

- they do not pay ownership tax (since 2016);
- they can access restricted traffic areas;
- they can park for free in the "blue areas".

5.3.3 Travel Characteristics

The mobility of the city of Genoa is characterised by 1,679,059 daily trips[51]. In terms of systematic trip (home based for work/school), the inhabitants of the city of Genoa create about 335,000 day trips (~21% of the total) (Figure 25).

In Genoa context there is a good level of public transport use, with a modal share of 27% (bus/underground + urban train), which reaches 40% for particular purposes, such as "study" [52] (Figure 25).

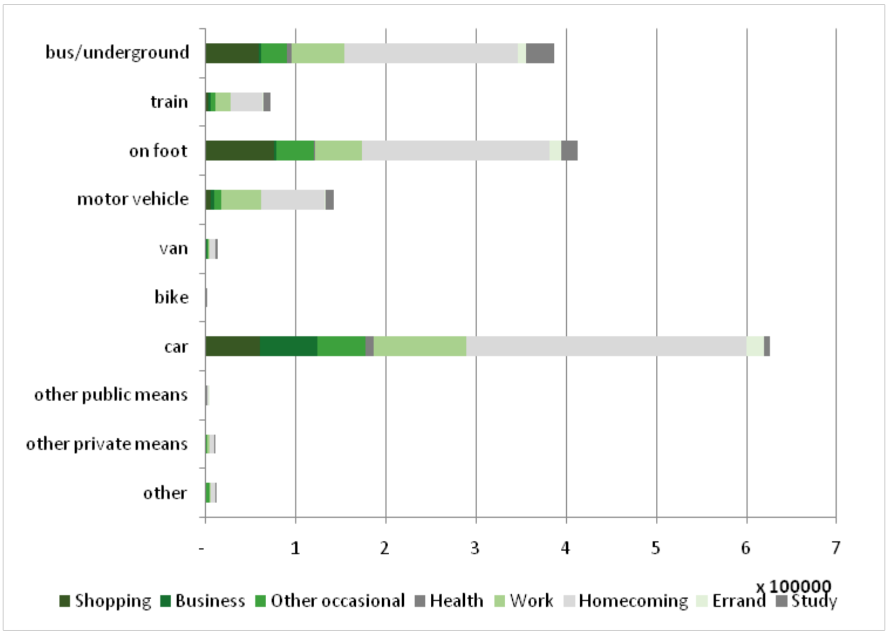

Figure 25: Number of daily trips in Genoa per transport means and purpose[53]

5.3.4 L-V/EL-V Use

Nowadays, there is not a specific scheme for EL-Vs in urban areas, except for restrictions for traditional motor-vehicles, in according to which motor vehicles and mopeds cannot access some areas and streets in the city. On the contrary, more rules have been identified for goods delivery in each Limited Traffic Zone. In general, there are perimeter parking areas dedicated to goods vehicles and internal parking areas accessible only in permitted window frames, generally early morning for food and morning for the remaining goods categories.

[51] Source: OD Matrix 2016 Municipality of Genoa.
[52] Source: OD Matrix, Municipality of Genoa, Mobility Department (2016).
[53] Source: OD Matrix, Municipality of Genoa, Mobility Department (2016).

Car sharing in Genoa provides about 60 cars with ~2500 service members and is managed by ACI (Italian Car Club) and 50 parking areas dedicated to car sharing (Table 26).

Table 26: Genoa EVs mobility characteristics

Charging points (No.)						
No. of public charging points	17					
No. of public charging locations	17					
No. of charging points per location	1					
No. of parking places reserved	n.a.					
Incentives Scheme(Y/N)						
Economic incentives	Y					
Ownership tax	Y					
Access in restricted areas	Y					
Infrastructure plan	n.a.					
Economic incentives	Y					
Number of L-Vs/EL_Vs(No.)						
Type of Vehicles	**L-Vs**			**EL-Vs**		
	Two-wheeler	Three-wheeler	Four-wheeler	Two-wheeler	Three-wheeler	Four-wheeler
Number of Vehicles	139,070*		816	48*		29
Sharing scheme (No.)						
Number of sharing scheme	0	0	0	0	0	0
Number of pick-up points in city	0	0	0	0	0	0

* The total amount of "motorcycles". Source of the data: Italian Driver & Vehicle Licensing Agency (31/12/2014)
Brief comments: nowadays in Genoa there is not an existing sharing service for light-vehicles, in spite of more ELVsellers and providers.

As for L-V sharing usage, currently there is no scooter-sharing (two-wheelers vehicles) company, but the IEE Ele.C.Tra. project (coordinated by the Municipality), finished at the end of 2015 and involved 47 business operators operating in Liguria and in Italy in the field of e-vehicle market (not only sharing), and 5 of them have already signed Memorandum of understandings.

Traditional bicycle sharing is operating in Genoa, called MOBIKE, and it is managed by Genovaparcheggi (entirely owned by the Municipality of Genoa,). The service provides 104 parking places located near the main points of interest, where anyone can rent bicycles through an electronic card.

5.4 Málaga

5.4.1 General City Characteristics

Málaga is the capital of the Province of Málaga, in the Autonomous Community of Andalusia, Spain. With an estimated **population** of 570,006 inhabitants in 2017, it is the second-most populous city of Andalusia and the sixth largest in Spain. The city extends mainly over a flat land.

The most important business sectors in Málaga are tourism, construction and technology services. Moreover, Málaga is the main economic and financial centre of southern Spain and the fourth-ranking city in economic activity in Spain behind Madrid, Barcelona and Valencia.

The **employment ratio** (persons in employment with age between 15 and 65 years) is equal to 42%, for the city, which corresponds to 243,600 people.

92.23% of the population is Spanish. The immigrant groups come from other European countries (1.90%), especially from Great Britain and Germany, and 5.87 % from not European countries.

Regarding the **climate**, Málaga has a subtropical-Mediterranean climate and experiences the warmest winters of any European city with a population over 500,000. The average temperature during the day in the period December-February is 17–18 °C. Generally, the summer season lasts about eight months, from April to November (>24 °C, and in particular from 26 to 34 °C during the day in August).

Air quality data in Málaga has been obtained from WeatherBug, a website that combines from data including governmental monitoring stations, satellites, traffic conditions, and air dispersion models. The data given is collected in real time, which means that actual values will fluctuate depending on environmental conditions throughout the day. The overall air pollution level is considered Fair at 28 units on the AQI scale, taking both concentration and time into account as a measure of the dosage. Main pollutants include PM2.5 (10.4$\mu g/m^3$), PM10 (21.8.1$\mu g/m^3$), O_3 (34.9ppb), NO_2 (19.3ppb), SO_2 (2.07ppb) and CO (470ppb). As can be seen from the data, the partial pressure of CO is significantly higher than that of the other gaseous pollutants, suggesting that CO is one of the main contributors to low air quality.

5.4.2 Transport Characteristics

The infrastructural road network in Málaga is composed mainly of local streets (267 km). The City also has peripheral motorways in order to facilitate the traffic flows from and to external areas.

The total vehicle fleet in Málaga consists of 347,347 vehicles, of which 67.42% concerns cars (mainly unleaded petrol and diesel). Green fleets in 2017 include 1,286 hybrid and 86 electric vehicles (Table 27).

Table 27: Vehicle fleet in Málaga[54]

	Cars	Motorcycles	Trucks & vans	Buses	Other vehicles	Total
n	234,168	51,859	53,387	1,783	6,150	347,347
%	67.42%	14.93%	15.37%	0.51%	1.77%	100.00%

The EMT (*Empresa Malagueña de Transportes),* is the transport operator that operates the urban public bus network in the city of Málaga. The main lines along the most important routes have high frequency (5 and 10 minutes) during a working day (Table 28).

The City is also served by two underground lines and a commuter train linking the coast to the city centre to Fuengirola (located 40 km away). The railway stations María Zambrano and Málaga-Centro-Alameda station have the public bicycle service Málaga Bici.

[54] Source: https://www.dgt.es/menusecundario/dgt-en-cifras/ [Accessed 20 December 2019].

Table 28: Main characteristics of the PT network in Málaga[55]

Transit	Bus	Commuter train	Metro
Network length (km)	386.5	66	11,3
Lines (Day/ Night)	43/3	2	2
Vehicles	258	6	8
No. of lines with frequency <5min	0	0	0
No. of lines with frequency between 5-10min	40	0	2
No. of lines with frequency between 10-35min	3	2 (20min)	0
No. of lines with frequency >35min	3	0	0
No. of lines without a fixed frequency	0	0	0
Average peak time frequency (min) on weekday	5	10	5/10
Average waiting time(min)	5	5/10	5/10
Single ticket cost	1.30 €	1.80 €	1.35 €
Monthly ticket cost for unlimited urban travel	1.10 €	47.85 €	47.85 €
Kilometres travelled per year	11 M	N/A	N/A
Travellers transported per year	44,558,475	10,141,000	5,000,000
Number of workers	907	46	81

In 2014, the estimated average number of trips made inside the city during a working day was equal to 1.38 million. The modal split is dominated by walking (48.3%), followed by car (30.7%) which remains the first choice among motorized modes (Figure 26: Modal split in Málaga).

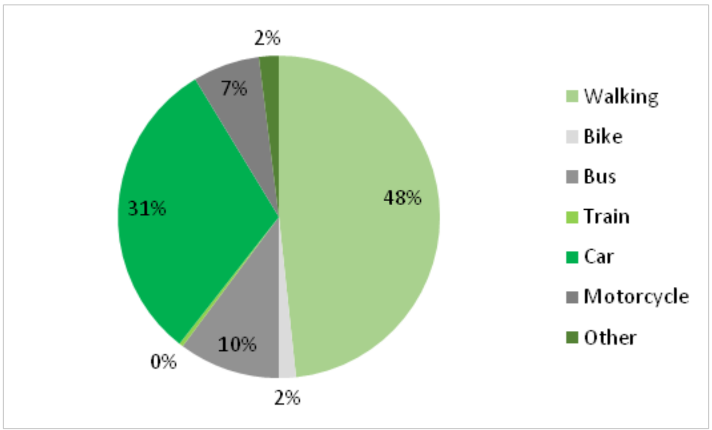

Figure 26: Modal split in Málaga [56]

[55] Source: http://www.emtmalaga.es; http://www.renfe.com; https://metromalaga.es [Accessed 20 December 2019].
[56] Source: 'Estudio de demanda de movilidad en la ciudad de Málaga' (2014), https://www.omau-malaga.com [Accessed 20 December 2019].

The pedestrian mobility is fostered by the good weather, the impacts of the economic crisis and the progressive pedestrianisation of the historical centre, the main attractor in the city.

Compared to 2008, walking and bikes in 2014 present an increase of 2.3% and 1.3% respectively. In particular, the bicycle shows a significant relative growth, increasing its share from 0.4% to 1.7%. The main cause of this growth has been the increase of the mobility supply based on:

- New bike lanes (35 km approximately);
- Implementation of the system of the public pickup points (22 stations with 400 bicycles), managed by the bus company;
- New bicycle racks (900 seats).
- New projects, among which Málaga Bici that provides access to the bicycle pickup points for users having a bus annual ticket.

For the public bus mode, only the urban service (which accounts for around 44-46 million trips/year) increased its shares, both in relation to the global modal split (+0.6%) and in relation to the only motorized mobility (+2.4%). It has been affected by investments like increase of bus lanes and deployment of real information panels in stops. The interurban bus, instead, presents a 0.1% decrease.

Finally, train and motorcycle are characterised by a modal share increase (respectively 0.2% and 0.5%), while taxi share results unchanged.

About regulations to access the city centre, size and weight restrictions are applied.

The municipal company of Parking and Services, S.A. currently has twelve underground parking facilities, for a total offer of 6,760 parking spaces, of which 16 with e-charging points. Moreover, there is a parking regulation system called S.A.R.E which was implemented in 1987 in order to limit the maximum parking time in areas with high demand. In addition to the regular parking places, the S.A.R.E. offers 2,296 extra parking places, with a total of 3,155,232 users in 2016. Downtown parking costs 1,5 € for 1 hour 6 € for 4 hours. Electrical vehicles are allowed to park in S.A.R.E spaces free of charge and without a time limit, as a local measure to boost the purchase and use of these vehicles. Moreover, in order to facilitate inter-modality, the parking company has also deployed 40 parking spaces for bicycles as part of a project demonstrator.

Among the main policies pursued by the Administration to make the transport system more sustainable the following can be cited:

- fostering the electric vehicle use;
- strengthening the use of low-emission mopeds and motorcycles, paying attention to e-mobility.
- promotion of the use of bicycles by extending the network of bike lanes and public bicycle stations, supplying an environmental and cheaper service.

5.4.3 Travel Characteristics

The number of urban trips in Málaga during a working day is 1,380,984. Table 29 reports a description of them by mode, both in terms of average distance and duration.

Table 29: Average trip characteristics in Málaga[57]

	Minutes	Km
Walking	20.70	0.90
Car	23.40	8.50
Motorcycle	17.00	4.60
Public transport	45.40	10.00

About purposes, systematic journeys for work and study account for 64% of the total; in particular, 39% of trips are work-related and 25% are study-related.

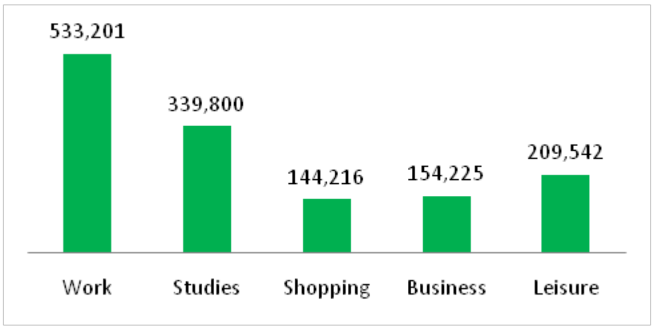

Figure 27: Trips in a working day, Málaga

Considering the mode used per single purpose, it can be observed that car is the first choice for work-related trips, while walking is the most preferred option for the other ones (Figure 27).

Regarding systematic mobility ("work" and "study" purposes) only, 69% of the total of the daily trips to get to working places concern the use of private motorized vehicles, with an average travel time of 22 minutes. Instead, more than half of the trips for study purposes are carried out exclusively on foot; in particular, 14% of trips have duration of less than 5 minutes while around 47% of trips have duration of longer than 5 minutes.

Approximately 83% of the population makes at least one trip per working day. The average number of trips per day is 2.4 and, considering only active people, the average is 3.3. The number of trips decreases on weekends, falling to 72% of the population. In each day of the weekend 2 trips are made per person, which is 25% less than a working day. The average for active people is 2.9 trips, which is similar to the number of trips per working day (Figure 28).

[57] Source: https://www.mapa.gob.es/es/ [Accessed 20 December 2019].

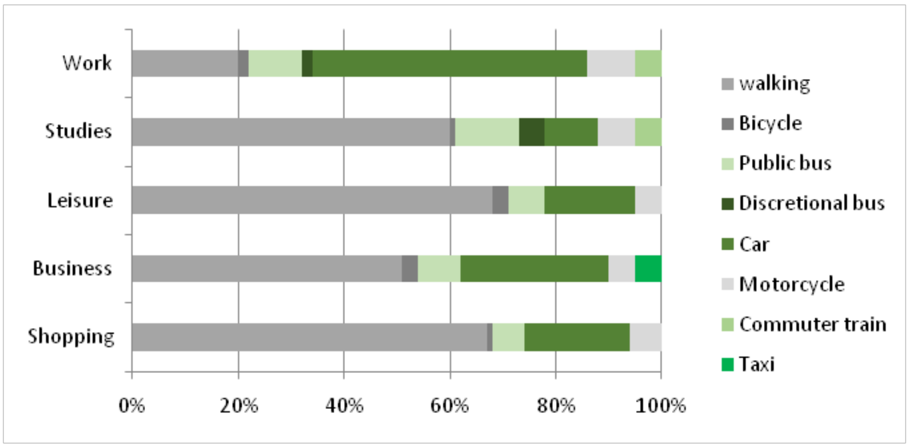

Figure 28: Transport means used per purpose, Málaga

5.4.4 L-V/EL-V Use

In 2017, there were 1,286 hybrid and 86 electric vehicles circulating in Málaga.

There are 29 public charging points for EL-Vs located in Málaga and other in near towns (Torremolinos, Fuengirola, Marbella and Benahavís), for a total of 71 points[58]. In particular, two different types of charging point have been implemented:

- Regular charging units which deliver a full charge in eight hours;
- Fast charging units which deliver up to 80% of the charge in 30 min or less.

Besides, the parking company provides a total of 14 charging points inside the public parking spaces at a rate of 0.30€/Kw.

Spain adopted MOVALT PLAN which is an incentive scheme for the purchase of alternative vehicles. The Plan has a budget of € 20 million and it is estimated that during its life (12/2017 -6/2018) 5,600 vehicles will be acquired. The incentive amount varies between € 500 and € 18,000 for the acquisition of new (or less than nine months old) vehicles powered by autogas (LPG), natural gas (CNG, LNG), gasoline-gas, biofuel, electricity (BEV, REEV, PHEV), as well as by fuel cell.

The pioneering international electric vehicle pilot project ZEM2All (Zero Emissions Mobility to All), involving Japanese and Spanish Governments, Mitsubishi, Hitachi, Endesa, Telefonica and Ayesa with 200 electric vehicles and 220 interconnected charging points, was developed in Málaga from 2012 to 2015. Its mission was to understand the impacts of electric mobility in Smart Cities using electric vehicles (EV), their recharging and the services that may be offered. In Málaga the project provided 7 quick recharging stations for 21 vehicles, as well as 6 charging stations with V2G (vehicle to grid) technology, in order to return the EV power to the electrical grid.

The City of Málaga promoted the following main incentives:

- Use of 45 EV for the car fleet of the City Hall;
- 75 % reduction of motor vehicles tax for EVs;
- Access to LTZ for EVs;
- 10% discount for EVs in the blue parking zone and in short-stay areas (45 min. free);

[58] Source: https://www.electromaps.com/en [Accessed 20 December 2019].

- Deployment of exclusive parking spaces for electric vehicles in public streets;
- Coordination with the Municipalities of Fuengirola and Marbella (through signed agreements).

5.5 Rome

5.5.1 General City Characteristics

Rome is the Capital of Italy located in Lazio Region. The City extends in the middle of a flat land and is spread along the two banks of Tiber River. Its territory has an extension of 1,285 km^2 while its metropolitan area is spread over 5,352 km^2. The City is administrated through 15 Districts. District IX (Figure 29), south located, which hosted the ELVITEN demonstration, extends over 183 km^2.

Around 64% of the territory of the city is hilly (41% slightly hilly and 23% very hilly); in particular, for District IX this percentage rises to 70% (40% slightly hilly and 30% very hilly). Green areas are predominant and cover around 68% of the city territory.

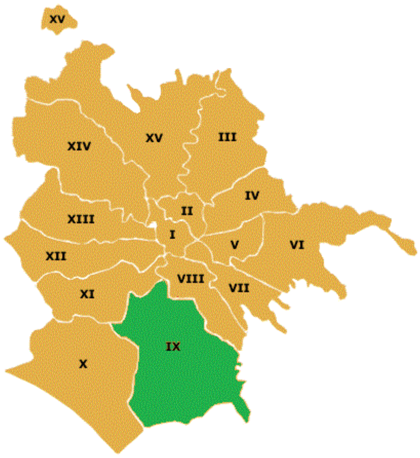

Figure 29: Rome Districts

With a population of 2,873,494 people in 2017 (47% male and 53% female) as shown in Table 30, Rome is the most populated Italian City[59]. Its metropolitan area and District IX account respectively for around 4,340,900 people and 182,000 people. The city inhabitants are mostly concentrated in the age group 45-59 (24%). 57% of the population falls in the category 25-65 years old (the range the EL-Vs users mainly fall in, according to literature).

Founded the 21 April 753 BC, Rome possesses a huge historical, cultural and archaeological heritage, The city is the most visited in Italy with around 20 million tourists hosted in the accommodation facilities each year.

The number of persons in employment in the city is around 1,210,000 (42% of the entire population), with a contribution by District IX of 108,000 persons (59% of the entire population). The unemployment rate, calculated at level of metropolitan area, in 2015 amounts to 10.7%[60].

[59] Source: ISTAT, https://www.istat.it/en/ [Accessed 20 December 2019].
[60] Source: Rome Capital Statistical Bureau (ISTAT data).

The percentage of residents with a 'third level'[61] education degree is around 20% of the global City population older than 6 years. Among them, 22% possess a higher-level degree (4% over the entire population).

Most people living in the City are Italian, followed by persons coming from countries outside EU and from other EU countries to a lesser extent[62].

Table 30: Demographic characteristics in Rome

Characteristics	n	%
Population		
Total	2,873,494	
Male	1,362,384	47%
Female	1,511,110	53%
Age Group		
0-14	385,056	13%
15-29	400,564	14%
30-44	596,823	21%
45-59	690,166	24%
60-74	468,915	16%
>74	331,970	12%
Education		
Third level education degree	500,515	20%
Higher level degree	109,778	22%
Employment		
Employment rate	1,210,000	42%
Nationality		
Italian	2.496.277	87%
Other EU countries	125.801	4%
Non-EU countries	251.416	9%

The climate of Rome is mild with hot summer and mild and rainy winter. The hottest period of year is July-August when respectively an average daytime temperature of 26° C and 24° C is reached. Instead in January, the coldest month of year, an average daytime temperature of 8° C is registered. The wettest period for the city is October-November, with 24 average days of rain, while the driest is July with 10 average days of rain[63] (Figure 30).

In the following table (Table 31) an estimation of pollutant emissions in the City in 2015 is reported. The contributions are from cars, followed by commercial vehicles and motorcycles.

Air quality data in Rome has been obtained from WeatherBug, a website that combines from data including governmental monitoring stations, satellites, traffic conditions, and air dispersion models. The data given is collected in real time, which means that actual values will fluctuate depending on

[61] Source: Elaboration of ISTAT data (2011) - According to the ISTAT classification it is the highest level of education and includes: university degree, and non-university degree (e.g. art academies qualifications).
[62] Source: Elaboration of ISTAT data.
[63] Source: www.ilmeteo.it [Accessed 20 December 2019].

environmental conditions throughout the day. The overall air pollution level is considered Fair at 36 units on the AQI scale, taking both concentration and time into account as a measure of the dosage. Main pollutants include PM2.5 (22.1μg/m^3), PM10 (20.7μg/m^3), O_3 (29.6ppb), NO_2 (33.7ppb), SO_2 (0.54ppb) and CO (213ppb). As can be seen from the data, the partial pressure of CO is significantly higher than that of the other gaseous pollutants, suggesting that CO is one of the main contributors to low air quality.

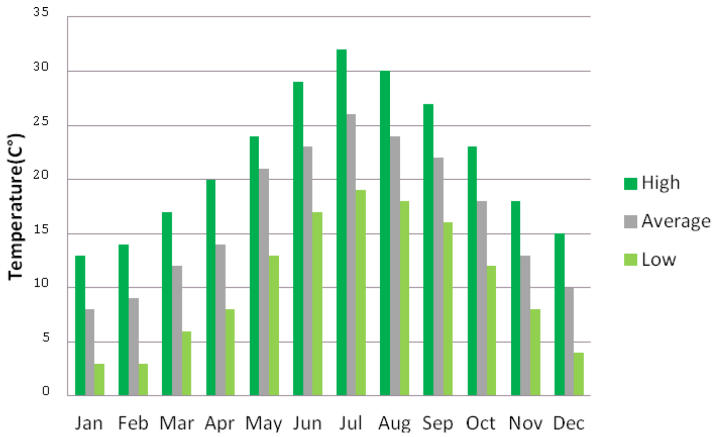

Figure 30: Monthly Average/low/high temperature in Rome city[64]

Table 31: Pollutant emissions in Rome (2015) [65]

	Emissions (tonnes/year)	Emissions density (tonnes/year)/ Km^2
CO	73,498	57.2
NOx	13,781	10.7
NMVOC	11,150	8.7
PM10	912	0.7
CO2	4,343,344	3,380

5.5.2 Transport Characteristics

The city has a road network of 8,000 km, divided into motorways/expressways (117 km), main roads or class 1 roads (60 km), other local roads/streets (7.823 km). The extension of the reserved bus lanes in the road network is 112 km, while the roads in which bicycles are allowed account for 240 km. As reserved cycling infrastructures in the city, there are 112 km of green bike paths and 128 km of other bikes paths.

The public transport network is composed by 2,298 km of urban bus lines, 207 km of railways (urban and regional for the part inside the city), 58 km of metro infrastructure and 31 km of tram infrastructure.

The free parking places for interchange between private and public transport are globally 23,251. Instead, for private transport, there are less than 40 toll places per thousand cars circulating[66].

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[64] Source: https://www.holiday-weather.com/rome/averages/ [Accessed 20 December 2019].
[65] Source: Roma Servizi per la Mobilità S.r.l.
[66] Source: ISTAT (2011).

Public transport is managed by ATAC S.p.A which operates metro, urban railway, tram and bus lines. Around 20% of the urban bus lines (peripheral) are managed by Roma TPL s.c.a.r.l. Interurban bus lines are instead managed by Cotral S.p.A. Regional railway lines are managed by Trenitalia S.p.A.

In 2015, the average daily number of trips in the City was equal to 6.4 million. The modal split during the morning peak hour (07:45-08:45) is characterised by a huge percentage of transport by car or van (49.3%), followed by public transport (29.6%), motorcycle (15.6%) and a 5.5% of soft modes (walking, cycling, with this latter being around 1%) as it can be seen in Figure 31. Around 168,000 trips are globally made by public transport with an average length of 11.4 km. Trips by private transport are instead 370,00, with an average length of 13.3 km. Public Transport performs poorly compared to private transport, being characterised by lower commercial speed (see Table 32). Furthermore, during the entire day, the share of public transport drops to 22%. The average waiting time at bus stop during weekdays is 32 minutes, while the frequency of metro and tram is respectively between 7-10 and 5-15 minutes.

Congestion in the city network, on average, causes 40% of extra time compared to a free-flow condition[67], which means 42 minutes extra per day and 163 hours extra per year. During morning and evening peaks, the increase is respectively of 74% and 68%. The low average car occupancy, which in 2017 is equal to 1.37, contributes to the phenomenon[68].

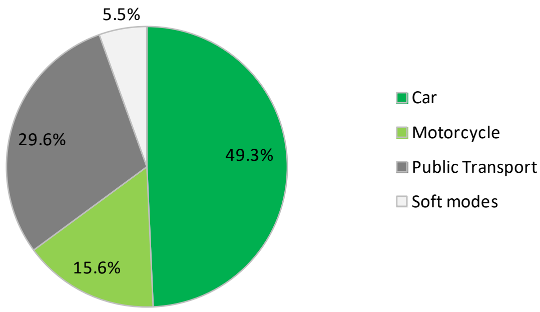


Figure 31: Overall modal split (%) in Rome

Table 32: Characteristics of trips in private and public transport, Rome

	Public Transport	Private Transport
Average length of trip (km)	11.4	13.3
Average travel time (min)	48.9	44.6
Average speed (km/h)	14.0	17.8
Number of trips	168,352	369,594

The private vehicle fleet circulating in the City is substantially composed by traditional vehicles, with predominance of cars. In 2014, cars accounted for 72%, with predominance of gasoline vehicle (56%), followed by diesel and LPG vehicles (respectively 38% and 5%)[69]. Motorcycles accounted for 21% and are entirely gasoline powered. Finally, light commercial vehicles accounted for 6% (81% diesel-

[67] Source: Tomtom (2016).
[68] Source: Fondazione Caracciolo (2017).
[69] Source: ACI (Automobile Club d'Italia).

powered and 19% gasoline-powered) and heavy commercial vehicle for 1% (98% diesel-powered and 2% gasoline-powered).

Regarding travel costs, a local public transport single ticket is €1.50, while the monthly ticket allowing unlimited travel within the city is €35 for resident and €53 for not resident people. About private transport, the average cost for on-street parking and off-street public parking is 1 €/h.

From Monday to Friday, except for midweek non-working days, the following vehicles are not allowed to enter the Green Zone (Fascia Verde) in the city centre: Euro 0 vehicles (petrol and diesel), Euro 1 vehicles (petrol and diesel), Euro 2 vehicles (diesel). The 4 Limited Traffic Zones (LTZ) of the city (Historical Centre, Testaccio, Trastevere, San Lorenzo), are instead accessible only through a permit and the cost varies depending on the proximity of the area to the city centre. Moreover, the cost also depends on the type of engine for car/motorcycle: petrol or diesel (higher cost), Gpl or electric (lower cost).

A car sharing service is provided by 4 companies (Car Sharing Roma, Car2Go, Enjoy, Share'n go) which deploy a vehicle fleet of 2,035 cars, both in 'free-flow' and fixed-point scheme. Two companies (Ecooltra and ZigZag) offer 'free-flow' scooter-sharing service for a global fleet of 401 vehicles. Finally, a 'free-flow' bike sharing service is provided by GoBeeBike (1,800 bikes).

5.5.3 Travel Characteristics

Focusing on systematic trips made by resident population, 1,340,818 persons travel daily for work and study purposes[70]. In particular, 897,331 people travel to reach the workplace (67% of the total) while 443,487 travel to reach the study place (33%) as it is shown in Figure 32.

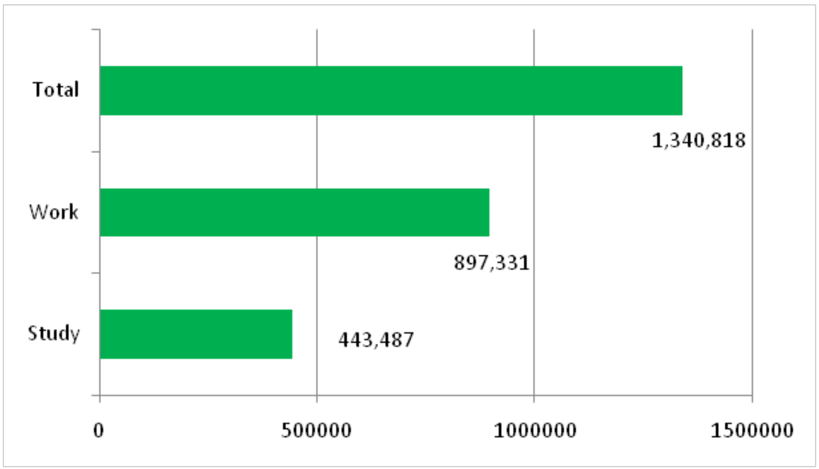


Figure 32: Systematic trips (number persons travelling per purpose), Rome

5.5.4 L-V/ EL-V Use

Two companies offer scooter-sharing service in Rome in 'free-flow' scheme: Ecooltra and ZigZag. The global fleet is composed by 401 vehicles and 241 of them (provided by Ecooltra) are electric and directly recharged by the company (Table 33).

[70] Source: ISTAT (2011).

Bike sharing is provided by GoBeeBike, which started operating since mid-December 2017, with 1800 vehicles (not electric) in 'free-flow' scheme deployed in District I (historical centre) and District IX. Service will be expanded in 2018 in other Rome Districts.

About electric car sharing, instead, 518 electric vehicles are deployed by Share'n go.

Table 33: Type and number of L-V/EL-VS in sharing in Rome

Vehicle Sharing	Number of Vehicles
Bicycles	1,800
Scooters	401
EL scooters	241
EVs	518

In order to promote electric mobility, besides allowing a free access to the Limited Traffic Areas for electric vehicles, during last year the Municipality cooperated with ENEL S.p.A to deploy a wide network of charging stations. Now there are 118 stations (97 for cars, 12 for motorcycles and 9 for car sharing), with an expected increase to 300 in the near future. Other charging stations in the City are provided on-site by private operators (e.g. hotels, vehicles dealers). Moreover the Municipality fosters the development of electric mobility also in City logistics through the implementation of National and European Research projects (Electric Van sharing, Novelog, Citylab). Finally, an extension of cycling network in the short period is a measure the Administration intends to adopt in order to promote this mode.

5.6 Trikala

5.6.1 General City Characteristics

Trikala is a medium-sized provincial city located in Northwestern Thessaly, in the middle of Greece and the capital of the Trikala regional unit. According to the Greek National Statistical Service[71] (2011), Trikala is populated by 81,355 inhabitants, over 608.48 km^2, with a population density of approximately 134 inhabitancies /km^2, while in total Trikala regional unit is populated by 131,085 inhabitants, over 3.383 km^2.

In detail, 49.6% are males and 50.4% are females (Table 34). Minors (children ages 18 and younger) are approximately 16.7% of the population compared to pensioners who number 13.5%. Over half of the population is aged more than 40 years, showing a tendency towards an aging local society. The main active workforce, arbitrarily assuming it could range from 25 to 65years of age, covers 58% of the total population[72].

A percentage of around 40% of the inhabitants have been educated up to elementary school (including illiteracy), 23% range from junior high school to technical high school and finally 16% have received a diploma, MSc or PhD[73].

[71] Source: https://trikalacity.gr/wp-content/uploads/2016/03/stratigikos-sxediasmos.pdf [Accessed 20 December 2019].
[72] Source: https://www.statistics.gr/en/home [Accessed 20 December 2019].
[73] Source: http://www.trikala-chamber.gr/trikala/articles/article.jsp?context=103&categoryid=601&articleid=603 [Accessed 20 December 2019].

About 72% of the population is of Greek nationality. The immigrant groups come from other European countries, with the only noteworthy nationality percentage following Greek's predominance being Albanian, which reaches a total of 3.24%. The migration percentage concerns migration sourcing from other (group) countries with reference year 2010. According to unofficial data, around 500 refugees inhabit in Trikala since 2015, out of which 56% male and 44% female.

Within the Municipality of Trikala, 6 out of 10 people are financially inactive. From the rest, 4 out of 10 are financially active and a percentage of 19.65% from these are unemployed.

In detail, the characteristics of the population in Trikala City and in the greater area are presented below (Table 34).

Air quality data in Trikala has been obtained from WeatherBug, a website that combines from data including governmental monitoring stations, satellites, traffic conditions, and air dispersion models. The data given is collected in real time, which means that actual values will fluctuate depending on environmental conditions throughout the day. The overall air pollution level is considered Fair at 26 units on the AQI scale, taking both concentration and time into account as a measure of the dosage. Main pollutants include PM2.5 (12.1μg/m^3), PM10 (17.9μg/m^3), O_3 (32.7ppb), NO_2 (1.12ppb), SO_2 (0.09ppb) and CO (107ppb). As can be seen from the data, the partial pressure of CO is significantly higher than that of the other gaseous pollutants, suggesting that CO is one of the main contributors to low air quality.

Table 34: Demographic Characteristics in Trikala

	Trikala Prefecture		**Trikala Municipality**	
	N=131,085		N=81,355	
	n	%	n	%
Population				
Male	65,152	49.70%	40,353	49.6%
Female	65,933	50.30%	41,002	50.4%
Age Group				
<25			16,784	21%
25 - 65			47,320	58%
>65			17,132	21%
Education				
<High School	64,189	48.97%	43880	53%
College	42,276	32.25%	19083	23%
>College	17,122	13.06%	13286	16% [74]
Employment			(Financially active) 32,323	(Financially active) 40%
Employment			25,392	
Unemployment			6,391	
Nationality				
Greek			58,575	72%
Other EU Countries			2,635	3.24%

[74] An 8% of the population hasn't been categorised in terms of its education.

	Trikala Prefecture		Trikala Municipality	
	N=131,085		N=81,355	
	n	%	n	%
Non EU Countries				24.76%

The area topography is shown in Figure 33 below. The south-eastern part of the Trikala prefecture belongs to the Thessalian plain. The forested Pindus mountain dominates the western part. The northern part of Trikala prefecture is also mountainous and made up of forests and barren lands. On the other hand, the terrain of Trikala Municipality can be characterised as flat. The city straddles the Lithaios River, which is a tributary of the greater Pineios River.

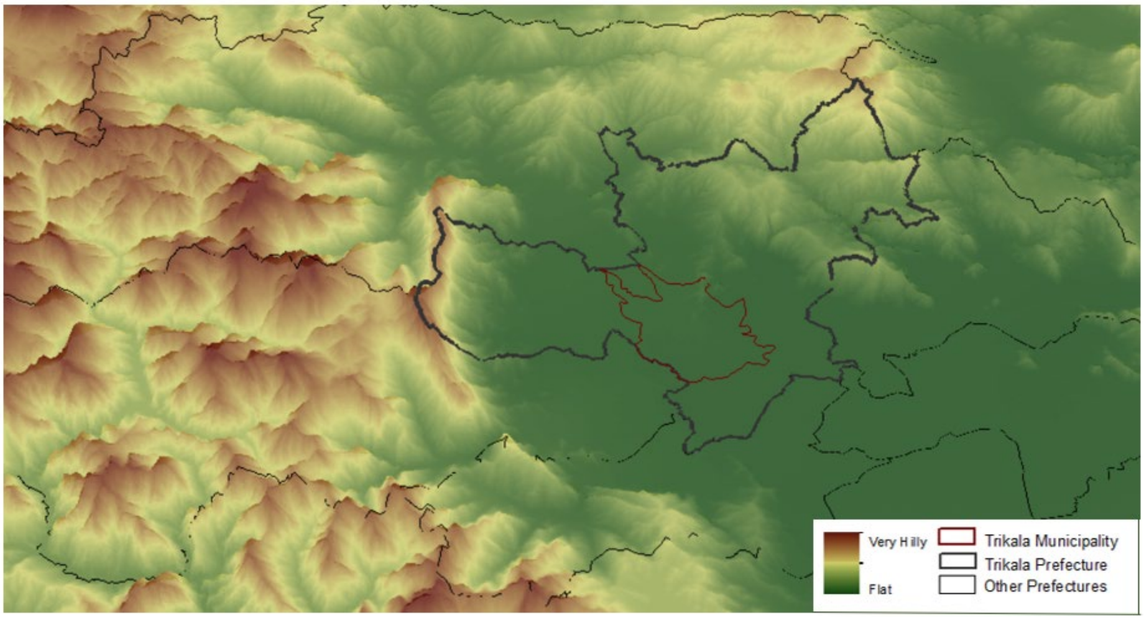


Figure 33: Topology of the Trikala area

The climate is mainly of Mediterranean character, with warm summers and mild winters, while the temperature is affected by the mountains nearby. The average daytime temperature in the hottest month of the year is equal to 29.9 °C, while it drops to 4.6 °C in the coldest month (Figure 34).

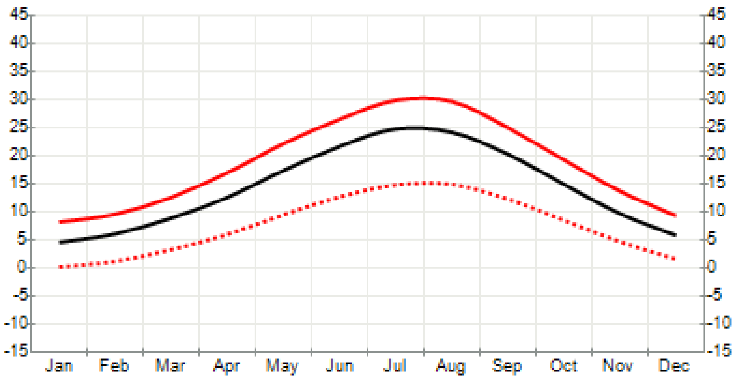


Figure 34: Average low/high temperature per month in Trikala

The city is close to a highly touristic area of international importance, called Meteora, just 21km on the west, a unique rock formation and an UNESCO world heritage site, hosting one of the largest and most precipitously built complexes of Eastern Orthodox monasteries. The six monasteries are built on immense natural pillars and hill-like rounded boulders that dominate the local area.

5.6.2 Transport Characteristics

The **road network** in Trikala covers 313 km. 65.48% of the network is in residential areas, 15.14% tertiary, 6.76% secondary and 6.31% is unclassified.

Although the city is of medium size and does not suffer from severe congestion problems, it has nonetheless congestion issues during peak hours. The main points of congestion within the city are around the three bridges crossing the river that passes through the city centre. Traffic congestion within the Municipality mostly occurs in the early morning hours (09:00-10:00) and around noon (12:30-14:30).

Local **public transport** consists of buses and free shared bicycles and is an economic option. The one-way bus ticket for an average journey in the city costs €1.20, and the monthly card for unlimited travel within the city costs €39.00 (Table 35). The use of private car costs €1.54 (per litre of unleaded petrol) and €1.25 (per litre of diesel). The Urban Public Transportation of the Municipality operates a fleet of 26 new public buses serving 30 lines within the borders of the city and other close settlements to the boundaries of the new Municipality of Trikala, also serving a few villages. 8 of the main lines (nominated as a deviation) interconnect the city centre with the neighbouring settlements, covering the main directions as are delineated by the city's road map arterial network. Moreover, there are 3 lines which are dedicated to the city's function and serve the centre and the urban network in principle. Each line has independent frequency and timetable, depending on the distance and the demand. The buses are in general reliable, because the traffic loads are quite fixed and never lead to unsatisfactory delays for the passengers. The lines operate from Monday to Saturday except from the route of the mini-bus interconnecting the intercity bus terminal with the city centre, which operates all days of the week. The timetables start from 06:00 until 22:00. The details are summarised below.

Table 35: Public Transport in Trikala

Transport mode	Bus
Network length (km)	205
Lines	30
Vehicles	26
Single ticket cost for an average journey in the city (€)	1.2
Monthly ticket cost for unlimited travel within the city (€)	39

Four parking areas exist within the Municipality of Trikala, the available parking places are 43, 132, 70 and 110 respectively. Two of them are free to use and for the other two users are asked to pay. There are approximately 1,110 roadside parking places. Around 350 of them are controlled by the municipality.

As regards **local policies**, Trikala support the Greek SUMP Network (Sustainable Urban Mobility Plans) and the Mayor's office plans the city's participation in this network. Local authorities also want to promote "green mobility", having fewer cars in the city centre, and work for expanding the usage of L-Vs to EL-Vs. Under this direction, the city has participated in the CityMobil2 project (Cities demonstrating cybernetic mobility, FP7, contract 314190). In the framework of this project, six driverless minibuses were demonstrated in the city between September 2015 and January 2016 on dedicated lanes along a 2.5 km route in the city centre. After the end of the project, the dedicated lanes are used as bicycle lanes (Figure 35).

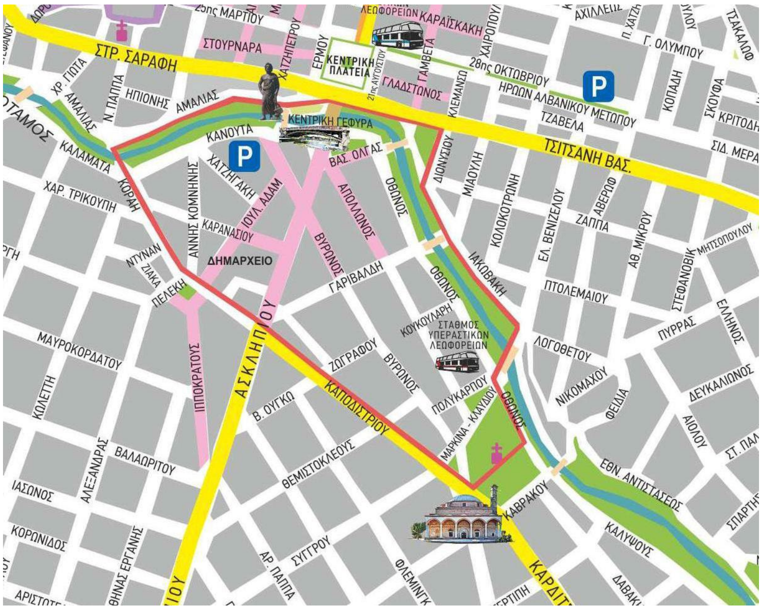


Figure 35: Cycle lanes in Trikala

5.6.3 Travel Characteristics

It is estimated that in Trikala there are 259 cars (public and private), 2 public buses, 70 motorcycles, and 140 trucks – goods road motor vehicles[75] per 1,000 citizens.

There are around 85,000 trips per day in the City by residents and visitors. Recent observations in a daily user survey by e-Trikala have shown that during peak hours, traffic is composed by private cars (66%), buses (4%), taxis (4%), trucks (9%), motorcycles (8%) and bicycles (9%) as it is shown in Figure 36.

Similarly, another survey performed by e-Trikala in 2013 found that private cars are preferred by 60.57% of people. The usage of bicycles and buses sums up to 15%. The usage of conventional L-Vs (motorcycles) reaches 11.30 %. In detail the modal preferences according to this survey is presented in the figure below.

[75] Source: http://observatory.egnatia.gr/reports/vehicles_report_10-2007.pdf [Accessed 20 December 2019].

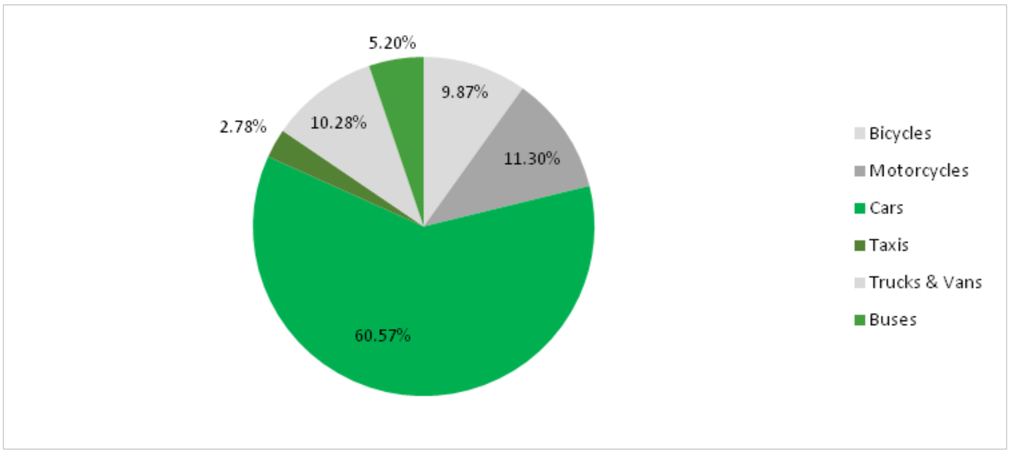


Figure 36: Modal split in Trikala

5.6.4 L-V/EL-V Use

No light electric vehicles currently exist in Trikala. As regards conventional light vehicles, according to data from the Ministry of Transport, there were 567 new motorcycles registrations in Trikala up to 2010. It is estimated that there are more than 30,000 bicycles in the city (Figure 26). According to the previous survey by e-Trikala, the usage of motorcycles is preferred by 11.30% while the usage of bicycles by 9.87% people.

Figure 37: Bicycles in Trikala city

Led by the Municipality of Trikala, there is a free service that allows sharing of municipal bicycles, which presently reach a total number of 100 bicycles. Users parking at two of the municipal parking areas may get one of the offered bicycles and use it for free for up to 3 hours.

5.7 Comparison of mobility conditions across the demonstration cities

This section provides a cross-comparisons across the six cities focusing on EL-V related factors. Factors involved in the comparison were selected aiming to ensure that the comparison is relevant and objective. The selection was done as follows:

- There should be research evidence that the factor influences EL-V adoption.
- There should be data available from the demonstration cities to calculate the factor.
- A factor must be calculated in the same way and from the same time periods.

- A factor must be available across all the cities.

Based on the selected factors, a city profile of factors influencing EV-L adoption was developed, including details of city features and comparisons between demonstration cities.

It is assumed that the factors influencing EV adoption identified in section 2 may also be valid to EL-Vs as they are a subset of EVs. The table in Annex C groups all factors that affect EL-V adoption based on findings from existing research and the data collected from each demonstration city.

The factors calculated per city are as follows:

- **Population density**: measured or derived from the number of inhabitants per square kilometre.
- **Age**: Percentage of population in young and middle age groups was measured, as the majority of EL-V users are in these groups. Data collected varies between cities due to availability of relevant data.
- **Topography**: measured by the percentage of hills in the city, the average gradient of land, and the total ascent or descent in metres. In the profile, a low percentage of hills are labelled as "Flat".
- **Congestion level**: measured by percentage increase of overall travel times in 2016 when compared to a free flow (uncongested) situation.
- **Charging infrastructure**: current total number of charging stations and charging density.

  It is difficult to discern the charging density per EV, as there is not enough information available on the number of registered EVs per city. Thus, two measurements have been derived to identify charging infrastructure density in this study:

  1. Number of charging stations per EV in 100,000 inhabitants;
  2. Number of charging station per km^2.
- **Climate**: In this profile, climate has been quantified by measuring the total number of months per year with extreme cold (<15°C), hot (>24°C) and optimal (between 15°C and 24°C) temperatures.
- **Education**: the percentage of population with degree or higher education level is included in the profile.
- **Incentives**: current types of incentive schemes available.

The results are presented in Figure 38 to Figure 43, to visualise existing characteristics. Each layer of the radar chart in the diagrams represents the ranking of each city factor relative to other cities. Instead of scoring each city quantitatively, these charts give an overview of the current EL-V factors measures between them. This provides a comparative visualisation of EL-V related factors in all demonstration cities. Specific characteristics are displayed at the outside of the radar charts.

Flatness: The diagrams in the following six figures demonstrate that Bari, Trikala and Berlin have the highest ranking in the "Flatness" category, suggesting that their topographies are the most suited to EL-V use. In contrast, Genoa has the lowest ranking which means its topography results in the highest level of energy consumption, and thus is least suited to EL-V use.

Traffic flow level: this is inversely correlated to congestion level. For instance, the outermost layer of the diagrams indicates highest traffic flow, which infers that congestion level is at its lowest. This pattern is observed in Trikala; it has the lowest level of congestion amongst all cities, which subsequently results in the lowest levels of energy consumption in the usage of EL-Vs. Rome, however, has the highest levels of congestion, which will prove a great challenge towards the implementation of EL-Vs while on the other hand it may be seen as an opportunity for light vehicles.

Incentive schemes: The "Incentive schemes" category in the diagrams indicates the ranking of each city based on the total number of different schemes available. A mix of policies is much more effective than a single policy in the promotion of electric vehicles, as highlighted by Hardman *et al.* (2017) and Mersky *et al.* (2016) [53][54]. Rome has the highest number of different schemes available, which indicates that its influence on EL-V use through government schemes might be the greatest compared to other cities. Trikala has the potential to improve EL-V usage if more incentive programs are implemented, as it has the least number of incentive schemes currently available.

Charging station density: Compared to other cities, Berlin has the highest charging station density as indicated by the diagrams, implying that its charging infrastructure is most suitable for EL-V use. However, Trikala has no charging stations at all, which means that the city faces a huge challenge in boosting EL-V use without the necessary support from developed charging infrastructure.

Population density: The diagrams show that Berlin has the highest population density, whereas Trikala has the lowest. The population density in Berlin is therefore most suited to EL-V use, and Trikala is the least.

Optimal temperature duration: As shown by the outermost and innermost layers of the diagrams respectively, Málaga has the longest mean optimal temperature duration in a year whereas Berlin has the shortest. Thus, the energy consumption performance is at its highest Málaga and its worst in Berlin compared to other cities.

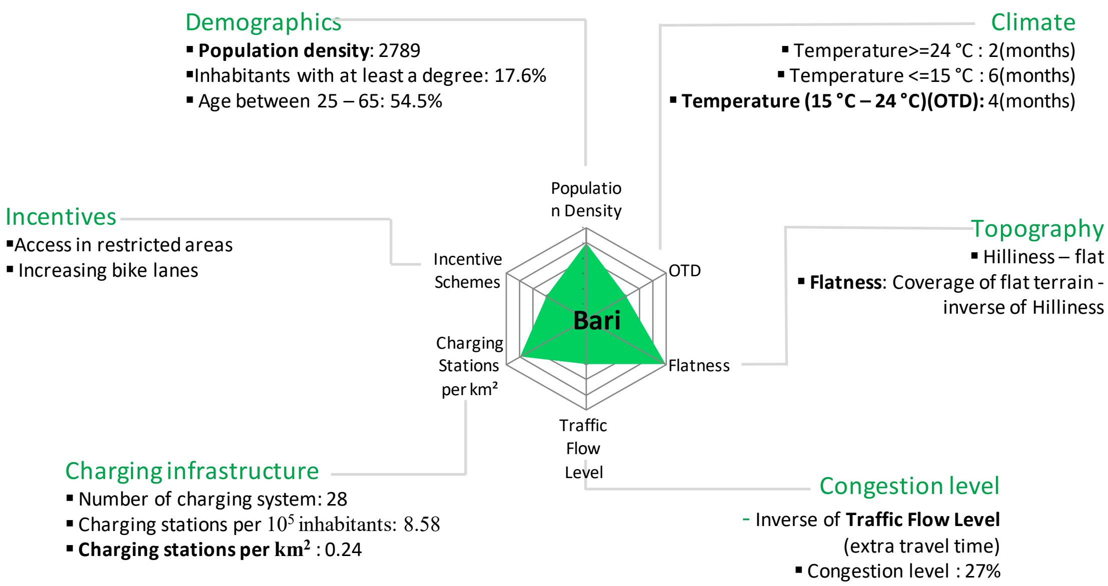


Figure 38: City typology in relation to EL-Vs, Bari

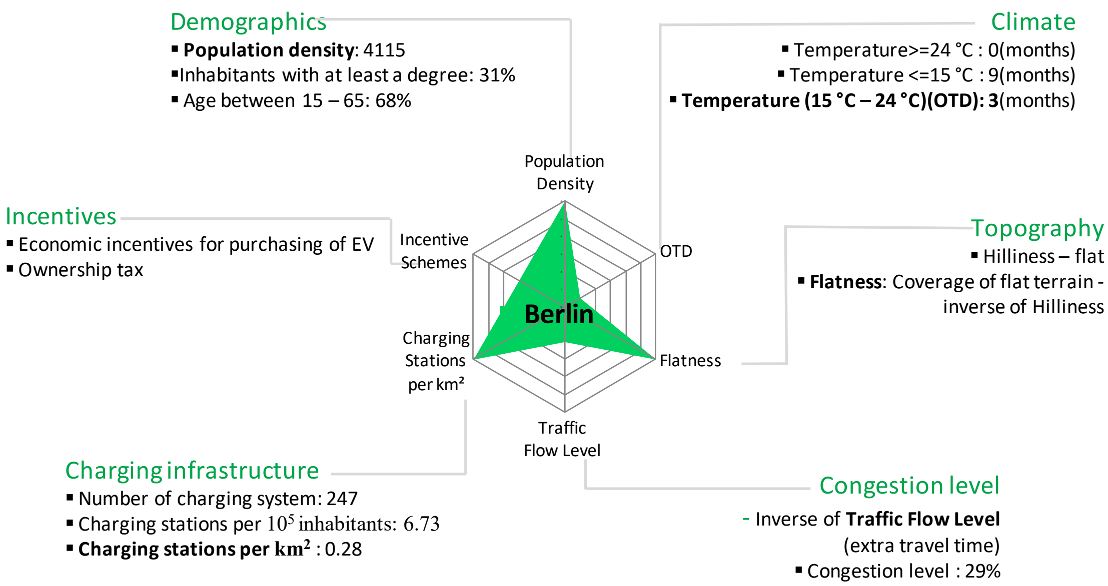


Figure 39: City typology in relation to EL-Vs, Berlin

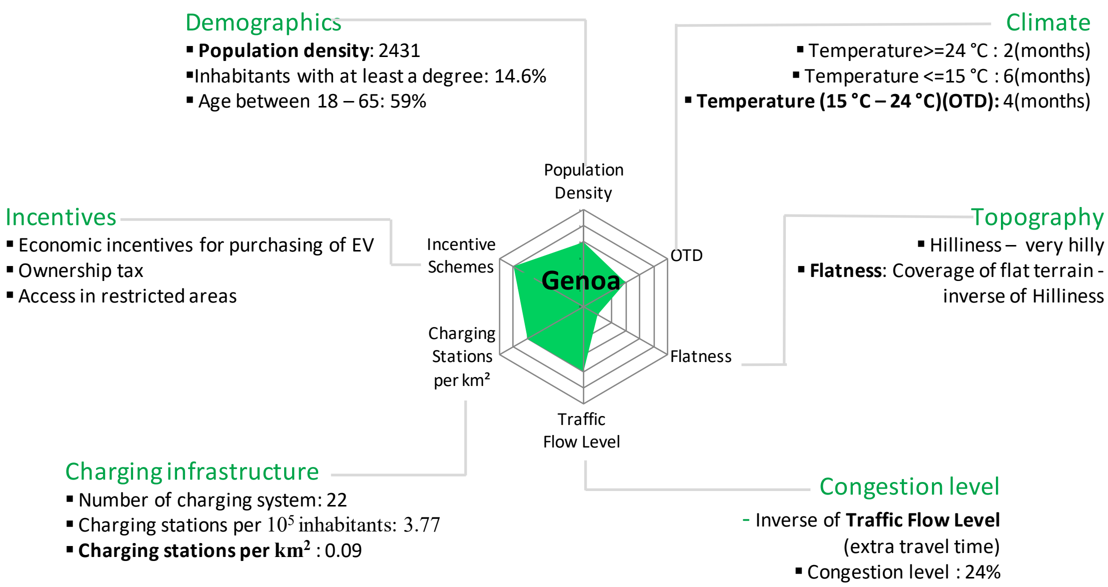


Figure 40: City typology in relation to EL-Vs, Genoa

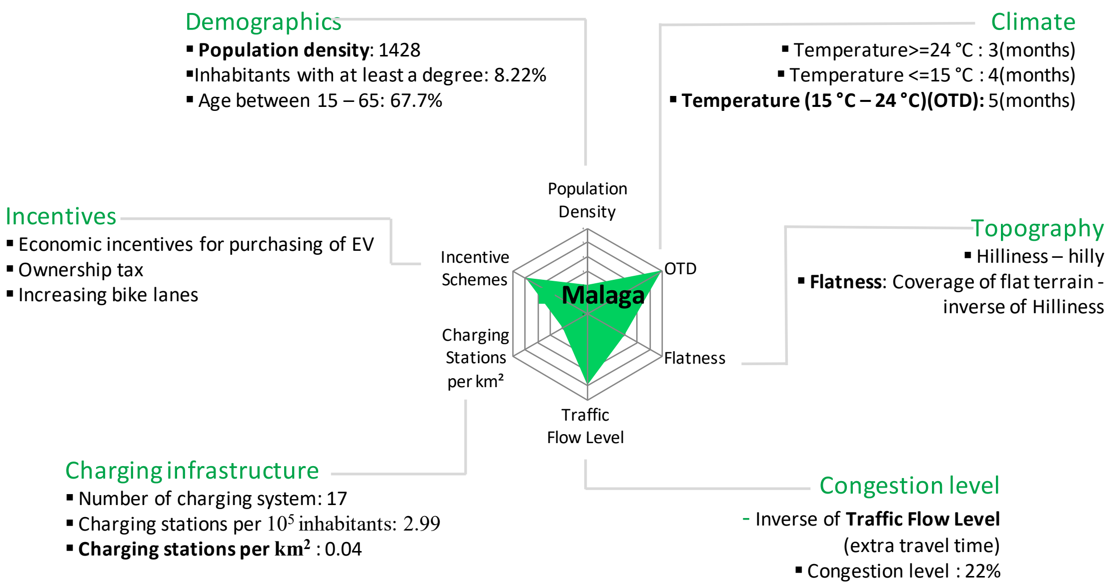


Figure 41: City typology in relation to EL-Vs, Málaga

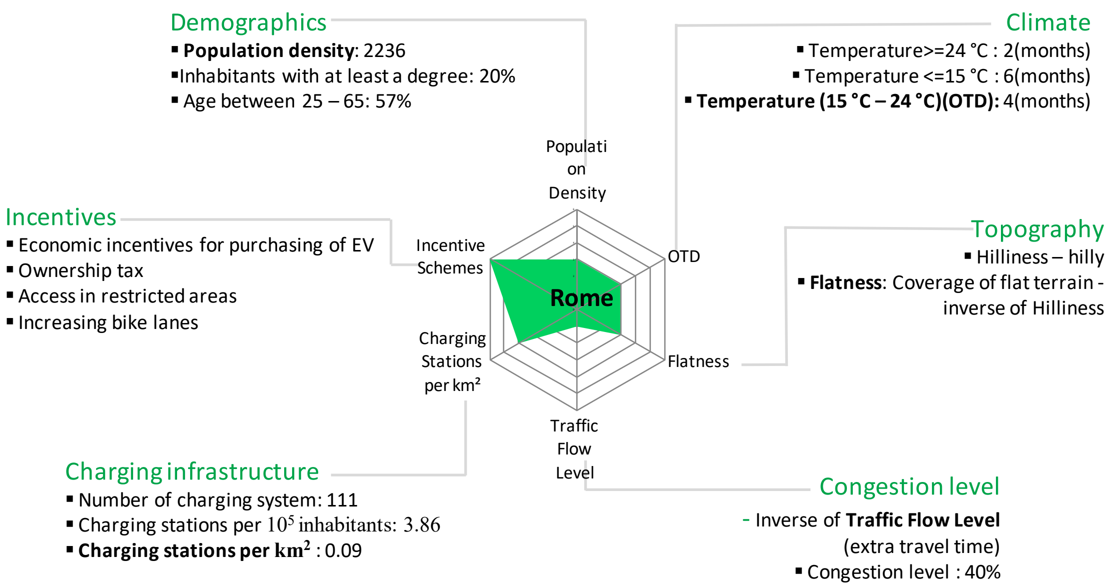


Figure 42: City typology in relation to EL-Vs, Rome

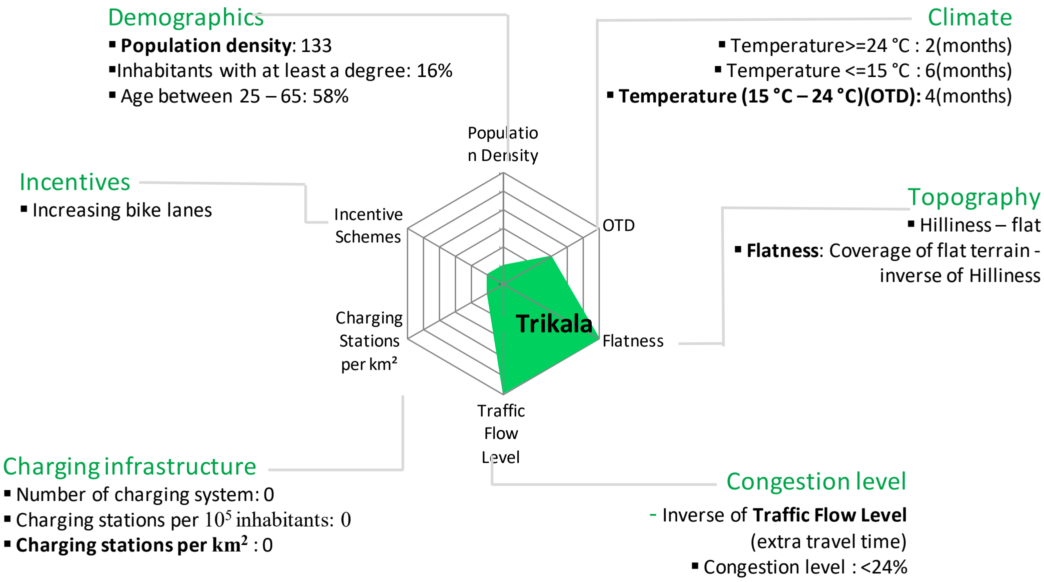


Figure 43: City typology in relation to EL-Vs, Trikala

6 Public Perception Online Survey

6.1 Public Perception Survey Overview

A public perception survey of residents of the six demonstration cities was conducted in order to gather their opinions and attitudes towards different aspects of EL-V use for different trip purposes in their city. It covered positive or negative perceptions about different aspects of 2-, 3- and 4-wheel EL-Vs (for example safety, ease of parking, charging, luggage capacity, etc.) and opinions on what are the key measures to make EL-V use more attractive.

Opinions and perceptions were compared per respondent profile (age group, gender, etc.) as well as per current trip behaviour (purpose, frequency, modes used) and per experience with light vehicles (whether they currently own or use a light vehicle).

The purpose of the study was to capture perceptions and to correlate them with current trip behaviour. It was not expected that the study would result in a census of current trip behaviour, as the survey respondents might not be representative of the city's population. For example, it could be the case that people with more interest in urban mobility issues, users of bicycles and L-Vs or those interested in electric vehicles might be more likely to respond than those who have no interest in changing their travel patterns.

The survey was available online in five languages, namely English, German, Greek, Italian and Spanish and was accessible via a link to SurveyMonkey portal. It was widely publicised in all of the six demonstration cities and has reached out beyond to other cities and countries which were however not counted in the final analysis, as no big enough samples were collected from other cities. The targeted audience were citizens of the project cities.

The final analysis is based on responses collected from those who answered at least up to the first question asking about an opinion, namely question 13 (complete questionnaire can be found in Annex D) and not only factual questions referring to their current mobility behaviour.

6.2 Questionnaire Design and Execution

This public perception survey was designed using the SurveyMonkey online tool/platform. The survey consisted of 27 questions, mostly in multiple choice format with few questions requiring answers or comments in text format. Visual explanation was provided to certain questions in order to enable an easier grasp of the different types of EL-Vs. The survey was conducted in an online form in order to reach out to as many users as possible.

It was available in English, German, Greek, Italian and Spanish and aimed at citizens from the project demonstration cities (Bari, Berlin, Genoa, Málaga, Rome, and Trikala). Although it targeted audience from the listed cities, it was not country-specific and a number of replies from other cities and countries outside our cities were received. All the text comments received were firstly translated by native speakers from the six demonstration cities and then combined together in a consistent version in English for analysis.

The questionnaire was accessible via a link in all the above-mentioned languages, and it was easy to complete in a short time (completion time was 7 to 10 minutes for most respondents). A short introductory text was included at the beginning of the survey to inform the respondents about the purpose and scope of the survey, its estimated duration (10 minutes) and the complete anonymity, namely that no personal data or IP addresses were being collected during the survey so it would be impossible to identify the identity of a respondent. Clear reference to compliance with the SurveyMonkey privacy policy was provided, as well as a direct link to the full version of it.

The survey was easily accessible via smart phones, as the questionnaire was well readable on mobile screens, to attract more replies than if it had only been available as a desktop version.

This survey targeted citizens in the six demonstration cities, not experts in the field of transport and mobility, in order to collect existing opinions and attitudes from the citizens of the concerned cities. It was widely publicised via various public channels (as described below) and therefore it was available to anyone who had the link to access the questionnaire. Due to this fact a certain bias may exist, and it should be taken into consideration that the survey sample is not necessarily representative of the whole city population. Nonetheless, it was a perception survey and any replies from users were welcome and beneficial to the overall result as long as the minimum necessary number of questions was answered.

The survey consisted of 27 questions and included visual support in form of pictures explaining types of vehicles which the questions referred to (for example see figure below). The full questionnaire is given in Annex D.

14. In the future, would you consider using one of the following vehicles? If your answer is no, please skip to the next question.

	Electric bicycle	Electric motorcycle	Electric three-wheel vehicle	Electric four-wheel LIGHT vehicle (not an electric car)
for trips to work/education	☐	☐	☐	☐
for trips for shopping	☐	☐	☐	☐
for trips for leisure, entertainment and visits (family/friends) within my city	☐	☐	☐	☐

Figure 44: Example screenshot from the online questionnaire survey (English version)

Dissemination of the survey was carried out in collaboration with representatives of each of the six demonstration cities. In order to publicise it widely each city was requested prior to the launch of the survey to identify and provide a list of dissemination channels (websites, Facebook pages, Twitter accounts, LinkedIn, etc.) which were feasible for them to use for the promotion of the questionnaire. Based on this list, the launch of the survey was announced via various channels and social media generating a great number of responses. It was particularly successful in cities where public authorities are partners in the project and hence had direct access to online portals popular among citizens. For instance, Roma Capitale publicised the survey using their website, Facebook page, Twitter and radio station, greatly contributing to generating an impressive amount of replies from this city in a short period of time. The city of Berlin which is the only demonstration city not directly represented by a public authority, found it more challenging to collect as many replies (target was 1,000 responses per city or 6,000 in total) in a short period of time (the survey was open for one month). In order to gather a critical mass of responses which would allow for a representative analysis, local company Hubject collaborated with a market research company to collect the needed number of responses.

The main dissemination channels per demonstration city included:

Bari:

- Municipality of Bari (website, Facebook page, Twitter)
- Metropolitan city of Bari (website, Facebook page)

Berlin:

- Market research company
- Agency for Electro-Mobility (Berliner Agentur für Elektromobilität-eMO)

Genoa:

- Comune di Genova (website, Twitter, Facebook)
- Città Metropolitana di Genova (website, Facebook)
- AMT Genova (public transport authority) (website)

Málaga:

- ProMálaga mailing list
- Bici newsletter

Rome:

- Roma Capitale (website, Facebook, YouTube, Twitter, Radio, Mailing list)
- Città metropolitana (website, Facebook, YouTube, Twitter)

Trikala:

- Trikala Municipality (website, Facebook, Twitter)
- e-Trikala (website, Facebook, Twitter)

Publicity banners for visual promotion were developed and publicised via online media (shown below in Figure 45). Infographics were available in each of the five languages and included a short description of the project and the announcement of the survey.

Figure 45: Examples of infographics in different languages to promote the questionnaire survey via online media

6.3 Questionnaire Reponses

6.3.1 Overview and eligibility

The online survey was closed on 12 February 2018 and the total number of questionnaires submitted by that date was 8,240, with a completion rate of between 63% and 87%, depending on the language.

Some of the partially completed questionnaires did provide useful data, although they were not completed to the final question, whereas others only answered the first couple of questions and were therefore not useful for analysis. It was decided that eligible questionnaires for analysis would be those that were answered at least up to Question 13. This question asked "If there was a sharing scheme for these kinds of light electric vehicles in your local area would you consider using it?" and as such was the first question focusing on opinions and perceptions, rather than facts. As the questionnaire aimed to gather public perceptions and preferences and is not a census of current behaviour (factual questions such as frequency of trips or modes used), it was decided that questionnaires that did not include any perception data would be rejected from the analysis.

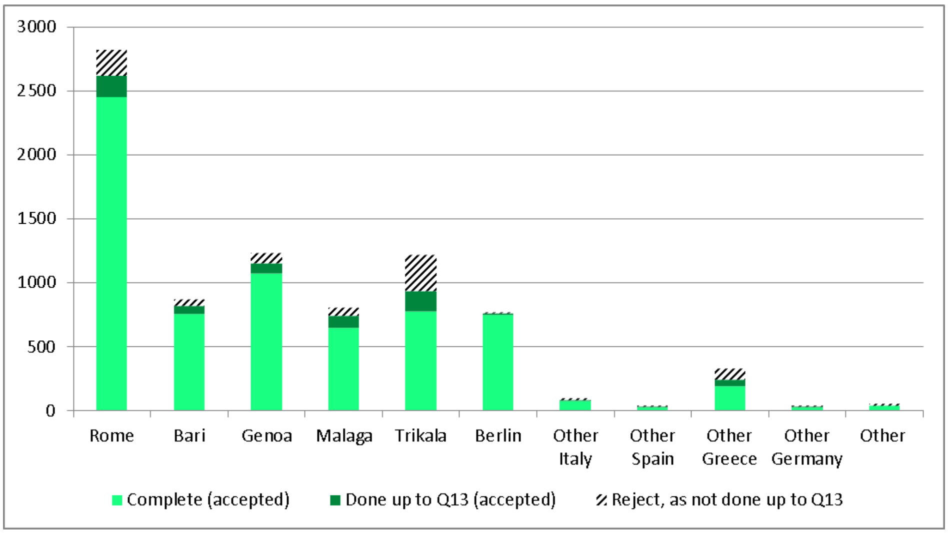


Figure 46: Public perception questionnaire responses per city

In total, 6,753 questionnaires were fully completed (27 questions), of which 6,419 were from the six demonstration cities (or nearby towns). A further 637 questionnaires were partially completed (at least up to Question 13), of which 569 were from the demonstration cities.

Most of the questionnaires filled in from other places were by people in one of the four countries where the demonstration cities are located (Italy, Germany, Greece and Spain), where most of the publicity was concentrated, so these were usable to a limited extent as a national benchmark against which to compare the six demonstration cities. Finally, 36 questionnaire responses came from other countries, and as there were no more than eight responses from any one city or country, these could not logically be included in any of the analysis.

The total numbers of questionnaire responses (complete, partially complete and eligible, and partially complete but rejected as ineligible) per city are shown in Figure 46.

6.3.2 Profile of respondents in demonstration cities and their travel behaviour

The background data of respondents in the six demonstration cities, including gender, age group, occupation, possession of a driving licence, ownership of a bicycle, electric bike, ICE L-V or EL-V, is summarised in Annex E.

It should be noted that the sample of respondents might not be typical of all the cities' populations, as there may be a bias according to the media used to disseminate the questionnaire, e.g. because it was online and disseminated on certain websites only. This may be a reason why there were relatively few respondents in the over 60 age group.

6.3.3 Willingness to use an EL-V sharing scheme

Figure 47 illustrates the responses from each city (by gender) to the question "If there was a sharing scheme for these kinds of light electric vehicles in your local area would you consider using it?"

This question was also analysed for responses coming from other cities in the four countries concerned (Italy, Germany, Spain and Greece), as a benchmark. Furthermore, because of the high number of responses from Greece from cities other than Trikala (particularly other large towns and small cities in the same region as Trikala), the Greek results were split by "big cities", comprising Athens, Thessaloniki and Patras, and other cities (medium and smaller cities which have closer characteristics to Trikala). There were not enough respondents from the other three countries to split the group in this way, and in any case, most responses from other locations in Italy, Germany and Spain were from big cities. The actual numbers of respondents in each case are given in the X axis of this figure (n=x) so that findings from the cities with few responses (e.g. other cities in Germany and other cities in Spain, each having fewer than 30 responses) can be treated with some caution.

Overall there appeared to be a high level of interest, with a majority of respondents in all cases except for Berlin saying they would use such a scheme either frequently or occasionally. In Berlin, these two categories nevertheless accounted for almost half of respondents, but with more people responding "maybe". Berlin had the greatest proportion of respondents who would not consider using an EL-V at all, but even this proportion was only 16%. Interest from other places in Germany appeared to be higher than in Berlin, although the low number of respondents in this "other cities in Germany" category means that we should not consider this as very significant.

The level of interest in Bari appeared to be around the same as the Italian "average" (other cities in Italy), while in Rome it was slightly above and in Genoa there was less willingness to use EL-V sharing schemes than elsewhere in Italy (although even in Genoa interest was above 50% of respondents).

Málaga results were similar to the rest of Spain, although with more people stating that they would use an EL-V sharing scheme occasionally, while in other Spanish cities (mostly Madrid and Barcelona) nobody said that they would prefer to buy an EL-V than use a shared one.

Results from Trikala showed similar levels of interest than Genoa, more than Berlin and less than the other three demonstration cities. They were very consistent with the views of people from other smaller and medium-sized Greek cities, whereas interest in EL-Vs from Greece's three largest cities (Athens, Thessaloniki and Patras) was slightly higher.

As there was relatively little difference in opinions between female and male respondents to this question these are not shown in the graphs for simplicity. The main observed differences are, however, that in Bari women were more likely to be positive about using such schemes, whereas in Málaga, men appeared to be more inclined to use a sharing scheme.

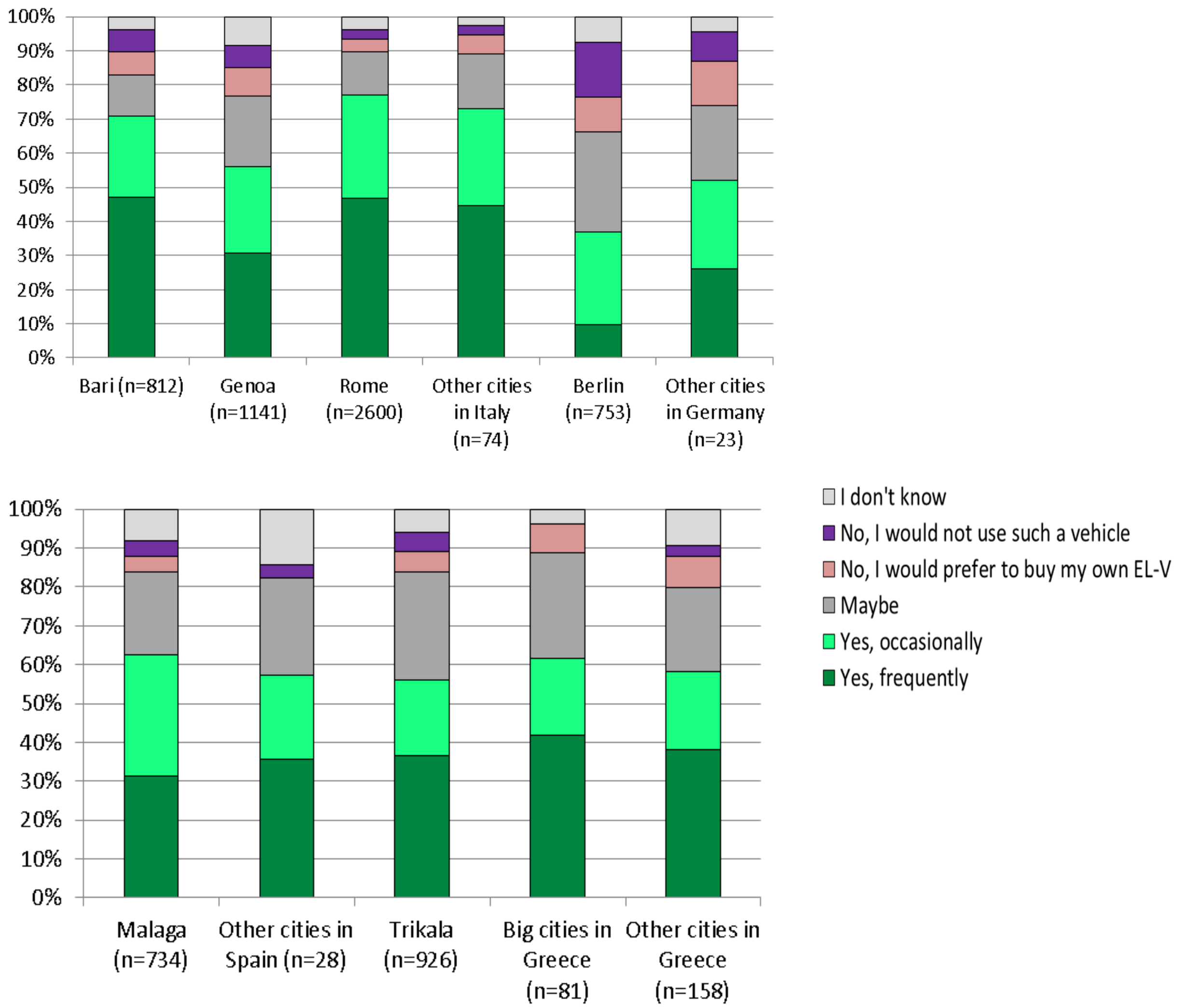
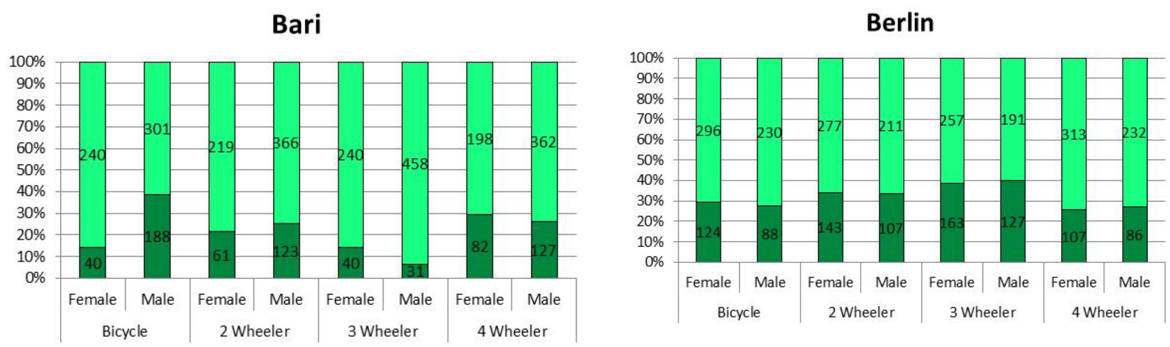


Figure 47: Willingness to use an EL-V sharing scheme: All cities and countries

6.4 Willingness to use different types of EL-V per trip purpose

The survey asked "in the future, would you consider using one of the following vehicles?" with a choice of bicycle (this option included electrically assisted bicycles) and 2-, 3- and 4-wheeled EL-Vs. The results are shown in the following charts for each city, by gender, for work and education trips (Figure 48), shopping trips (Figure 49) and trips for leisure, including entertainment, visiting friends or relatives, and other personal trips in the city that are not work or shopping related (Figure 50).



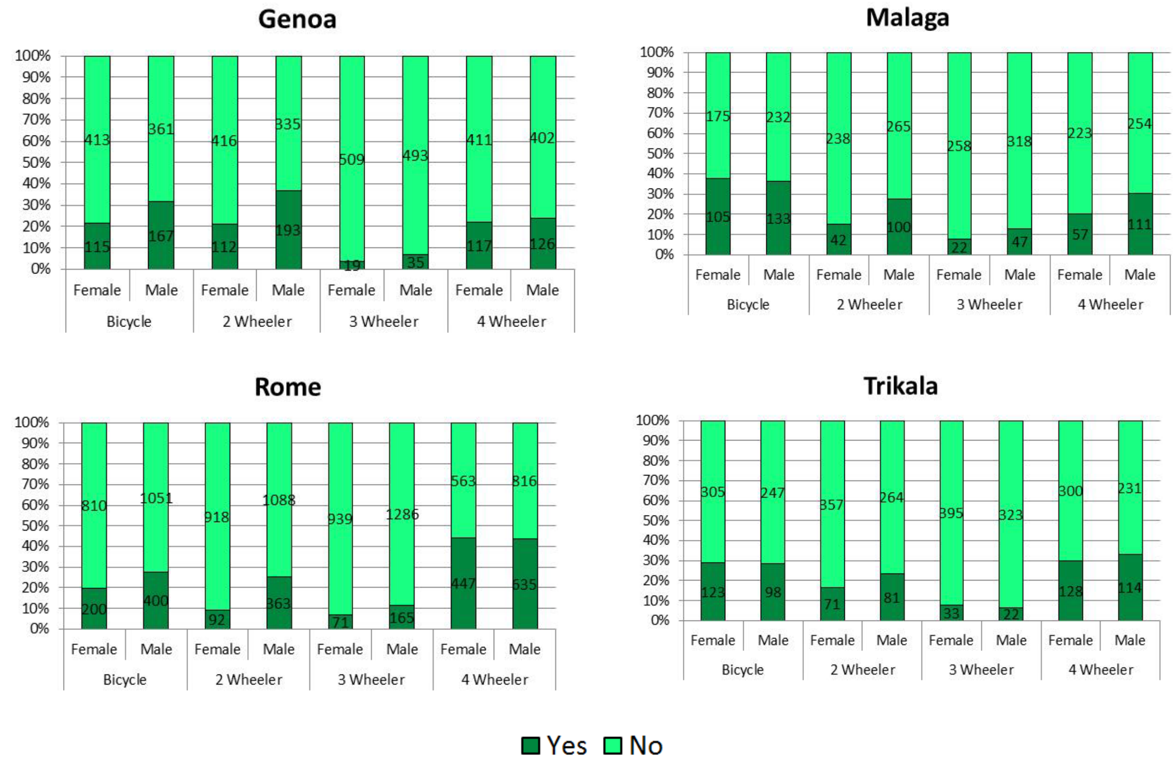
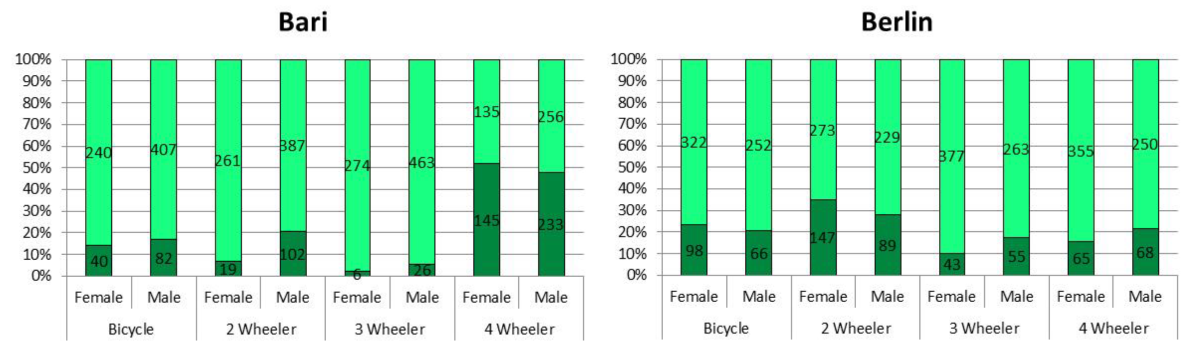


Figure 48: Willingness to use different types of EL-Vs for journeys to work or education

Note that respondents were not asked to select their preferred type of vehicle; they could select "yes" to several or all vehicle types if they wished, or not select any of them. The following figures show the percentages of females and males responding "yes" and "no" for each vehicle type, with the actual numbers of respondents giving each response appearing on each bar.

For work or education trips, there seems to be more willingness among men than women to use both bicycles and most types of EL-Vs across all cities, especially with regard to bicycle use in the three Italian cities. Overall willingness to use a bicycle for work or education purposes is highest in Málaga, perhaps due to the relatively flat topography, the climate and the existence of a bike sharing scheme. 2 and 4-wheel EL-Vs were the most popular types in all cities except for Berlin, where 3-wheel EL-Vs were seen as attractive by the greatest number of respondents.



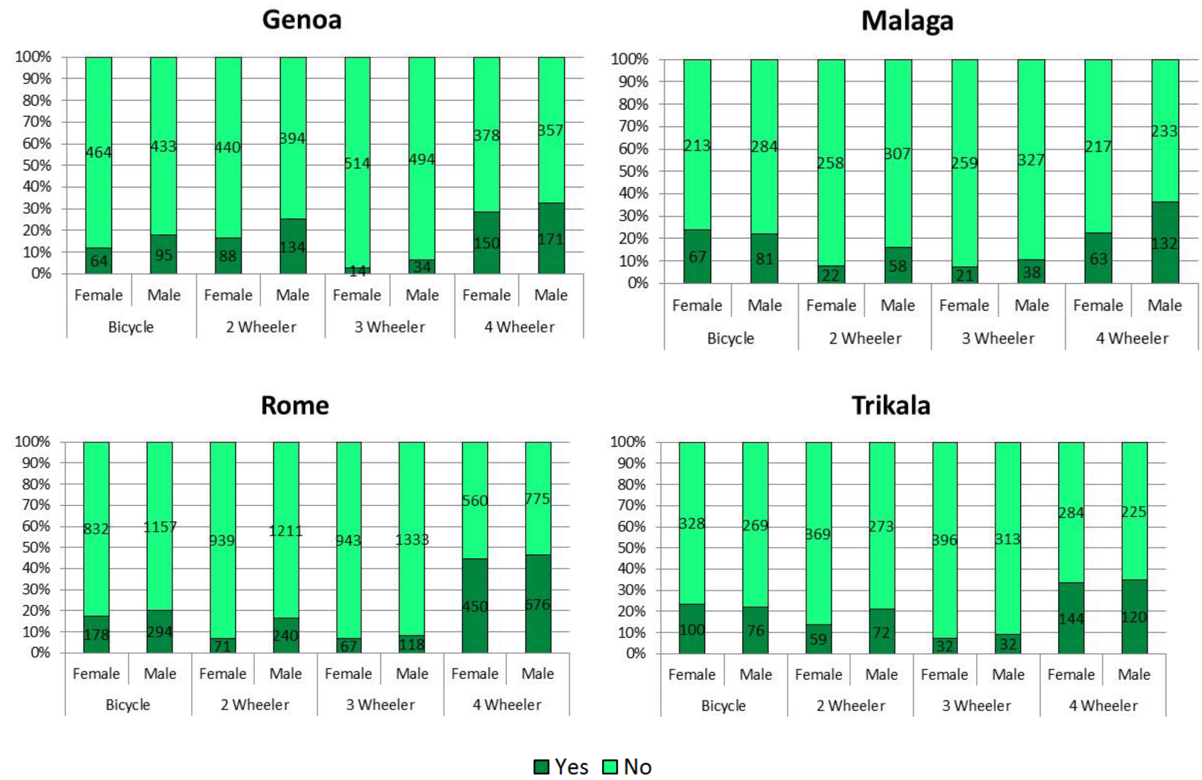


Figure 49: Willingness to use different types of EL-Vs for shopping trips

The willingness to use bicycles and EL-Vs for shopping trips was noticeably lower than for commuting trips, possibly due to luggage carrying issues. 4-wheeled EL-Vs were hence the most popular out of the vehicles offered in this question, except in Berlin where a greater number of respondents were willing to use 2-wheeled EL-Vs for this purpose.

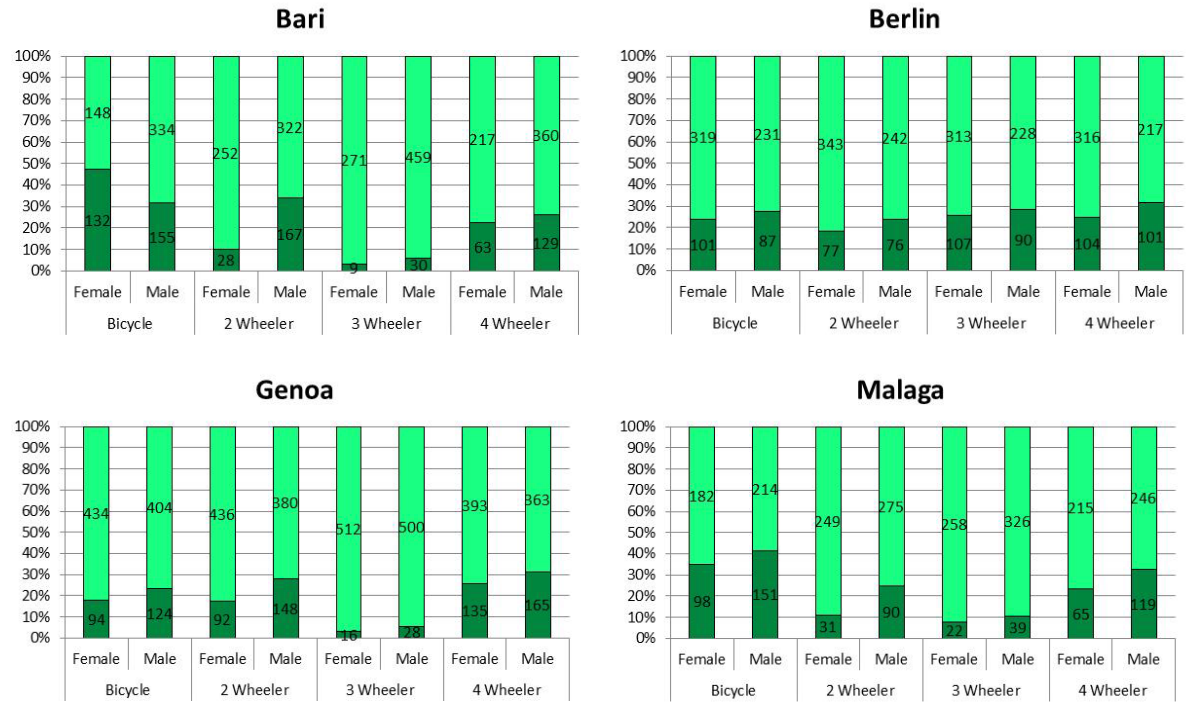


Figure 50: Willingness to use different types of EL-Vs for leisure and personal trips

6.5 Perceptions about different EL-V attributes

Six of the 27 questions of the survey were focused directly on different attributes of EL-Vs, namely comfort, safety, convenience of charging, security of parking, luggage capacity and cost-efficiency. The responses are presented in the next sections. Each question refers to one of the attributes in respect to 2, 3 and 4-wheeled EL-Vs. The purpose of this categorization derives simply from the fact that each vehicle type suits different needs for different purpose of trips, for instance a 2-wheeler might be more convenient to travel to work and get past other traffic while for a shopping trip more people would prefer a vehicle with greater luggage capacity, such as a 3- or 4-wheeled EL-V.

The graphs below represent answers of the survey respondents. Possible answers to each question were strongly agreed, rather agree, rather disagree, strongly disagree and 'I don't know'. They are presented by gender and age group for all six demonstration cities together, with equal weighting for each (i.e. the percentages for each of the six cities were added together, not the actual numbers, to avoid a bias towards cities with more questionnaire responses). The results are then presented for each demonstration city (regardless of gender or age group).

6.5.1 Comfort of EL-Vs

Respondents stated that they would feel more comfortable in 4-wheel EL-Vs, and this is true for both men and women and for all age groups. Men would feel more comfortable than women in 2-wheelers or 3-wheelers. More people aged 30-59 stated that they would feel more comfortable than the other age groups using 2-wheelers or 3-wheelers.

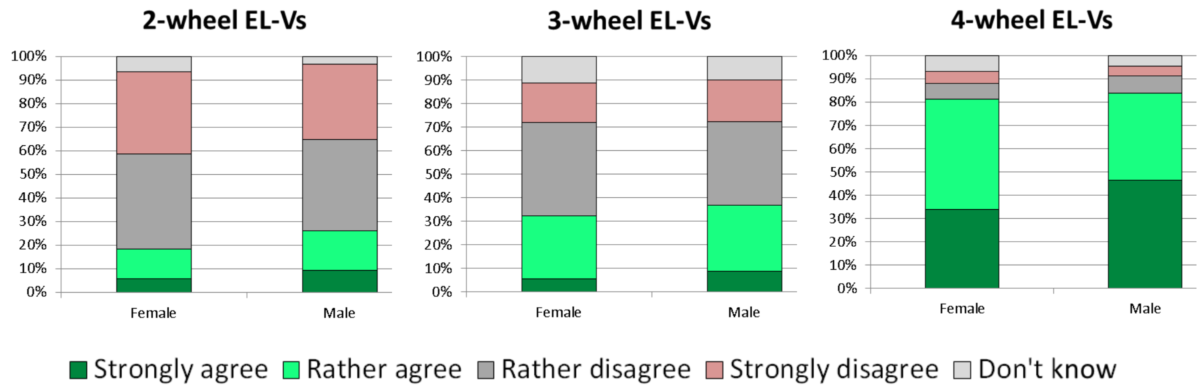


Figure 51: Perceptions of Comfort of EL-Vs for all cities (split by gender)

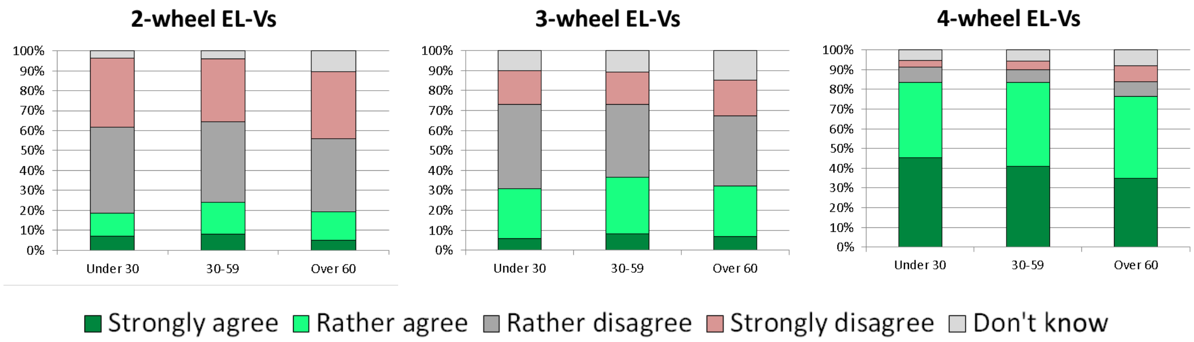


Figure 52: Perceptions of Comfort of EL-Vs for all cities (split by age group)

No notable differences in comfort perceptions per city can be seen. The perception of comfort of 2-wheelers seems to be lower in Rome and higher in Berlin and Trikala, this may be due to the extensive use of bicycles in these two cities. The perceived comfort of 3-wheelers is lower in Genoa, Málaga and Rome. 4-wheelers are seen as the most comfortable everywhere.

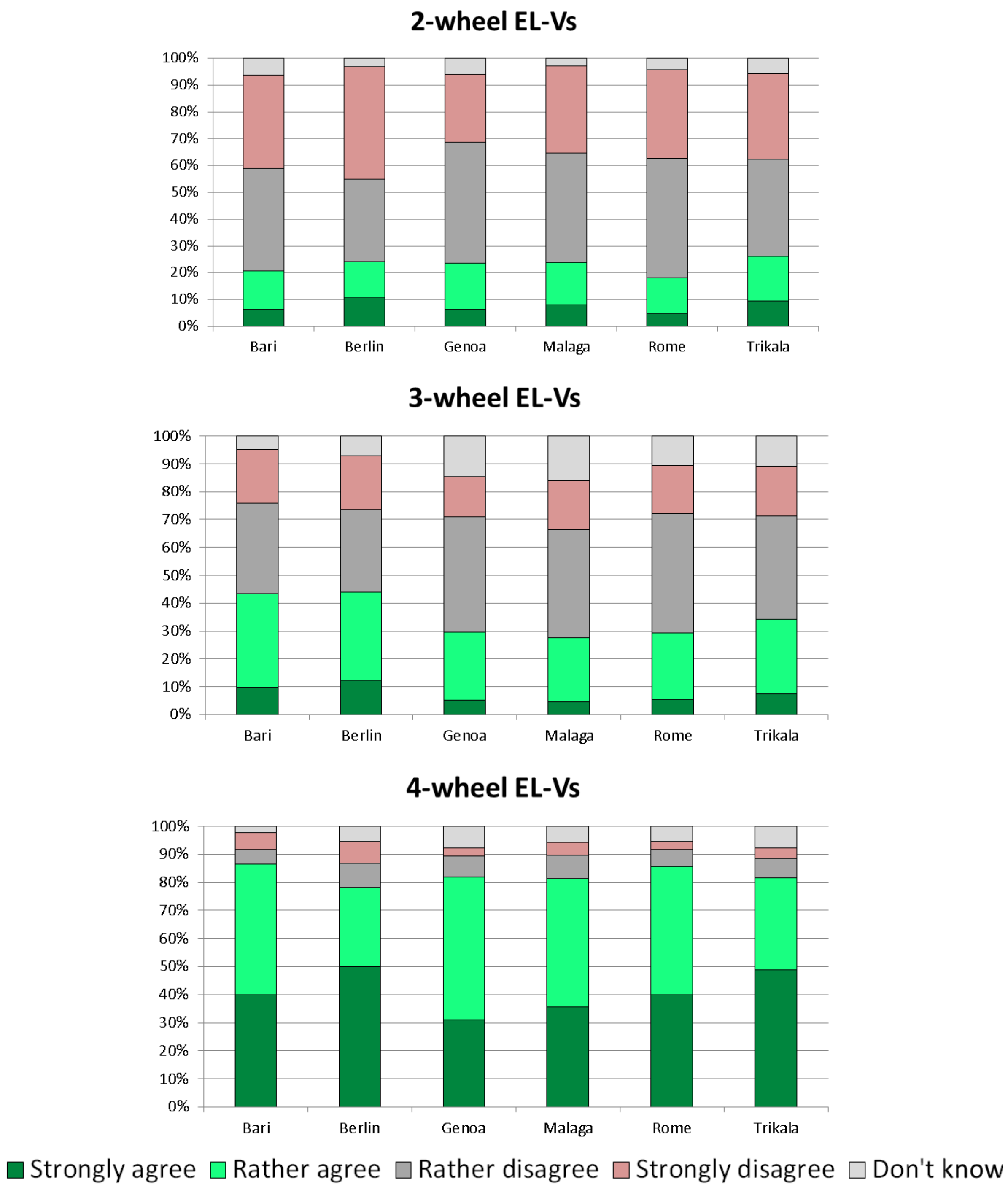


Figure 53: Perceptions of Comfort of EL-Vs by city

6.5.2 Ease of parking of EL-Vs

Unsurprisingly, parking was seen as being easier for 2-wheeled EL-Vs than the other categories, however there was not much difference between 3 and 4-wheeled EL-Vs regarding this question. There was a slight propensity for men to find 2-wheelers easier to park than woman, but for 3 and 4-wheelers, slightly higher proportions of women than men considered them to be easy to park. By age group, younger respondents considered parking to be easier than older respondents for 2-wheeled EL-Vs, but there was little difference between age groups for 3 and 4-wheeled EL-Vs.

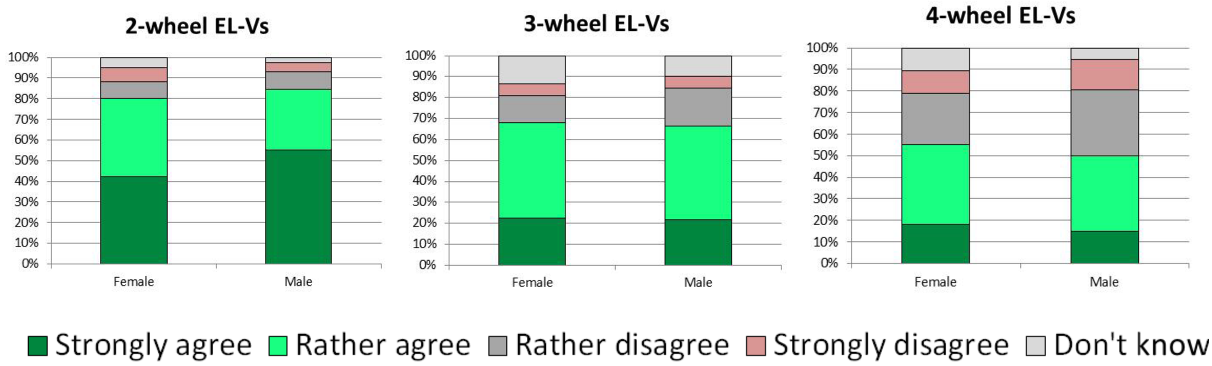


Figure 54: Perceptions of Parking easiness of EL-Vs for all cities (split by gender)

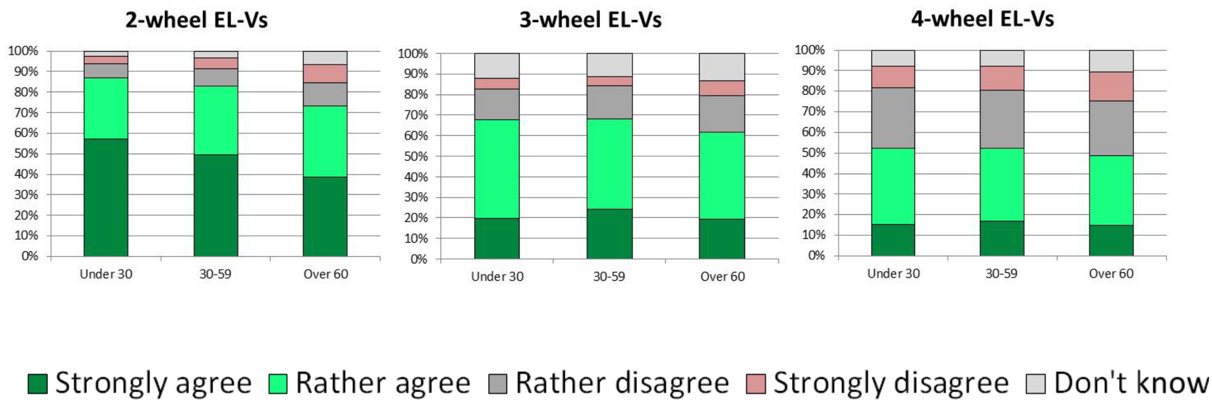
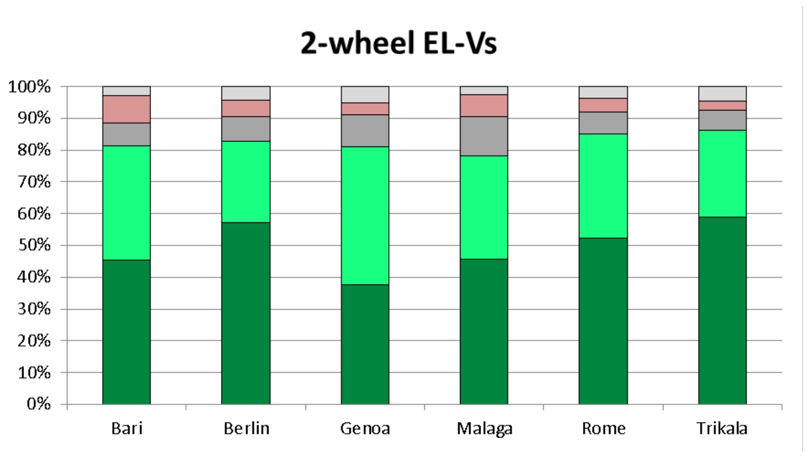


Figure 55: Perceptions of Parking easiness of EL-Vs for all cities (split by age group)

By city, parking was considered easiest in Berlin and Trikala for all vehicle types, and also in Rome for 2-wheeled EL-Vs. Genoa and Málaga were the only two cities where, for 4-wheeled EL-Vs, the numbers disagreeing (either rather or strongly) that parking was easy exceeded the people agreeing (either rather or strongly).



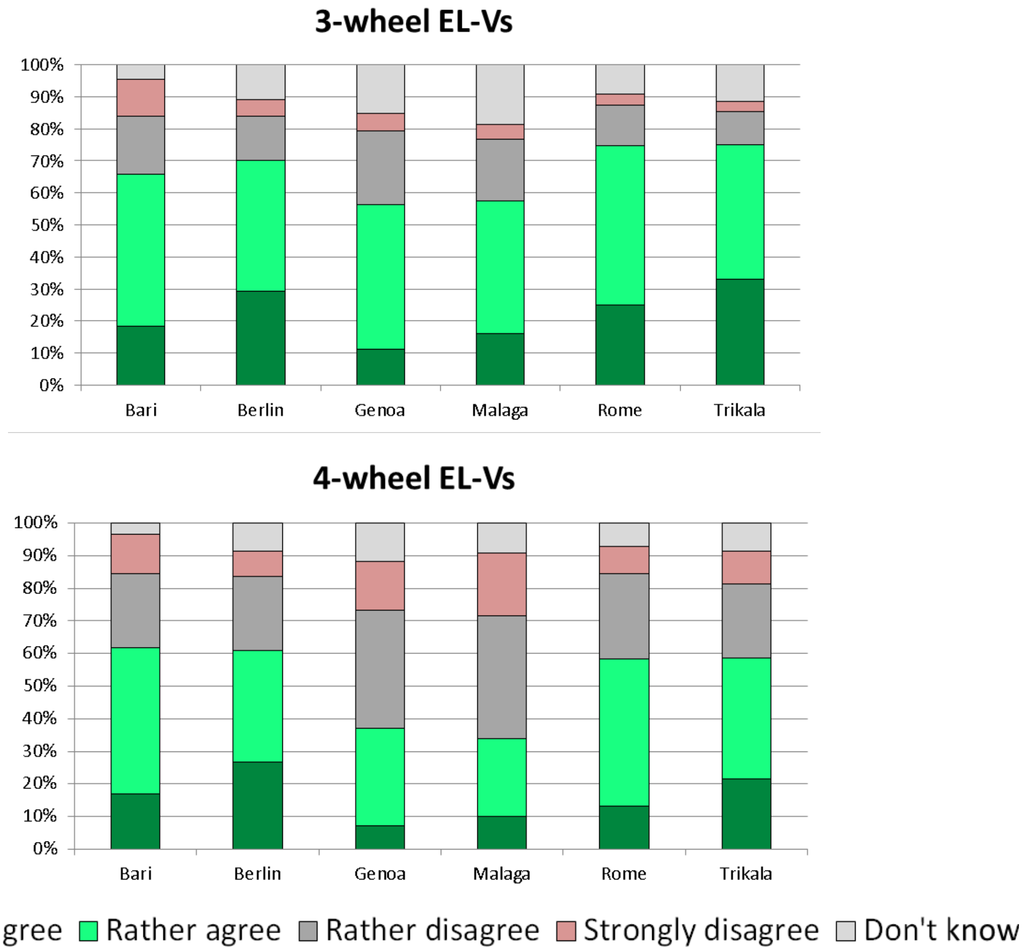


Figure 56: Perceptions of Parking easiness of EL-Vs by city

6.5.3 Safety of EL-Vs

Perceptions of EL-V safety increased with the vehicle size (number of wheels). Men were slightly more likely than women to say that they would feel safe using one. Younger age groups would also feel safer than older ones, although the difference is less marked for 4-wheeled EL-Vs.

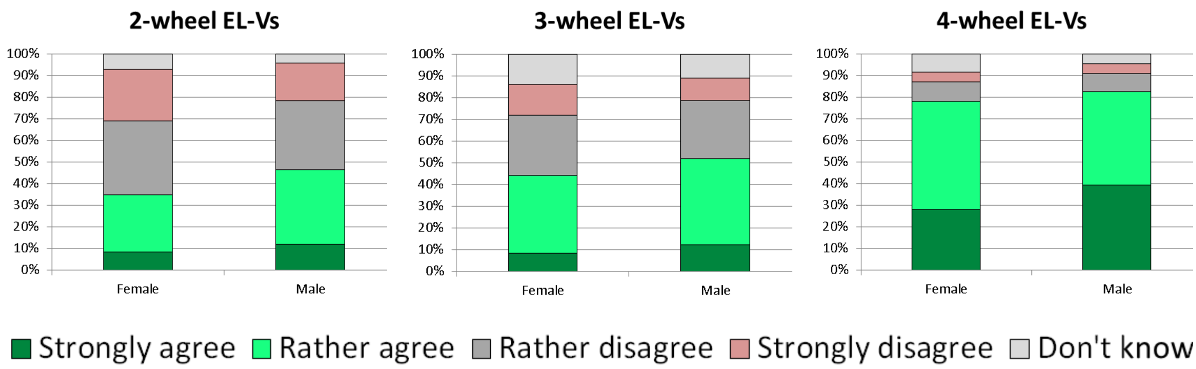


Figure 57: Perceptions of Safety of EL-Vs for all cities (split by gender)

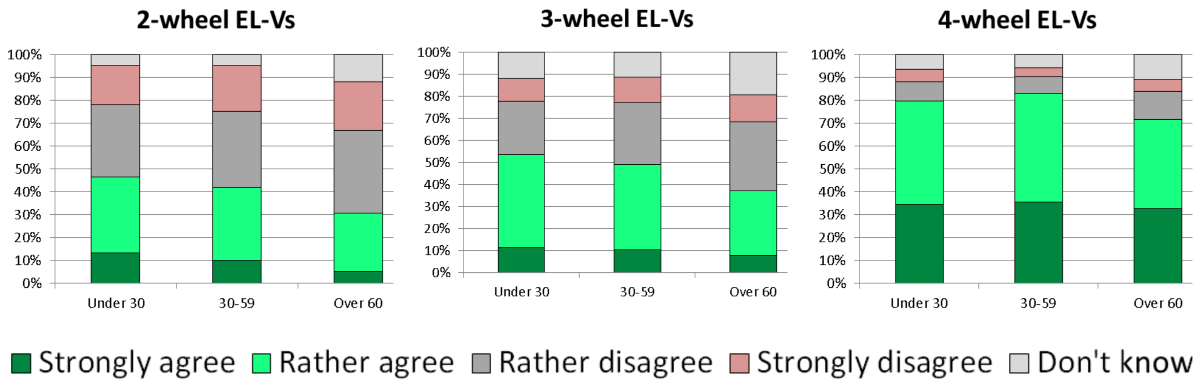
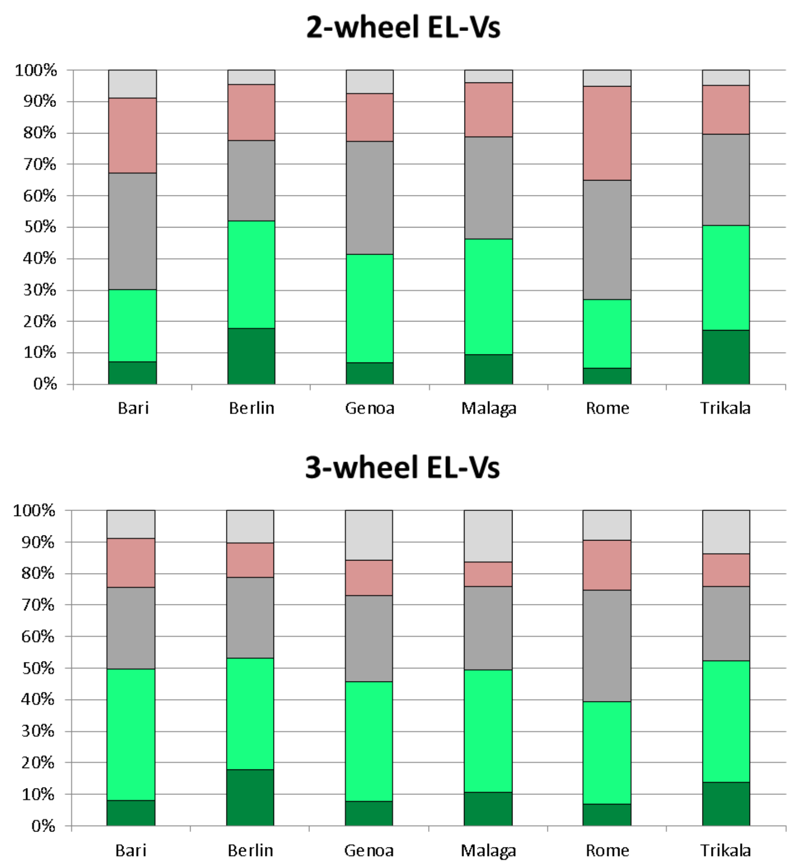


Figure 58: Perceptions of Safety of EL-Vs for all cities (split by age group)

By city, a higher proportion of respondents in Berlin and Trikala stated that they would feel safe using EL-Vs (for all types), with just over 50% agreeing (either rather or strongly) about the safety of 2-wheeled EL-Vs. Respondents from Rome and Bari were less likely to agree with this statement, especially for 2-wheeled EL-Vs, where the numbers who (either rather or strongly) did think they were safe exceeding the numbers who (either rather or strongly) agreed that they were safe. For 3 and 4-wheeled EL-Vs, there was less difference between the views from the different cities, and for 4-wheelers, large majorities in every city (between 75% for Bari and 85% for Málaga) agreed (either rather or strongly) that they would feel safe using one.



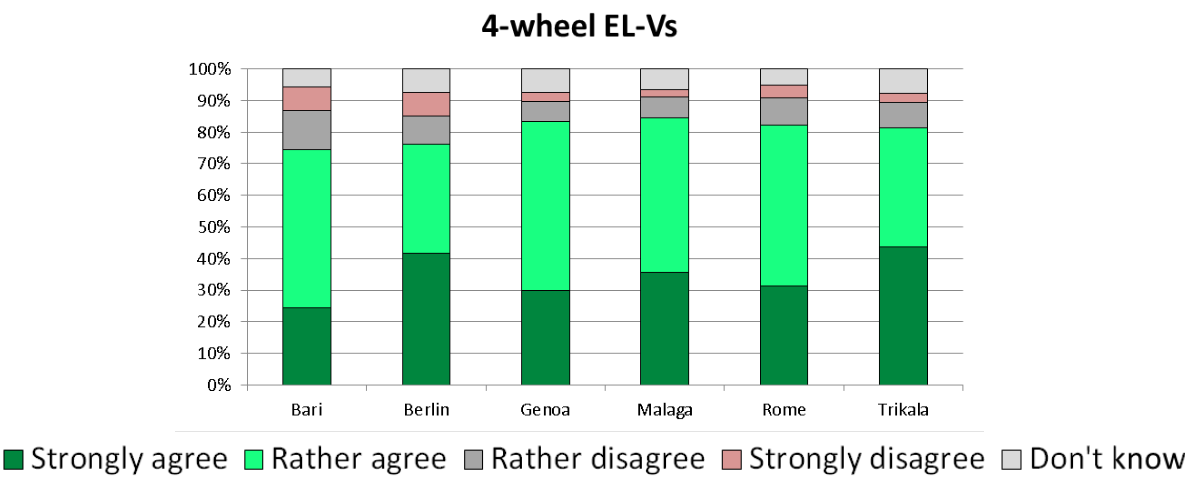


Figure 59: Perceptions of Safety of EL-Vs by city

6.5.4 Convenience of charging of EL-Vs

Perceptions on the convenience of electrically charging EL-Vs hardly differed at all according to the number of wheels. Men and younger respondents were slightly more likely than women or older age groups to consider them convenient to charge.

There were high proportions of "don't knows" across all categories, which may be explained because most respondents should not have had direct experience in charging an electric vehicle and therefore could have felt unable to judge, or unaware of what charging infrastructure exists in their city.

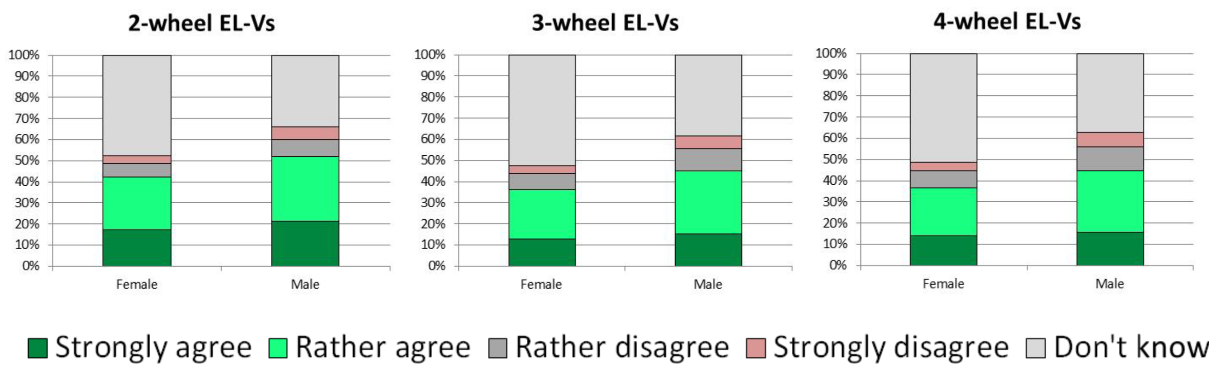


Figure 60: Perceptions of Charging convenience of EL-Vs for all cities (split by gender)

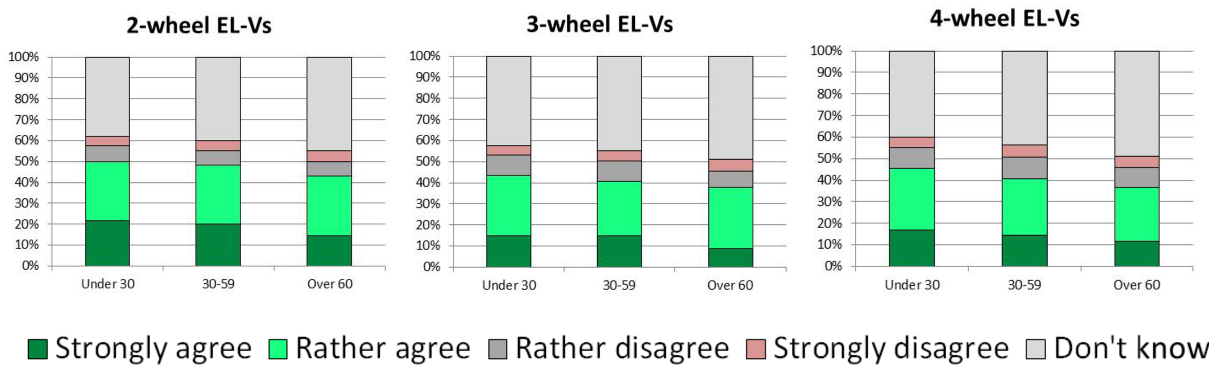


Figure 61: Perceptions of Charging convenience of EL-Vs for all cities (split by age group)

Respondents in Bari and Rome considered charging to be more convenient than those in other cities, including Berlin even though that city currently has the most comprehensive charging infrastructure of the six demonstration cities. Málaga and Trikala respondents were least likely to consider charging to be convenient, with the greatest proportion of “don’t know” being from Trikala (which at present has no public charging infrastructure network).

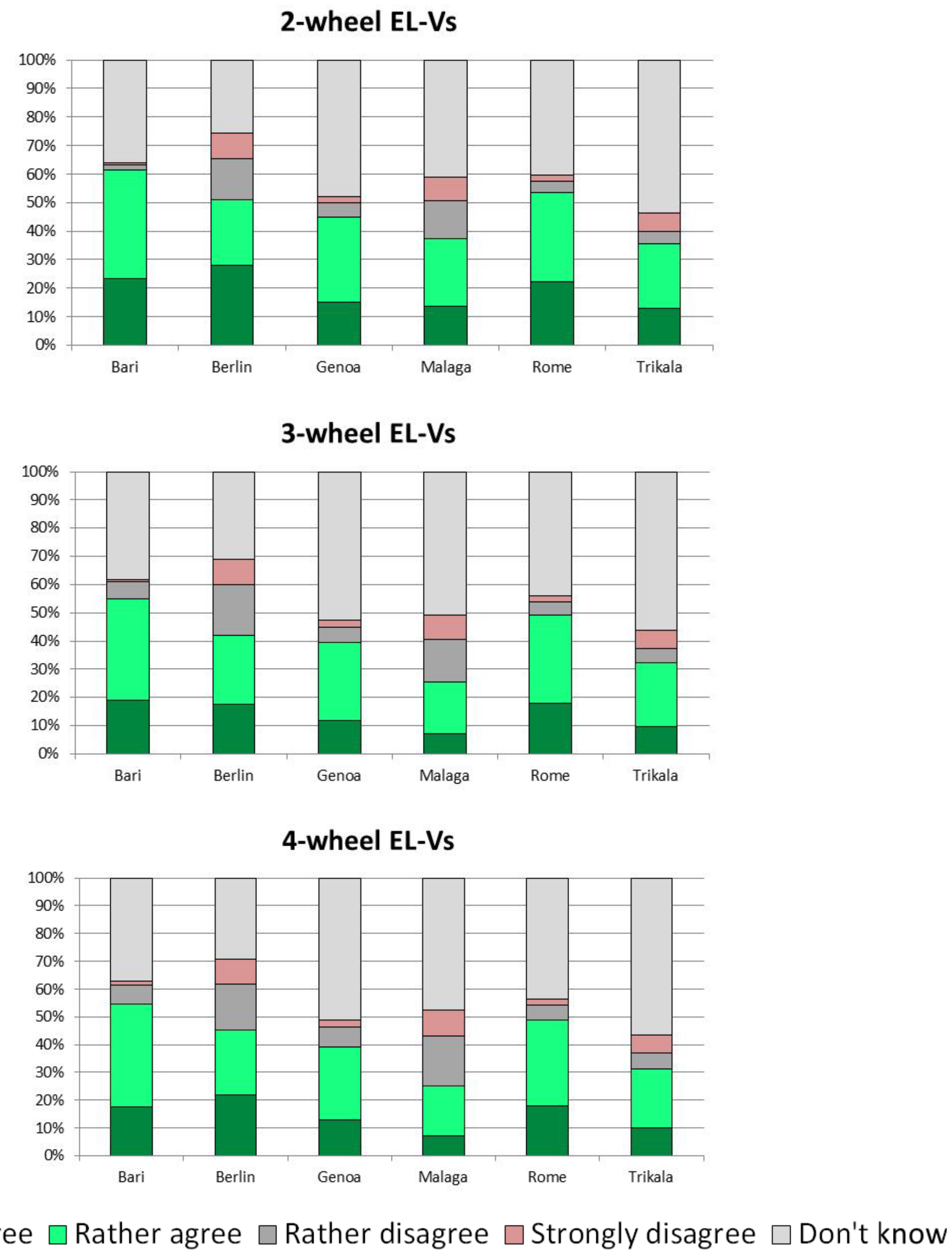


Figure 62: Perceptions of Charging convenience of EL-Vs by city

6.5.5 Affordability of using and operating EL-Vs

The affordability of 2-wheel EL-Vs was considered to be better than for 3 and 4-wheelers (with little difference in perception between these latter two categories). Men were slightly more likely than women to consider EL-Vs as being affordable, while there were no significant differences in this question by age group.

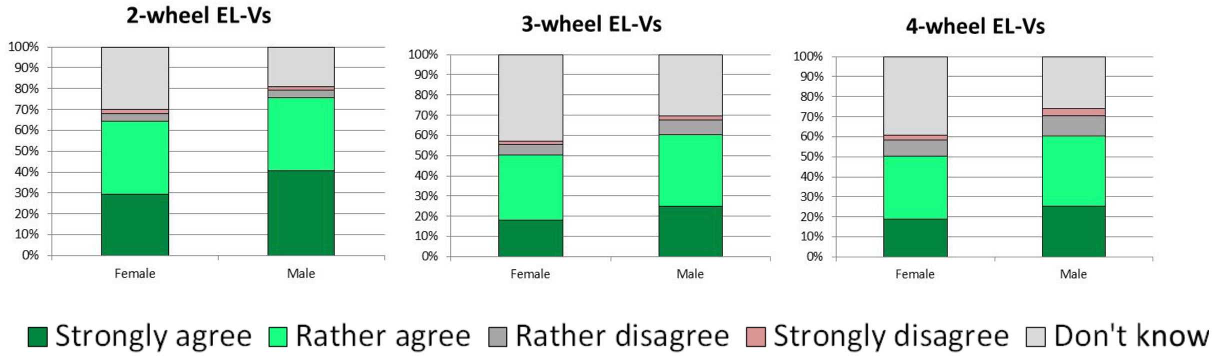


Figure 63: Perceptions of Affordability of EL-Vs for all cities (split by gender)

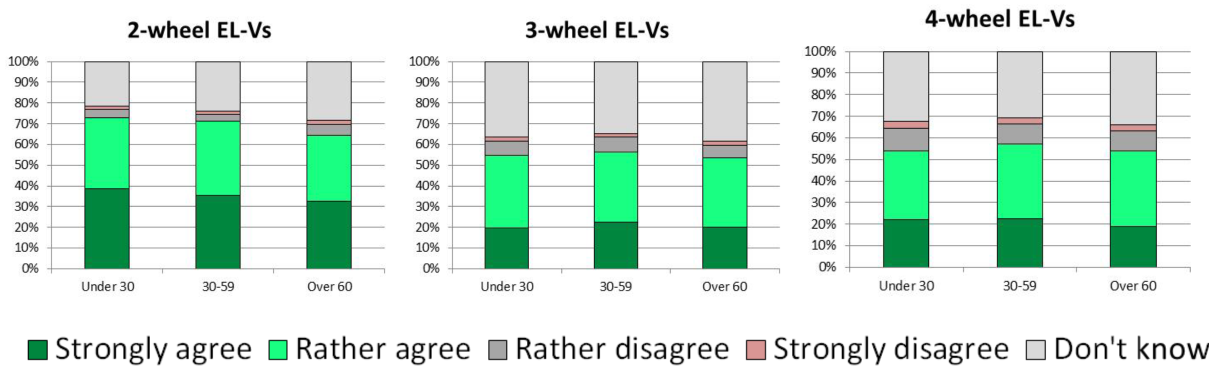


Figure 64: Perceptions of Affordability of EL-Vs for all cities (split by age group)

By city, respondents from Bari and Málaga were more likely to consider EL-Vs as being affordable and Berlin was least likely. Berlin was the only city where the numbers “rather” or “strongly” agreeing were below 40% for 3 and 4-wheel EL-Vs (perhaps surprising as Berlin is the richest city out of the six). Another anomaly was that in Málaga, 4-wheeled EL-Vs were considered affordable by more people than were 3-wheeled EL-Vs.

Figure 65: Perceptions of Affordability of EL-Vs by city

6.5.6 Luggage capacity EL-Vs

Respondents agreeing that luggage capacity was sufficient for their needs increased with the number of wheels of the EL-V. Men and younger age groups were more likely to agree with this statement than women and older age groups, although differences among these were very slight. Overall, between 20 and 30% of respondents considered (either rather or strongly) that 2-wheelers have sufficient luggage capacity, rising to over 60% for 4-wheeled EL-Vs.

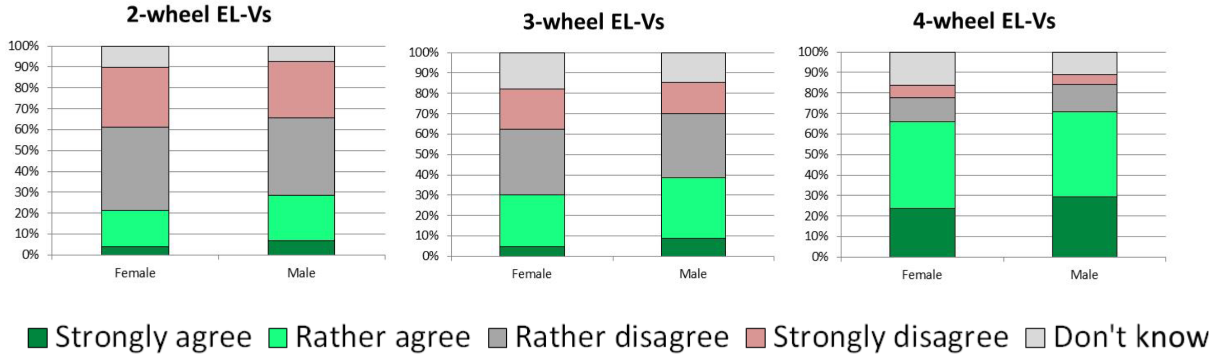


Figure 66: Perceptions of Luggage capacity of EL-Vs for all cities (split by gender)

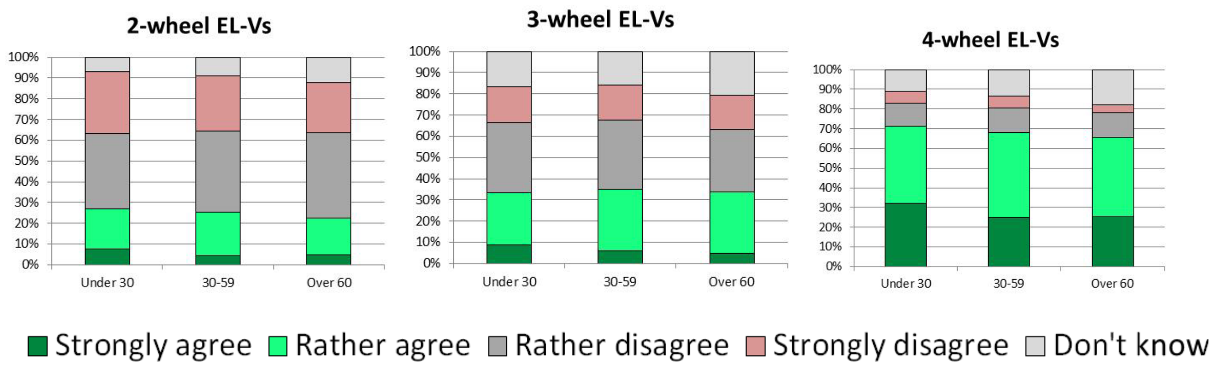


Figure 67: Perceptions of Luggage capacity of EL-Vs for all cities (split by age group)

Berlin was the city that agreed the most that luggage capacity was sufficient, although for 2-wheelers this only constituted 10% strongly agreeing to this statement and a further 18% rather agreeing. Trikala was also more positive about capacity for 3 and 4-wheeled EL-Vs. The lowest ratings for luggage capacity were from Málaga, Genoa and Rome.

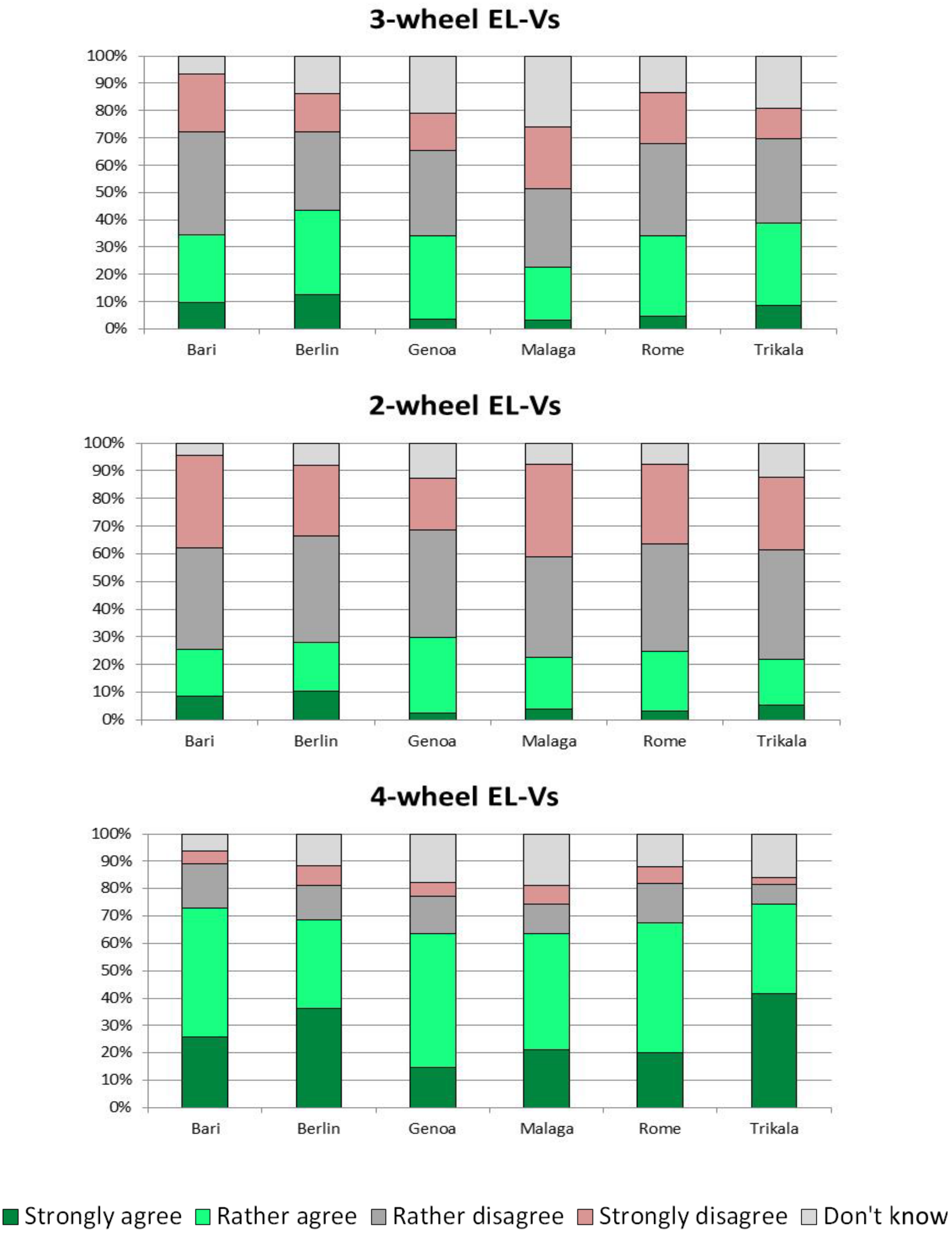


Figure 68: Perceptions of Luggage capacity of EL-Vs by city

6.6 Willingness to use EL-Vs as part of a multimodal trip

Respondents were asked "do you, or would you consider, using one of these kinds of electric vehicles as a part of multi-modal journey, with for instance public transport?" This was a multiple-choice question with only one possible answer. The results for all six cities are given in Figure 69.

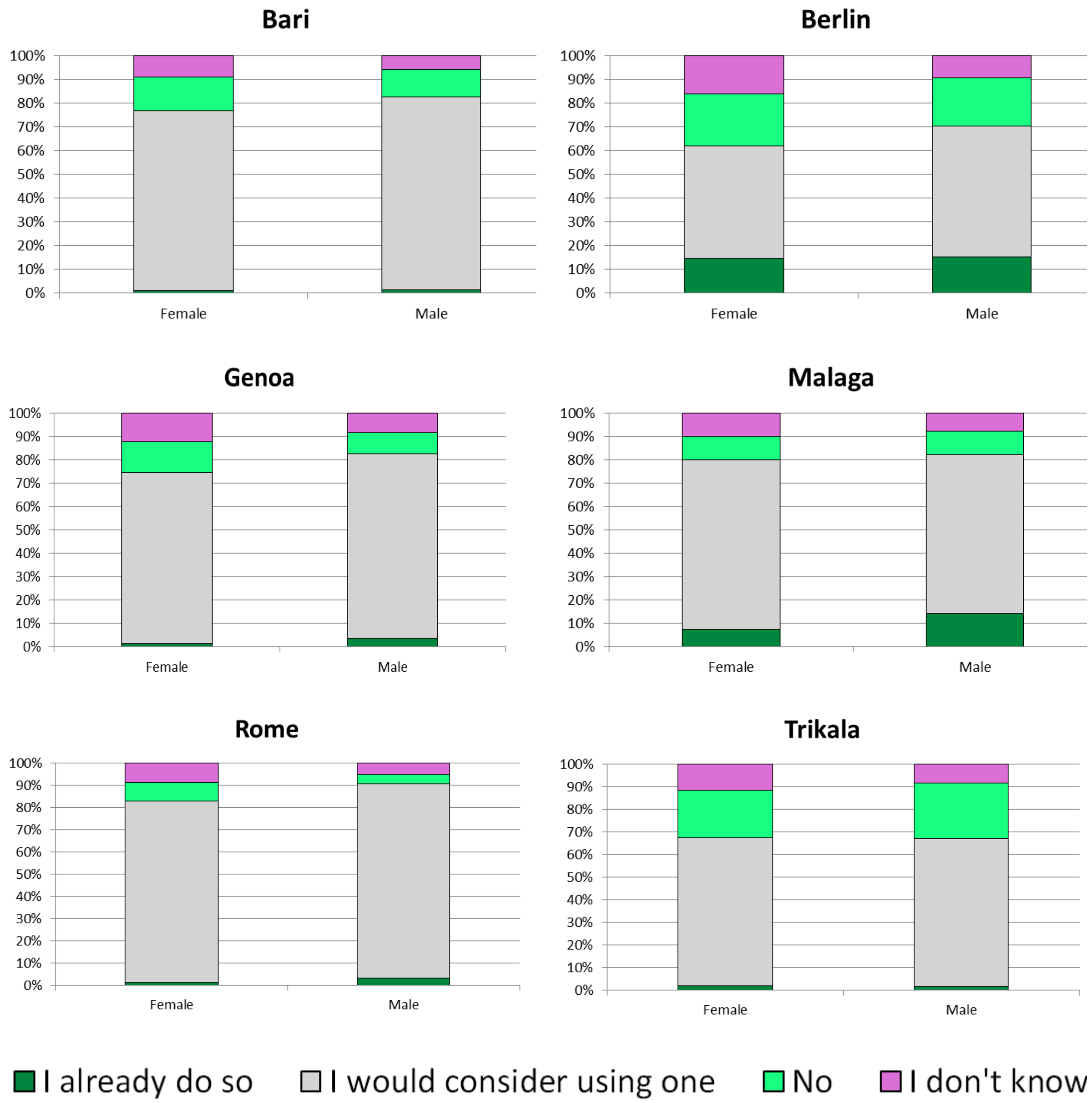


Figure 69: Willingness to use EL-Vs as part of multimodal journey

Very few people use EL-Vs as part of multimodal journeys at present, except for some in Berlin and Málaga, although it is possible that some respondents might have understood this question as relating to use of ICE L-Vs as well.

A considerable majority in the three Italian cities and Málaga said they would consider using EL-Vs as part of a multimodal journey. Although this is only a stated preference study and does not commit people, the level of positive consideration is quite impressive. Even in Berlin, where enthusiasm appears to be more muted, people who would consider using an EL-V in this way are still the biggest category.

According to gender, there was a slight propensity for men to be more likely to consider using EL-Vs as part of a multimodal journey than women, except in Trikala where the level of interest between men and women was almost the same.

6.7 Measures to encourage use of EL-Vs

This question asked "what in your opinion are the most necessary measures to encourage greater use of these kinds of electric vehicles?" Respondents were invited to select up to three from the following, although (due to the online questionnaire structure) it was possible for them to select more than three. The measures proposed in the questionnaire were:

- Sufficient secure parking
- Sufficient electric charging infrastructure
- Offer sharing schemes for such vehicles
- Integrated payment or card for sharing such vehicles and public transport
- Allow use of bus and cycle lanes by 2- or 3-wheel electric vehicles
- Navigation services aimed at electric light vehicles
- User assistance (rescue, information or training services)
- Incentive schemes for purchase or renting
- Other ideas (free text answer in own language – these are summarised in English for each city in section below).

Figure 70 to Figure 75 show the relative popularity of each measure to encourage EL-V use for each of the six demonstration cities. The following graphs show each of these measures in absolute numbers (percentages do not apply because people can select more than one). Hence, they show the relative popularity of each measure. Measures with fewer "votes" are not necessarily unpopular or unwanted; they might just not be in people's top three priorities.

6.7.1 Popularity of measures per city

Sufficient electric charging infrastructure was the most popular measure in every city, but the second most popular measure varied, with incentive schemes taking second place in Bari and Trikala, sufficient secure parking in Berlin and Málaga, and allowing use of bus lanes by EL-Vs in Genoa and Rome.

Across five of the cities, navigation services for EL-Vs and user assistance took the bottom two places, but in Berlin the measure receiving the fewest "votes" was incentive schemes, in direct contrast to Bari and Trikala.

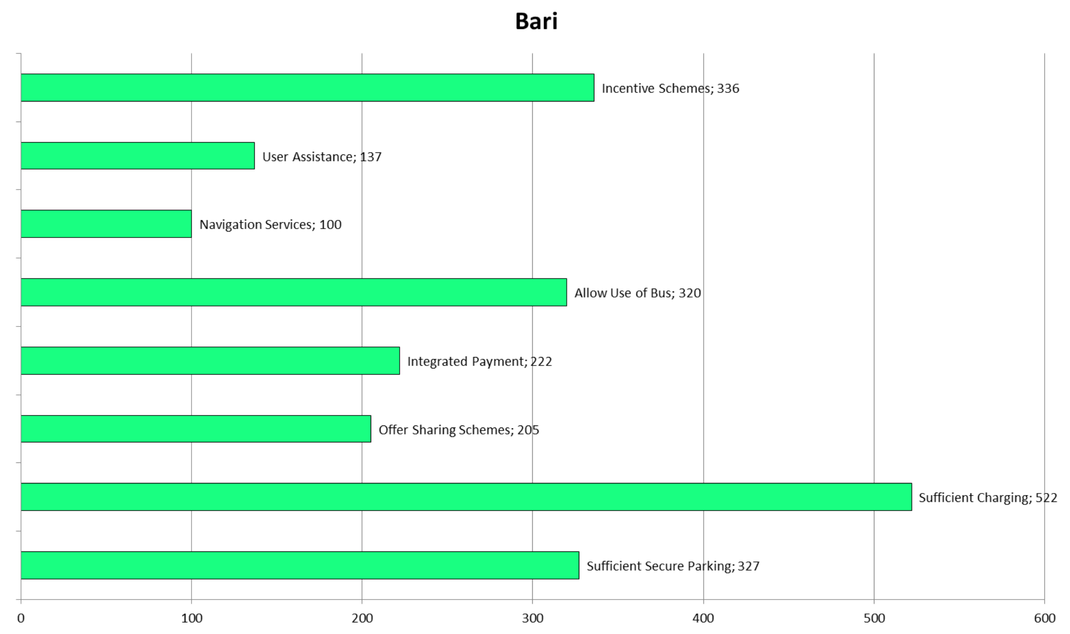


Figure 70: Preferred measures to facilitate use of EL-Vs, Bari

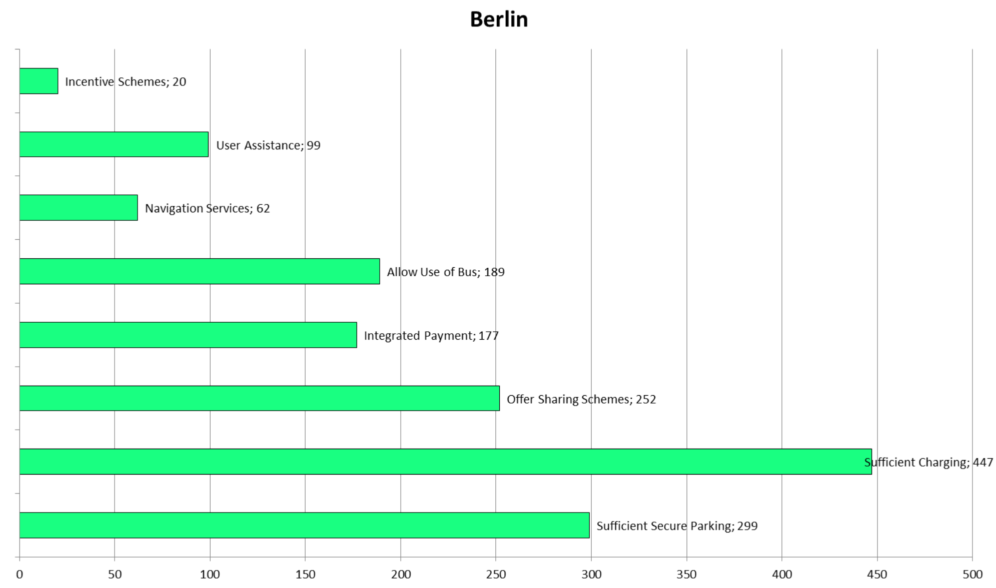


Figure 71: Preferred measures to facilitate use of EL-Vs, Berlin

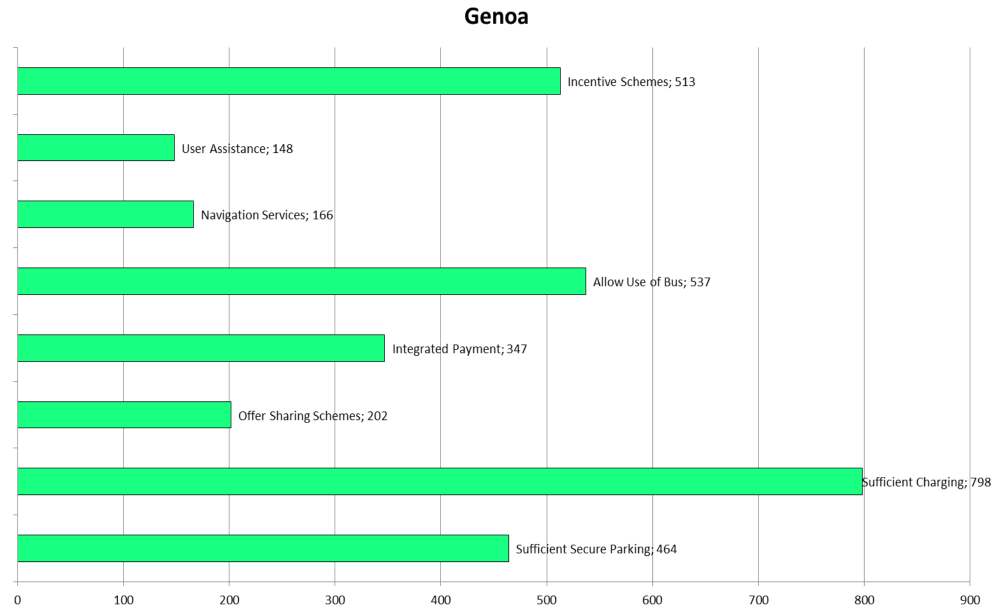


Figure 72: Preferred measures to facilitate use of EL-Vs, Genoa

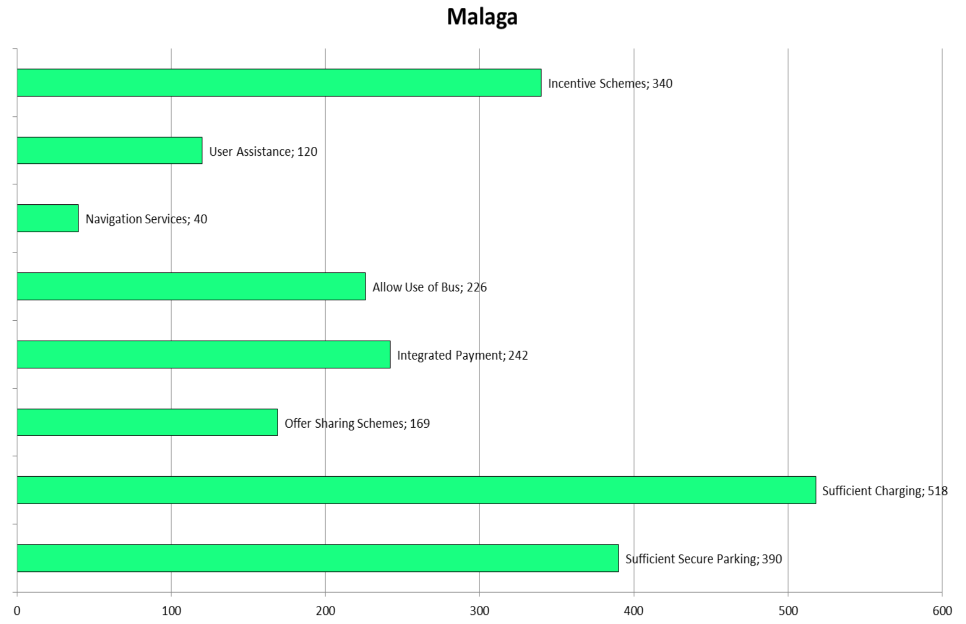


Figure 73: Preferred measures to facilitate use of EL-Vs, Málaga

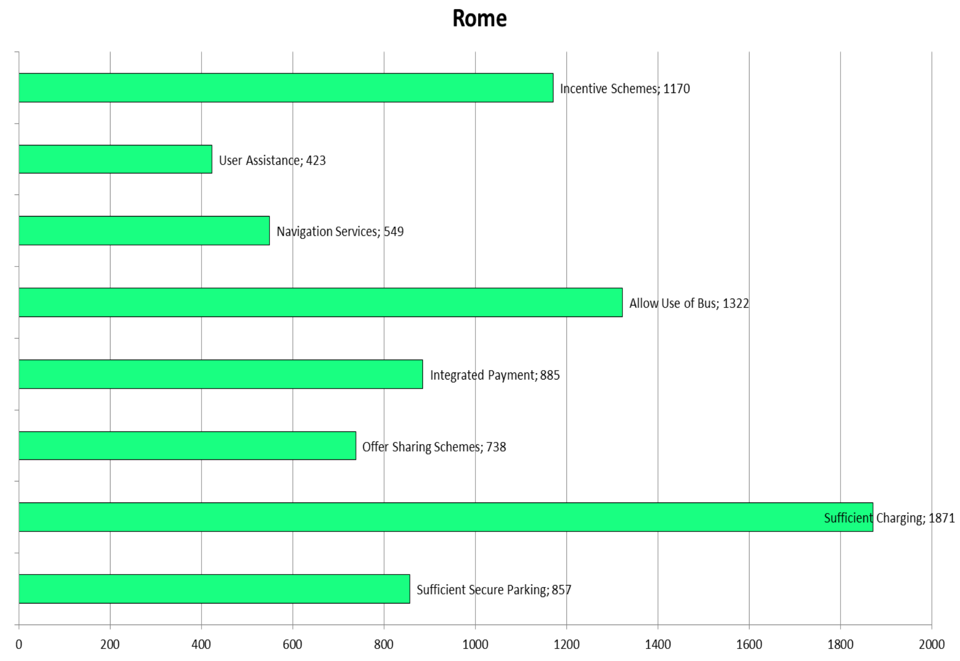


Figure 74: Preferred measures to facilitate use of EL-Vs, Rome

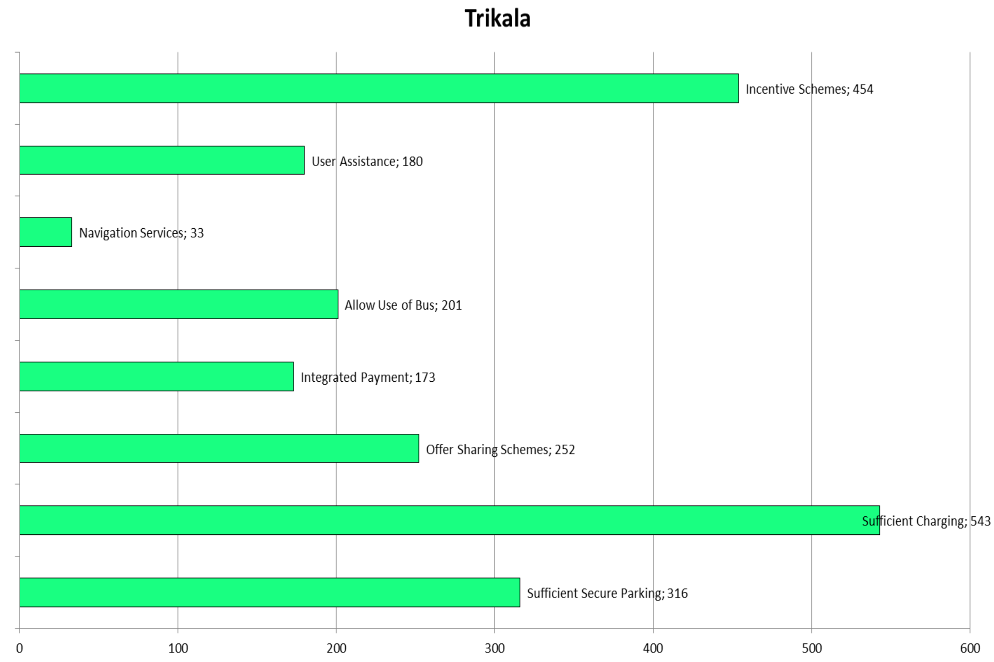


Figure 75: Preferred measures to facilitate use of EL-Vs, Trikala

6.7.2 Text comments for other measures

The following is a translated summary of the main types of other measures or other miscellaneous comments (as this was the only question permitting a free text response) per city.

Bari

For the city of Bari, 24 comments were received about the most necessary measures to encourage greater use of EL-Vs. In particular:

- Three suggestions identified as strategy the use of adequate systems to block and deposit the vehicles to guarantee the security of vehicle by thefts and vandalism phenomena.
- Six suggested increasing the road infrastructure, by guaranteeing dedicated parking slots for electric vehicles, more cycle paths, increasing the limited zone traffic (ZTL) with free access only for these vehicles.
- One suggestion identified as solution the widespread diffusion of these vehicles in the city so that users can find the vehicles very close to own home.
- One comment focused on the long-term booking possibility for these vehicles.
- One participant suggested that municipality should oblige the reduction of ICE vehicles uses in the city.
- Three suggestions pointed out to increase the implementation of electric vehicles with public transport systems, in order to increase the inter-modal changes and the public transport offer.
- Another suggested that the private companies give to their employees shared electric vehicles to reach the workplace.
- Two respondents underlined the necessity to increase the electric infrastructure in the city and that each building, above all residential buildings, has a parking area provided with charging points for electric vehicles.
- Three suggested the necessity to have adequate economic incentives and tax reductions to buy these vehicles.
- Two proposed to increase the advertising and the demonstration tests of these vehicles so that citizens try and become more confident in driving them.
- One suggested that these vehicles should have adequate and bigger baggage space.

Berlin

From Berlin, there were 35 relevant textual comments. These are summarised as follows:

- 15 regarded the price, with concerns on the high price of buying or renting light electric vehicles.
- Five participants had concerns about the safety of EL-Vs.
- Four comments were about the missing charging infrastructure and the vehicles themselves.
- Other comments mentioned the limited choice of EL-Vs and the load capacity.

Genoa

For the city of Genoa, around 80 comments were collected, some of which included more than one suggestion. The main topics (with numbers of respondents mentioning this topic) were as follows:

- Interoperability with cars, through more accessible interchange parking located out of the centre, prohibition for polluting vehicles to the city centre and discounts for parking fees (12).
- Purchasing and sharing incentives and facilities, e.g. bonus by the employer, free trial periods and economic facilities for young people (11).
- Reduction of purchasing and running costs of the vehicles (10).

- More interoperability with public transport, through an improvement of the public service: more frequent, widespread, reserved lanes for buses, different tariff systems for distance categories, etc. (8).
- More awareness and knowledge of the vehicle: training to the users, trial days, knowledge of guarantee conditions, battery autonomy, etc. (5).
- More safety in the use of all light vehicles, e.g. improving road conditions (5).
- Longer bike path network in the city (5).
- More charging infrastructure (4).
- More battery autonomy of the vehicles (3).
- More space on board of electric vehicles, both in terms of space for safety helmet and clothes and also for other passengers (3).
- Free flow sharing (3).
- More facility for renting, including more pickup points, easy cash or ATM payment and inclusion of a certain number of charging in the long-term renting costs (3).
- Lower taxation for electric vehicles (3).
- Antitheft systems for e-vehicles and security issues (2).
- More models and improvement of the appearance of the vehicles (2).
- More safety and facility in the use of e-bikes, through reserved lanes and bike racks (2).
- Faster charging sessions (1).
- Adaptability to retired people (1).
- Customer assistance included in the purchasing cost (1).
- Update of rules about the use of electric vehicles, e.g. pedelecs (1).
- More electric vehicles used for Public Administration fleet (1).
- More interoperability with all the public transport services through a prepaid card (1).
- Induction systems in the streets (1).
- Creation of purchasing groups of municipality employees (1).
- Incentivise the production of alternative energies (1).

Málaga

For Málaga, 73 relevant text comments were received:

- Twenty-two of them pointed out the need for safer road infrastructure and risks due to drivers not driving with consideration to others or within the law.
- Twenty-one mentioned limited traffic zones and that there should be more areas where cars are banned but EL-Vs are allowed, and another supported use of bike lanes.
- Eighteen said that the price of a sharing scheme or buying EL-Vs would need to be attractive to encourage usage.
- Twelve comments said that would need more parking spaces specific for these vehicles.
- Seven comments supported closer integration with public transport or with the multimodal use of the transport.
- Three comments mentioned that improvements were needed to the maintaining of the bike sharing system of Málaga.

Rome

For the city of Rome, just over 200 relevant textual comments were received, (about 11% of the total number of people who answered the online questionnaire). Their suggestions concerned three main key themes: Road Safety, Infrastructures and Discounts and Promotions.

The Road safety (52) theme mainly regarded the poor conditions of the road surface. Among them, one said that EL-Vs are not suitable for the transportation of children, elderly or disabled people. A small group (11) also suggested the use of alarms and visual surveillance to prevent theft and damage to parked vehicles.

Concerning Infrastructures (39), all opinions focus on the need to build dedicated lanes, ad-hoc parking areas and recharging points for electrical vehicles. Some others suggested that all of these infrastructures should be present in the suburbs, also beyond the GRA (Grande Raccordo Anulare, the road ring which surrounds Rome).

Finally, most of those who expressed their opinion on Discounts and Promotions (38), suggested to reduce both purchase and maintenance costs. One person suggested entering into agreements with large companies to motivate their employees to use EL-Vs in exchange for tax benefits.

Alongside these three major groups a set of non-critical proposals were made in order to spread the use of electric vehicles (42). Most of those who added comments (18) have proposed to introduce bans and sanctions in order to stimulate a change in habits considered as harmful to the environment. They further suggested to:

- introduce fines and stricter regulations to sanction the use of polluting vehicles;
- increase the price of petrol and diesel;
- encourage teleworking or modulate working and school hours in order to avoid large concentration of traffic during the rush hours.

Others are in favour of improving the access to car sharing (10) of smartphone apps (8) and the dissemination of more information regarding electric vehicles (6).

Finally, there was a number (42) of critical comments of various kinds. Some (14) especially referring to the duration of the recharge, problems not yet solved on the lack of autonomy that do not allow electric vehicles to cover long distances (3). Others (11) argue that the greater diffusion of EL-Vs is not sufficient to solve the problems of traffic and pollution in a large city like Rome. Finally, others (6) suggested that strengthening the public transport system is more important to solve the problems of city mobility.

Trikala

For Trikala, 24 “free text” answers were received, highlighting people’s views on the adoption of potential measures that could boost the electric vehicles uptake and use.

- Five out of 24, pointed out the importance of financial and monetary incentives, such as tax credits, subsides and road tax exemptions.
- A same number of people illustrated the significance of deploying the appropriate and suitable infrastructure, such as dedicated lanes, as well as legislation (e.g. control of illegal parking) and other incentives (e.g. allowing EL-Vs in restricted areas like the city centre).
- A major concern for five out of 24 people was safety of use of EL-Vs, as regards protection from the weather conditions and during driving.
- Three out of 24 people mentioned the affordability of purchasing or renting an electric vehicle, as an important issue encouraging their use.
- Three people suggested a change in people’s attitudes towards the use of such vehicles in terms of adopting a more ecological perspective and more responsible driving behaviour.

- One respondent proposed the existence of instantaneous availability in rented electric vehicles.
- One person commented that no driving licence should be required for light electric vehicles.
- One person was not in favour of electric vehicles.

7 Validity of measurement model and hypotheses test

7.1 Constructs, indicators and moderators proposed

Based on the UTAUT construct methodology presented in sub-Chapter 4.1, this Chapter explores a number of hypotheses around eight user perceptions and attitudes (indicators) that influence mobility behavioural intention, moderated by gender, age and occupation, as follows:

Table 36: Mapping of indicators (perceptions/attitudes) per construct

UTAUT construct	Indicator (Perception/Attitude)	Relevance
Behavioural Intention (BI)	*BI1: Willingness to use*	It portrays if the user is willing to use EL-Vs in the future according to his/her mobility needs.
	BI2: Willingness to use as a part of a multimodal trip	It conveys if the user is willing to use EL-Vs in the future in a trip involving other modes of transport.
Performance Expectancy (PE)	*PE1: Ease of parking*	It reveals if the user perceives parking the EL-V would be as easy and secure as with a similar ICE (combustion-powered) vehicle.
	PE2: Comfort	It conveys if travelling with the EL-V is perceived as comfortable as with a similar ICE (combustion-powered) vehicle.
	PE3: Safety	It shows if the user would feel as safe during the trip with the EL-V as with a similar ICE (combustion-powered) vehicle.
	PE4: Luggage capacity	It reveals if the user feels the EL-V has sufficient luggage capacity for his/her needs.
Facilitating Conditions (FC)	*FC1: Charging convenience*	It portrays if the user feels the charging would be convenient for his/her needs.
Price Value (PV)	*PV1: Affordability*	It portrays if the EL-V is perceived to be as affordable to use and operate than a similar ICE (combustion-powered) vehicle.
Moderators		
Gender, Age, Occupation	Background questionnaire	Background data related to demographics.

The online survey designed in sub-Chapter 4.4 contains specific questions that address each of the variables (eight indicator and three moderators) mentioned above:

Table 37: Questions about perceptions/attitudes per UTAUT construct

UTAUT construct	Indicator (Perception/Attitude)	Question in online questionnaire
Behavioural Intention (BI)	*BI1: Willingness to use*	Question 13
	BI2: Willingness to use as a part of a multimodal trip	Question 22
Performance Expectancy (PE)	*PE1: Ease of parking*	Question 17
	PE2: Comfort	Question 16
	PE3: Safety	Question 18
	PE4: Luggage capacity	Question 21
Facilitating Conditions (FC)	*FC1: Charging convenience*	Question 19
Price Value (PV)	*PV1: Affordability*	Question 20
Moderators		
Gender		Question 25
Age		Question 26
Occupation		Question 27

7.2 Data analysis

In order to achieve an expressive and relevant data analysis, the available survey data must be first filtered, then the 11 selected variables (eight indicators and three moderators, as per Table 36 and Table 37) are grouped into different constructs, as proposed by the Unified Theory of Acceptance and Use of Technology (UTAUT) model presented by Venkatesh *et al.* (2003) [84], and in addition the final composite reliability and the average variance extracted. Finally, correlations between the different constructs are analysed using a Pearson bivariate correlation and conclusions of this analysis are drawn.

7.2.1 Filtering of dataset

In total, and in the context of the online survey, 6,753 questionnaires were fully completed (27 questions), of which 6,419 were from the six demonstration cities (or nearby towns). A further 637 questionnaires were partially completed (at least up to Question 13), of which 569 were from the demonstration cities. The generic data analysis of the online survey has been presented in Chapter 6.

However, for the purpose of this Chapter, it is relevant to secure survey questions 13, 16, 17, 18, 19, 20, 21, 22, 25, 26 and 27 were answered, as described in Table 37 above. To do so, the 7,357 suitable surveys have been filtered.

In a first step, all datasets were merged into one and irrelevant answers (such as incomplete survey responses) were filtered and eliminated from the dataset. After the quality control and filtering of the data, 6885 datapoints remained and all data was turned into numerical values, in order to analyse those questions, which were designed as Likert scales. For those questions which required the participants to rank their answers, the lowest value (1) also represents the lowest acceptance or agreement, while the highest value (4) represents absolute acceptance or agreement, while the values 5 and 6 mean "*I don't know*" and "*Exclude from analysis*" respectively.

The following table shows the questions that were selected for the data analysis, in order to focus only on aspects and indicators or relevance to this thesis. As is visible in the table, each question had as possible answers a set of ranked Likert-scale responses:

Table 38: Relevant questions from online survey

13.	If there was a sharing scheme for these kinds of light electric vehicles in your local area, would you consider using it?	1 2 3 4 5 6 Blank	Yes, frequently Yes, occasionally Maybe No, I would prefer to buy my own one No, I would not use such a vehicle I don't know Exclude from analysis of this question
16.	Travelling with it is comfortable irrelevant of the weather conditions	1 2 3 4 5 Blank	I strongly disagree I rather disagree I rather agree I strongly agree I don't know Exclude from analysis of Q16
17.	Parking is easy and secure	1 2 3 4 5 Blank	I strongly disagree I rather disagree I rather agree I strongly agree I don't know Exclude from analysis of Q17
18.	I would feel safe during the trip	1 2 3 4 5 Blank	I strongly disagree I rather disagree I rather agree I strongly agree I don't know Exclude from analysis of Q18
19.	Charging is convenient	1 2 3 4 5 Blank	I strongly disagree I rather disagree I rather agree I strongly agree I don't know Exclude from analysis of Q19
20.	It is affordable to use and operate	1 2 3 4 5 Blank	I strongly disagree I rather disagree I rather agree I strongly agree I don't know Exclude from analysis of Q20
21.	It has sufficient luggage capacity for my needs	1 2 3 4 5 Blank	I strongly disagree I rather disagree I rather agree I strongly agree I don't know Exclude from analysis of Q21
22.	Do you or would you consider using one of these kinds of electric vehicles as a part of multi-modal journey, with for instance public transport?	1 2 3 4 Blank	I already do so I would consider using one No I don't know Exclude from analysis of Q22
25.	Are you:	1 2 3 or blank	Female Male Prefer not to say or no answer (Exclude from analysis of Q25)
26.	Please tell us your age:	1 2 3 4 5 Blank	Under 18 18-29 30-59 60-74 75 and more Exclude from analysis of Q26
27.	What is your current occupation?	1 2 3 4 5 6 Blank	In education/student Full-time employment Part-time employment Unemployed Retired Other Exclude from analysis of Q24

7.3 UTAT model and construct attribution

In order to attribute the variables to constructs as per the UTAUT model, a Principle Component Analysis (PCA) is conducted following Jolliffe *et al.* (2016) [88], which serves in achieving a better overview over this large dataset, which is also quite multidimensional with 11 variables. Conducting this analysis allows a better interpretability of the data and the grouping of variables into joined constructs and requires first the standardization of the data. Following the PCA, a Varimax rotation with Kaiser normalization is also added to be able to easily identify related variables at a glance by rotating orthogonally to align with the relevant coordinates within the coordinate system (Kaiser, 1958) [89].

Equation 1: Principle Component Analysis and Varimax Rotation

$$\boldsymbol{P}rinciple\ \boldsymbol{C}omponent\ \boldsymbol{A}nalysis\ (\boldsymbol{PCA}) = Z = XS^{-1}$$

$$Varimax\ Rotation = \frac{1}{k} * \sum_{j=1}^{m} [\sum_{i=1}^{k} \left(\frac{b_{ij}^2}{\varphi_i}\right)^2 - (\frac{1}{k}\sum_{i=1}^{k} \left(\frac{b_{ij}^2}{\varphi_i}\right)^2]^2$$

Herein X is the data matrix, S is the diagonal matrix of standard deviations.

As a result, the following rotated component matrix is achieved, which indicates clearly, which variables could be grouped together into constructs respectively.

Table 39: Rotated Component Matrix per indicator/moderator

Question	Indicator	1	2	3	4
Q13	Usage	-.013	-.034	**.804**	.131
Q22	Multi-modality	-.015	.032	**.803**	.089
Q18	Safety	**.800**	-.008	-.031	-.006
Q17	Parking	**.578**	.150	.057	-.120
Q16	Comfort	**.789**	-.020	-.088	.062
Q19	Charging	.164	**.842**	.021	.026
Q21	Luggage	**.678**	.225	-.048	.055
Q20	Affordabilit y	.152	**.841**	.025	.039
Q25	Gender	.083	-.295	-.339	**.139**
Q26	Age	-.048	.027	-.028	**.854**
Q27	Occupation	.025	-.006	.182	**.798**

It became obvious after this analysis that the variable explored with question 25, concerning the gender of the survey participants, does not align with any of the other variables. As evidenced in the previous analysis in Chapter 6, it can be assumed that the gender dimension has a very limited impact on the rest of the responses to this survey and therefore can be neglected in this analysis. The question has therefore been removed from the dataset.

The questions and their respective indicators are grouped into different constructs, which can be compared across questions to give a more complete picture of relationships between different constructs.

To ensure that the questions fit with each of the constructs and to prove convergent validity, the examination of two parameters are conducted:

1. Composite Reliability (**CR**) of >0.7 is required to measure the internal consistency of scale items, as highlighted by Netemeyer *et al.* (2003) [90]. This measure summarises the true score variance and puts it into perspective to the total scale score variance, according to Brunner *et al.* (2005) [91]. Therefore, it can be considered as the shared variance of all variables.
2. Average Variance Extracted (**AVE**) of >0.5 from the measures is required as per Fornell et al. (1981) [92].

Equation 2: Composite Reliability and Average Variance Extracted

$$Composite\ \boldsymbol{R}eliability\ (\boldsymbol{CR}) = \frac{(\sum_{i=1}^{p} \lambda_i)}{(\sum_{i=1}^{p} \lambda_i)^2 + \sum_i^p Var(\boldsymbol{e}_i)}$$

$$Average\ \boldsymbol{V}ariance\ \boldsymbol{E}xtracted\ (\boldsymbol{AVE}) = \frac{(\sum_{i=1}^{p} \lambda_i)^2}{(\sum_{i=1}^{p} \lambda_i)^2 + \sum_i^p Var(\boldsymbol{e}_i)}$$

Wherein p is the number of items, λ_i the factor loading of item i, and $Var(\boldsymbol{e}_i)$ the variance of the error of item i.

A factor analysis is conducted using IBM's SPSS Statistics software[76], which can then be used to calculate both the CR and the AVE. The validity analysis results of the factor analysis are depicted in the table below (the rotated component matrix), proving that the designed constructs match the question indicators. The square root of the AVE of a construct should be greater than its correlation with another construct, in order to achieve the satisfactory discriminant validity. In below it is clearly visible, that discriminant validity has been achieved, since all CR and AVE values surpass the thresholds defined above.

Table 40: Discriminant validity of constructs and moderators proposed

UTAUT construct	Indicator (Perception/Attitude)	Relevance	AVE	CR
Behavioural Intention (BI)	*BI1: Willingness to use*	It portrays if the user is willing to use EL-Vs in the future according to his/her mobility needs.	0.6456	0.7846
	BI2: Willingness to use as a part of a multimodal trip	It conveys if the user is willing to use EL-Vs in the future in a trip involving other modes of transport.		
Performance Expectancy (PE)	*PE1: Ease of parking*	It reveals if the user perceives parking the EL-V would be as easy and secure as with a similar ICE (combustion-powered) vehicle.	0.5141	0.8064

[76] https://www.ibm.com/spss [Accessed 22 December 2022].

	PE2: Comfort	It conveys if travelling with the EL-V is perceived as comfortable as with a similar ICE (combustion-powered) vehicle.		
	PE3: Safety	It shows if the user would feel as safe during the trip with the EL-V as with a similar ICE (combustion-powered) vehicle.		
	PE4: Luggage capacity	It reveals if the user feels the EL-V has sufficient luggage capacity for his/her needs.		
Facilitating Conditions (FC)	*FC1: Charging convenience*	It portrays if the user feels the charging would be convenient for his/her needs.	0.709	0.709
Price Value (PV)	*PV1: Affordability*	It portrays if the EL-V is perceived to be as affordable to use and operate than a similar ICE (combustion-powered) vehicle.	0.7073	0.7073
Age	*BQ1*	Background information on the age of the survey participant.	0.6831	0.8115
Occupation	*BQ2*	Background information on the occupational status of the survey participant.		

This table can also be translated into a simple graph, which aids as a visual overview over the UTAUT model and all variables and constructs:

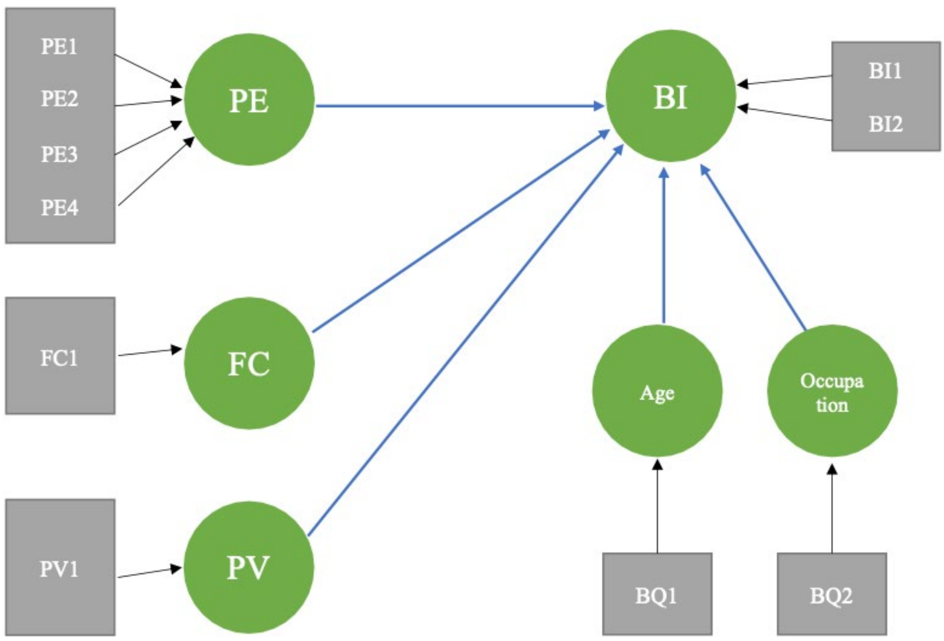


Figure 76: The research model used, UTAUT constructs overview

Note: Circles represent the constructs, boxes the indicator/moderator variables, and blue arrows the hypotheses to be tested.

7.4 Hypotheses formulation

Following the attribution of the variables to the constructs, it's possible to formulate concrete hypotheses based on the work and insights described in previous chapters of the thesis and the CR & AVE values obtained.

With the above in mind, the following five research hypotheses have been formulated:

Table 41: Hypotheses formulation

Hypotheses proposed	Hypothesis Code
H1: Perceived Performance Expectancy of the system in the daily travel activities of the users has a direct effect on behavioural intention to the deployment and use of EL-Vs	PE --> BI
H2: Facilitating conditions have a direct effect on behavioural intention to the deployment and use of EL-Vs	FC --> BI
H3: Value for Money has a direct effect on the deployment and use of EL-Vs	PV --> BI
H4: Age has a direct effect on behavioural intention to use of EL-Vs	Age --> BI
H5: Occupation has a direct effect on behavioural intention to use of EL-Vs	Occupation --> BI

7.5 Bivariate Pearson correlation

After this analysis and the grouping of the different variables into their respective constructs, a Pearson correlation coefficient is applied, which is the most suitable form of regression for the available dataset and using bi-variate correlation to spot direct correlations (or non-correlations) between the data collected. According to Rodgers *et al.* (1988), this allows to dive deeply into each factor and its relationship to all other factors to draw comprehensive and conclusive conclusions from the analysis [93].

Equation 3: Pearson Correlation Coefficient

$$r = \frac{\sum_{i=1}^{n=6888}(x_i - \bar{x}) * (y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n=6888}(x_i - \bar{x})^2 * \sum_{i=1}^{n=6888}(y_i - \bar{y})^2}}$$

Table 42: Bivariate Pearson correlation of constructs

	BI	PE	FC	PV	Age	Occupation
Behavioural Intention (BI)	***1.000***					
P-value						
Performance Expectancy (PE)	*-0.066***	***1.000***				
P-value	*<0.001*					
Facilitating Conditions (FC)	*0.045***	*0.253***	***1.000***			
P-value	*<0.001*	*<0.001*				
Price Value (PV)	*0.054***	*0.247***	*0.543***	***1.000***		
P-value	*<0.001*	*<0.001*	*<0.001*			
Age	*.102***	*-.023*	*.019*	*.023*	***1.000***	
P-value	*<.001*	*.061*	*.126*	*.054*		
Occupation	*.195***	*.016*	*.009*	*.016*	*.413***	***1.000***
P-value	*<.001*	*.180*	*.467*	*.187*	*<.001*	

Significant and relevant correlations can be observed between the constructs, which are highlighted in the table. As expected, the correlation between a construct and itself must be 1.000 (100%). It is clear that many results are statistically significant with a p-value below 0.05 (*), and even below 0.001 (**), in which cases a correlation is proven.

What is striking is that the correlation with the two moderators (age and occupation), the p-value is greater than 0.05, which indicates that the null-hypothesis cannot be rejected and therefore, no statistically relevant correlation can be established. These cells are highlighted in red colour to easily differentiate them from the rest of the table.

In order to also identify further correlations, a second Pearson bivariate correlation was conducted with the indicators directly as variables of the analysis. This analysis goes beyond the UTAUT analysis and model and instead compares the variables with each other directly.

Table 43: Bivariate Pearson correlation of indicators

Indicator		Q13	Q22	Q18	Q17	Q16	Q19	Q21	Q20	Q25	Q26	Q27
Q13	Usage	***1.000***										
P-value												
Q22	Multi-modality	*.407***	***1.000***									
P-value		<.001										

Q18	Safety	-.050**	-.039**	***1.000***								
P-value		<.001	.001									
Q17	Parking	-.028*	-.013	.319**	***1.000***							
P-value		.020	.290	<.001								
Q16	Comfort	-.063**	-.074**	.475**	.319**	***1.000***						
P-value		<.001	<.001	<.001	<.001							
Q19	Charging	.031*	.059**	.152**	.178**	.146**	***1.000***					
P-value		.011	<.001	<.001	<.001	<.001						
Q21	Luggage	-.031*	-.025*	.419**	.222**	.410**	.245**	***1.000***				
P-value		.011	.043	<.001	<.001	<.001	<.001					
Q20	Affordability	.036**	.073**	.141**	.179**	.117**	.543**	.261**	***1.000***			
P-value		.003	<.001	<.001	<.001	<.001	<.001	<.001				
Q25	Gender	-.092**	-.091**	.044**	-.066**	.036**	-.117**	.015	-.085**	***1.000***		
P-value		<.001	<.001	<.001	<.001	.003	<.001	.219	<.001			
Q26	Age	.093**	.081**	-.038**	-.040**	.017	.019	-.007	.023	*.043***	***1.000***	
P-value		<.001	<.001	.002	<.001	.171	.126	.591	.054	<.001		
Q27	Occupation	.178**	.150**	.013	-.025*	.026*	.009	.027*	.016	*-.059***	*.413***	***1.000***
P-value		<.001	<.001	.273	.039	.035	.467	.024	.187	<.001	<.001	

7.6 Hypotheses validation

The hypotheses test has been conducted using the IBM's SPSS Statistics software. The table below shows the results produced. Using α = 5% (p-value) as significance level threshold, we can see that the five hypotheses of the research model are valid.

Table 44: Hypotheses testing results using SPSS software

Hypothesis	Constructs Correlation	P-value	Correlation	Description
H_1	PE → BI	<0.001	-0.066	Has a very light negative influence
H_2	FC → BI	<0.001	0.045	Has a very light positive influence
H_3	PV → BI	<0.001	0.054	Has a very light positive influence
H_4	Age → BI	<0.001	0.102	Has a positive influence
H_5	Occupation → BI	<0.001	0.195	Has a positive influence

7.7 Conclusions

For all the hypotheses, the null-hypotheses could be rejected and although the influence of the constructs onto each other are only very light, the relationship is statistically very significant with a p-value of less than 0.001.

From the data analysis of the constructs (Behavioural Intention (BI), Performance Expectancy (PE), Facilitating Conditions (FC), Price Value (PV), Age and Occupation), the following conclusions can be drawn with significant confidence, due to the large number of responses to this survey on the one and the clear correlation results emerging from the Pearson regression conducted. It should be noted that none of the results of either of the regressions yielded a case of strong correlation (r-value higher than 0.7), and that all the described relationships are of low to medium strength. This is not surprising as there is a plethora of external variables which could have influenced the responses of participants, including factors which were not included in the survey. However, and due to the very high number of survey responses, the conclusions are statistically sound and quite expressive.

- The Facilitating Conditions (FC) are correlated to the Performance Expectancy (PE), indicating that users might conclude the quality of one onto the other and meaning that these two factors are linked to each other. If facilitating conditions (e.g., charging stations) are in good shape and well-designed, user also expect their vehicle to perform better within the transport network.
- The Price Value of the vehicles has a notable impact on both the Performance Expectancy (PE) and the Facilitating Conditions (FC). This is probably due to the expected additional external costs the user can expect when purchasing or renting a vehicle. The higher the pricing, the higher the expectations for the performance and surrounding conditions (e.g., supporting facilities, equipment

or infrastructure) are. Users are willing to pay more not only for a premium product but a premium experience.

- Finally, both age and occupation are slightly related to the Behavioural Intention (BI) to use the system, which is quite interesting and suggests that certain user groups (e.g., generations) are more likely to use these vehicles than others. As discussed within the last point in the next list of conclusions, age and occupation are also strongly interlinked. This could be due to the stage of life they are in (e.g., whether they might have underage children they need to transport or are retired with lower physical activity).

Furthermore, from the second analysis of the individual variables (questions), the following conclusions can be drawn:

- Users who consider using the service are also interested in using the service as part of a multi-modal trip and the integration into existing public transport networks seems to have a solid acceptance amongst the participants. Two other factors are influencing these responses: on the one hand, the availability of ample and easy-to-use parking facilities available (installation of safe and surveillance parking facilities at multimodal stops) and on the other hand, the overall comfort of the vehicles and the rental system influences the participants' willingness to use the service in the multimodal context.
- Apart from these considerations involving a wider transport network, the perceived comfort of the vehicle usage is linked heavily to the perceived safety-of-use, luggage capacity offered and availability of parking services. Use cases such as rental systems within a company or university campus should consider this, as parking should also be available at the user's home and commuting destination (whether it be their place of work/study or a point of interest within the city centre).
- The participants express some concerns by establishing a relationship between the safety and maximum load of luggage on the vehicle with the overall safety of using the vehicle. This indicates that the vehicles are probably suitable as cargo vehicles, given an appropriate and secure adaptation of the frames to carry higher weight loads. Additionally, persons who are purchasing or using the vehicle should probably be informed of the exact loading capacity to remove any anxiety around safety of the vehicle, since they also indicated that increased loads could impact the comfort of the vehicle usage.
- Interestingly, the willingness to pay for the service is heavily (it is the strongest correlation of the analysis) to the charging convenience of the vehicle. This could be due to the famous phenomenon of 'charging anxiety', wherein users of electric vehicles experience significant anxiety about the state of their battery and remaining charge (which is often completely irrational), as highlighted by Neuebauer *et al.* (2014) [94]. Much recent work has focussed on exploring this phenomenon and ways to bridge/overcome this fear are being developed; the absolute number of publications on the publisher's website ScienceDirect (Elsevier) have reached almost 46,000+ publications at this point[77]. Another possible explanation would be the actual price users have to spend on electricity to charge their vehicles – this depends a lot on the use case:
    - Is charging offered for free to the user, for example due to adapted parking facilities around the city/their place of work/study or via a public municipal charging system, which is paid for by the municipality to encourage the use of EVs?

[77] 46,907 results about 'charging anxiety' at https://www.sciencedirect.com/search?qs=charging%20anxiety [Accessed 22 December 2022].

  - Does the user have to organise and pay for their own charging (e.g., charging is only possible at home via a regular outlet within the user's home)?

  It seems of great interest and value to explore this topic in particular through future works of research, liaising multi-disciplinary teams together across different disciplines and sectors, including for example by bringing together behavioural science, battery or power engineers, economists, municipalities of different sizes, user groups and commercial operators could all greatly benefit from this.

- Finally, another correlation could be identified between age and occupational status of the participants, which seems logical, as the occupational categories offered to the participants focussed purely on the form of employment and not on the sector or experience level of their profession. Answers ranged from 'student', via 'part-time employment' and 'full-time employment' to 'unemployed' and 'retired', though two extra options were given by 'other' and 'exclude from analysis'. Due to the anonymous nature of the answers, it is safe to say that most participants did not mind sharing their employment status openly.

8 Operator Interview Survey

In addition to the online public survey, a limited set of interviews were conducted among companies operating vehicle fleets in each of the six demonstration cities, with focus on companies using L-category vehicles, cars or vans for deliveries (which could potentially transfer some of their operations to EL-Vs), but also including some companies operating vehicle rental or sharing schemes. In four of the cities, interviews were also conducted with a small selection of drivers from companies undertaking delivery work (post, parcels, food, etc.).

The purpose was to gain perceptions and opinions towards this type of electric light vehicles from business owners and individual drivers and to understand the factors that might be hindering their willingness to use them instead of traditional fossil-fuel vehicles.

The survey consisted of a number of specific questions designed to collect existing opinions on the usage of electric light vehicles, in respect to safety, comfort, efficiency and luggage capacity, among other aspects. Respondents to the interview were fleet operators, mostly managers and business owners and individual drivers, the latter group reflecting more directly the user opinion. Among the number of companies interviewed it was distinguished between companies delivering goods (flowers, parcels, food, etc.) and car sharing and rental firms. The purpose of this identification was to recognise different needs of businesses, for instance for a delivery company goods capacity will be prioritised while for a car sharing firm availability of parking and charging would play the key role in deciding on changing to EL-Vs.

The interviews covered companies of different sizes (in terms of fleet and number of employees) and types (delivery, car sharing, rental) in order to present a representative overview of perceptions and potential demand for EL-Vs, especially as very small businesses (e.g. a family catering or food delivery service with one or two vehicles) would have very different needs to a large international courier service or national postal service.

8.1 Interview Design and execution

The interviews were designed to take around 15 minutes and be possible to be conducted either by telephone or face-to-face. The questionnaires were printed out on paper and answers collected from respondents were written down on those sheets and then transferred over to a designated Excel sheet with data organised per city.

Different interviews were elaborated for fleet managers and drivers, with the former focusing more on management aspects (choice of vehicle type and suitability for the work the company does) and the latter being closer to the public perception questionnaire in that it focuses more on actual or perceived driving experiences. The purpose was to learn about existing opinions and perceptions towards EL-Vs and to raise awareness of these types of vehicles. Chosen individual candidates were:

- Fleet managers/business owners recognised as the ones who use vehicles (for transporting goods or people) or which rent out vehicles to the public (for example sharing schemes). Big organisations (postal service or parcels courier) or small ones (for example local/family businesses with only 1 or 2 vehicles, like pizza delivery) were considered eligible to participate. Operators which don't own or control their own fleet (for example companies using private individuals' vehicles, like Uber, Lyft, Blablacar, Deliveroo), were not targeted in this survey. Also, their fleet should be constituted by fuel (petrol/diesel) or electric vehicles; light vehicles, or standard cars or vans. Operators of heavy vehicles (trucks, buses), were not selected to participate, because EL-Vs are not a suitable substitute (they do not have the capacity). Last but not least, companies which deliver only by bicycle, were not part of this interview survey, as of the aim of the interviews was not to attract the use of EL-V instead of cycling. However, companies providing cycle sharing or hire schemes, were eligible to participate with the view to checking their interest in expanding this to certain types of EL-V as well.

- Drivers – individual employees of the above-mentioned types of companies whose opinions constituted user perception.

The above-mentioned individuals were asked about the number and type of vehicles currently owned their regular number, purpose and distance of trips and types of goods each company delivers. In case of the manager interviews the questions were more detailed in respect to the operational aspects of the fleet and potential willingness to consider changing from traditional fossil fuels vehicles to electric light vehicles in the future. Additionally, for those who already own electric vehicles it was investigated whether they would consider switching to light electric vehicles from cars and small vans.

The interviews were conducted by representatives of the six demonstration cities in national languages. Prior to having the interview taken each participant interviewed was made aware of the privacy policy clearly explaining that we do not collect any personal data, only opinions and perceptions. The only data gathered was the name of each company which was not used in the analysis, only referred to in descriptive way in respect to the type or size of a business. Each respondent was informed that there are no wrong or right answers and that their opinion, for instance if negative, will have no impact on their company or job because we only collect opinions and perceptions.

The interview questions are given in Annexes F and G.

8.2 Interview Responses

The companies interviewed ranged from small businesses with one vehicle to a national mail service with hundreds of vehicles in the city concerned and many thousands nationwide. The main findings from the final analysis show that there is a general positive attitude among business operators towards EL-Vs.

8.2.1 Operator/Manager Responses

A total of 37 fleet operators (e.g. managers, CEOs, owners) were interviewed in the six demonstration cities, with 21 of them in the delivery business, 6 in rental and 4 in catering service as well as sharing, public transport and building system monitoring service. These businesses operate at differently scales with 57% locally, 35% nationally and 8% globally.

They own or lease a total of 2567 vehicles which include 1542 cars (60%), 643 L-Vs (25%), 330 vans or lorries (13%) and 52 others such as regular bicycles. The numbers of vehicles running on petrol, diesel and electricity (full or hybrid) are 569 (22%), 1065 (41%) and 898 (35%), respectively. There are a small number of vehicles which use other types of fuel such as Compressed Natural Gas (CNG), Liquefied Petroleum Gas (LPG).

8.2.2 Driver Responses

In four of the demonstration cities (Bari, Málaga, Berlin and Trikala), some drivers from the same companies were also interviewed, a total of 22 fleet driver interviews.

Most of them (i.e. 20 out of 22) use either petrol or diesel fleet. They drove most of time in the week (i.e. 4 days or more). 50% of the vehicles used are L-Vs, followed by 30% N-Vs (goods-carrying vehicles) and 20% M-Vs (passenger-carrying vehicles).

8.3 Overall Interview Analysis (Managers)

8.3.1 Advantages and Disadvantages of EVs

The interviewees were asked to indicate what in their opinions the main advantages (or motivations) and disadvantages (or barriers) of EVs/EL-Vs are. The interview data show that the interviewees highly appreciate that EVs have a number of advantages including:

- The vehicles are environmentally friendly;
- They have low costs for maintenance and use and possibility to access to Limited Traffic Zones;
- EL-Vs have flexibility in traffic, produce lower noise and are safer as they run at a lower speed;
- EL-Vs also have smaller size and thus produce lower carbon footprint;
- EVs are an innovative solution.

On the other hand, the interviewees expressed their concerns about using EVs/EV-Vs for their businesses, as listed below:

- Difficulty in electricity supply;
- The batteries may not last long and there may be problems to dispose of the deteriorated ones that are very polluting;
- No or limited recharge points available;
- The batteries can be stolen (with reference to EL-Vs);
- Excessive duration of charging times;
- Little battery autonomy and low driving distance;
- Limited EV models and infrastructure.

8.3.2 Attitudes towards EL-Vs

Three questions were given to the interviewees about their attitudes of changing from their current vehicles to EL-Vs as summarized as follows:

- Changing from ICE L-Vs to EL-Vs: 20 interviewees answered the question and 18 of them indicated that they would consider (13 out 18) or have already considered (5 out of 18) changing to EL-Vs.
- Changing from electric cars or vans to EL-Vs: 7 interviewees answered the question and 5 of them indicated that they would consider (2) or have already considered (3) changing to EL-Vs changing to EL-Vs.
- Changing from ICE cars or vans to EL-Vs: 21 interviewees answered the question and 17 of them indicated that they would consider (10) or have already considered (7) changing to EL-Vs changing to EL-Vs. 2 firms said that they would not consider changing to electric cars or vans, and another 2 indicated that they would not consider changing to any kind of electric vehicle.

8.3.3 Measures to Encourage Greater Use of EVs/EL-Vs

The questionnaire specified four measures in order to encourage greater use of electric vehicles including EL-Vs and asked the interviewees to indicate if these measures are important and improvements are needed.

Measure 1: Dedicated delivery spaces (on street)

- About 60% of the interviewees who answered this question said that this measure was either very or quite important.
- 11 interviewees believe that improvements to dedicated delivery spaces are needed whereas only 4 don't.

Measure 2: Electric charging infrastructure

- 28 of 30 (93%) interviewees who answered this question said that this measure was either very or quite important and only 2 said it wasn't.
- The majority of them believe that improvements to charging infrastructure are needed.

Measure 3: Allow use of bus and cycle lanes by 2- or 3-wheel electric vehicles, or other means of priority or safety measures on the roads

- Amongst 30 interviewees who answered this question, 14 of them believed that this measure was either very or quite important, but 16 said no.
- Surprisingly, 18 interviewees said that improvements to this measure are needed whereas only 7 said no.

Measure 4: Specific navigation services aimed at electric light vehicles

- Similar to measure 3, amongst 30 interviewees who answered this question, 14 of them believed that this measure was either very or quite important, but 16 said no.
- 13 interviewees said that improvements to this measure are needed whereas only 5 said no.

8.3.4 Additional Comments

While the interviewees have very positive attitudes towards EL-Vs, they also indicated many barriers and factors which may influence their willingness of using this kind of vehicles for their businesses. This section quotes typical comments from the interviewees with reference to different barriers.

8.3.4.1 Costs

- *"Keep the vehicle rental rates and the top-up costs low"*
- *"Vehicles too costly; more European funds"*
- *"To promote the use of electric vehicles we should first adopt incentive measures for craftsmen and entrepreneurs with bonuses, VAT discounts and any measure useful to push electro-mobility, first of all to the SMEs and artisans who are the main production categories"*
- *"Anyone would like to save money and not to pollute, but I'm pessimistic about the short-term success of using EL-Vs"*
- *"Lower the costs of purchase and management of vehicles"*

8.3.4.2 Infrastructure

- *"Road infrastructures need improvement, paint at pavement corners, a traffic light at the central square"*

- *“It is essential to increase the recharge points to promote widespread circulation”*
- *“Have a capillary network of charging points and improve the quality of the road surface”*
- *“The road surface is crumbling; the rescue services are not prompt; lighting is inadequate; there is no specific signage”*
- *“The state of the road surface in many European cities is bad and does not guarantee safety for two-wheeled vehicles”*

8.3.4.3 Policy

- *“Advertising by City; fine payments method; special permits; safety”*
- *“We are far from achieving a sustainability goal in city journeys”*
- *“There are no policies dedicated to these vehicles to facilitate their circulation and / or parking, there is no management of roads according to their transit, there is no specific signage, there are no typical infrastructures, specific charging points”*

8.3.4.4 Education

- *“Focusing on citizens' education - education in schools - the lack of civic sense leads to acts of vandalism and theft of light vehicles that are more exposed.”*

8.3.4.5 Technology

- *“Same characteristics of traditional vehicles”*
- *“Improve the technology and equate it with that of current fossil fuel vehicles (autonomy, recharge times, etc...)”*

8.4 Overall Interview Analysis (Drivers)

8.4.1 Real-Driving Conditions

Question 6): *If you used an EL-V for your work, do you expect the following aspects would be better or worse compared to your current vehicle(s)?*

Seven scenarios were put forward to the interviewees to consider. As these drivers didn’t use any EL-V, this question was to test their stated preferences. The responses are summarized in Table 45.

Table 45: Drivers' responses to question 6

Aspects	Better	The Same	Worse	Don’t Know
a) Comfort in hot weather	6	15	1	0
b) Comfort in cold or rainy weather	3	13	5	1
c) Ability to park easily for loading and deliveries	8	13	1	0
d) Ability to get past traffic jams	11	10	1	0
e) Feeling of safety	2	11	9	0

Aspects	Better	The Same	Worse	Don't Know
f) Capacity to carry my usual amount of goods	2	15	5	0
g) Security of the goods I am carrying	2	14	4	2

Overall, the majority of the drivers interviewed believed that they would expect all the aspects to be either better than or the same as their current vehicles.

On three aspects (i.e. comfort in hot weather, ability to park easily for loading and deliveries, and ability to get past traffic jams), more drivers believed that the aspects would be better by using EL-Vs than worse.

However, on other four aspects, more drivers believed that the aspects would be worse by using EL-Vs than better, especially for safety.

8.4.2 Measures to Encourage Greater Use of EVs/EL-Vs

The questionnaire specified four measures in order to encourage greater use of electric vehicles including EL-Vs and asked the interviewees to indicate if these measures are important and improvements are needed.

Measure 1: Dedicated delivery spaces (on street)

- 12 (55%) interviewees who answered this question said that this measure was either very or quite important.
- 7 interviewees believe that improvements to dedicated delivery spaces are needed whereas 4 don't.

Measure 2: Electric charging infrastructure

- 17 (77%) interviewees who answered this question said that this measure was either very or quite important.
- 8 interviewees believe that improvements to electric charging infrastructure are needed whereas 3 don't.

Measure 3: Allow use of bus and cycle lanes by 2- or 3-wheel electric vehicles, or other means of priority or safety measures on the roads

- 12 (55%) interviewees who answered this question said that this measure was either very or quite important.
- 11 interviewees believe that improvements to this measure are needed whereas 4 don't.

Measure 4: Specific navigation services aimed at electric light vehicles

- 12 (55%) interviewees who answered this question said that this measure was either very or quite important.
- 4 interviewees believe that improvements to this measure are needed whereas another 4 don't.

Additional Comments:

One fleet driver commented that "*EL-Vs awareness campaign, incentives for sale and rental*" are needed, and "*drive tests*" would be useful.

8.5 General conclusions on Barriers and Suppressed Demand

"Suppressed demand" is the situation where the support provided to EL-Vs are insufficient, due to a number of factors including infrastructure, incentives, facilities and services, to meet the needs of people's mobility and goods' movement. In this research, the definition of suppressed demand for EL-Vs is based on the positive answers to the aforementioned attitudes (i.e. already considering or would consider).

The following table gives a very rough indication of potential suppressed demand of EL-Vs based on the operator surveys. It was calculated according to the percentage of trips or fleet the interviewed firms would consider changing to EL-Vs (for respondents able to give data on fleet size and kilometres driven, as well as an indicative percentage of transfer to EL-Vs that could be possible).

Table 46: Indicative suppressed demand analysis based on operator surveys

		Existing Demand		Change to EL-Vs		Suppressed Demand	
	Number of companies	Number of vehicles	km/year	% of vehicles	% of km	Number of vehicles	km/year
National postal service	1	542	9,542,600	20%	20%	108	1,908,520
Medium-sized parcel delivery company	1	80	624.000	0%	0%	0	0
Small delivery companies	12	49	454.870	47%	38%	23	171,340
Rental companies	3	716	5,908,000	2%	5%	13	309,600

The first two lines of above table show larger companies (one very big – a national postal service) and one medium-sized). Although the sample size does not pretend to be representative (only one interview in each category), it shows the potential of a relatively modest switch of just 20% of vehicles in a big company, which can create a shift of almost 2 million km per year to electric power.

For smaller delivery companies (mostly 2 to 10 vehicles), the conclusion is quite positive, more than half are interested in EL-Vs, we estimate that 47% of current vehicles could be replaced by EL-V (depending on the company and their capacity needs), representing a 38% shift to electro-mobility in kilometre terms. For rental and sharing companies, the expected shift to EL-Vs was much smaller but even a low percentage could move large numbers of kilometres to electric modes. Because this latter group are essentially procuring vehicles to meet their customers' demand (rather than for their own use for deliveries, etc.) the potential to shift to EL-Vs is much less certain but likely to increase as users of rented and shared vehicles become more familiar with electromobility and more likely to demand such types of vehicles.

9 Conclusions of empirical research

Cities with high levels of air pollution would be more likely to adopt EL-Vs as a transport alternative in order to reduce emissions and provide a solution to increasing pollution levels. As explained in section 2.1.2, there are many factors affecting EL-V adoption. Technology factors are one such aspect; battery charging time and driving range are limiting factors. People are most likely to accept alternative modes of transport in more congested areas, including densely populated zones or historic city centres where road and parking space is very limited. High population density could also allow for an increase in charging infrastructure, as more people can be covered per station. On the other hand, areas of lower population density often have less dense and less widespread public transport services, thus creating a gap which EL-Vs could fill (including using EL-Vs to access a public transport stop or station in a suburban area). Education level is also believed to be a significant factor in influencing preferences towards adoption of cleaner vehicles; consumers who express early interest are typically more highly educated, more aware of new mobility services and sensitive to effects on the environment. Energy consumption increases in very low or very high temperatures, therefore more temperate climates are better suited to EL-V usage. Topography of the underlying land is also a significant factor affecting energy consumption of EL-Vs; high variation in altitude increases rate of energy consumption, so flatter areas of land are more suitable for EL-Vs. However, demand for EL-Vs may be higher in hilly areas where cycling is more difficult.

The mobility characteristics vary from city to city analysed in the context of this study. As attitudes towards EL-Vs depend on the mobility context, these also vary between cities. The conclusions of this work are therefore organized by city to ensure clarity.

9.1 Conclusions across demonstration cities

Bari, Rome, Genoa, Málaga, and Trikala all had a large observed interest in EL-V sharing schemes. Berlin and Trikala have the potential to increase their sharing scheme usage by attracting users that are still unsure. A higher percentage of respondents in Berlin would either prefer to buy their own or would not consider using an EL-V at all.

Opinions on the relative comfort of different EL-V types were consistent across all six cities. Moreover, there was negligible difference in opinion between men and women, regardless of age group. Positive opinions increased with the number of wheels across both age and gender demographics. "Don't Know" answers occurred in the lowest frequency. Of this group, most respondents were over 60 years of age, and most answered in reference to the relative comfort of 3-wheelers. This is most likely due to their limited experience with 3-wheeled L-Vs and EL-Vs.

Perceptions of EL-V safety were consistent across all demonstration cities; people felt safer in vehicles with more wheels. A slightly higher percentage of male than female participants confirmed a perception of safety across all EL-V types in all the age groups. In contrast, a higher percentage of women than men responded with uncertainty on their perceptions across all EL-V types in all the age groups. More respondents, especially in older age groups, answered "Don't Know" for 3 wheeled EL-Vs. This could be due to either a neutrality of opinion or a lack of information on EL-Vs. Perceived advantages of EL-Vs by fleet operators include their flexibility of use in traffic, lower carbon footprint and noise production, and enhanced safety at lower speeds. However, a lot of drivers believed that they would feel less safe using EL-Vs than their current vehicles.

Across all cities, men were observed to be more inclined to use EL-Vs for trips related to work or education purposes than women. 2- and 3-wheel EL-Vs were popular in Berlin and only 2-wheel EL-Vs were popular in Genoa. Cycling was a more popular choice than EL-Vs in the all the cities for leisure and personal trips. There was no observed interest in 4-wheel EL-Vs.

Slightly more men (just above 80%) than women (just under 80%) strongly or rather agreed that parking for two-wheeled EL-Vs is easy. In contrast, slightly more women than men agreed on the ease of parking for the other two categories of EL-V.

A higher proportion of men (45-50%) than women (35-40%) had positive opinions on ease of charging for all EL-V types. In contrast, a higher proportion of women than men answered "Don't know", which means that more focus on the female population of the target use groups is necessary.

Positive opinions on affordability decreased with the number of wheels of EL-Vs (two, three, four-wheel) for all cities except Málaga. However, the low costs for maintenance and the possible access to Limited Traffic Zones were expressed as advantages by fleet operators.

Perceptions of luggage capacity for all EL-V types were consistent across both age and gender demographics. The proportion of positive responses increased with the number of wheels of the vehicle.

Overall, the majority (at least 60%) of respondents would consider using EL-Vs as part of a multimodal journey. A smaller proportion of these do so at present, with the gender demographic is slightly skewed towards men.

Sufficient electric charging infrastructure was obviously the most popular measure in every city, by both fleet operators and drivers, whereas the least popular measure was the existence of appropriate Navigation Services. Dedicated delivery spaces on streets were considered an important measure by fleet operators and drivers in order to encourage greater use of electric vehicles including EL-Vs.

Incentive schemes received the fewest votes as a measure for encouraging the use of EL-Vs in Berlin, despite consistently being one of the most popular measures in other demonstration cities. As incentives help initial market creation, this may indicate that Berlin is at a more developed EL-V market stage than other demonstration cities.

Apart from Málaga and Trikala, the use of bus and cycle lanes by 2- or 3-wheeled EVs was ranked in the top four most popular measures for EL-V uptake in all other cities. Most fleet drivers also believed that it is an important measure and improvements to this measure are needed. Fleet operators also agreed on the necessity of improvements, but most believed that this was not an important measure.

Overall, the majority of the drivers interviewed believed that they would expect all the aspects, such as comfort, parking, safety, efficiency and luggage capacity, to be either better than or the same as their current vehicles.

9.2 Conclusions per city

9.2.1 Bari

Bari has suitable weather conditions, the topology of the land is completely flat, and there is a medium population density. In Bari, the frequency of bicycle usage is low, bicycle users make up only 3% of the population. Perhaps this is because of the limited number of bicycle lanes available. Currently, there is still a limited usage of EL-Vs, possibly resulting from the lack of lanes, both EL-V specific and shared with bicycle/buses, or from the limited charging infrastructure. Apart from infrastructure introducing more effective incentives might also help in increasing usage of EL-Vs.

Despite currently having a low usage of EL-Vs, most respondents in Bari were willing to use EL-V sharing schemes (nearly 50% would use them frequently and about 20% of would use them occasionally).

Over 80% of respondents in Bari agreed that 4-wheel EL-Vs are comfortable for use and nearly 45% of this population think 3-wheel EL-Vs are comfortable. Only about 20% believed that two-wheelers are also comfortable to use.

Positive perceptions on safety in Bari increased with the number of wheels of EL-Vs. Only a relatively low percentage of respondents (about 30%) agreed that 2-wheelers are safe for a journey.

Over a third of respondents in Bari would be willing to use a bicycle for leisure and personal trip purposes, particularly with women in Bari (nearly 50%), which was the highest percentage of those among all demonstration cities. In comparison, just over 30% of men would be willing to use bicycles for travel or leisure purposes. However, a high percentage of male respondents (about 40%) may be willing to consider using bicycles for commuting to work, compared to less than 15% of women. Almost 60% of both men and women were willing to use 4-wheel EL-Vs for shopping purposes. This is perhaps due to the higher luggage-carrying capacity of 4-wheelers. 3-wheelers were the least favoured choice for all trip purposes (below 10% in total). More men (about 35%) than women (about 10%) were willing to use 2-wheel EL-Vs for leisure and personal trips.

Most respondents (around 80%) showed very positive intentions towards using EL-Vs as part of multimodal journey, with slightly more men than women, as also seen in Genoa. A very limited number of respondents had already used them as part of a multimodal journey.

About 80 percent of respondents strongly or rather agreed that two wheel EL-Vs are easy to park in Bari. The difference between agreement relating to three- and four-wheelers is negligible; about 60% of respondents strongly or rather agreed and 10% of respondents strongly disagreed.

Perceptions of EL-V charging in Bari were quite similar to that of all type of EL-Vs, around 55-60% of respondents strongly or rather agreed that EL-V charging is convenient. However, almost 40% of respondents chose “Don’t know”. This might be due to their lack of experience with EL-Vs in general. The consequence is that effort should be placed on Bari to encourage people to experience different types of EL-Vs.

Positive opinions on affordability of use and operation in Bari decreased with the number of wheels on EL-Vs (two, three, four-wheel) with about 75%, 65% and 60% positive respectively.

Positive opinions on luggage capacity in Bari increased with the number of wheels on EL-Vs (two, three, four-wheel) with about 25%, 35% and just below 75% positive respectively.

Apart from charging infrastructure and incentive schemes, the use of bus and cycle lanes by 2- or 3-wheel EL-Vs and secure parking were considered almost equally important measures in encouraging the use of EL-Vs.

9.2.2 Berlin

The climate in Berlin has fluctuations in temperature and the area is mostly flat, thus making it quite suitable for EL-V usage. Furthermore, pollution levels exceed the legal limit several times per year. 41% of the population are between the ages of 15 – 44; thus, efforts should focus on targeting this group as they are most likely to be accepting EL-Vs. Berlin has a well-developed public transport system and has become well suited to incorporating electric vehicles into transport networks. It has the most charging points in Germany, and thus provides suitable infrastructure to support innovations in EL-V technology.

Bicycles are also readily used for trip lengths that are within a convenient distance, so the population has transferrable skills for two-wheeler EL-Vs when longer distances are required.

Less than 40% of respondents in Berlin were willing to use EL-V sharing schemes. Only about 10% of these were willing to use them frequently, and around 30% of the respondents were unsure. This proportion of Berlin's population that use EL-Vs in sharing services could potentially increase, if effective measures are deployed. The highest percentage (around 10%) of respondents in Berlin would prefer to buy their own vehicle. 15% would not consider using an EL-V at all, which is also the highest percentage of all demonstration cities.

Positive opinions on comfort increased with the number of wheels of EL-Vs. For 3-wheel EL-Vs, the percentage of respondents with positive perceptions was slightly higher than those in other demonstration cities.

Most respondents (over 75%) in Berlin considered 4-wheel EL-Vs safe for a journey. Over 50% of respondents felt safe with 2-wheel EL-Vs, in contrast to cities such as Rome and Bari wherein less than 30% thought 2-wheelers are safe, the highest percentage among all demonstration cities.

Out of all EL-V types, 3-wheel EL-Vs were the most popular choice in Berlin, followed by 2-wheel EL-Vs, when used for work commuting or education. There was negligible difference between men and women for the use of all EL-V types for this particular trip purpose. 2-wheel EL-Vs were mostly favoured for shopping purposes by both men (nearly 30%) and women (about 35%). The willingness to use EL-Vs for leisure or personal activities was quite similar regardless of EL-V type.

Compared to other demonstration cities, more participants (15% of both men and women) in Berlin already used EL-Vs as part of a multimodal journey. The level of interest displayed in Berlin was the lowest of all demonstration cities; however, of those expressing interest, most viewed EL-Vs positively. More than 10% of participants answered "Don't know". Therefore, an effective approach would be to attract this group of people as the target audience to promote the use of EL-Vs as part of a multimodal journey.

About 80 percent of respondents strongly or rather agreed that two-wheel EL-Vs are easy to park in Berlin. Slightly more respondents (around 65%) strongly or rather agreed on three-wheel than four-wheel EL-Vs (around 60%) relating to ease of parking.

Perceptions of EL-V charging in Berlin are quite similar for all type of EL-Vs. Around 45-50% of respondents strongly or rather agreed that EL-V charging is convenient. Less than 30% of respondents chose "Don't know", the least among all demonstration cities. In contrast, a higher proportion (around 10%) chose "Strongly disagree" than that of other cities.

Positive opinions on affordability of use and operation in Berlin decreased with the number of wheels of EL-Vs (two, three, four-wheel) with about 60%, 40% and 35% positive respectively.

Positive opinions on luggage capacity in Berlin increased with the number of wheels of EL-Vs (two, three, four-wheel) with nearly 30%, 45% and just over 70% positive respectively.

Respondents from Berlin considered secure parking as the second most important measure after charging infrastructure in encouraging the use of EL-Vs. Incentive schemes were perceived to be the least important. This result is different compared to the other cities, and is perhaps due to cultural factors, or the fact that effective incentive schemes have already been implemented in order to introduce a new technology and EL-Vs in Berlin have already progressed to more advanced stages of development.

9.2.3 Genoa

Due to its coastal proximity, Genoa's climate is temperate. The topology is not flat and there are many hills; this may increase EL-Vs' energy consumption. Therefore, more government incentives may be required to help encourage the adoption of EL-Vs. On the other side, Genoa has the highest usage of motorcycles of any major Italian city, likely due to its hilliness, providing the highest level of transferable skills to two-wheeler EL-Vs. The public transport infrastructure in Genoa is mostly old and its geographic features are hindrances to further developments. Thus, government incentives such as bike-sharing systems have been promoted. However, these incentives have only recently been introduced and so there is no conclusive evidence on the effectiveness of the scheme.

The perceptions on EL-V comfort were similar to the other cities across all EL-V types. The percentage of participants responding "Don't Know" was slightly higher than that seen in other cities, suggesting that more effort should be put into informing the population about and attracting new people towards EL-Vs.

Nearly 60% of respondents in Genoa were willing to use EL-V sharing schemes either frequently or occasionally. About 20% were unsure and 10% would prefer to buy their own vehicle.

Positive perceptions on safety in Genoa increased with the number of wheels of EL-Vs, with about 40% to 2-wheelers, 45% to 3-wheelers and 85% to 4-wheelers. Around 15% answered "Don't know" for 3-wheelers, which was relatively high compared to those in other demonstration cities.

Out of all EL-V types, 2-wheel EL-Vs are the most popular choice for work and education purposes. Men were observed to be more willing to use EL-Vs than women for all EL-V types and all-purpose usage. 3-wheelers are the least favourable choice for all trip purposes (below 10%). 4-wheel EL-Vs are the most popular choice for both shopping and leisure and personal trips.

The majority of respondents from Genoa are inclined to use EL-Vs as part of a multimodal journey. Of these, more men (over 80%) responded positively than women (just under 75%); more female participants refused to use EL-Vs than male. Roughly 10% of both males and females answered "Don't know".

Just over 80 percent of respondents strongly or rather agreed that two-wheel EL-Vs are easy to park in Genoa. More respondents strongly or rather agreed on the ease of parking three-wheel EL-Vs than four-wheelers, with nearly 60% and less than 40% respectively.

Perceptions of EL-V charging in Genoa were quite similar for all type of EL-Vs, around 40-45% of respondents strongly or rather agreed that EL-V charging is convenient. Over 50% of respondents chose "Don't know", which suggests that efforts should focus on how to educate and enrich people's experiences of EL-Vs.

Positive opinions on affordability in Genoa decreased with the number of wheels of EL-Vs (two, three, four-wheel) with about 60%, 50% and just over 45% respectively.

Positive opinions on luggage capacity in Genoa increased with the number of wheels of EL-Vs (two, three, four-wheel) with about 30%, 35% and 65% respectively.

Apart from sufficient charging infrastructure, the use of bus and cycle lanes by 2- or 3-wheel EL-Vs was seen as the most important measure in encouraging use of EL-Vs. Incentive schemes and secure parking were deemed to be important measures as well.

9.2.4 Málaga

Málaga extends mainly over flat land. Congestion levels in the city are relatively low compared to other demonstration cities. These, as well as its temperate climate, are most suited to EL-Vs. Málaga is still recovering from the economic crisis, so the government is looking for alternatives to expensive modes of transport. Bikes have had the highest relative growth of all transport modes in the last 8 years; this statistic is promising for further expansion and has already been proven effective due to a 23.9% decrease in traffic levels. EL-V promotion should target this as there is a clear gap in the market for cheaper transport methods, and the population is likely to be accepting this new technology as they have already responded positively to the existing development in infrastructure. Tourism is one of the most important business sectors. Thus, this demographic can be targeted for new EL-V schemes.

Just over 60% of respondents in Málaga were willing to use EL-V sharing schemes either frequently or occasionally. Around 20% were unsure, and very few respondents were either willing to buy their own vehicles and or would not consider using them at all.

The lowest percentage of respondents in Málaga agreed that 3-wheel EL-Vs are comfortable. The rate of “Don’t Know” was the highest among all the demonstration cities for this type of EL-Vs, might be because they were not familiar with them, implying that more awareness and knowledge of the vehicles should be targeted during EL-V promotion or demonstration.

Málaga received the highest percentages of respondents answering positively regarding the safety of 4-wheel EL-Vs out of all demonstration cities. In addition, the highest percentage of respondents answering “Don’t Know” for 3-wheel EL-Vs were observed to be from Málaga.

In Málaga, bicycles were a more popular choice for almost all types of trip purpose with EL-Vs, especially for leisure and personal trips, followed by 4-wheel EL-Vs. More men than women were willing to use EL-Vs, especially 2-wheelers, for all trip purposes. 3-wheelers were the least favourable choice (about 10% in total).

The percentage of respondents currently using EL-Vs as part of a multimodal journey was the second highest after Berlin. Most respondents (around 80%), expressed very positive intentions in using EL-Vs as part of a multimodal journey, with slightly more men showing inclination than women.

Nearly 80 percent of respondents strongly or rather agreed that two-wheel EL-Vs are easy to park in Málaga. Almost 60% of respondents strongly or rather agreed on ease of parking three-wheel EL-Vs. Just above 30% of respondents strongly or rather agreed on ease of parking four-wheel EL-Vs.

More respondents (around 40%) in Málaga expressed positive opinions on the convenience of charging two-wheel EL-Vs than that of three-four-wheelers (both around 25%). Almost half of respondents chose “Don’t know”, which suggests that EL-V promotion and demonstration should prioritise activities to increase the number and visibility of charging facilities and to inform the population.

Positive perceptions on affordability of use and operation in Málaga decreased with the number of wheels of EL-Vs (two, three, four-wheel) with about 60%, 50% and just over 45% positive respectively.

Positive opinions on luggage capacity in Málaga were similar with two and three wheeled EL-Vs with less than 25%, and four-wheelers with 65%.

Secure parking was considered the second most important measure to encourage use of EL-Vs, followed by incentive schemes.

9.2.5 Rome

The congestion levels in Rome are very high and thus average travel time is increased by 40%. Effective incentive schemes would encourage more EL-V use in the city and improve its congestion situation as well. There are three main transport sharing schemes in Rome; bike sharing, scooter sharing, and electric car sharing, although the bike sharing scheme is not electric, this provides a gap in the market which EL-V deployment could cover. Both electric schemes (car and scooter) have not deployed as many vehicles as the bike sharing scheme. The government is currently working on schemes that increase the number of charging stations in the city; more advertising in government incentives will also result in a consequent increase in public interest.

Nearly 80% of respondents in Rome were willing to use EL-V sharing schemes either frequently or occasionally – the highest percentage compared to other demonstration cities. Of these, nearly 50% would use them frequently and only 30% would use them occasionally. Very few respondents were either willing to buy their own vehicle or were not considering use at all.

Positive perceptions on comfort in Rome increased with the number of wheels of EL-Vs. Like the other demonstration cities the majority of respondents in Rome had positive opinions on the comfort of 4-wheel EL-Vs. However, a low percentage of respondents agreed on comfort for 2- and 3-wheel ELVs compared to other demonstration cities.

Positive perceptions on safety in Rome increased with the number of wheels of EL-Vs. Compared to other demonstration cities, a low percentage of respondents in Rome believe 2- (below 30%) and 3-wheelers are (about 40%) safe for trip usage.

In Rome, over 90% of males and over 80% of females expressed interest in using EL-Vs as part of a multimodal journey. This was the highest recorded interest of all demonstration cities. However, very few people are currently using EL-Vs as part of a multimodal journey, despite observed interest.

Nearly 85% of respondents strongly or rather agreed that two-wheel EL-Vs are easy to park in Rome. Almost 80% of respondents strongly or rather agreed on the ease of parking three-wheeled EL-Vs, and about 60% of respondents strongly or rather agreed on the ease of parking four-wheeled EL-Vs.

Respondents in Rome expressed similar opinions on the convenience of charging for all EL-V types with around 50% answering positively and 40% answering “Don’t know”. This indicates that efforts should be made to increase the number and visibility of charging stations and to inform the population of Rome.

Positive opinions on affordability of use and operation in Rome decreased with the number of wheels of EL-Vs (two, three, four-wheel) with about 70%, just above 60%, and just below 60% positive respectively.

Positive opinions on luggage capacity in Rome increased with the number of wheels of EL-Vs (two, three, four-wheel) with less than 25%, 35%, and 70% positive respectively.

The use of bus and cycle lanes by 2- or 3-wheel EL-Vs was considered the second most important measure to encourage use of EL-Vs, followed by incentive schemes.

9.2.6 Trikala

Over half of Trikala’s population is aging. Assuming that they are also in the active workforce and require commuting to work, EL-V promotion and demonstration should focus their efforts on targeting this demographic instead of the much lower percentage of the population in younger age groups. Trikala is characterised as flat, and so it is suited for EL-Vs. Local authorities have expressed interest in expanding the usage of EL-Vs, but no projects have been undertaken as of yet. Trikala also has the highest percentage of bikes used by its population compared to other cities. This implies a high level of public interest in light transport means; thus, the population should be more readily accepting of EL-Vs. There will also be a higher level of transferrable skills from bikes to E-bikes.

More than 60% of respondents in Trikala were willing to use EL-V sharing schemes either frequently or occasionally. Very few respondents were either willing to buy their own vehicles or were not considering use at all. Around 30% of respondents were still unsure.

Positive perceptions on comfort in Trikala increased with the number of wheels of EL-Vs. Like the other demonstration cities, the majority of respondents in Trikala had positive opinions on the comfort of 4-wheel EL-Vs. Out of all demonstration cities, Trikala had the highest observed percentage of comfort with 2-wheeled EL-Vs.

Over 50% of respondents believed that 2- and 3- wheeled EL-Vs are safe for a journey. Similar statistics were observed in Berlin. The majority of respondents in Trikala (over 80%) believe that 4-wheeled EL-Vs are safe for a journey.

In Trikala, 4-wheeled EL-Vs were the most popular choice for all purposes out of all EL-Vs, ahead of bicycles. More men than women were willing to use 2-wheeled EL-Vs for all-purpose usage. There was a negligible difference in perceptions between men and women towards bicycles and other types of EL-Vs. The least popular choice out of all EL-Vs is 3-wheelers, with less than 10% of the population choosing to use this type.

Nearly 70% of both men and women would consider the use of EL-Vs as part of a multimodal journey. However, the percentage of men and women who did not intend to use EL-Vs was the highest of all demonstration cities. This suggests that more effective measures are needed in order to increase the number of willing users.

About 85% of respondents strongly or rather agreed that two-wheel EL-Vs are easy to park in Trikala. Almost 80% of respondents strongly or rather agreed on the ease of parking of three-wheeled EL-Vs, and about 60% of respondents strongly or rather agreed on that of four-wheeled EL-Vs.

Similar opinions were expressed on the convenience of charging in Trikala for all EL-V types with positive responses at around 35%. About 55% answered "Don't know", the highest statistic among that of all cities, which implies that increased experience and awareness of EL-Vs will be necessary in Trikala, which can be implemented through promotion measures.

Positive opinions on affordability in Trikala decreased with the number of wheels of EL-Vs (two, three, four-wheel) with about 70%, just above 60%, and just below 60% positive respectively.

Positive opinions on luggage capacity in Trikala increased with the number of wheels of EL-Vs (two, three, four-wheel) with just above 25%, less than 40%, and just below 75% positive respectively.

In Trikala, incentive schemes were considered as a crucial measure in encouraging use of EL-Vs, followed by secure parking. Navigation services were considered to be the least important measure.

9.3 Barriers and suggestions

While the respondents from the public and fleet operators had positive attitudes towards EL-Vs, they also indicated barriers that may influence their willingness to use them, giving suggestions for improving the adoption of such vehicles. The additional concerns are categorised as follows:

- *For EL-V manufacturers*

Barriers associated with batteries included limitations in lifetime, problems with disposal, theft, and limited availability of recharge locations, low driving distance, and lengthy charging times. Additional barriers associated with price, capacity, and technology were also identified as limited choice in models and capacity and high purchase costs. Some solutions were given, including increased purchasing incentives, a necessity for adequate build-in antitheft systems, improved vehicle appearance and adding characteristics seen in existing traditional vehicles.

- *For service providers and organisations*

  Suggestions associated with sharing or renting services included increasing accessibility, reducing cost for sharing and renting, introducing free-flow sharing, and creating incentives such as free trial periods. Organizations could also play important roles in supporting EL-V adoption by giving bonuses to employees and providing shared EL-Vs for commuting to work.

- *For planning authorities*

  Planning authorities could promote EL-V adoption by focusing on infrastructure, incentives, and policy.

  In relation to infrastructure, the needs were expressed as follows:

  - Increased charging infrastructure – more charging points available, better charging facilities;
  - Improved road conditions, lighting and provision of specific signage – to increase safety and the perception of safety of using EL-Vs;
  - Increased integration of EL-Vs with public or other transport systems – improved mobility;
  - Increased number of bike path networks and dedicated lanes in the city that are shared with 2- or 3-wheeled EL-Vs – also to increase safety but also to give EL-V users more priority over other traffic and more attractive routes;
  - Dedicated parking with charging points – convenient for both charging and parking;

  Suggested incentives are as follows:

  - Increasing the limited zone traffic (in cities where these exist, e.g. ZTL in some Italian cities) with free access specifically for these vehicles;
  - Adequate financial and monetary incentives such as tax credits, subsidies, road tax exemptions, and discounts for parking fees.

  Policy related suggestions were as follows:

  - Prohibition of polluting vehicles in the city centre;
  - Legislation to control illegal parking of polluting vehicles;
  - Increasing the price of petrol and diesel.

- *For EL-V promotion and demonstration*

  Some suggestions promote the need to enhance awareness and knowledge of such plans, by increasing the number of campaigns and the number of vehicle demonstration tests so that citizens can familiarise themselves with the EL-Vs.

9.4 Overall Conclusions

By looking at city demographics and mobility characteristics, and learning about existing opinions towards EL-Vs, a clear overview and proposition for the next steps in EL-V promotion and deployment are given as follows.

Although the current characteristics of demographics and mobility vary dramatically across the demonstration sites studied, some perceptions and attitudes between the cities were similar.

Instead of owning EL-Vs, most users would prefer to use shared or rented vehicles and were likely to consider using EL-Vs as part of a multimodal journey. Apart from those who responded positively, EL-V promotion and deployment should aim to attract those who responded with neutrality, which were largely concentrated in Berlin and Trikala. This attitude may be an advantage to promote EL-Vs as complimentary or alternative solutions.

Positive perceptions regarding comfort, capacity and safety increased with the number of wheels on the vehicle, while perceptions related to parking and affordability generally decreased with the number of wheels.

In general, a higher percentage of women and elderly declared "Don't know" across almost all the attributes. There was a slight propensity for men to consider using EL-Vs as part of a multimodal journey than women, and a higher percentage of men and young people than women and the elderly respectively had positive attitudes towards EL-Vs. EL-V promotion and deployment should specifically focus on women and elderly populations for awareness and training activities.

It seems possible that most people were unfamiliar with 3-wheelers regardless of gender and age groups. This could be improved through EL-V promotion and deployment activities.

Furthermore, it seems that the observed attitudes towards using EL-Vs for all-purpose trips are still quite negative, regardless of EL-V type and gender and age groups. The most popular measure to improve EL-V adoption for all-purpose trips may be to provide sufficient electric charging infrastructure. This measure would mitigate the limitation of current battery related technology, e.g. limited driving distance and excessive duration of charging times. Incentive schemes, sufficient secured parking and use of bus lanes by EL-Vs were also considered important measures for a wider diffusion of the EL-V market across all demonstration cities.

It must be noted that the present survey might not be representative of the whole population because of differential Internet access. Not all people are reached through the distribution channels used in the demonstration cities. People who have access to internet are more likely to exclude certain social groups such as older people. In addition, people who completed the survey are more likely to be interested in EL-Vs or innovative transport solutions in general, whereas those with no interest in the topic are likely to have either ignored the questionnaire or terminated completion before the end. Therefore, the results might be biased in terms of percentages of people willing to use EL-Vs. Still, the main value of this work is to provide a snapshot of what types of trips people would most likely use EL-Vs for, what modes they currently use, what they see as the main benefits and disadvantages of EL-Vs and what measures would most likely encourage them to use this mode.

The measurement model followed reveals that:

- The Facilitating Conditions (FC) are correlated to the Performance Expectancy (PE), indicating that users might conclude the quality of one onto the other and meaning that these two factors are linked to each other. In other words, if facilitating conditions (e.g., charging stations) are in good shape and well-designed, user also expect their vehicle to perform better within the transport network.

- The Price Value of the vehicles has a notable impact on both the Performance Expectancy (PE) and the Facilitating Conditions (FC). This is probably due to the expected additional external costs the user can expect when purchasing or renting a vehicle. The higher the pricing, the higher the expectations for the performance and surrounding conditions (e.g., supporting facilities, equipment or infrastructure) are. Users are willing to pay more not only for a premium product but a premium experience.
- Finally, both age and occupation are slightly related to the Behavioural Intention (BI) to use the system, which is quite interesting and suggests that certain user groups (e.g., generations) are more likely to use these vehicles than others. As discussed within the last point in the next list of conclusions, age and occupation are also strongly interlinked. This could be due to the stage of life they are in (e.g., whether they might have underage children they need to transport or are retired with lower physical activity).

Furthermore, from a detailed analysis of the individual variables used in the model, the following conclusions can also be drawn:

- Users who consider using the service are also interested in using the service as part of a multi-modal trip and the integration into existing public transport networks seems to have a solid acceptance amongst the participants. Two other factors are influencing these responses: on the one hand, the availability of ample and easy-to-use parking facilities available (installation of safe and surveillance parking facilities at multimodal stops) and on the other hand, the overall comfort of the vehicles and the rental system influences the participants' willingness to use the service in the multimodal context.
- Apart from these considerations involving a wider transport network, the perceived comfort of the vehicle usage is linked heavily to the perceived safety-of-use, luggage capacity offered and availability of parking services. Use cases such as rental systems within a company or university campus should consider this, as parking should also be available at the user's home and commuting destination (whether it be their place of work/study or a point of interest within the city centre).
- The participants express some concerns by establishing a relationship between the safety and maximum load of luggage on the vehicle with the overall safety of using the vehicle. This indicates that the vehicles are probably suitable as cargo vehicles, given an appropriate and secure adaptation of the frames to carry higher weight loads. Additionally, persons who are purchasing or using the vehicle should probably be informed of the exact loading capacity to remove any anxiety around safety of the vehicle, since they also indicated that increased loads could impact the comfort of the vehicle usage.
- Interestingly, the willingness to pay for the service is heavily (it is the strongest correlation of the analysis) to the charging convenience of the vehicle. This could be due to the famous phenomenon of 'charging anxiety', wherein users of electric vehicles experience significant anxiety about the state of their battery and remaining charge (which is often completely irrational), as highlighted by Neuebauer *et al.* (2014) [94]. Another possible explanation would be the actual price users have to spend on electricity to charge their vehicles – this depends a lot on the use case:
    - Is charging offered for free to the user, for example due to adapted parking facilities around the city/their place of work/study or via a public municipal charging system, which is paid for by the municipality to encourage the use of EVs?

- Does the user have to organise and pay for their own charging (e.g., charging is only possible at home via a regular outlet within the user's home)?

  It seems of great interest and value to explore this topic in particular through future works of research, liaising multi-disciplinary teams together across different disciplines and sectors, including for example by bringing together behavioural science, battery or power engineers, economists, municipalities of different sizes, user groups and commercial operators could all greatly benefit from this.

- Finally, another correlation was identified between age and occupational status of the participants, which seems logical, as the occupational categories offered to the participants focussed purely on the form of employment and not on the sector or experience level of their profession. Answers ranged from 'student', via 'part-time employment' and 'full-time employment' to 'unemployed' and 'retired', though two extra options were given by 'other' and 'exclude from analysis'. Due to the anonymous nature of the answers, it is safe to say that most participants did not mind sharing their employment status openly.

10 Preliminary guide for EL-V demonstration and deployment

10.1 Overview

Based on the results of the surveys conducted, this section makes a step forward and proposes:

- A set of 40 key requirements for urban EL-V demonstration and deployment, structured into three categories, and
- A set of six usage schemes to demonstrate and/or deploy EL-Vs in urban areas.

10.2 Requirements

The 40 requirements identified for urban EL-V demonstration and deployment can be structured into three categories:

1) **Operational requirements** [OP]. These relate to specific infrastructure (such as parking or charging facilities) as well as user services (other than ICT applications).
2) **Policy requirements** [POL]. These are areas where a political decision is likely to be required, such as for infrastructure measures which require reallocating road space or priority from other modes of transport, as well as access issues (might depend on local bye-laws or national traffic laws, which might also require enforcement), or financial incentives.
3) **ICT requirements** (apps or other ICT services aimed at the end user), which serve as a basis for software development.

Some of these categories overlap to a certain extent, particularly the operational and policy requirements. The importance of each demonstration/deployment requirement is assigned as follows, with distinctions between sharing schemes and ownership schemes:

1) **Essential**: These should be the minimum requirements to make the scheme work. For example: the existence of shared vehicles, maintenance facility, account creation and management. It is considered that "essential" requirements need to be implemented for relevant schemes in each of the demonstration cities.
2) **Desirable**: These are requirements that are considered important for the attractiveness and smooth operation of a scheme, but the implementation would be able to function without them.
3) **Nice to have**: These are optional extras to improve the scheme and might be specific to only one city or some cities.

In sum, below 16 operational requirements, 5 policy requirements and 19 ICT requirements are defined. Fifteen of them are considered essential for an EL-V sharing scheme to operate, but none are absolutely essential for an ownership scheme, because these can consist of different measures and incentives in each city, without any specific minimum requirements. However, many of the sharing scheme requirements are also desirable for ownership schemes, meaning that when specifying, building and implementing measures (infrastructure, ICT tools, etc.) for shared EL-Vs, consideration should be given to whether it is appropriate or suitable to extend the service to people using their own EL-Vs.

10.2.1 Operational requirements

The following table lists the operational requirements proposed:

Table 47: Operational requirements

ID	Requirement	Priority for sharing schemes	Priority for ownership schemes
OP001	EL-Vs are available for sharing in dedicated locations, where they are parked and charging (including e-hubs).	Essential	Not applicable
OP002	The parking and charging areas are safe and secure.	Essential	Desirable
OP003	EL-Vs are equipped with black boxes, with unique vehicle or black box IDs.	Essential	Not applicable
OP004	A user can pick up and return an EL-V at this location 7 days a week, (24h a day, or perhaps limited e.g. 07:00-23:00?)	Desirable	Not applicable
OP005	An operator on-the-spot, checks users' documents and delivers the EL-V and usage instructions to the user.	Desirable	Not applicable
OP006	The operator instructs the user how to use the various apps available and how to register in the EL-V sharing system	Desirable	Not applicable
OP007	If needed, the operator helps the user register for the first time in the EL-V sharing system and get his/her unique user ID. [Also ICT006]	Essential	Not applicable
OP008	A user may exchange bonus points for awards. [Also ICT012 and POL001]	Desirable	Desirable
OP009	A user can evaluate and provide feedback on using the electric vehicles and the sharing system apps, through a corresponding questionnaire.	Essential	Not applicable
OP010	EL-V sharing stations to be available at multimodal transfer points (bus and rail stations, park-and-ride facilities) to enable users to easily transfer from public transport or a private car.	Desirable	Not applicable
OP011	Parking and charging areas are provided for owned EL-Vs (not part of sharing scheme)	Not applicable	Desirable
OP012	Charging stations for owned EL-Vs can be booked	Not applicable	Desirable
OP013	Charging stations are connected to e-roaming networks	Desirable	Desirable
OP014	Delivery spaces for EL-Vs (where there is demand)	Desirable	Desirable
OP015	Assistance is available in case of EL-V breakdown / failure /accident / theft	Essential	Desirable
OP016	For EL-Vs where a helmet is mandatory, shared ones include a secure box containing one (or two,	Essential	Not applicable

ID	Requirement	Priority for sharing schemes	Priority for ownership schemes
	depending on passenger capacity) as well as disposable inner linings for hygiene purposes.		

10.2.2 Policy requirements

The following table lists the policy requirements suggested:

Table 48: Policy requirements

ID	Requirement	Priority for sharing schemes	Priority for ownership schemes
POL001	A user may exchange bonus points for awards. [Also ICT012 and OP008]	Desirable	Not applicable
POL002	A variety of award options is available (e.g. redeeming the point awards for bus tickets, free parking etc.) for the accumulated bonus points, along with their prerequisites (e.g. number of tickets, hours of parking etc).	Desirable	Not applicable
POL003	Targeted improvements in road infrastructure to make EL-V use safer and more attractive [can include shared use of other lanes e.g. cycle, bus, or priority at traffic lights, where appropriate]	Desirable	Desirable
POL004	EL-Vs to have free access to areas where other traffic is either restricted or has to pay a toll (limited traffic zones, etc.)	Desirable	Desirable
POL005	Economic/financial incentives for EL-V purchase	Not applicable	Desirable

10.2.3 ICT requirements

The following table defines the software requirements. These focus on the overall functional requirements only, not on the characteristics of specific apps or other ICT tools.

Table 49: ICT requirements

ID	Requirement	Priority for sharing schemes	Priority for ownership schemes
ICT001	A user must be authenticated / authorised before picking up the EL-V.	Essential	Not applicable
ICT002	A user's registration application is available, assigning unique IDs per physical person.	Essential	Not applicable

ID	Requirement	Priority for sharing schemes	Priority for ownership schemes
ICT003	A Booking app is available, which shows dynamic availability of EL-Vs, a description of each vehicle characteristics and their location.	Essential	Not applicable
ICT004	A SmartCard app is available for the city, calculating bonus points (either per vehicle booking, driving distance or driving style) and adding them to the user account.	Desirable	Desirable
ICT005	An EL-V app is available for the user, showing the battery level of the vehicle and the estimated driving range.	Essential	Desirable
ICT006	If needed, the operator helps the user register for the first time in the EL-V sharing system and get his/her unique user ID. [Also OP007]	Essential	Not applicable
ICT007	A front end is available to the operator so that he/she can relate the user ID with the trip to be made with the specific vehicle.	Essential	Not applicable
ICT008	An authenticated user can book an EL-V in advance via the booking app, indicating the pick-up and return times.	Essential	Not applicable
ICT009	The EL-V app sends the distance-made details to the SmartCard app, so that it can calculate the bonus points and add them to the user’s account.	Desirable	Desirable
ICT010	The SmartCard app informs the user about the points gained.	Desirable	Desirable
ICT011	A Gamification app informs the user on his driving behaviour compared to other users, and provides a comparison between the driving of an ICE and an EL-V.	Desirable	Desirable
ICT012	A user may exchange bonus points for awards. [Also OP008 and POL001]	Desirable	Desirable
ICT013	An evaluation questionnaire is available in each system app.	Essential	Desirable
ICT014	An app shows the best route to take between an origin and destination for an EL-V (taking into account priority lanes, avoiding dangerous junctions, etc.)	Desirable	Desirable
ICT015	The routing app [ICT014] also allows users to save their most regular journey(s) and be informed if they should take an alternative route to avoid disruption.	Desirable	Desirable
ICT016	An app shows the status of all charging stations (occupied, free) compatible with the user's kind of EL-V and the ability to book them.	Desirable	Desirable
ICT017	An app allows interoperable payment for charging stations, also allowing company accounts for fleet EL-Vs (e.g. delivery fleets)	Not applicable	Desirable

ID	Requirement	Priority for sharing schemes	Priority for ownership schemes
ICT018	An app allows EL-V owners to remotely see charging progress (battery level) while charging.	Not applicable	Desirable
ICT019	An app allows booking of parking facilities for all EL-Vs (owned, shared)	Desirable	Desirable

10.3 Usage schemes

This chapter explains six usage schemes and the approach towards developing them. Usage schemes similarities are highlighted to ensure consistency among the schemes and to demonstrate the interoperability of applications between the demonstration sites, and to promote usage schemes' ease of access and user-friendliness.

The usage schemes include not only sharing schemes and charging facilities, but also elements which can help in defining ICT requirements, which are expressed through user stories. Moreover, user rewards, advertising, and possible infrastructure improvements to enable better integration of EL-Vs into the urban transport system are identifiable through usage schemes.

10.3.1 Sharing schemes for residents

These are aimed at short-distance commuters and occasional use such as shopping or leisure, with trips normally starting or ending at the user's home. Multimodal aspects (interchange with public transport) are included. The main features may include e-hubs, tools to encourage the use of EL-Vs, of charging points and multimodality, as well as short-term parking-related benefits. Pick-up points could be either fixed stations or free-floating. One-way rentals should be possible.

10.3.2 Sharing schemes for visitors

This is aimed at occasional or one-off use by people not resident in or near the city (leisure/tourism and event delegates). These users would need easy registration: user-friendliness is important as most users will be unfamiliar with the city and its road network. Some users will be from other countries, so language issues, smartphone data requirements and payment methods need to be considered. The schemes could include easily visible fixed vehicle pick-up stations, e-hubs, publicity and incentives. For EL-Vs where use of a helmet is obligatory by law, these schemes, as well as sharing schemes for visitors, should include one attached to the vehicle or in a secure box, with a disposable (single-use) inner lining for hygiene purposes.

10.3.3 Sharing schemes for businesses

These schemes are for occasional use by companies for home deliveries, etc. Different commercial activities may need to use a shared EL-V on an ad hoc basis, such as for repair and delivery of devices, occasional or one-off distribution, for example by independent artisans or small businesses.

10.3.4 Ownership schemes for citizens

These are aimed at commuters, students or leisure users in the city and suburbs. Features may include e-hubs, charging points at workplaces, places of education and at commercial premises, and financial encouragement to purchase an EL-V. Measures to promote multimodality are also included as well as preferential parking.

10.3.5 Ownership schemes for delivery businesses

This type of scheme is aimed at delivery companies in the city and metropolitan area, particularly those focusing on home deliveries. Features include e-hubs, parking facilities at key delivery points, charging points at commercial premises and access to any limited traffic zones (for example in historic city centres).

10.3.6 Ownership schemes for other businesses

These schemes aim to cater for short-distance urban trips made by employees in the course of their work, excluding deliveries. A company, public service or other institution or organisation could purchase EL-Vs to allow their staff to use an EL-V during the course of their working day for professional trips where walking or public transport is not suitable (instead of using private car, taxi, etc.). It would include features such as e-hubs, parking, and charging facilities at workplaces and commercial premises, as well as economic incentives for purchase and maintenance.

11 Future research lines

This piece of research has taken a close look at the key factors influencing the adoption of EL-Vs, explored six European cities' mobility features, and carried out extensive surveys into the a-priori attitudes of citizens and stakeholders towards such vehicles.

For EL-Vs to accelerate their market uptake in a significant manner, the analysis of a-priori perceptions should be complemented with extensive research supported by empirical research into other key issues such as:

1. *Collection and analysis of real usage data of EL-Vs and of users' acceptance after experiencing such vehicles in real conditions (pilots, demonstrations, commercial usage).*

   Specifically, this research line would analyse the users' behaviour and opinions by means of data collection from multiple sources, including questionnaires depicting user data (such as user age, occupation, and gender), booking information, monitoring of vehicle activity (tracking of trip data such as speed, trip distance, purpose, geolocation) and charging behaviour (including state of voltage).

2. *Design of a new generation of ELV-s taking into consideration the findings above.*

   This research line should provide grounded guidelines to manufacturers based on customer expectations as well as on operational requirements, covering issues such as the development of purposeful backends for operators, integrated navigation & tracking systems, advanced users' protection against bad weather and a new generation of vehicles' batteries.

3. *Exploration of sustainable business models for service providers, ICT tools developers and other support services connected with EL-V deployment.*

   This research line would explore the marketability of selected EL-V services and their related ICT tools, including a detailed analysis of the stakeholder frameworks that would make EL-V services attractive to cities, companies and citizens alike, hence making the usage of EL-Vs financially and socially more convenient than using conventional ICE vehicles. Factors such as availability, reliability, price, maintenance, safety, integration with other systems, convenience and interoperability should be taken into consideration.

4. *Definition of the most suitable usage schemes for EL-V city deployments, allowing an optimal user experience and awareness about EL-Vs performance and usefulness.*

   This research line should study the optimal conditions for the creation of a local ecosystem of public and private players – also engaging with citizens - in order to develop an integrated approach to the planning of EL-V infrastructure, the deployment of EL-V services and their most convenient integration into the urban network following a perspective of a Mobility as a Service. This line should also explore avenues to better integrate EL-Vs into Sustainable Urban Mobility Plans (SUMPs).

5. *Review of the scaled-up impacts on mobility and traffic of the widespread the usage of EL-Vs at a city-level.*

   In order to better understand the traffic and environmental impacts of a hypothetical increased EL-Vs usage, theoretical approaches that derive traffic relationships (flow, density, speed) should be reviewed, together with empirical evidence for traffic relationships. Future studies should then consider their application to real-traffic data to improve EL-V driving models at the microscopic level and to validate the findings of scaling-up methodologies.

6. *Cost-benefit analysis of the widespread the usage of EL-Vs at a city-level.*

   This research line would first i) quantify the environmental impacts from the usage of EL-Vs instead of conventional internal combustion engine (ICE) vehicles and to convert these impacts into monetized benefits, to then ii) estimate the potential market uptake of EL-Vs by comparing the environmental benefits against the costs associated with the introduction and usage of more EL-Vs (and the usage of less ICE vehicles) via Cost Benefit Analysis (CBA) models. The latter would help clarify the question of whether replacing ICE vehicles with EL-Vs is financially justifiable (i.e., if the benefits are higher than the costs) or if the (technology, infrastructure and other) costs greatly exceed the (environmental, health, and other) benefits expected.

7. *Study of 'security' as a factor influencing the adoption of EL-Vs.*

   This research line would cover a topic mostly ignored by literature, except for a few surveys exploring the weather conditions and ease of parking affecting EL-V usage. Further research is needed to explore an adequate response and recovery time to incidents caused by vandalism and/or theft, at the same time not hindering for instance the normal flow of users in shared fleets. The aspect of cyber-security has also become a core aspect of transportation which surges to protect data exchanges, privacy as well as the health and safety of citizens.

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Annex A: City Data Collection Templates

Template for City Characteristics

Characteristics	Genoa		Rome			Bari		Trikala		Berlin		Málaga		
	City	Metro	District IX	City	Metro	City	Metro	Municipality	Regional	City	Metro	District I	City	Metro
Size (km^2)														
Population														
Persons in employment														
Persons in full time education:														
Age 16-18														
Age 19 and over														
Population/nationality:														
% nationals of that country														
% nationals of other EU countries														
% from non-EU countries														
Weather/Climate:														
Average daytime temperature														
in hottest month of year (°C)														
in coldest month of year (°C)														
Average days of rain														
in driest month														
in wettest month														
Topography: approximate %:														
% of area flat or nearly flat														
% of area slightly hilly														
% of area very hilly														

Characteristics	Genoa		Rome			Bari		Trikala		Berlin		Málaga		
	City	Metro	District IX	City	Metro	City	Metro	City	Metro	District IX	City	District I	City	Metro
Pollution and air quality:														
NO_2: Min_value														
NO_2: Avg_value														
NO_2: Max_value														
NO_2: No_observations														
SO_2: Min_value														
SO_2: Avg_value														
SO_2: Max_value														
SO_2: No_observations														
Comments area:														

Template for Travel Costs

(City only, not metro-area)	Genoa	Rome	Bari	Trikala	Berlin	Málaga
Local public transport (bus, metro or tram):						
Single ticket cost for an average journey in the city						
Monthly ticket cost for unlimited travel within the city						
Car or motorcycle:						
Average local cost per litre of unleaded petrol						
Average local cost per litre of diesel						
Average local cost for 1h on-street parking in central area						
Average local cost for 4h in off-street public car park						
Description of any restrictions on petrol/diesel vehicles entering the city centre (types of vehicles banned or restricted and when)						
Costs for permit or right to drive in city in the case of restrictions (Eco-tax, limited traffic zone, congestion charge, etc.)						
Comments Area:						

Template for Trip Characteristics

Trips per average weekday		Genova		Rome			Bari		Trikala		Berlin		Málaga		
		City	Metro	District	City	Metro	City	Metro	Municipality	Regional unit	City	Metro	District I	City	Metro
By Purpose	Home Based Non-Work														
	Non-Home Based														
	Light Goods Delivery														
	Other purposes														
By Mode *(no. of trips to, from, through or within the area)*	Bus														
	Tram														
	Metro/underground														
	Rail														
	Car or van (driver)														
	Car or van (passenger)														
	Taxi or ride sharing service														
	Motorcycle														
	Moped/scooter														
	Cycle														
	Walk														
	Other (specify, e.g. funicular, ferry, etc.)														
Average vehicle occupancy	Bus -peak periods														
	Bus -off-peak periods														
	Tram or metro -peak periods														
	Tram or metro -off-peak														
	Car or van -peak periods														
	Car or van -off-peak														
	Taxi -peak periods														
	Taxi -off-peak														
Comments															

Template for Transport System

Characteristics	Genova		Rome		Bari		Trikala		Berlin		Málaga	
	City	Metro	City	Metro	City	Metro	Municipality	Regional	City	Metro	City	Metro
Car or van												
Public transport												
Motorcycle												
Bicycle												
Other (specify modes)												
Road length (km):												
Motorways												
Principal roads												
Other/Local roads												
Bus lanes (km/dir)												
of which bicycles allowed												
of which scooters allowed												
Separate bicycle lanes (km/ direction)												
No. *of vehicle-km* *per average weekday within the area*												
Cars												
of which electric vehicles												
L-category vehicles												
of which electric L-Vs												
Light goods vehicles												
Trucks												
Motorcycles												
of which electric ones												
Bicycles												
Buses and coaches												
Traffic Issues: Average traffic volume -hourly												
Average traffic volume												
Average traffic flow rates (vehicles/hour)												
Average daily road capacity of (vehicles/day)												
Mean travelling speeds (km/h)												

Characteristics	Genova		Rome		Bari		Trikala		Berlin		Málaga	
	City	Metro	City	Metro	City	Metro	Municipality	Regional	City	Metro	City	Metro
Public transport network(km) (bus/tram/rail/metro)												
Length of bus network												
Length of tram network (if any)												

Length of metro network (if any)												
Length of suburban rail network												
No. of PT lines freq. daytime >= 15 min.												
No. of PT lines with daytime freq. between 15 min. and hourly												
Public transport quality												
Average waiting time at bus stop												
Average frequency of metro on weekdays												
Average frequency of tram on weekdays												
Congestion, EV facilities and parking												
Traffic congestion: Congestion Level (increase in overall travel times when compared to a Free Flow situation.)												
Traffic congestion: Extra Travel Time: (extra travel time during peak hours vs. an hour of driving during Free Flow situation)												
No. of urban policies and bonuses to promote virtuous behaviours and e- or e-light vehicle use (e.g. use of bus lanes, discounts for PT, access to LTZ)												
Please indicate what are the policies												
No. of public charging points for EVs (individual poles, so there might be 2 or more at the same location)												
No. of public charging locations for EVs (a location might include two or more charging points, or only one)												
Public off-street parking (car park) spaces												
No. of parking places reserved for light vehicles, of which for e-light vehicles;												
No. free at all times												
No. charged for												
No. *of on street parking spaces*												
No. free at all times												
No. charged for or need permit for												
Comments Area:												

Template for Shared Mobility

(City only, not metro-area)	Genoa	Rome	Bari	Trikal a	Berlin	Málaga
Car sharing (self-service, not traditional rental):						
No. of companies						
Names of companies						
Total no. of cars for sharing in cities						
No. of these which are electric or hybrid cars						
No. of car pick-up points in city						
No. of charging stations for shared EVs						
Car sharing usage:						
No. of persons subscribed (all operators)						
Average no. of rentals per car per week						
Average km driven per car per week						
LV Sharing (self-service, not traditional rental):						
No. of companies						
Names of companies						
Total no. of LVs for sharing in cities						
No. of these which are eLVs						
No. of LV pick-up points in the city						
LV sharing usage:						
No. of persons subscribed (all operators)						
Average no. of rentals per car per week						
Average km driven per car per week						
Bike Sharing (self-service):						
No. of companies						
Names of companies						
Total No. of bicycles for sharing in cities						
No. of docking stations in city						
No. of free-floating cycles (no docking station)						
No. of these which have electric assistance						
Bike sharing usage:						
No. of persons subscribed (all operators)						
Average No. of rentals per car per week						
Average km driven per car per week						
Comments Area:						

Annex B: Additional City Mobility Data (Bari and Genoa)

B-1. Bari

1.1 General City Characteristics

PM10 concentration for Metropolitan area of Bari

City	Zone typology	Monitoring station typology	Yearly average value [µg/m3]	Max value [µg/m3]	number of days a year PM10 exceeds 50 µg/m3
Altamura	suburban	traffic	17	104	7
Bari	suburban	background	32	89	28
Bari	urban	traffic	24	62	7
Casamassima	suburban	background	20	93	9
Modugno	suburban	industrial	26	68	12
Modugno	suburban	industrial	23	88	21
Monopoli	suburban	traffic	18	80	1

NO_2 concentration for Metropolitan area of Bari

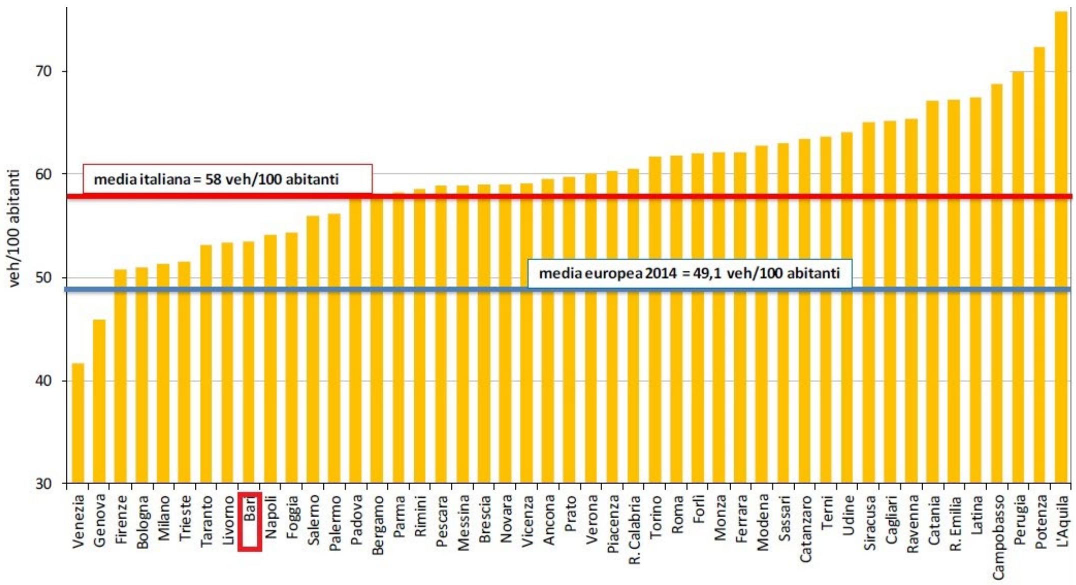
City	Zone typology	Monitoring station typology	Yearly average value [µg/m3]	Max value [µg/m3]	number of days a year NO_2 exceeds 200 µg/m3
Altamura	suburban	traffic	25	223	1
Bari	urban	traffic	31	140	0
Bari	suburban	background	22	157	0
Bari	suburban	background	17	116	0
Bari	suburban	background	23	140	-
Casamassima	suburban	background	12	87	0
Modugno	suburban	industrial	23	132	0
Modugno	urban	industrial	22	143	0
Modugno	suburban	industrial	16	97	-
Molfetta	urban	traffic	21	104	-
Monopoli	suburban	traffic	19	137	0
Monopoli	suburban	traffic	15	78	0

SO_2 concentration for Metropolitan area of Bari

City	Zone typology	Monitoring station typology	Yearly average value [µg/m3]	Max value [µg/m3]	number of days a year SO_2 exceeds 125 µg/m3
Bari	urban	traffic	5	19	0
Bari	suburban	background	4	30	0
Bari	urban	traffic	3	28	0
Bari	suburban	background	5	33	0
Modugno	suburban	industrial	4	15	0
Molfetta	suburban	industrial	8	80	0
Molfetta	urban	traffic	6	61	0

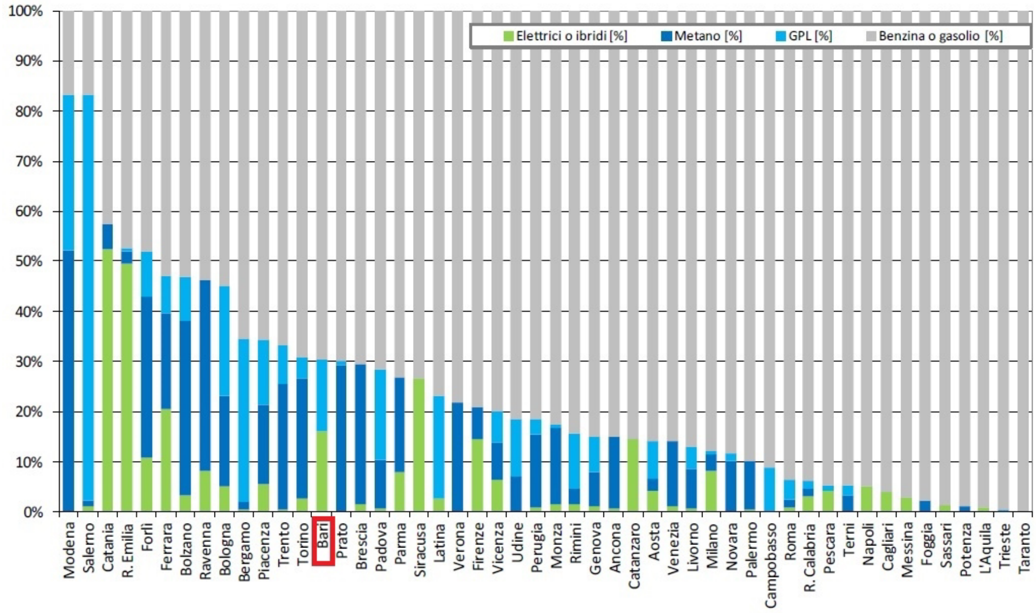
1.2 Transport Characteristics

Motorization index for different Italian cities[78] (2016)



Classification vehicles for the motor power by electric or hybrid, CNG, petrol or diesel (2016)

[78] Source: Osservatorio Mobilità Sostenibile in Italia, Euromobility.



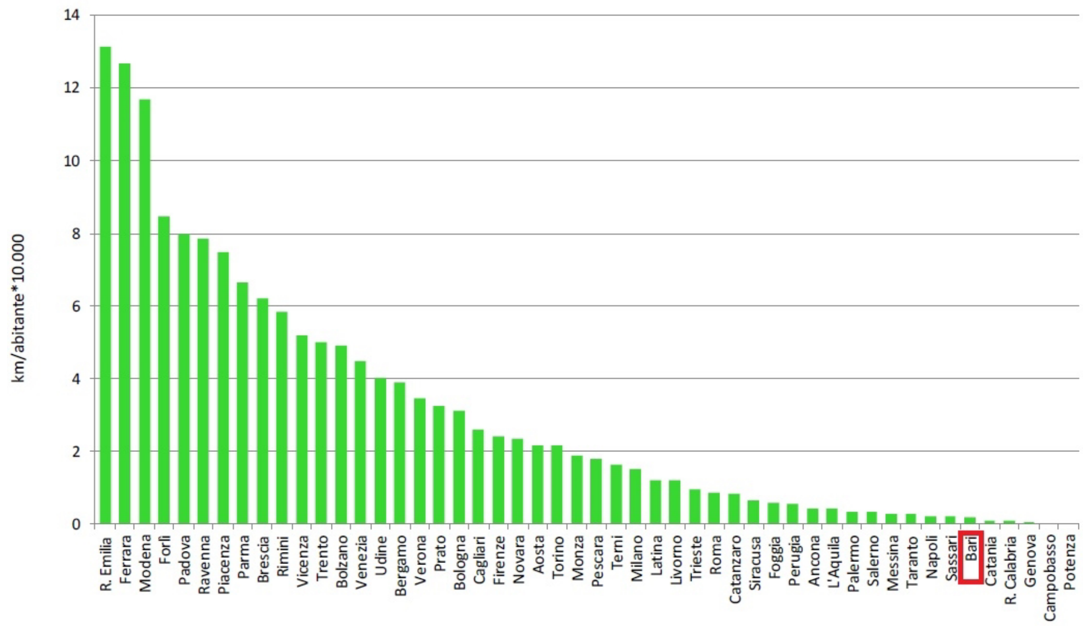
Public Transport in Bari

Transit	Bus	Rail	Metro
network length(km)	621	38.6	20.5
Lines	45	6	1
Vehicles	241		
No. of lines with frequency <15min	4		
No. of lines with frequency >15min	31	4	
No. of lines without a fixed frequency	10		
Average peak time frequency (min) on weekday	15-20	15	
Average waiting time(min)	20		
Single ticket cost for an average journey in the city (€)	1.0		
Monthly ticket cost for unlimited travel within the city(€)	35		

Road length in Metropolitan area of Bari

	Motorways/ expressway (km)	Principal (km)	Local roads/ streets (km)	Travelled roads by public transport (km)	Bicycle lines (for Bari city) (km)	Railway network (km)
Metropolitan area of Bari	78	1816	412	1293	24	1232

Cycle paths (km/10,000 inhab) in Bari[79]



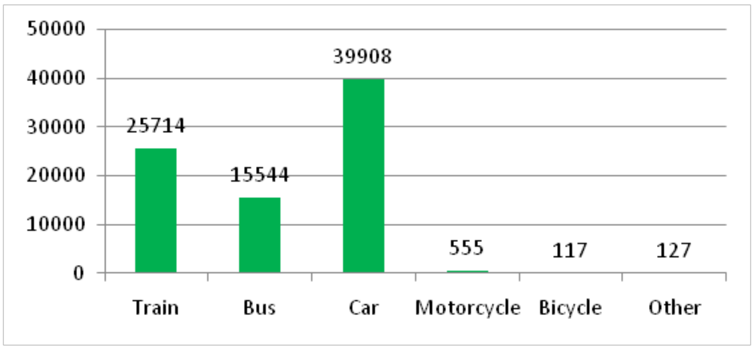
Indicators for public bus transport

Indicator	calculation
Punctuality of Service	Travel on time/trips made (%)
Average distance of bus stops	Average distance of bus stops in the city centre
Trips security - vehicles modernity	Vehicles average age
Road accidents	Nr. road accidents/10,000 km
Personal security	Bus with surveillance system (%)
Web information	Frequency of internet updates
On board comfort	Vehicles with air conditioning (%)
Accessibility for disabled	Vehicles with reserved seats and lowered platform (%)
Electric vehicles	Electric vehicles (%)
CNG vehicles	CNG vehicles (%)

[79] Source: Osservatorio Mobilità Sostenibile in Italia, Euromobility.

1.3 Travel Characteristics

Trips by mode from metropolitan of Bari area to city of Bari for study and work



1.4 L-V/EL-V Use

Electric charging locations in Bari

Charging infrastructure and electric vehicle sharing schemes in Bari in 2017

Charging information	
No. of public charging points	26
No. of public charging locations	14
Sharing scheme	
Number of electric sharing vehicle	23

Number of pick-up points in city	14
Monthly average trips for E-CAR	12
Travelled km for car	612 km/year
Average travelled km for trip	5.0 km
Average time for trip	36 min
Nr. people registered to the car sharing service	564

Electric Car sharing results in Bari

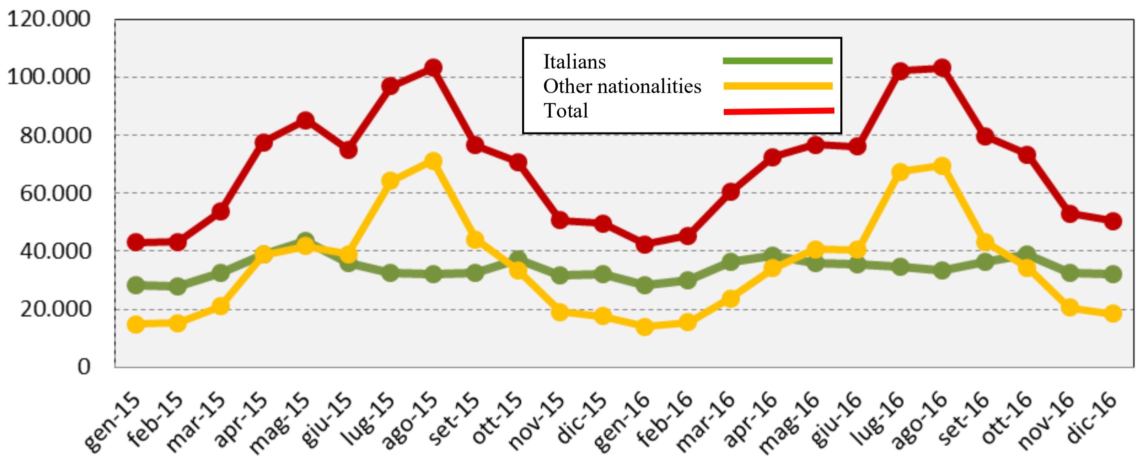
Month	Nr. trips	Total travelled km	Travel times (min)
January	448	1,746	5,562
February	299	1,438	4,244
March	376	1,543	4,837
April	452	3,393	7,685
May	351	1,693	4,523
June	424	2,272	6,220
July	339	1,308	3,898
August	226	1,847	3,900
September	408	1,230	4,227
October	360	1,910	5,254
Total	**3,683**	**18,380**	**50,350**

B-2. Genoa

2.1 General City Characteristics

In consideration of the enormous cultural and historical heritage of the city of Genoa, having one of the largest and most populated historical centre in Europe and several areas which has been identifies as UNESCO World Heritage, the tourist flow are increasing, with 850,000[80].

Tourism trend in Genoa. Source: Municipality of Genoa, Statistics Department



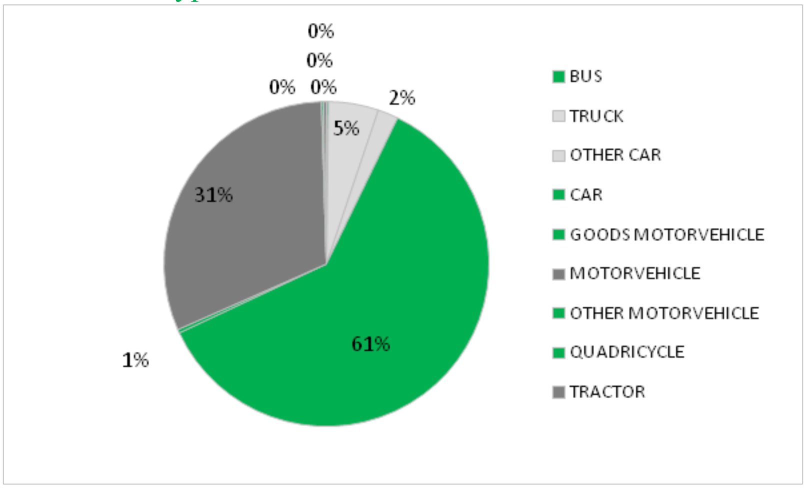
2.2 Transport Characteristics

Road network in Genoa

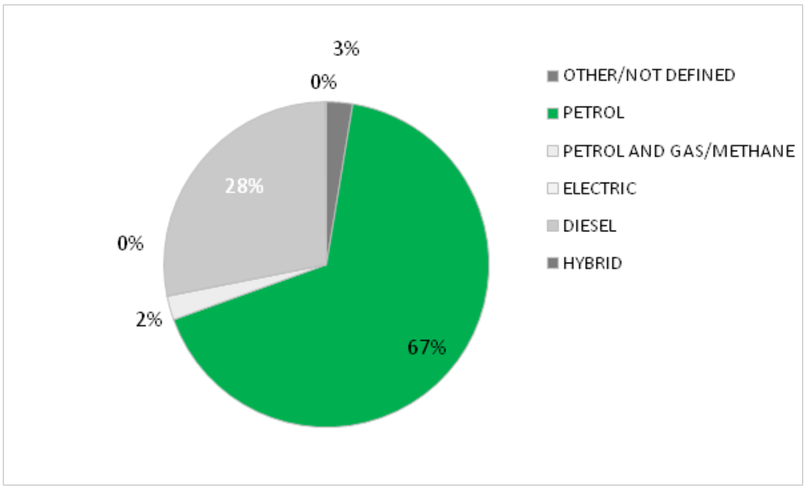
Road length[81]	km	%
Motorways/Expressways	116,607	6.5%
Principal or Class 1 roads	42,941	2.4%
Other/Local roads/streets	1,607,534	89.6%
Bus lanes (km per direction)	26,659	1.5%
km of which bicycles allowed	0	0.0%
km of which scooters/mopeds allowed (if any)	0.3	0.0%
Bicycle lanes (not part of bus lane) (km per direction)	3.6	0.0%

[80] Source: Municipality of Genoa, Statistics Department (years 2015 and 2016).
[81] Source: Municipality of Genoa, Mobility Department (2017).

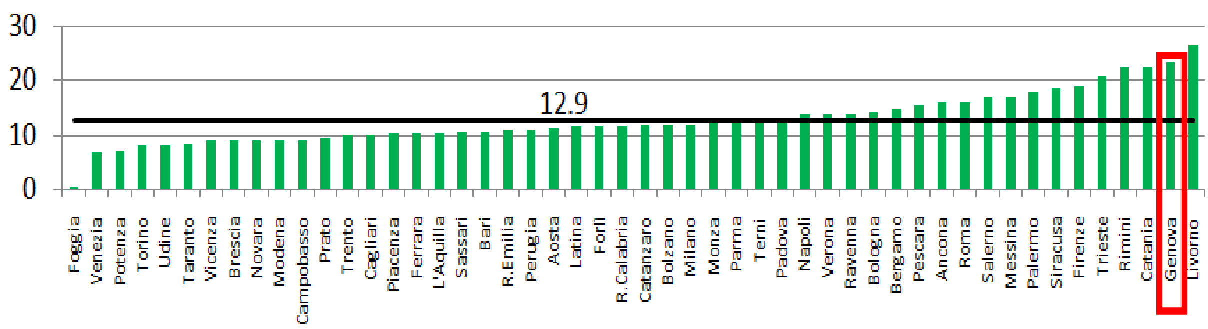
Types of vehicles of the Genoese fleet



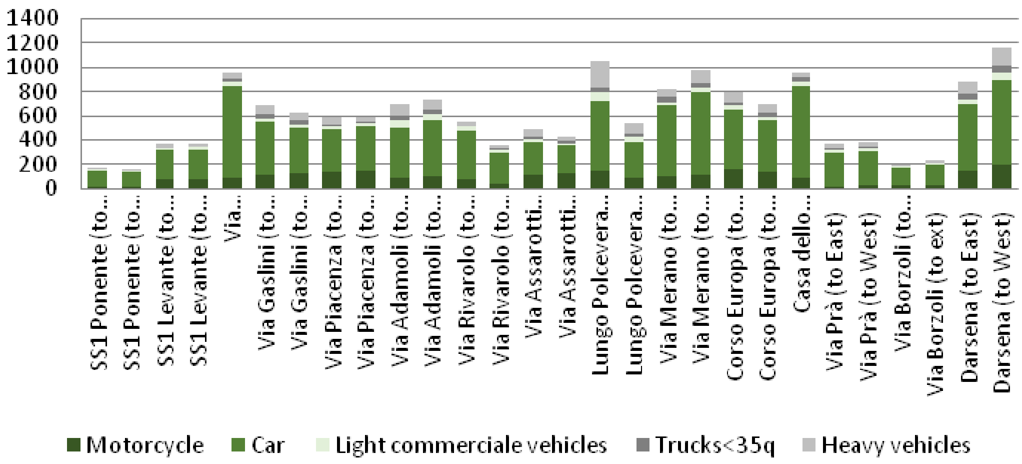
Types of fuel/energy supply



Motorcycle motorization rate (vehicles/100 inhabitants)



Daily traffic flow in the 15 sections in Genoa, distinguishing the type of vehicles



Public transport network in Genoa

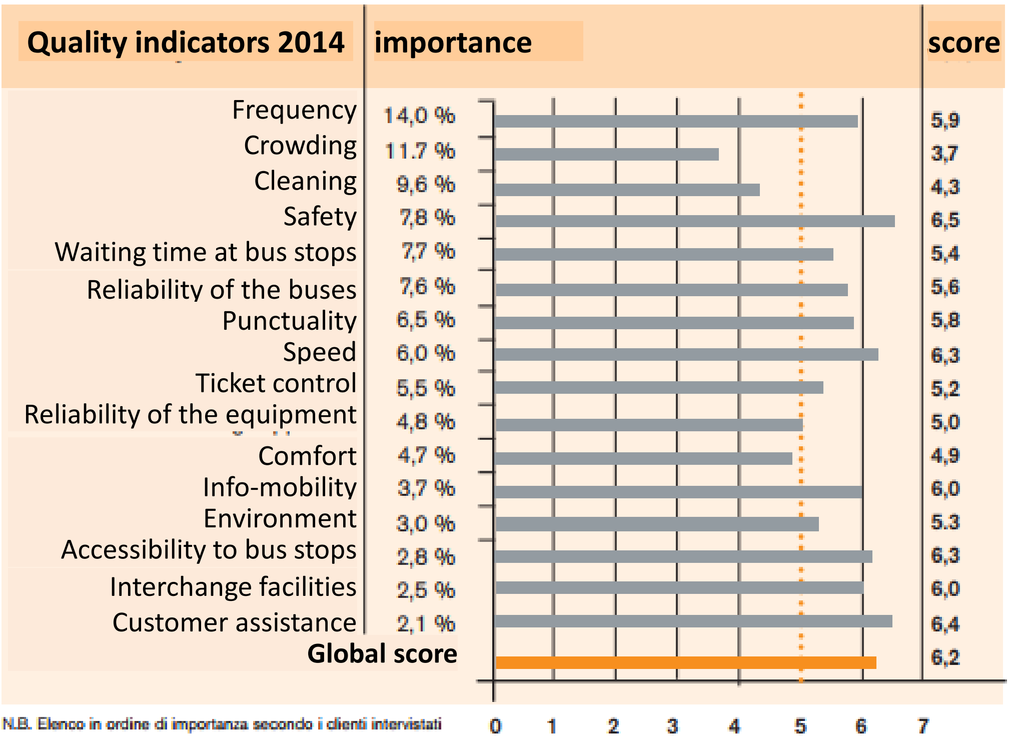
Public transport network[82]	km
Length of bus network	925.37
Length of tram network (if any)	0
Length of metro/underground network (if any)	7.2
Length of suburban rail network (if any)	0

Public transport services in Genoa

Winter working day[83]	Rush hour		
	morning	afternoon	evening
no. of lines with frequency =< 5 min	5	0	3
no. of lines with frequency > 5 min and =< 10 min	30*	21	22
no. of lines with frequency > 10 min and =< 35 min	51	63	57
no. of lines with frequency > 35 min or without a fixed frequency	8	9	11
no. of vehicles circulating	483	383	405
* including underground			

Customer satisfaction indicators and scores (2014). Source[84]: AMT "Carta della mobilità"

[82] Source: Municipality of Genoa, Mobility Department (2017).
[83] Source: AMT "Carta della Mobilità" (Azienda Mobilità e Trasporti).
[84] Source: AMT (Azienda Mobilità e Trasporti).

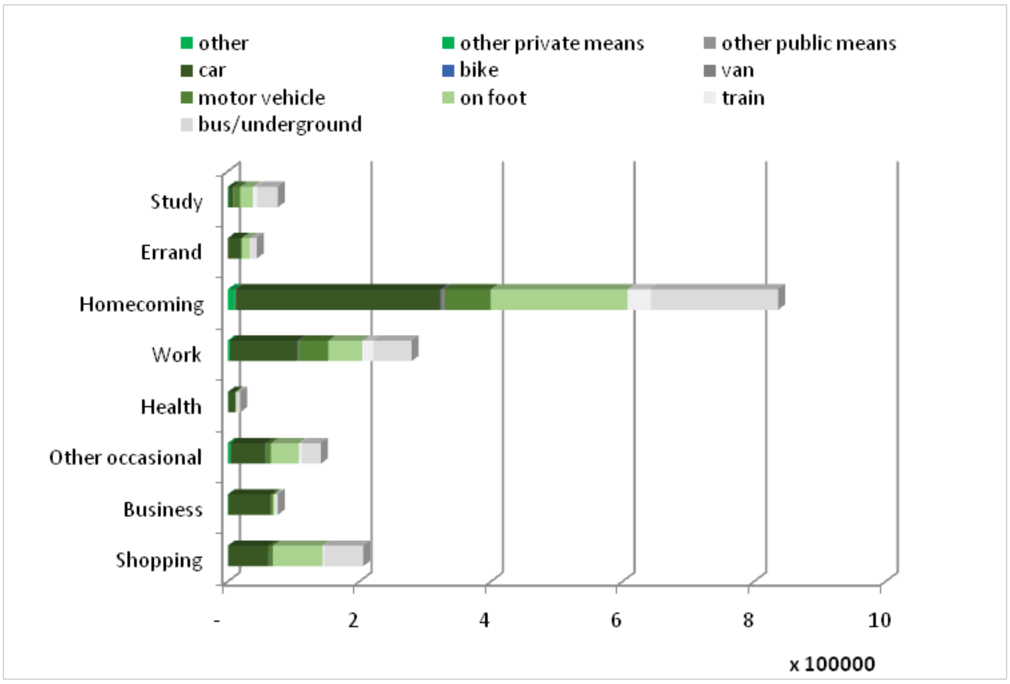


Fares of the urban PT service in Genoa

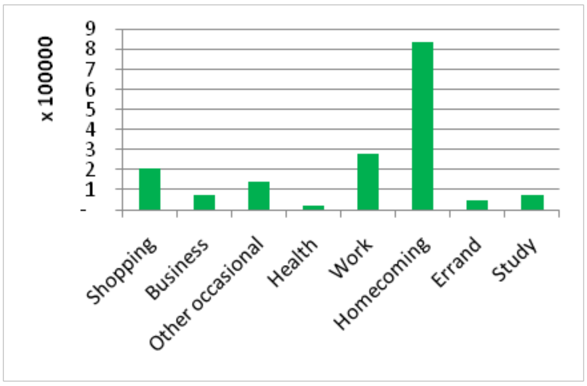
Urban fares	Price
Single ticket cost for an average journey in the city (integrated with railway)	€ 1.50
Single ticket cost for an average journey in the city (100 min only for bus/metro or lift)	€ 1.60
Daily ticket cost for unlimited travel within the city	€ 4.50
Monthly ticket cost for unlimited travel within the city	€ 46.00
Yearly ticket cost for unlimited travel within the city	€ 390.00

2.3 Travel Characteristics

Number of daily travels in Genoa per purpose and per transport means[85]

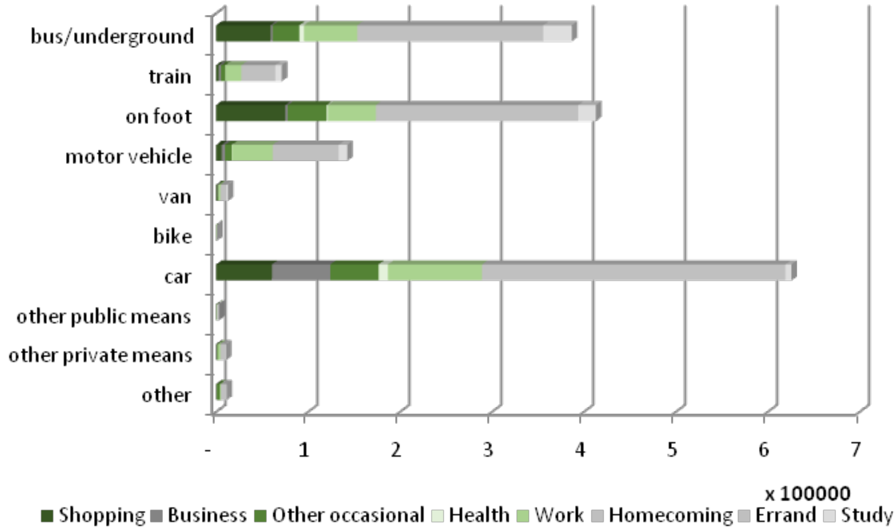


Trips by purpose in Genoa



[85] Source: "Osservatorio Mobilità Sostenibile in Italia", Euromobility.

Number of daily travels in Genoa per transport means and purpose[86]



2.4 L-V/EL-V Use

Currently there is not scooter-sharing (two-wheelers vehicles) company active in Genoa, but the IEE Ele.C.Tra. project, finished at the end of 2015 and in which the Municipality was the Coordinator, involved 47 business operators operating in Liguria and in Italy in the field of e-vehicle market (not only sharing), out of which 5 signed Memorandum of Understandings.

[86] Source: OD Matrix, Municipality of Genoa, Mobility Department (2016).

Annex C: City profile of factors influencing EL-V adoption

	Bari		Berlin		Genoa		Málaga		Rome		Trikala	
Population Density[87]	2789		4115		2431		1428		2236		133	
Age	%	Age Range	%	Age Range	%	Age Range	%	Age Range	%	Age Range	%	Age Range
	54.5	25-65	68	15-64	59	18-65	67.66	15-65	57	25-65	58	25-65
Education[88]	57,848 (17.6%)		1,138,010 (31%)		85,340 (14.6%)		46,953 (8.22%)		500,515 (20%)		13,286 (16%)	
EHTD[89]	2		0		2		3		2		2	
ECTD[90]	6		9		6		4		6		6	
OTD[91]	4		3		4		5		4		4	
Flatness	Flat		Flat		Very Hilly		Hilly		Hilly		Flat	
Congestion Level (extra travel time)	27%		29%		24%		22%		40%		<24%	
Charging Stations	N=28		N=247		N=22		N=17		N=111		N=0	
Charging Station Density: [92]	$n/10^5$	n/km^2	$n/10^5$	n/km^2	$n/10^5$	n/km^2	$n/10^5$	n/km^2	$n/10^5$	n/km^2	$n/10^5$	n/km^2
	8.58	0.24	6.73	0.28	3.77	0.09	2.99	0.04	3.86	0.09	0	0
Incentive Schemes(Y/N)												
Economic incentives for purchasing of EV	N		Y		Y		Y		Y		N	
Ownership Tax	N		Y		Y		Y		Y		N	
Access in Restricted Areas	Y		N		Y		N		Y		N	
Infrastructure Plan (e.g. increasing bike lanes)	Y		N		N		Y		Y		Y	

[87] Population density measurement: inhabitancies/ km^2.
[88] Education: population(percentage) >= university level.
[89] Extreme Hot Temperature Duration (>=24 °C) (N): number of months in a year are or hotter than 24 °C.
[90] Extreme Cold Temperature Duration (<=15°C) (N): number of months in a year are or colder than 15°C.
[91] Optimal Temperature Duration(16°C-23°C) (N): number of months in a year temperature in the range of 16°C-23°C
[92] Charging station density ($n/10^5$): Number of charging station per 10^5 inhabitancies. Charging station density (n/km^2): Number of charging station per km^2.

Annex D: Public Perception Questionnaire

Below is the English version of the online survey aimed at citizens. It was also available in Italian, German, Greek and Spanish.

Note that the web URLs given in the introductory text below are no longer available, since the survey was closed in February 2018.

Introduction

Public survey on travel in cities (ELVITEN project)

Thank you for taking part in this survey. It is part of the European project ELVITEN, which aims to make the use of light electric vehicles in cities more attractive, as a complement to public transport and as an alternative to driving traditional fossil-fuel vehicles.

We welcome your responses, whatever your local travel patterns and habits are. You do not need any prior knowledge of electric vehicles. Please answer honestly according to your usual travel patterns within your city (or regular travel to your nearest city) and your personal opinions. The questionnaire relates to urban and suburban trips only. Please do not answer with respect to occasional long-distance trips such as holidays.

We do not ask for personal details like name, address, email or other contact details. It is completely anonymous, and we comply with SurveyMonkey privacy policy which is available here: en.surveymonkey.com/mp/policy/privacy-policy/. The survey has a maximum of 26 questions and should take up to 10 minutes. It would greatly help us analyse travel patterns and opinions if you could complete it to the final page, which asks whether you have a driving licence, and also your gender, age group and employment status. These are anonymous questions but very important for us to analyse your responses.

The ELVITEN project includes three demonstration sites in Italy (Rome, Bari and Genoa) and one each in Germany (Berlin), Greece (Trikala) and Spain (Málaga). This is why these six cities appear in the first question. But if you live in or near a different city, we still want to hear from you! Just enter your city and country.

Please note that this questionnaire is available in German, English, Italian, Greek and Spanish. You can respond to any of these regardless of which city or country you live in. You can find the other language versions at:

German: https://www.research.net/r/ELVITEN-DE

Greek: https://www.research.net/r/ELVITEN-GR

Italian: https://www.research.net/r/ELVITEN-IT

Spanish: https://www.research.net/r/ELVITEN-ES

To continue in English, click OK

Questions with coding for analysis

Q. No.	Question	Column	Response format	Explanation
	ID	**A**	Number	
	Language	**B**	English, German, Greek, Italian, Spanish	Version of questionnaire answered (irrespective of city)
	Country	**C**	Country name (text)	
1	Demo city	**D**	Bari, Berlin, Málaga, Rome, Trikala, z Other	Use "z Other" if not a demo city so that it comes at the end of the list if sorted
	If other	**E**	Name of city	If not a demo city
2	For the following bicycles, please specify which one(s) you use or own? *(several responses possible)*	**F**	1 Blank	Pedal cycle own No
		G	2 Blank	Pedal cycle shared No
		H	1 Blank	Electric cycle own No
		I	2 Blank	Electric cycle shared No
3	For the following vehicles, please specify which one(s) you own or use *(several responses possible)*	**J**	1 Blank	2-wheel petrol own No
		K	2 Blank	2-wheel electric own No
		L	3 Blank	2-wheel petrol share No
		M	4 Blank	2-wheel electric share No
		N	1 Blank	3-wheel petrol own No
		O	2 Blank	3-wheel electric own No
		P	3 Blank	3-wheel petrol share No
		Q	4 Blank	3-wheel electric share No
		R	1	4-wheel petrol own

			Blank	No
		S	2 Blank	4-wheel electric own No
		T	3 Blank	4-wheel petrol share No
		U	4 Blank	4-wheel electric share No
4	How often do you travel for work or education?	V	1 2 3 4	4 days a week or more At least once a week Less often Rarely or never *(these people were not asked Q5 and 6)*
5.	What is the average one-way distance for your trips to work or education?	W	1 2 3 4 Blank	Up to 5 km 6-15 km 16-25 km 26 + km Rarely or never travels for this purpose
6.	Which is your main mode of travel for your trips from home to work or education?	X For cross-analysis, group: 1 2, 3 4, 5, 6, 7, 8, 9 10, 11, 13 12	0 1 2 3 4 5 6 7 8 9 10 11 12 13 Blank	Other *(do not count in analysis)* Walking Pedal bicycle Electric bicycle 2-wheel petrol 2-wheel electric 3-wheel petrol 3-wheel electric 4-wheel petrol 4-wheel electric Diesel, petrol or hybrid car or van Fully electric Public transportation Taxi or ride-sharing Rarely or never travels for this purpose *(do not count in analysis)*
		Y	Other (text)	
7.	How often do you travel for shopping?	Z	1 2 3	4 days a week or more At least once a week Less often

			4	Rarely or never *(these people were not asked Q8 and 9)*
8.	What is the average one-way distance for your trips for shopping?	**AA**	1 2 3 4 Blank	Up to 5 km 6-15 km 16-25 km 26 + km Rarely or never travels for this purpose
9.	Which is your main mode of travel for your trips for shopping?	**AB** For cross-analysis, group: 1 2, 3 4, 5, 6, 7, 8, 9 10, 11, 13 12	0 1 2 3 4 5 6 7 8 9 10 11 12 13 Blank	Other *(do not count in analysis)* Walking Pedal bicycle Electric bicycle 2-wheel petrol 2-wheel electric 3-wheel petrol 3-wheel electric 4-wheel petrol 4-wheel electric Diesel, petrol or hybrid car or van Fully electric Public transportation Taxi or ride-sharing Rarely or never travels for this purpose *(do not count in analysis)*
		AC	Other (text)	
10.	How often do you travel within your city for leisure, entertainment and visits (family/friends)?	**AD**	1 2 3 4	4 days a week or more At least once a week Less often Rarely or never *(these people were not asked Q11 and 12)*
11.	What is the average one-way distance for your trips within your city for leisure, entertainment and visits (family/friends)?	**AE**	1 2 3 4 Blank	Up to 5 km 6-15 km 16-25 km 26 + km Rarely or never travels for this purpose

12.	Which is your main mode of travel within your city for leisure, entertainment and visits (family/friends)?	**AF** For cross-analysis, group: 1 2, 3 4, 5, 6, 7, 8, 9 10, 11, 13 12	0 1 2 3 4 5 6 7 8 9 10 11 12 13 Blank	Other *(do not count in analysis)* Walking Pedal bicycle Electric bicycle 2-wheel petrol 2-wheel electric 3-wheel petrol 3-wheel electric 4-wheel petrol 4-wheel electric Diesel, petrol or hybrid car or van Fully electric Public transportation Taxi or ride-sharing Rarely or never travels for this purpose *(do not count in analysis)*
		AG	Other mode (text)	
13.	If there was a sharing scheme for these kinds of light electric vehicles in your local area would you consider using it?	**AH**	1 2 3 4 5 6 Blank	Yes, frequently Yes, occasionally Maybe No, I would prefer to buy my own one No, I would not use such a vehicle I don't know Exclude from analysis of this question
14.	In the future, would you consider using one of the following vehicles?	**AI**	1 Blank	Work/education bicycle No
		AJ	2 Blank	Work/education 2-wheel EL-V No
		AK	3 Blank	Work/education 3-wheel EL-V No

		AL	4 Blank	Work/education 4-wheel EL-V No
		AM	1 Blank	Shopping bicycle No
		AN	2 Blank	Shopping 2-wheel EL-V No
		AO	3 Blank	Shopping 3-wheel EL-V No
		AP	4 Blank	Shopping 4-wheel EL-V No
		AQ	1 Blank	Leisure bicycle No
		AR	2 Blank	Leisure 2-wheel EL-V No
		AS	3 Blank	Leisure 3-wheel EL-V No
		AT	4 Blank	Leisure 4-wheel EL-V No
16.	Travelling with it is comfortable irrelevant of the weather conditions	**AU**	1 2 3 4 5 Blank	2W I strongly disagree 2W I rather disagree 2W I rather agree 2W I strongly agree 2W I don't know Exclude from analysis of Q16
		AV	1 2 3 4 5 Blank	3W I strongly disagree 3W I rather disagree 3W I rather agree 3W I strongly agree 3W I don't know Exclude from analysis of Q16
		AW	1 2 3 4 5 Blank	4W I strongly disagree 4W I rather disagree 4W I rather agree 4W I strongly agree 4W I don't know Exclude from analysis of Q16

17.	Parking is easy and secure	**AX**	1 2 3 4 5 Blank	2W I strongly disagree 2W I rather disagree 2W I rather agree 2W I strongly agree 2W I don't know Exclude from analysis of Q17
		AY	1 2 3 4 5 Blank	3W I strongly disagree 3W I rather disagree 3W I rather agree 3W I strongly agree 3W I don't know Exclude from analysis of Q17
		AZ	1 2 3 4 5 Blank	4W I strongly disagree 4W I rather disagree 4W I rather agree 4W I strongly agree 4W I don't know Exclude from analysis of Q17
18.	I would feel safe during the trip	**BA**	1 2 3 4 5 Blank	2W I strongly disagree 2W I rather disagree 2W I rather agree 2W I strongly agree 2W I don't know Exclude from analysis of Q18
		BB	1 2 3 4 5 Blank	3W I strongly disagree 3W I rather disagree 3W I rather agree 3W I strongly agree 3W I don't know Exclude from analysis of Q18
		BC	1 2 3 4 5 Blank	4W I strongly disagree 4W I rather disagree 4W I rather agree 4W I strongly agree 4W I don't know Exclude from analysis of Q18

19.	Charging is convenient	**BD**	1 2 3 4 5 Blank	2W I strongly disagree 2W I rather disagree 2W I rather agree 2W I strongly agree 2W I don’t know Exclude from analysis of Q19
		BE	1 2 3 4 5 Blank	3W I strongly disagree 3W I rather disagree 3W I rather agree 3W I strongly agree 3W I don’t know Exclude from analysis of Q19
		BF	1 2 3 4 5 Blank	4W I strongly disagree 4W I rather disagree 4W I rather agree 4W I strongly agree 4W I don’t know Exclude from analysis of Q19
20.	It is affordable to use and operate	**BG**	1 2 3 4 5 Blank	2W I strongly disagree 2W I rather disagree 2W I rather agree 2W I strongly agree 2W I don’t know Exclude from analysis of Q20
		BH	1 2 3 4 5 Blank	3W I strongly disagree 3W I rather disagree 3W I rather agree 3W I strongly agree 3W I don’t know Exclude from analysis of Q20
		BI	1 2 3 4 5	4W I strongly disagree 4W I rather disagree 4W I rather agree 4W I strongly agree 4W I don’t know

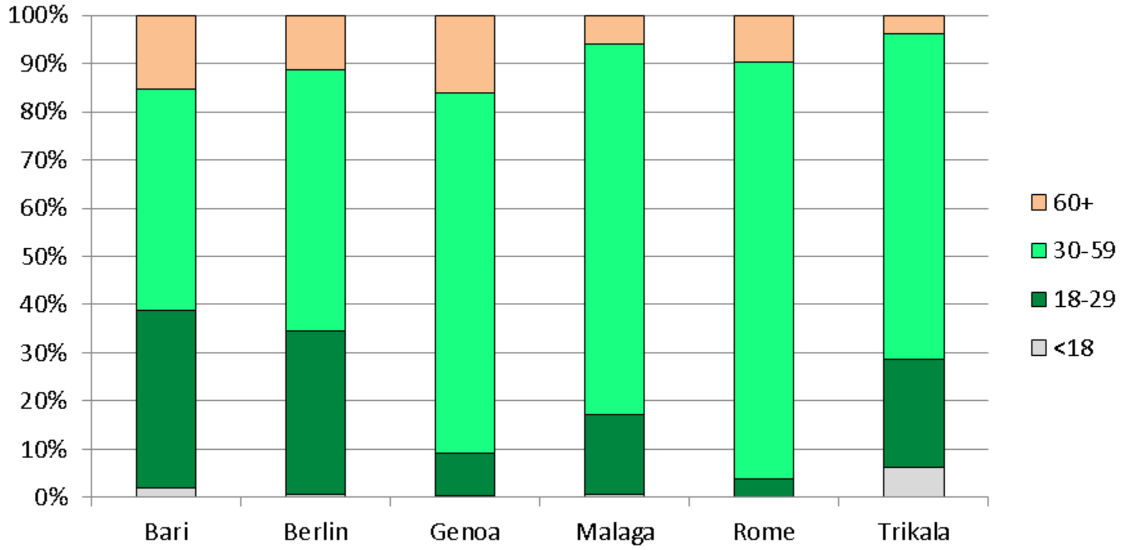
			Blank	Exclude from analysis of Q20
21.	It has sufficient luggage capacity for my needs	**BJ**	1 2 3 4 5 Blank	2W I strongly disagree 2W I rather disagree 2W I rather agree 2W I strongly agree 2W I don't know Exclude from analysis of Q21
		BK	1 2 3 4 5 Blank	3W I strongly disagree 3W I rather disagree 3W I rather agree 3W I strongly agree 3W I don't know Exclude from analysis of Q21
		BL	1 2 3 4 5 Blank	4W I strongly disagree 4W I rather disagree 4W I rather agree 4W I strongly agree 4W I don't know Exclude from analysis of Q21
22.	Do you or would you consider using one of these kinds of electric vehicles as a part of multi-modal journey, with for instance public transport?	**BM**	1 2 3 4 Blank	I already do so I would consider using one No I don't know Exclude from analysis of Q22
23.	What in your opinion are the most necessary measures to encourage greater use of these kinds of electric vehicles? Please select up to three from the list.	**BN**	1 Blank	Sufficient secure parking No

		BO	2 Blank	Sufficient electric charging infrastructure No
		BP	3 Blank	Offer sharing schemes for such vehicles No
		BQ	4 Blank	Integrated payment or card for sharing such vehicles and public transport No
		BR	5 Blank	Allow use of bus and cycle lanes by 2- or 3-wheel electric vehicles No
		BS	6 Blank	Navigation services aimed at electric light vehicles No
		BT	7 Blank	User assistance (rescue, information or training services) No
		BU	8 Blank	Incentive schemes for purchase or renting No
		BV	Other ideas (text, optional)	
24.	Do you have a driving licence?	**BW**	1 2 3 4 Blank	Type A Type B Type A+B None Exclude from analysis of Q24
25.	Are you:	**BX**	1 2 3 or blank	Female Male Prefer not to say or no answer (Exclude from analysis of Q25)
26.	Please tell us your age:	**BY**	1 2	Under 18 18-29

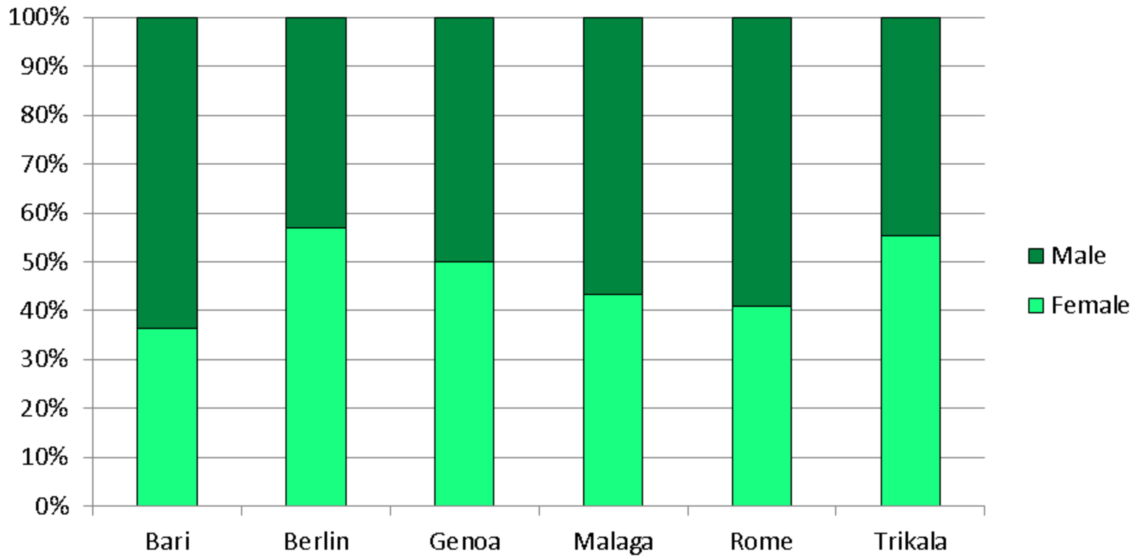
			3 4 5 Blank	30-59 60-74 75 and more Exclude from analysis of Q26
27.	What is your current occupation?	**BZ**	1 2 3 4 5 6 Blank	In education/student Full-time employment Part-time employment Unemployed Retired Other Exclude from analysis of Q24

Annex E: Profile of Public Perception Questionnaire Respondents

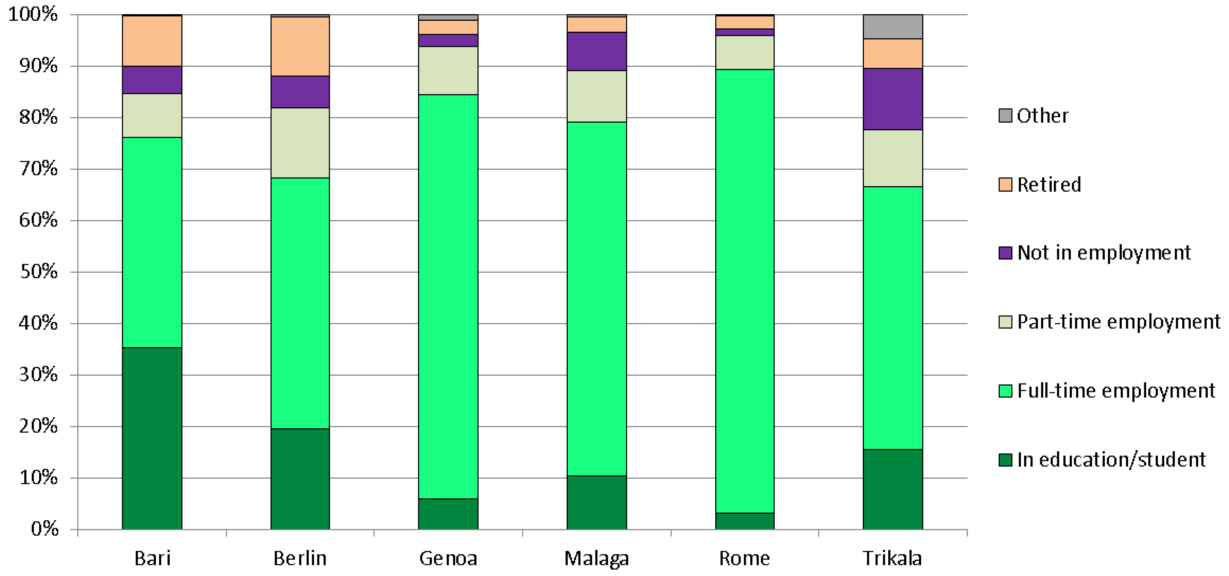
Profile of respondents by age group for each city (excluding those who did not specify)



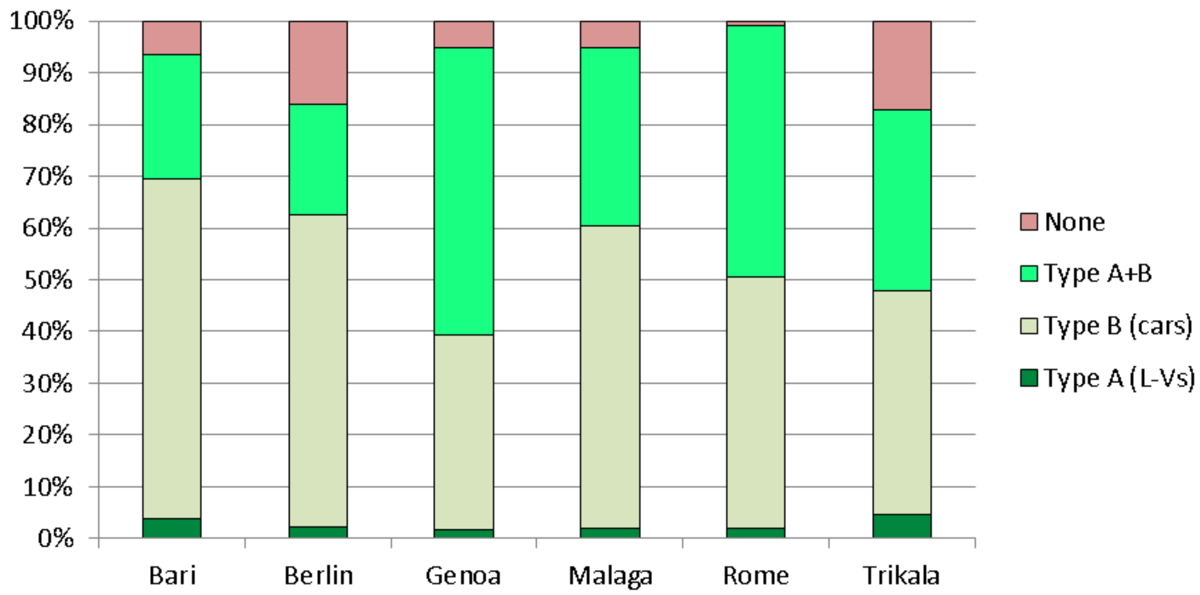
Profile of respondents by gender for each city (excluding those who did not specify)



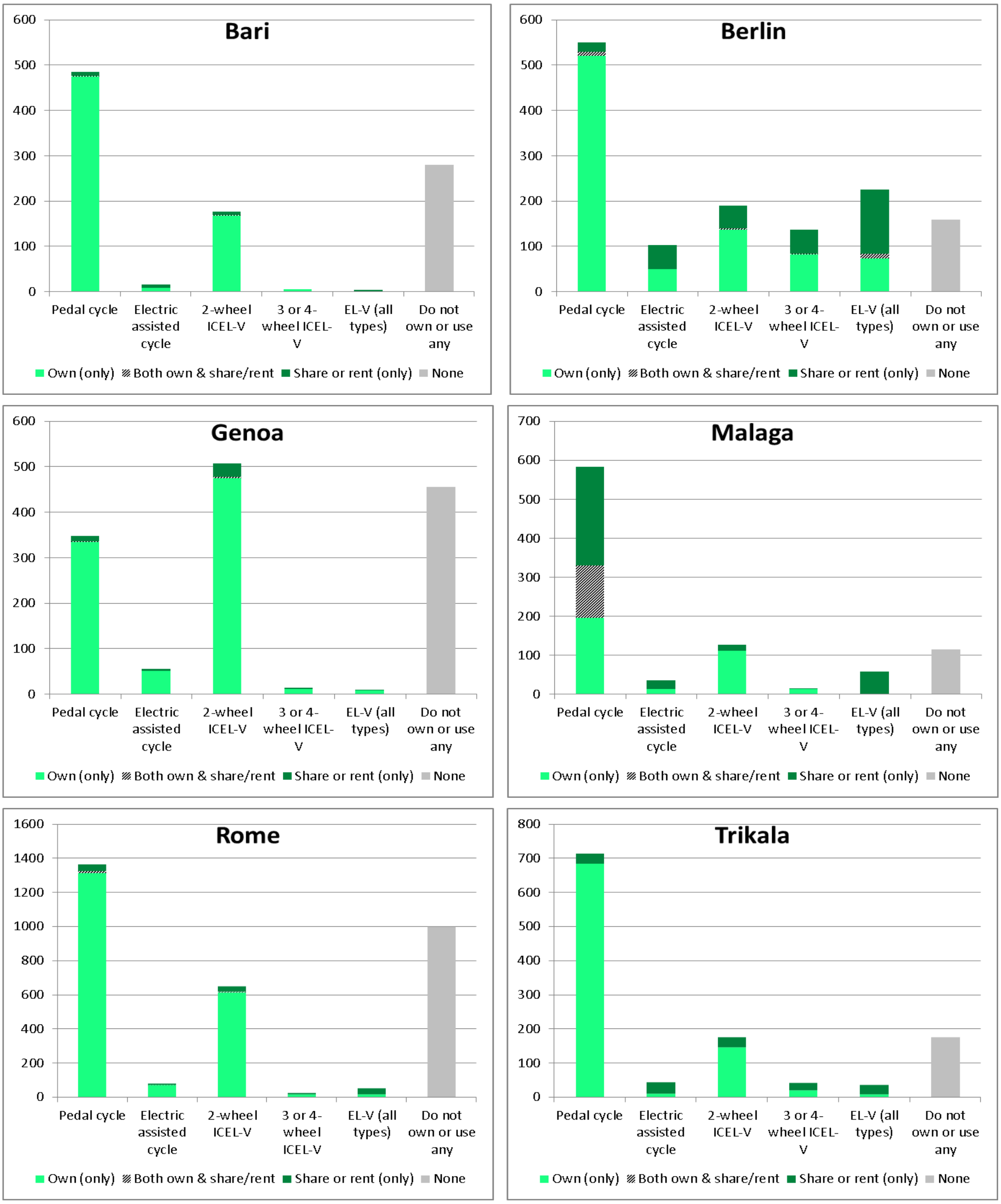
Profile of respondents by (main) occupation for each city (employment includes self-employed persons)



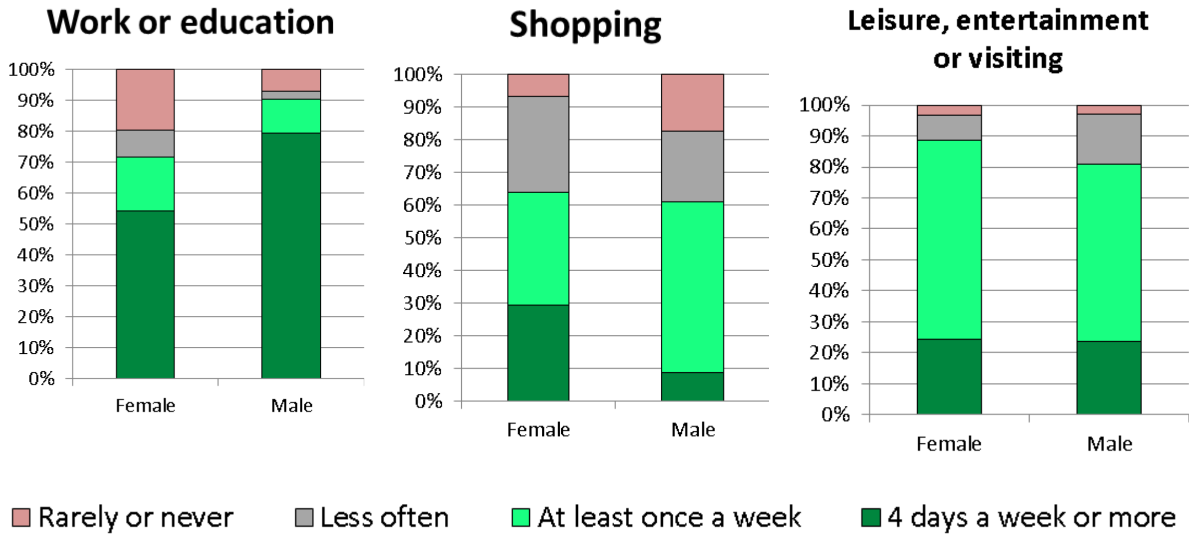
Profile of respondents by possession of driving licence for each city



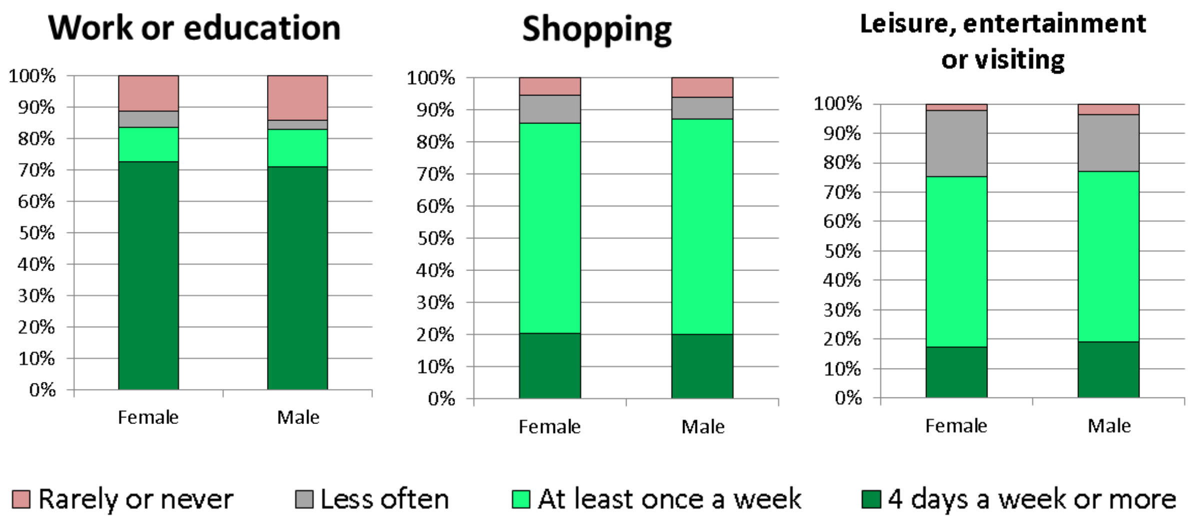
Current ownership and use of bicycles and L-Vs



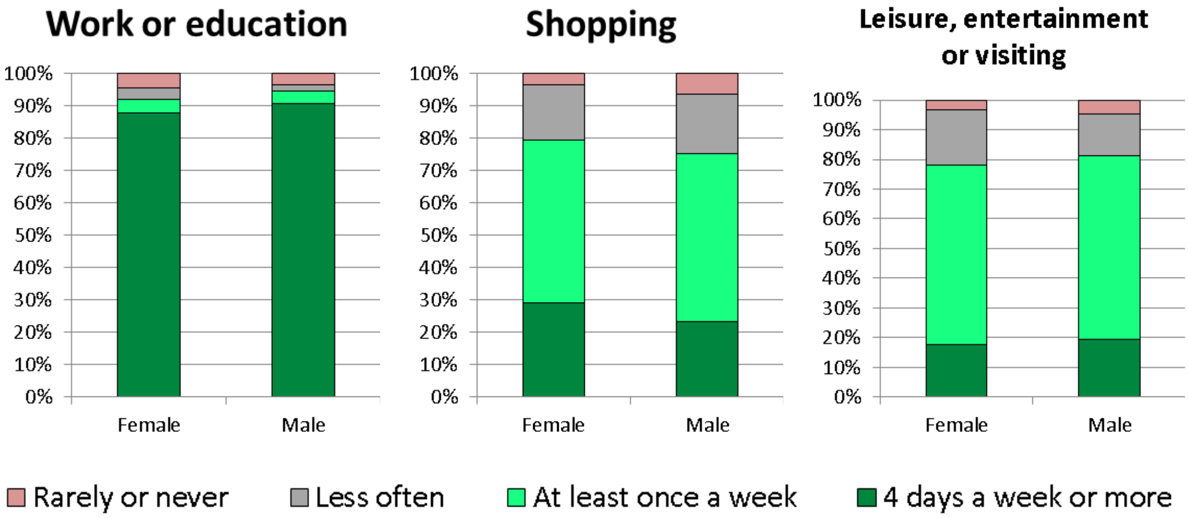
Urban trip frequencies by purpose: Bari



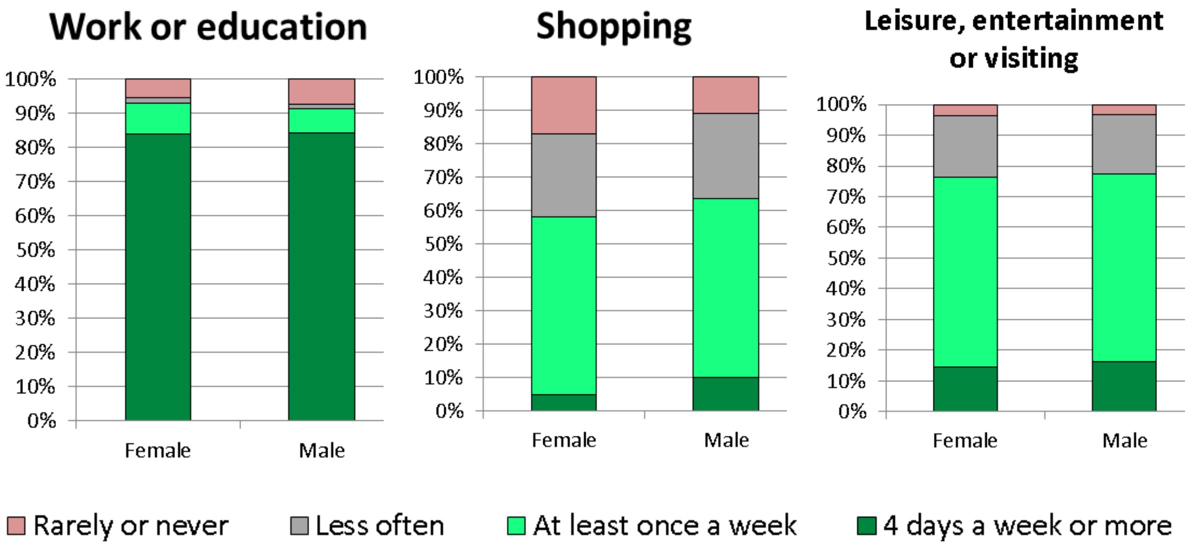
Urban trip frequencies by purpose: Berlin



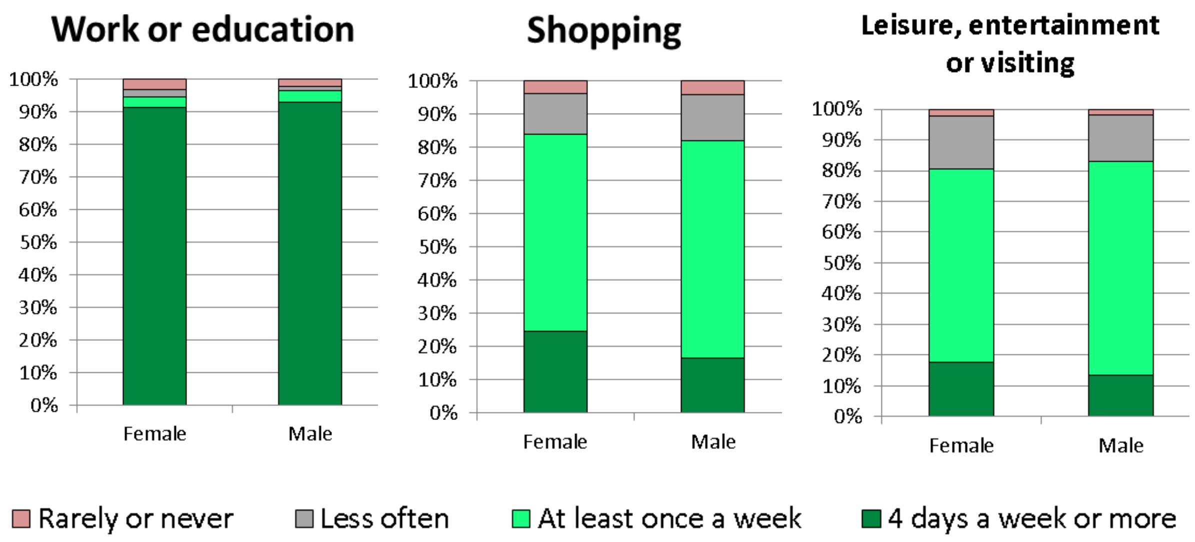
Urban trip frequencies by purpose: Genoa



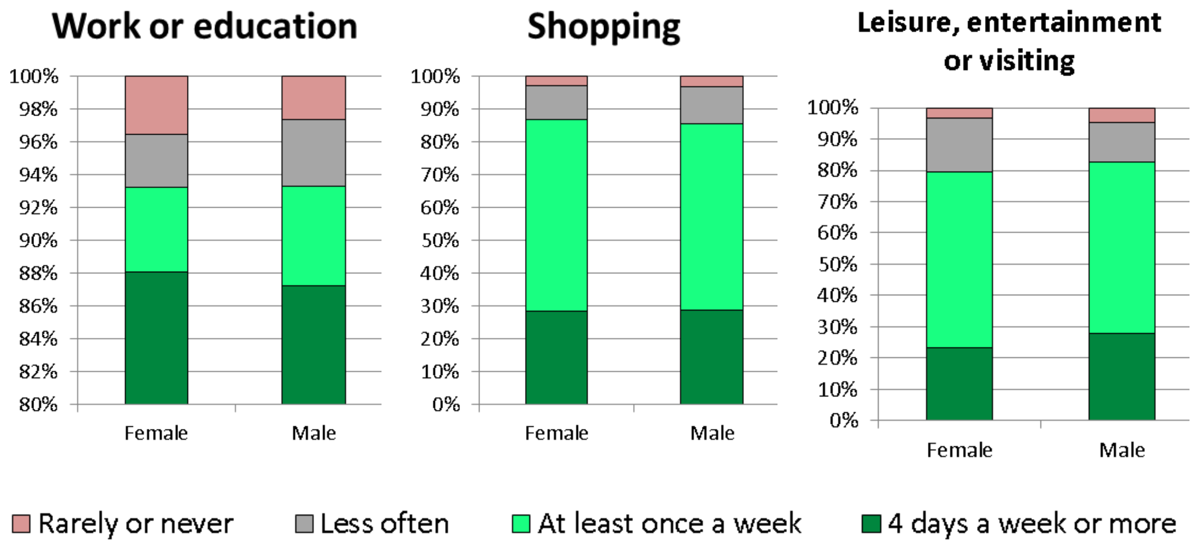
Urban trip frequencies by purpose: Málaga



Urban trip frequencies by purpose: Rome

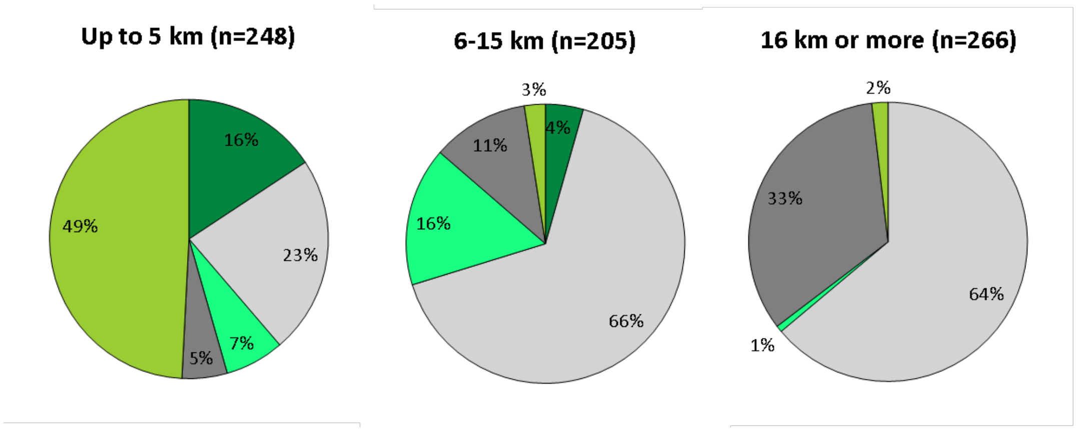


Urban trip frequencies by purpose: Trikala

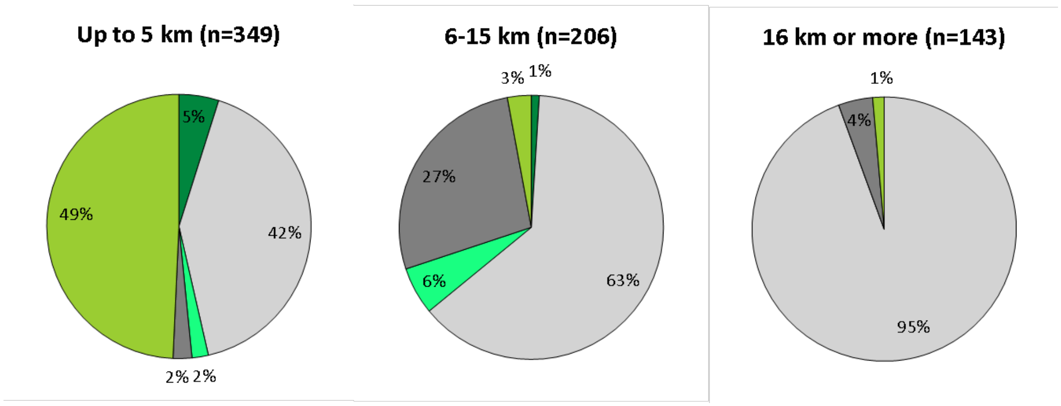


Urban trip modes used by distance: Bari

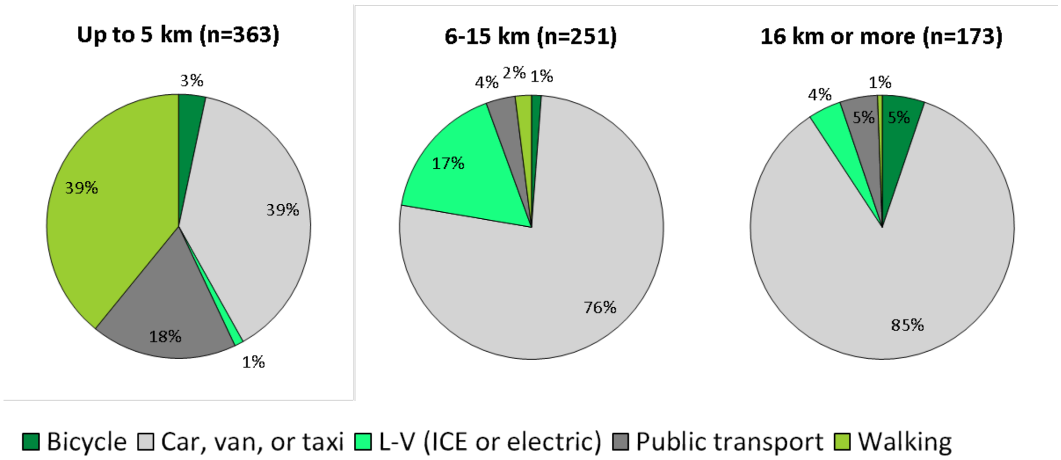
Work or education trips



Shopping trips

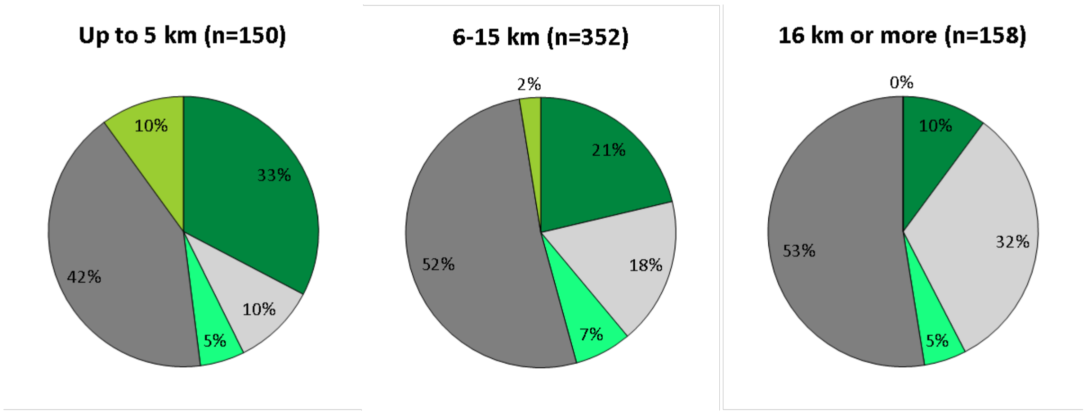


Leisure, entertainment or visiting trips

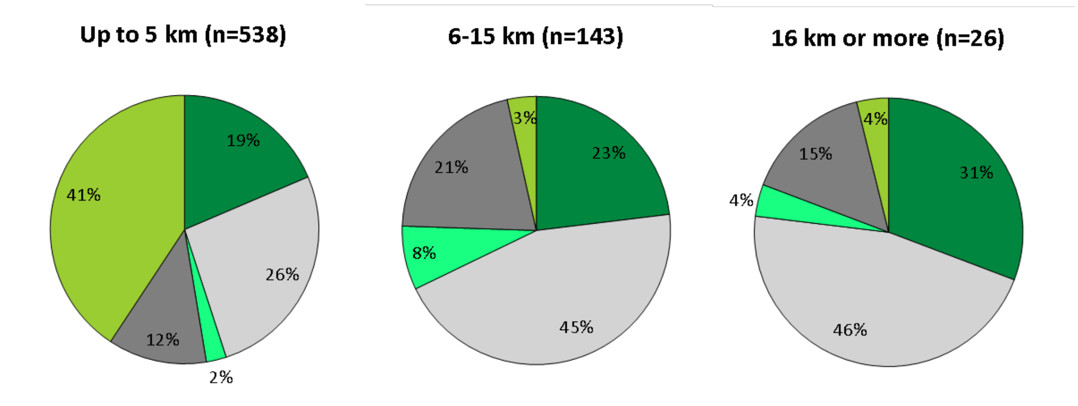


Urban trip modes used by distance: Berlin

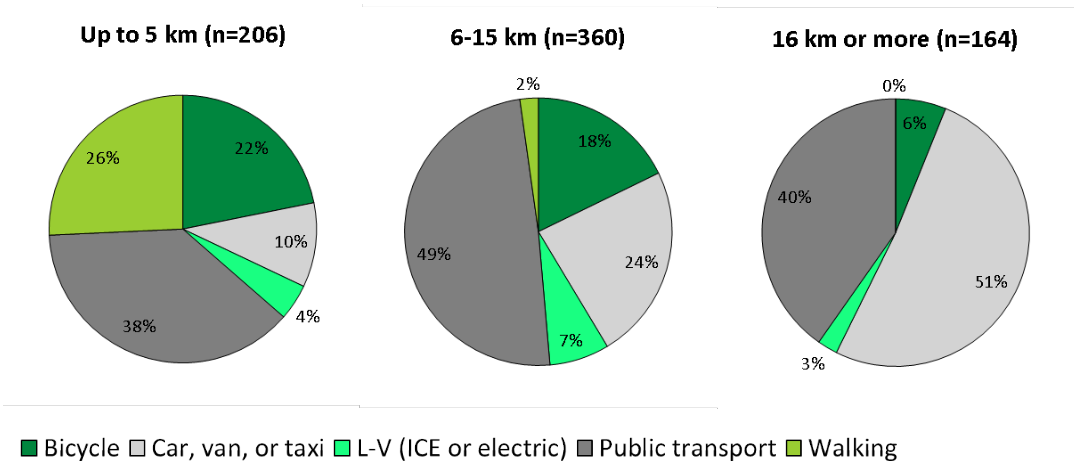
Work or education trips



Shopping trips

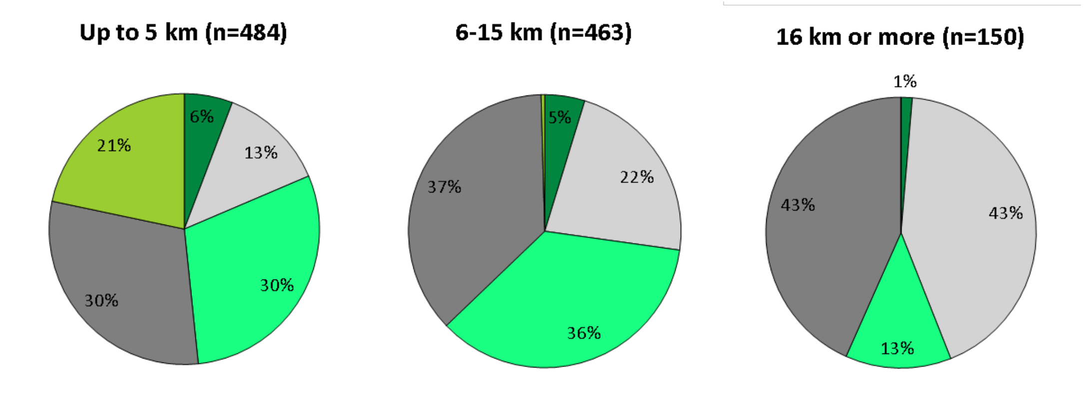


Leisure, entertainment or visiting trips

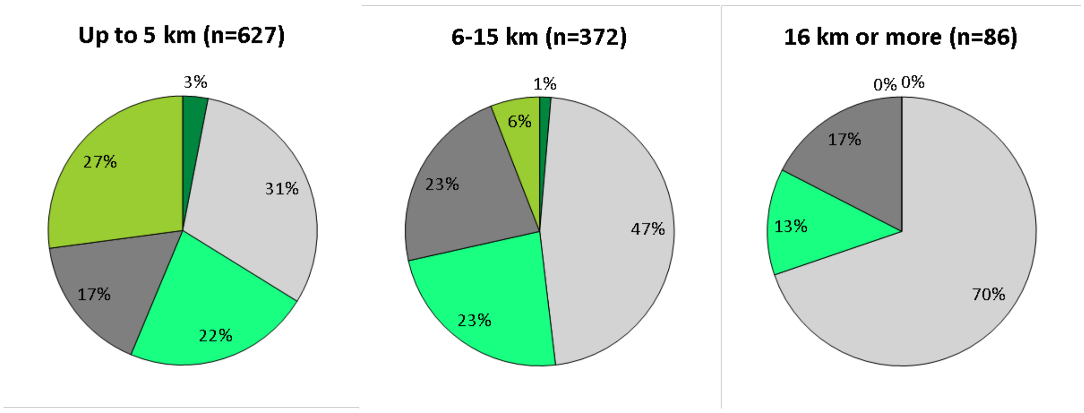


Urban trip modes used by distance: Genoa

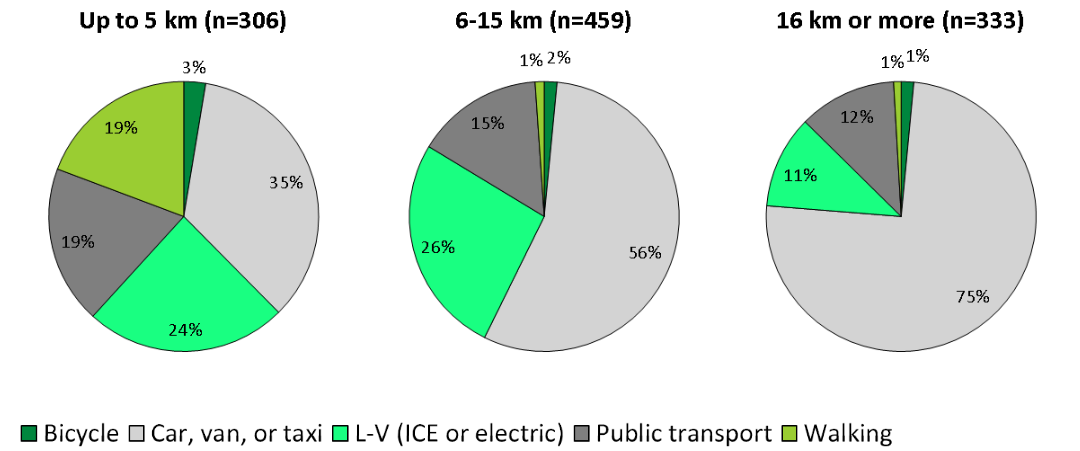
Work or education trips



Shopping trips

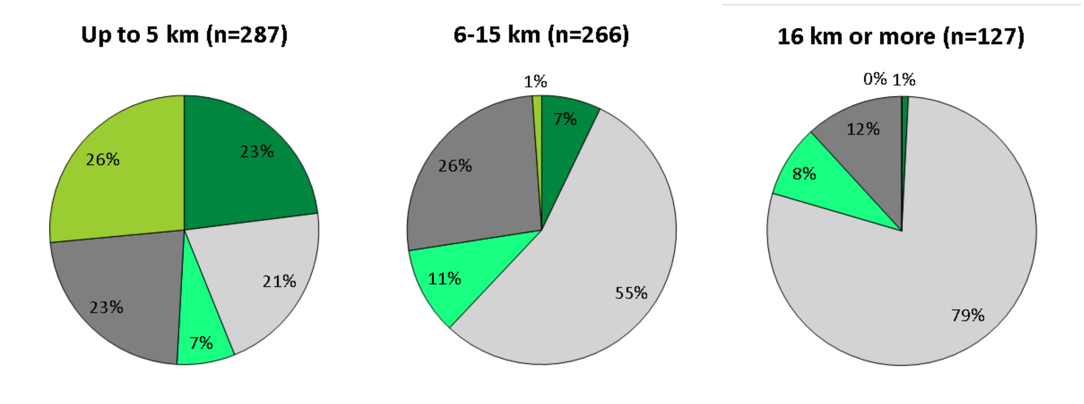


Leisure, entertainment or visiting trips

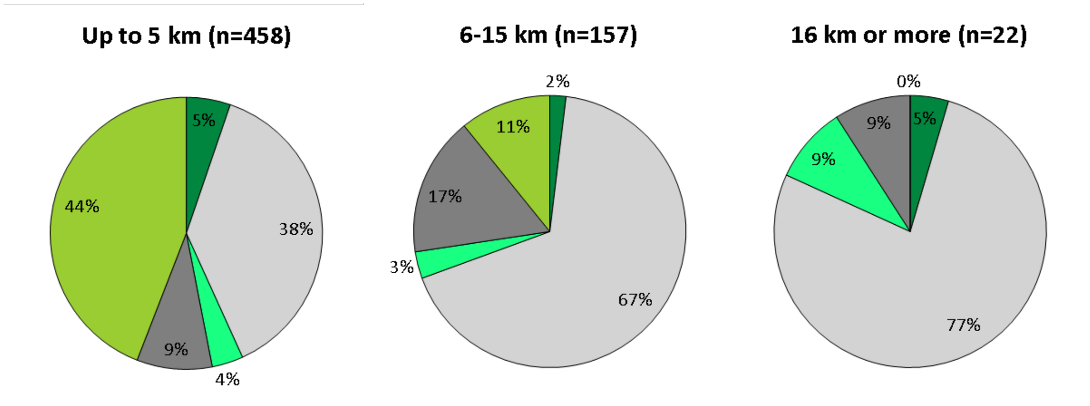


Urban trip modes used by distance: Málaga

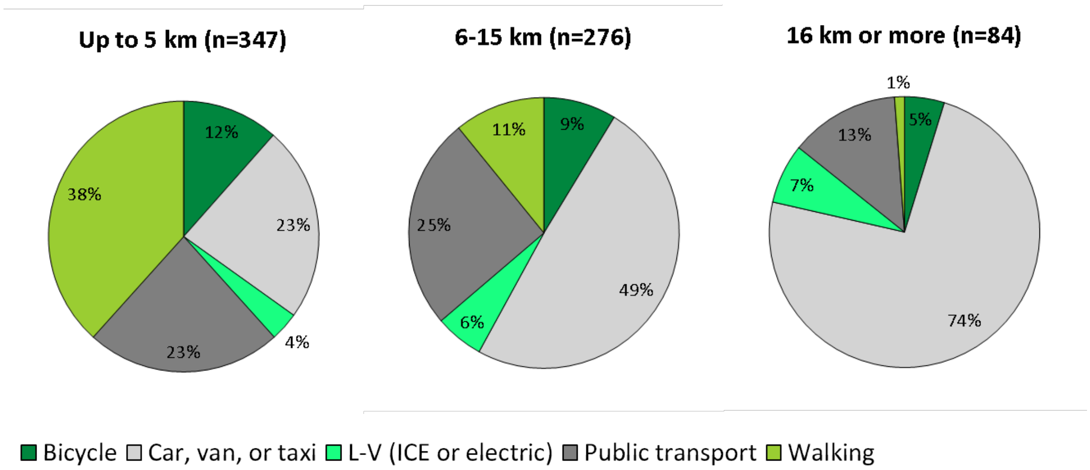
Work or education trips



Shopping trips

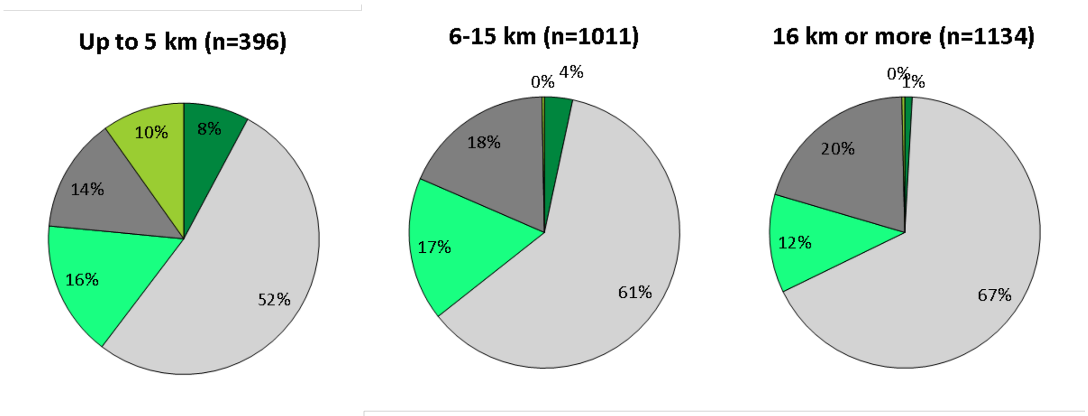


Leisure, entertainment or visiting trips

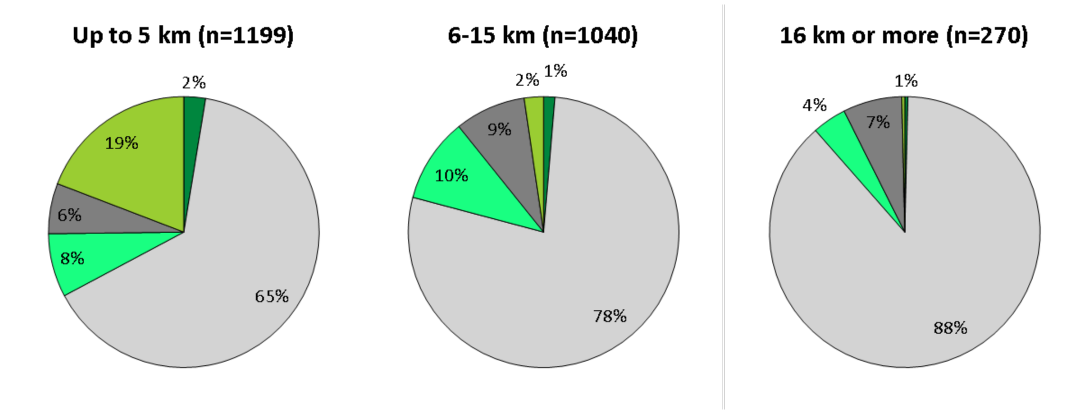


Urban trip modes used by distance: Rome

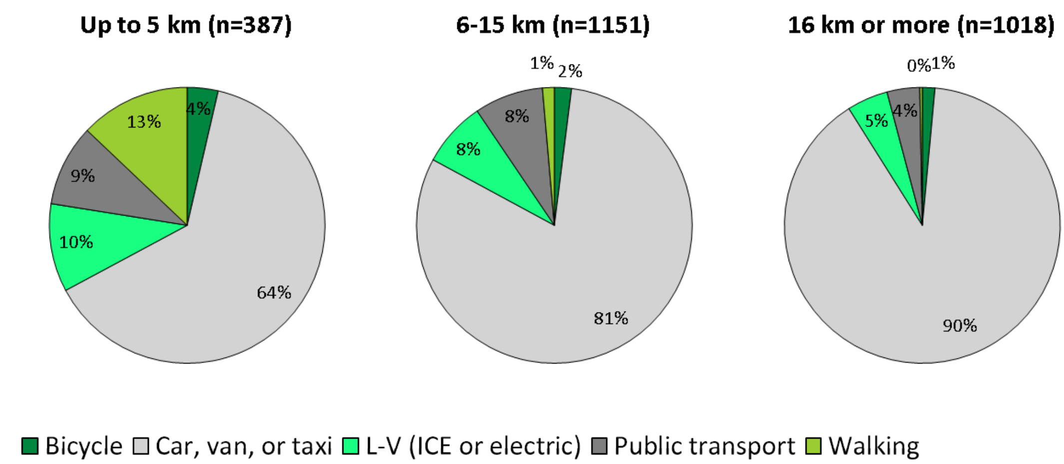
Work or education trips



Shopping trips

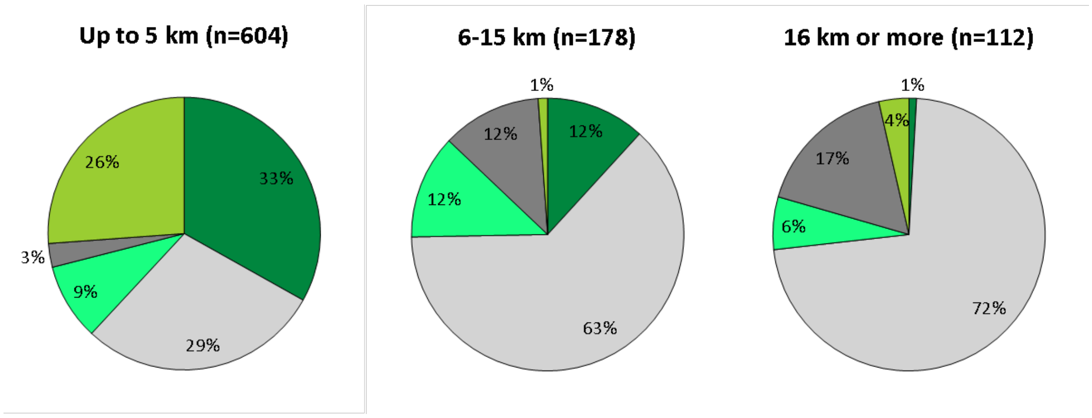


Leisure, entertainment or visiting trips

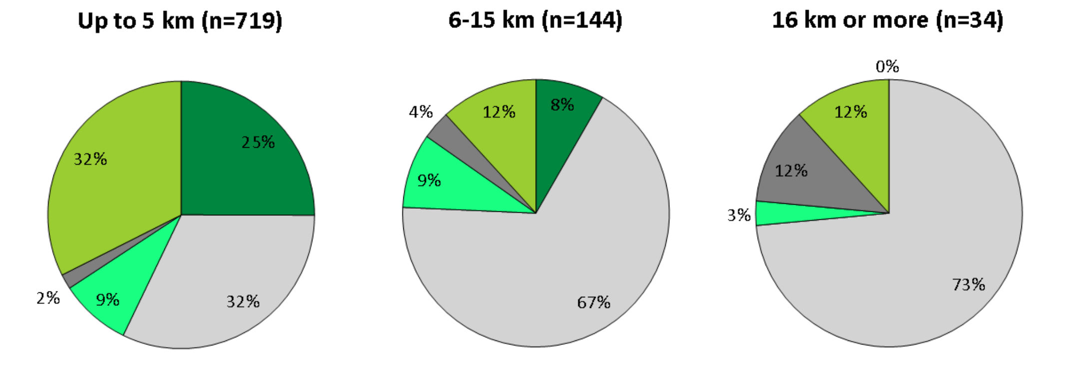


Urban trip modes used by distance: Trikala

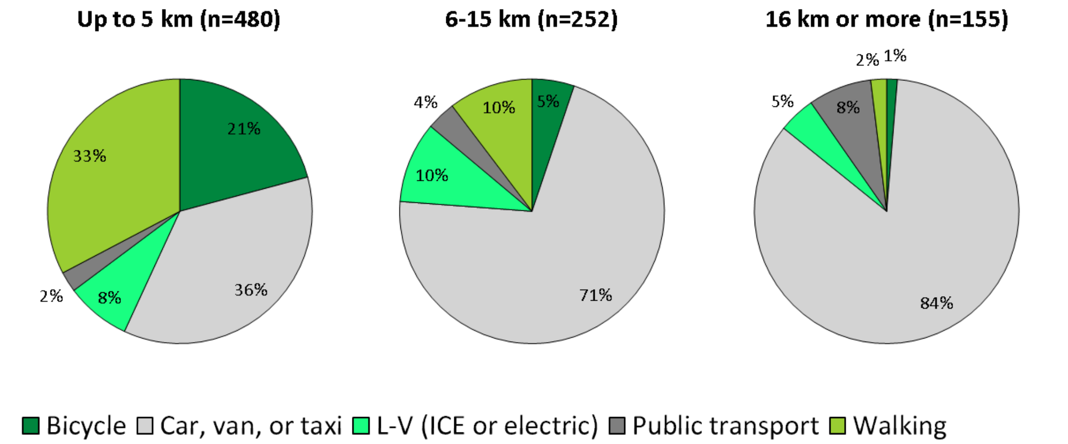
Work or education trips



Shopping trips



Leisure, entertainment or visiting trips



Annex F: Interview Survey for Fleet Operators

Introduction

This interview survey is part of the European project ELVITEN, which aims to make the use of light electric vehicles in cities (EL-Vs) more attractive as an alternative to driving traditional fossil-fuel vehicles. ELVITEN covers your city *(say who the local partners are)* and five others *(list the others: Genoa, Rome, Bari, Trikala, Málaga, Berlin).*

The project is conducting in parallel an online questionnaire aimed at all members of the public in this city and the five other cities. You might have seen links to it in the local media *(give one or two examples in your city where the online survey was promoted, for example the website of the municipality).*

These interview surveys are aimed at **businesses** and **individual drivers** (this particular survey is for businesses, aimed at the person responsible for deciding vehicle requirements and/or managing the fleet). They will help us see what fleet operators are either using electric light vehicles or considering using them. For those not using them, it is to check the level of interest, and any barriers or problems that, if overcome, could make these types of vehicles more attractive.

Show the interviewee some pictures of LE-Vs so they are clear what the scope is: 2, 3 and light 4 wheeled vehicles, not including electric-assist pedal cycles and not including full size cars.

There are no correct or wrong answers; we only want your honest personal opinions. If you don't know the answer to a question, have no opinion, or if it doesn't apply to you, then skip it.

Privacy statement

We record the company name and nature of its business in order to indicate in our analysis the number and types of businesses covered in this survey. We do not record the names of individual respondents.

All data files will be kept confidential within the core analysis team of the ELVITEN project and no contact details will be held.

All analysis will be presented anonymously. No report or presentation will mention the name of any individual or the specific responses of any person or organisation.

The answers given by drivers are not communicated to their company's management or anyone else; they are personal views and are kept anonymous.

The analysis report (in English) will be public.

City: ______________________ Interview number: __________

Name of company interviewed: ___________________________________

Main type of business: (deliveries, rental schemes, etc.)_________________________________

Address (office, depot or shop where vehicles are based): ___________________________________

Position of interviewee (job title): __________________________________ *(name is not required)*

Interview by telephone ☐

Face-to-face interview ☐ Date: ____-____-2018

ELVITEN partner conducting the interview:

Name: _________________________ Organisation: ___________________

Interview questions (with coding for analysis by project partners)

1) **Does this company or organisation own or use vehicles:**

Only in this city ☐ Code: a

Also in a few other cities ☐ Code: b

Nationwide ☐ Code: c

In several countries or globally ☐ Code: d

2) **Do vehicles based at this location (depot) operate:**

Only in this city and suburbs ☐ Code: a

Also medium distances (regional trips) ☐ Code: b

Also long distances (national or international) ☐ Code: c

3) **How many bases (depots) do you operate from in this city / metropolitan area?** ________

4) **Are decisions regarding your vehicle fleet (types and numbers of vehicles to purchase or lease, maintenance, operational procedures) mostly made:**

Here (in this city) ☐ *[select this one automatically if company only exists in this city]* Code: a

At another location (like a depot or head office in another city) ☐ Code: b

5) **Fleet details:**

Number of vehicles by type. *Use a separate line for each vehicle type and specify how many are owned and how many are leased.*

Only include vehicles based in this city or depot (not national fleet if it is a large company).

	column1	c2	c3	c4	c5	c6	c7	column8
	EU vehicle category (L, M, N)93	Vehicle make (e.g. Ford, Fiat, Renault, VW, etc.)	Vehicle model	Powertrain (petrol/gasoline, diesel, fully electric, hybrid electric, CNG, etc.)	Number of vehicles owned	Number of vehicles leased	Estimate of average age of vehicles (years)	Other comments
A	M1	Fiat	Brava	Petrol	5	0	1	
B	N1	Renault	Kangoo	Fully Electric (FEV)	40	0	2	
C								
D								
E								

93 Enter L for light vehicles, M for passenger vehicles (cars or bigger), N for goods vehicles (vans or bigger). The full category (e.g. L3e, M1, N1) can be added later from the vehicle make and model, referring to the list of vehicle categories in the Methodology note.

F								

6) Do you have a charging point for electric vehicles in your depot(s) or base(s)?

No ☐ code 0

Yes☐ code 1 If yes: How many? ________________________

What type(s)? (kW, rapid charge or standard, etc.?) _____________________

7) *[Only for companies which have some plug-in electric vehicles in Q5 above]* **For your electric vehicles, do you use on-street charging stations?**

No (all charging is done at base/depot) ☐ code 0

Sometimes ☐ code 1

Regularly ☐ code 2

If occasionally or regularly: At which locations? _____________________

What types of stations are used? _____________________

With which charging network(s), if any, do you have an account? _________

8) *[Only for companies using the fleet for transporting/delivering goods]* **How many drivers do you have?**

Full time: __50___________ Part time: ___10__________ code actual numbers

9) *[Only for companies using the fleet for transporting/delivering goods]* **Can you give me some information about the usage of your vehicle fleet?** Answers can be approximate or estimated if not known exactly. There is no need to search precise data; it is just to understand the type of use. Can be left blank if the respondent does not know. If there are different answers for different vehicle types, then give them separately (for example if a company owns scooters, cars and vans, with different type of duties intensity of use for each).

- How many trips does one vehicle do in an average day within this city or metropolitan area? ______________
- What is the annual km driven per vehicle, on average? (or estimate of km per vehicle per day) ______________
- What kind of goods is carried? (e.g. parcels, letters, food, industrial products)_____________

10) *[Only for companies renting out or sharing vehicles, where the end customer is the driver]* **Please can you tell me (or give an estimate):**

- The approximate number of subscribers you have in this city? _____________
- The approximate number rentals per day (or week or month) in this city? _________

- The number of stations in this city where customers can collect or return vehicles? _______

Can customers return the vehicle to a different place (in the same city/ metropolitan area) from where they picked it up?

Yes (included in the subscription or standard price) ☐

Yes (with an additional charge) ☐

No (vehicles must be returned to the same place at which the rental began) ☐

11) *If the company **already uses ICE L-Vs**:* **Would you consider changing to electric L-Vs?**

Already considering changing ☐ code 1

Yes, would consider ☐ code 2

No, would not consider ☐ code 3

12) *If the company **already uses EVs (electric cars or vans)**:* **Would you consider changing from electric cars or vans to EL-Vs?**

Already considering changing ☐ code 1

Yes, would consider ☐ code 2

No, would not consider ☐ code 3

13) *If the company **does not currently use** any EVs or any L-Vs.* **Would you consider changing to Electric L-category vehicles?**

Already considering changing ☐ code 1

Yes, would consider ☐ code 2

No, but would consider changing to electric cars or vans ☐ code 3

No, would not consider changing to any kind of electric vehicle ☐ code 4

14) *If any answer to Q11, 12 or 13 above is positive (already considering or would consider):*

- **What is your main motivation** for considering changing to EL-Vs? ______________________

- **What percentage of trips or fleet** would you consider changing to EL-Vs? (all trips/vehicles, or only some of them?) _______________

- What would be the **most suitable category** of EL-V for your business's needs?

2-wheel vehicle (electric scooter, motorcycle) ☐ code 2
3-wheel vehicle (electric tricycle, 3 wheel van) ☐ code 3
4-wheel vehicle (electric quad, micro-car) ☐ code 4
No preference/Don't know ☐ code 5

With luggage rack at front ☐ code 1	Fully enclosed EL-V ☐ code 1

With secure luggage compartment at rear ☐ code 2 No preference/Don't know ☐ code 3	EL-V with roof but open sides ☐ code 2 Open vehicle ☐ code 3 No preference/Don't know ☐ code 4

- If you added EL-Vs to your fleet, would you be more likely to purchase them or lease them?

Buy ☐ code 1 Lease ☐ code 2 Don't know ☐ code 3

15) What, in your opinion, are the main advantages of EL-Vs?

16) What are the disadvantages of EL-Vs, or the main barriers to your company using them?

17) What is the main measure or motivation that would persuade you to use more EL-Vs instead of your current vehicle fleet?

18) What in your opinion are the most necessary measures to encourage greater use of these kinds of electric vehicles?

If you think any of these improvements should be made in one or more specific locations in your city, please specify the places in your answers below.

a) Dedicated delivery spaces (on street)

Level of importance?	Are improvements needed?
Not important ☐ code 1	Yes ☐ code 1
Quite important ☐ code 2	No ☐ code 2
Very important ☐ code 3	Don't know ☐ code 3

If improvements are needed:

- What is needed? _______________

- Where? (Locations in your city; names of streets or districts/landmarks) _______________

b) Electric charging infrastructure

Level of importance?	Are improvements needed?
Not important ☐ code 1	Yes ☐ code 1
Quite important ☐ code 2	No ☐ code 2
Very important ☐ code 3	Don't know ☐ code 3

If improvements are needed:

- What is needed? _______________

- Where? (Locations in your city; names of streets or districts/landmarks) _______________

c) Allow use of bus and cycle lanes by 2- or 3-wheel electric vehicles, or other means of priority or safety measures on the roads

Level of importance?	Are improvements needed?
Not important ☐ code 1	Yes ☐ code 1
Quite important ☐ code 2	No ☐ code 2
Very important ☐ code 3	Don't know ☐ code 3

If improvements are needed:

- What is needed? _______________

- Where? (Locations in your city; names of streets or districts/landmarks) _______________

d) Specific navigation services aimed at electric light vehicles

Level of importance?	Are improvements needed?
Not important ☐ code 1	Yes ☐ code 1
Quite important ☐ code 2	No ☐ code 2
Very important ☐ code 3	Don't know ☐ code 3

If improvements are needed:

- What is needed? _______________

- Where? (Locations in your city; names of streets or districts/landmarks) _______________

e) Other improvements or services (training, rescue, road infrastructure, security, etc.)

- Is anything else needed? _______________

- If so: What? Where? _______________

19) Any other comments?

Thank you for your time!

Annex G: Interview Survey for Fleet Drivers

Introduction

This interview survey is part of the European project ELVITEN, which aims to make the use of light electric vehicles (EL-Vs) in cities more attractive as an alternative to driving traditional fossil-fuel vehicles. ELVITEN covers your city *(say who the local partners are)* and five others *(list the others: Genoa, Rome, Bari, Trikala, Málaga, Berlin).*

The project is conducting in parallel an online questionnaire aimed at all members of the public in this city and the five other cities. You might have seen links to it in the local media *(give one or two examples in your city where the online survey was promoted, for example the website of the municipality).*

These interview surveys are aimed at **businesses** and **individual drivers** (this particular survey is for drivers). They will help us understand drivers' perceptions towards using different types of vehicles in the city for their job and also their views on infrastructure (roads, traffic signs, parking, electric charging, etc.) – both current infrastructure and future needs.

Show the interviewee some pictures of LE-Vs so they are clear what the scope is: 2, 3 and light 4 wheeled vehicles, not including electric-assist pedal cycles and not including full size cars.

There are no correct or wrong answers; we only want your honest personal opinions. If you don't know the answer to a question, have no opinion, or if it doesn't apply to you, then skip it.

Privacy statement

We record the company name and nature of its business in order to indicate in our analysis the number and types of businesses covered in this survey.

We do not record the names of individual respondents.

All data files will be kept confidential within the core analysis team of the ELVITEN project and no contact details will be held.

All analysis will be presented anonymously. No report or presentation will mention the name of any individual or the specific responses of any person or organisation.

The answers given by drivers are not communicated to their company's management or anyone else; they are personal views and are kept anonymous.

The analysis report (in English) will be public.

City: ______________________ Interview number: __________

Name of company interviewed: ________________________

Address (office, depot or shop where vehicles are based): ___________________________________

Position of interviewee (job title): __________________________________ *(name is not required)*

Interview by telephone ☐

Face-to-face interview ☐ Date: ____-____-2018

ELVITEN partner conducting the interview:

Name: _________________________ Organisation: ___________________

Interview questions (with coding for analysis by project partners)

20) What kind(s) of vehicle(s) do you drive as part of your job? *Use a separate line for each vehicle type and specify how many are owned and how many are leased.*

	column1	c2	c3	c4	c5	c6
	EU vehicle category (L, M, N)94	Vehicle make (e.g. Ford, Fiat, VW)	Vehicle model	Powertrain (petrol/gasoline, diesel, fully electric, hybrid electric, CNG, etc.)	Frequency of driving (every working day, some days, only occasionally)	Other comments (if any)
A	L5be	Piaggio	Ape	Petrol	Every working day	EXAMPLE (delete this line)
B	N1	Renault	Kangoo	Fully Electric (FEV)	Once or twice a month	EXAMPLE (delete this line)
C						
D						

21) Trip details:

a) How many driving trips do you make in an average work day?

b) What is the average distance per trip? (or average km driven per vehicle per working day, if that is easier)

c) What kinds of items do you transport?

d) If you use more than one kind of vehicle in your job (Q4 above) please briefly describe the different type of duties that you use each vehicle type for.

22) *[For drivers **not using EL-Vs** for most trips]:* **Do you think that some or all of your trips could be made by one of the following types of electric L-category vehicle instead of the main type of vehicle you currently use?**

94 Enter L for light vehicles, M for passenger vehicles (cars or bigger), N for goods vehicles (vans or bigger). The full category (e.g. L3e, M1, N1) can be added later from the vehicle make and model, referring to the list of vehicle categories in the Methodology note.

	Yes	Maybe	No	Don't know
3a) 2-wheel EL-V	☐ code 1	☐ code 2	☐ code 3	☐ code 4
3b) 3-wheel EL-V	☐ code 1	☐ code 2	☐ code 3	☐ code 4
3c) 4-wheel EL-V	☐ code 1	☐ code 2	☐ code 3	☐ code 4

If Yes or Maybe to any of the above:

3d) Under which circumstances? (all trips? Only some trips?)

3e) Would any special configuration of the vehicle be needed: e.g. would it need a roof? Front or rear luggage rack? Other vehicle features?

3f) If No to any of the above, then why not? What are the main barriers?

23) What, in your opinion, are the main advantages of EL-Vs?

24) What are the disadvantages of EL-Vs?

25) If you used an EL-V for your work, do you expect the following aspects would be better or worse compared to your current vehicle(s)? *[If the driver already uses an EL-V ask opinion of that compared to the type of vehicle previously used]*

	Better	The same	Worse	Don't know
6a) Comfort in hot weather	☐ code 1	☐ code 2	☐ code 3	☐ code 4
6b) Comfort in cold or rainy weather	☐ code 1	☐ code 2	☐ code 3	☐ code 4
6c) Ability to park easily for loading and deliveries	☐ code 1	☐ code 2	☐ code 3	☐ code 4
6d) Ability to get past traffic jams	☐ code 1	☐ code 2	☐ code 3	☐ code 4
6e) Feeling of safety	☐ code 1	☐ code 2	☐ code 3	☐ code 4
6f) Capacity to carry my usual amount of goods	☐ code 1	☐ code 2	☐ code 3	☐ code 4
6g) Security of the goods I am carrying	☐ code 1	☐ code 2	☐ code 3	☐ code 4

26) What in your opinion are the most necessary measures to encourage greater use of these kinds of electric vehicles)?

If you think any of these improvements should be made in one or more specific locations in your city, please specify the places in your answers below.

f) Dedicated delivery spaces (on street)

Level of importance?	Are improvements needed?
Not important ☐ code 1	Yes ☐ code 1
Quite important ☐ code 2	No ☐ code 2
Very important ☐ code 3	Don't know ☐ code 3

If improvements are needed:

- What is needed? _______________
- Where? (Locations in your city; names of streets or districts/landmarks) _______________

g) Electric charging infrastructure

Level of importance?	Are improvements needed?
Not important ☐ code 1	Yes ☐ code 1
Quite important ☐ code 2	No ☐ code 2
Very important ☐ code 3	Don't know ☐ code 3

If improvements are needed:

- What is needed? _______________
- Where? (Locations in your city; names of streets or districts/landmarks) _______________

h) Allow use of bus and cycle lanes by 2- or 3-wheel electric vehicles, or other means of priority or safety measures on the roads

Level of importance?	Are improvements needed?
Not important ☐ code 1	Yes ☐ code 1
Quite important ☐ code 2	No ☐ code 2
Very important ☐ code 3	Don't know ☐ code 3

If improvements are needed:

- What is needed? _______________
- Where? (Locations in your city; names of streets or districts/landmarks) _______________

i) Specific navigation services aimed at electric light vehicles

Level of importance?		Are improvements needed?	
Not important	☐ code 1	Yes	☐ code 1
Quite important	☐ code 2	No	☐ code 2
Very important	☐ code 3	Don't know	☐ code 3

If improvements are needed:

- What is needed? _______________

- Where? (Locations in your city; names of streets or districts/landmarks) _______________

j) Other improvements or services (training, rescue, road infrastructure, security, etc.)

Is anything else needed?

- If so: What? Where?

27) Any other comments?

Thank you very much for your time!