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Mobility as a Service (MaaS) in suburban and rural areas: concept design and challenges

By

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Declaration

I hereby declare that, the contents and organization of this dissertation constitute my own original work and does not compromise in any way the rights of third parties, including those relating to the security of personal data.

Davide Longhi
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When the last tree is cut down,
when the last river is poisoned,
when the last bird is caught:
only then will you realize that money cannot be eaten.

Native American Saying

Contents

List of Figures

List of Tables

Abstract

Mobility as a Service (MaaS) is considered a new mobility paradigm. The concept of MaaS became popular few years ago and since then many trial projects have been carried out in urban environments. However, the first real Mobility as a Service was launched in Helsinki only in 2017.
Although there is not a unique definition of Mobility as a Service, its concept is based on allowing users to travel by traditional and alternative modes of transport which are used as a service. Mobility as a Service aims to reduce the car ownership. To this end, a unified platform provides the information related to the supply of transport, combining private and public transport operators. On the other hand, customers are able to purchase a unique ticket through a single account.

This Ph.D. thesis aims to understand if Mobility as a Service is suitable for suburban and rural areas. To reach this objective, both a bottom-up and a top-down approaches were used in order to assess the opinion about MaaS from, respectively, the population and the stakeholders. To this end, 146 municipalities in the province of Torino (Italy) were selected as a study area.
To reach the above objective, different methods were used, allowing the analysis of both quantitative and qualitative data. A survey was designed to assess how people travel and how they would like to improve their travel experience.
A cluster analysis was subsequently performed to define different categories of people according to their willingness to use Mobility as a Service.
Moreover, Focus Groups with a stratified sample of respondents were organized to collect qualitative data as well as validate the outcomes of the Cluster Analysis.

Personas, a tool used in User Experience Design to play a role and represent a specific segment of users, were created based on representative answers of the survey and assigned to the participants of the Focus Groups.
To this end, participants of Focus Groups were split into sub-groups and were asked to identify weaknesses and solutions aimed to improve the travel experience of their *persona*.
Finally, a Focus Groups with the main stakeholders of the study area was carried out to describe the outcomes of both the survey and the respondent's Focus Group. In this occasion, the stakeholders were asked to provide a definition of Mobility as a Service and assess the feasibility of the solutions delivered by the respondents.

The innovative methodology of this thesis is the use of both quantitative and qualitative data as well as of different disciplines such as User Experience and Service Design, aimed to determine and validate the clusters defined through the Cluster Analysis.
Besides, the use of both a bottom-up and a top-down approaches allowed to identify common points between respondents and stakeholders.

The quantitative data from the survey and the Cluster Analysis defined categories of respondents willing to use Mobility as a Service. However, Focus Groups validated the cluster analysis only partially.

Moreover, in contrast to the literature, the outcomes of both the survey and the Focus Groups showed a mistrust about Mobility as a Service.
On the other hand, stakeholders struggled to find a common definition to describe MaaS and the prices for the most positively evaluated mobility packages were considered economically unsustainable by the transport operators.

This thesis opens to a new perspective in terms of the design of Mobility as a Service that, in contrast to the literature, has to be tailored on the real needs of the population. Therefore, the success of Mobility as a Service is the outcome of the encounter of both user and stakeholder's needs.

Chapter 1

Introduction

During the last decades, world has seen rapid and radical changes which have affected population's life quality and the sustainability of the planet itself.

For more than two-hundred-thousands of years, the global population has been lower than a billion (Silby & Hone, 2002). From the beginning of the 19th century, it took less than 130 years before it doubled: in 1927 the global population was recorded to be 2 billion (Nielsen, 2016).
In 2011, it was estimated that about 7 billion people were living on our planet and this number is expected to increase to 16 billion by the end of the century.
This rapid growth of population is certainly the result of improvements in living standards which have increased life expectancy by reducing the death rates (Zhang, 2015).
However, there are substantial differences between countries in terms of population growth: due to its high fertility rates, the least developed countries' population is expected to double by 2050. Indeed, the countries with the highest population growth rate are mainly African, such as South Sudan, Angola, Malawi and Burundi (Indexmundi, 2018; The Data World Bank, 2018; Statista, 2017). In particular, the population of the 49 least developed countries is growing nearly twice as fast as that of the rest of the developing world (United Unions, 2010).

On the other hand, the most developed countries are facing to a low (or sometimes null) population growth, which, in turns, implies a growth of older persons. This is mainly due to the fact the developed countries notably have better health policies than developing countries, which in turn led to lower death rates caused by diseases. Besides, the educational system in the developed countries is more available to their citizens. Therefore, as education has become compulsory in most of the developed countries, having children can be considered an economic cost, which provides an incentive to reduce the size of the family. Indeed, as pointed out by the Centre of Economic and Business Research (2014), rising up a child until the age of 21, it might cost more than £230,000.
The trends described above about the uncontrolled population growth have consequences for the environment of our planet and its self-sustainability.
In late 1798, Thomas Malthus already pointed out that, in the absence of significant ongoing innovation, the population grows faster than the rate that food supplies does (Malthus, 1798). This is due to the fact that the population multiplies geometrically, while goods and foods arithmetically.

Thus, whenever the population improve its skills to produce food, more people then get born in a never-ending cycle which would eventually collapse.
However, the effects of climate change started to be tangible two-hundred years ago, with the transformation of the society from agrarian to an industrial one.

This has been possible thanks to technological innovations which, in turns, involved a large amount of energy in order to transform and labour natural resources.
To this extent, industrialization implicated mainly technological improvements, financial and social transformation: it was back in the 19th century when machines started to replace human labour spread throughout North America and Europe. This revolution is also referred as the world's industrialization.

However, human population growth is tied together with increased use of natural and man-made resources, energy, land for growing food and for living, and waste by-products that are disposed of, to decompose, pollute or be recycled. Therefore, the ability of producing things faster and the exponential population growth led to the exponential requirements for resources, energy, food, housing and land, as well as the exponential increase in waste by-products.
This increase demand of resources turned mainly into deforestations, soil consumption and burning fossil fuels coal for the development of new cities.

Although, fossil fuel coal drove the Industrial Revolution and has changed the way people's live and their way to use energy in their daily lives, enabling progresses and improvements of living conditions, it also brought costs to our health, and environment. To this extent, population growth and uncontrolled consumptions of natural resources might bring to worldwide catastrophic consequences: temperatures might rise up to 3 °C: this entity's climate change can lead substantial global exposures to coastal erosion, sea-level rise, water supply and climatic events that we are already experiencing.

To this extent, a series of feedback could push the Earth toward a threshold that, if crossed, can cause continued warming on a Hothouse Earth pathway even though human emissions are reduced. Crossing this edge would result in a far higher world average temperature than any interglacial within the past 1.2 million years and in ocean levels considerably over at any time within the Holocene period (11,000 years ago).
Such action entails stewardship of the entire Earth System—biosphere, climate, and societies—and could include decarbonization of the global economy, enhancement of biosphere carbon sinks, behavioural changes, technological innovations, new governance arrangements, and transformed social values (Spratt & Sutton, 2008).
Climate change is also bringing negative externalities on economical, societal and political level both at global and local-scale.

Indeed, researches proved that the rising of the temperatures is the main cause of the reduction of the rainfall (Quesada et al., 2017). As assessed by FAO (Food and Agriculture Organization of the United Nation), in 2018 there are 39 Countries

in the world which need external assistance for food; 31 of those are in Africa, 7 in Asia and 1 in Latin America (FAO, 2018).

It is challenging to isolate global warming and climate change from all the other trends; however, Willoughby (2015) pointed out that climate change is certainly the main cause of the 5% decrease of the global production of wheat and maize during the last 40 years.

Thus, migration has been recognised being a direct effect of climate change and particularly due to the fall of the crop's production.
As pointed out by several researches (Carbon Brief, 2016; United Nations, 2017), migration flows have increased in those countries afflicted by a decrease of the precipitation and where the coal and oil trades were not enough.

Therefore, with the incessant growth of population, also due to the migration flows and the spread of urban areas, transport field is one of the sectors mainly responsible for the emission of GreenHouse Gases (GHG).
In particular, since 1800, more and more people moved to cities, giving birth to a process of urbanization. Although the number and dimension of cities has increased since the industrial revolution, the peak is not yet in sight (Gollin , Jedwab, & Vollrath, 2016). Indeed, soil consumption and the loss of biodiversity surely represents other negative externalities which are directly related with the increase of pollution and traffic congestion. In particular, Milman (2015) claims that, during the last forty years, earth lost one third of cultivable land, mainly due to the pollution, erosion and the boost of global demand for food.
United Nations claims that almost 70% of the global population will live in urban areas by the next thirty years and, thus, one in eight people will live in 33 megacities worldwide (2018) and by the next 15 years, there will be at least 43 megacities with more than 10 million inhabitants, most of them in developing countries.

According to Eurostat (2018), more and more people are moving on the edges of urban areas, where living costs are generally lower than in the cities. However, these people generally keep commuting toward metropolitan areas where there is a wider range of labor. Spread and sprawl of urban areas lead to a growth of individual trip lengths, mostly in newly urbanised neighbourhoods which are generally car dependent due to the lack of public transport supply.
Thus, these areas bring increased transport emissions (Hoornweg et al., 2011; Camagni et al.,2002). Indeed, the growth of transport emissions is correlated to the population and economic growth: a greater number of passenger-kilometres and freight tonne-kilometres, led to increase transport emissions.

During the last fifty years, the production of greenhouse gases has increased significantly (Sims et al., 2014; European Environment Agency, 2015) and as pointed out by Ritchie and Roser (2018), the Carbon Dioxide accounts the 75% of the global greenhouse emissions. Nevertheless, methane and nitrous oxide are also

important sources, which respectively accounts for the 17% and the 7% of the global emissions (Figure 1).

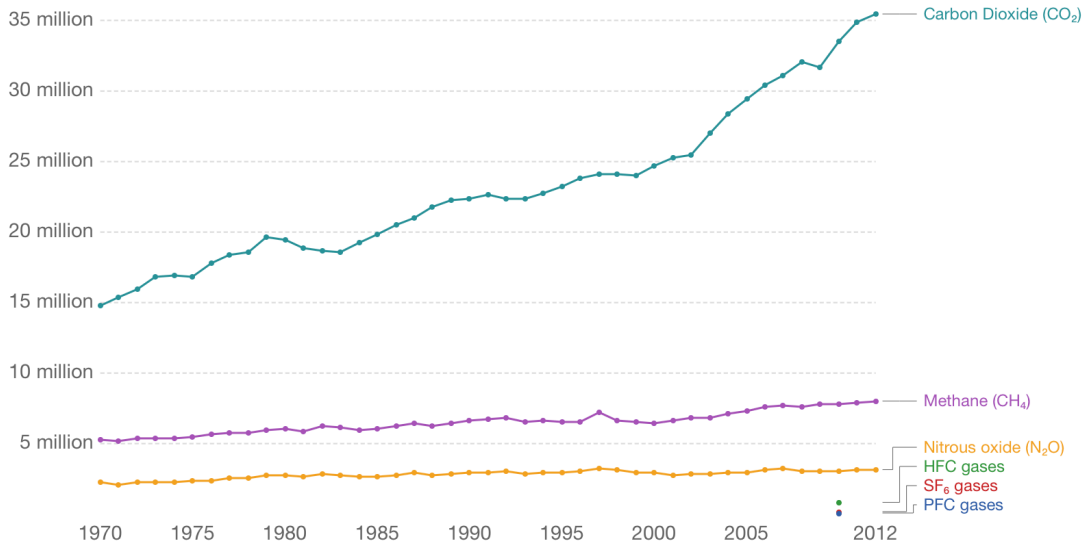

Figure 1 - Global greenhouse gas emissions by Gas

EPA (United States Environmental Protection Agency) claims that transportation is responsible for the 14% of the global greenhouse gas emissions (2016). This sector includes road and rail transport, domestic navigation and aviation and other transport modes.
Other sectors which represent the main cause of the greenhouse gases emissions are electricity and heat production (25%), agriculture (24%) - whose gases are mainly related to the enteric fermentation, manure management, the usage of synthetic fertilizers and burning crop residues - and industry (14%).

However, negative externalities related to transport can be recognized also at a local and urban level, where the spaces devoted to cars (roads and car-parks) can overcome 60% of the urban land in some cities of USA like Los Angeles (Gillis & Harvey, 2018).
Figure 2 shows the growth of Los Angeles's parking density between 1950 and 2010. In particular, Greene (2016) pointed out that in 2010 Los Angeles County counted almost 20 million parking spaces and this number is still growing.
Los Angeles represent an extreme example of soil consumption, but the global trends related to this aspect go in the same direction.

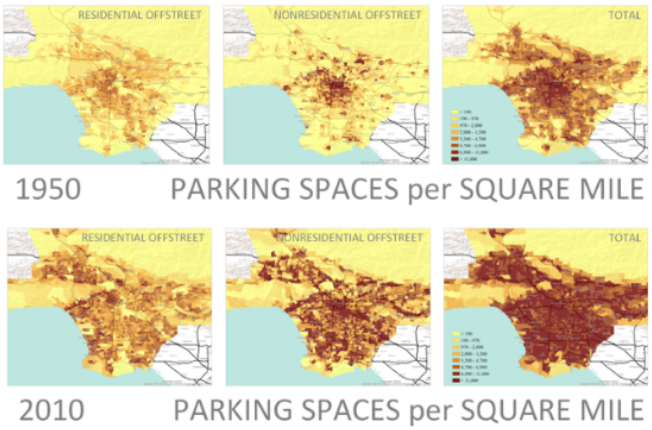

Figure 2 - Parking spaces per square mile in Los Angeles (1950 -2010) (Chestera et al., 2015)

Besides, also wildlife habitats are injured by the design and construction of new infrastructures (roads, rails, and waterborne transport) (Jackson, 2000) and also population is affected by isolation and fragmentation (Pero, 2003).
Therefore, the pollution level and congestion are increasing in the contiguous area of these above-mentioned infrastructures and this trend seems to continue in the following years with negative implication for both the population and wildlife. (European Commission, 2015).
Finally, traffic and congestion represent the main complications related to transport for people living in urban areas who have to face loss of time, stress and increase of travelling costs. The Economist, in 2018, published an article showing the cities with the highest number of hours wasted in congestion: above all Los Angeles, Moscow, New York and Sao Paulo (The Data Team, 2018). In this article, the authors calculated the economic impact of this waste of time: In Britain, Germany and the United States, such cost totalled $461bn last year, or $975 per person/year. In European Countries, these costs represent one third of total external costs of transport (Figure 3).

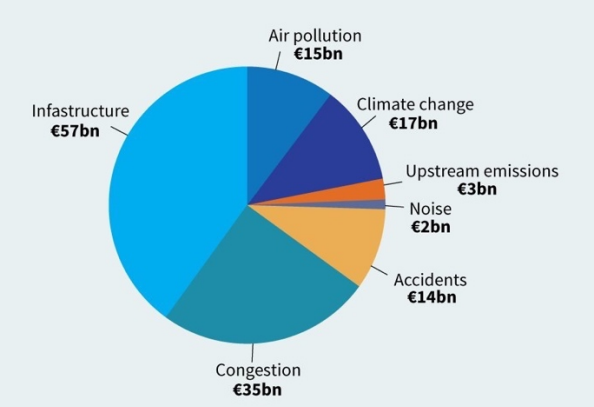

Figure 3 - Total external costs of transport in 2013 by externality (Delft, 2015)

To this extent, during the last 20 years, the EU policies focused on improve the CO2 efficiency of current traffic volumes.

The Directive 2003/30/EC on biofuels and the target of 120 g CO_2/km for passenger cars seemed to have had impacts in terms of emissions' savings (European Parliament, 2003) (European Parliament & Council of the European Union, Decision n°1753/2000 EC, 2000). Although these policies have undoubtedly brought emission savings, they did not stop their increase but simply slow their growth. Indeed, even if the Commission of the European Communities assessed that between 1995 and 2004, a 12% reduction of CO_2/km has been estimated (2007), during the same period, about 20% more cars were sold, counterbalancing the reduction of CO_2emission led by the above-mentioned policies (EEA, 2006).

Besides, the European Commission, with the EU Green Transport Package (2008) provided a framework to the policies of the Members States, by introducing charges for road usage by heavy trucks. Nevertheless, the charges introduced by the EU are not directly addressed to the private transport. On the other hand, the Green Paper on Urban Transport (European Commission, 2007) says that the suburbanisation and urban sprawl's trends are responsible for a low density and segregated land use which, in turn, results in increase transport due to dispersal of home, work and leisure. To this extent, European Commission has to face urban sprawl differently, by adopting better land-use policies and by incentivising the usage of alternative modes of transport so to better achieve a coordination between land-use planning and interurban transport.

It is evident that EU policies are focused on the improvement of the cars' CO_2 efficiency; however, they cannot be considered sufficient to stop the growth of the emissions. Indeed, if transport emissions are strongly correlated to transport emissions, EU's and State Members' policies have to limit urban sprawl to encourage the usage of alternative modes of transport.

Chapter 2

Literature review

The rise of new modes like Demand Responsive Transport (DRT) and car-pooling can be considered valid solutions to limit the main negative externalities related to private transport. In particular, investments in urban, suburban and rural areas have brought to a growth of the number of Demand Responsive Transport systems in Europe, whose efficiency is generally induced by technology, mostly in the field of ICT (Information and Communication Technologies) (Mageean & Nelson, 2003). If DRT systems can improve commuting for those people who live in areas where the public transport supply is not efficient enough, on the other hand, these solutions sometimes might represent an unsustainable economical solution for the transport operators that provide the service (Jani-Pekka, 2016).

Moreover, although in most of the developed countries the way people travel and commute has changed during the last years to the arise of new forms of transport, too many citizens still travel by cars.
Indeed, it has been pointed out that in the main European capitals, only 60% of the trips are made on foot, by cycling or public transport, while the rest of it depends on car (Buehler et al., 2016).
As pointed out by Balcombe et al. (2003), among the main factors which affect drivers' modal choice, flexibility, time, perceived cost and reliability are the most important ones. To this extent, several researches have been carried out in order to understand people's travel behaviour and how to change it (Ferguson, 2016; Anable, 2005; Ajzen, 1991, Pronello & Camusso, 2011).

Main European capitals like London and Paris are trying to change people their paradigms toward a more sustainable and integrated mobility, trough policies such as the Congestion Charge and Paris Respire. However, only during the last few years, local authorities have started to incentivise their citizens to use
The Congestion Charge and Paris Respire are undoubtedly the most renowned policies which aim at discouraging people to travel with their cars, however,

Understanding the key trends in transport and the users' mobility patterns likely to unfold over the coming years, is crucial to the implementation of new best practices and policies, including efforts to forge a new mobility paradigm. To this extent, more people commute for longer distances and they are more likely to make multimodal transfers to reach their destination (Klinger, 2017; Rodriguez Cotea & Diana, 2017; Langlois et al, 2016). Therefore, numerous transport systems around

the world, pursued the integration of more modes of transport in order to provide a seamless and smooth journey to their users (Pelletier, Trépanier, & Morency, 2011). Without doubt, smart-cards is the most common device which can be used for storing travel subscriptions and validating tickets.
However, this system alone is not enough to understand all the transport demand, thus, knowing transport demand represents a challenging task for local transport authorities.
Notably, understanding users' mobility patterns can be pursued using several methods: tracking users through GPS and WiFi access points (Sapiezynski et al., 2015), sentiment analysis and tweets (Li et al., 2017), surveys (Esztergár-Kiss et al., 2016) and smart-card data analysis (Pronello et al., 2018).
Especially Smart-Card and Automated Fare Collection Systems (AFCS) can play a key role: although Smart Card and AFCS were introduced almost fifty years ago in Germany, their usage in the transport sector has increased enormously during recent years (Pelletier et al, 2011; Shelfer & Procaccino, 2002). Fraud detection, the reduction of boarding times and the management of transport operators' revenue were among the main reasons leading transport companies to convert their traditional ticketing systems towards a more up to date AFCS (Mayes et al, 2009; Robinson et al, 2014; Lovric et al, 2013).

A further advantage of AFCS is provided by the possibility of extending the ticketing systems to different transport operators and modes of transport, making multimodal trips possible and smoother. Several studies pointed out that the integration of different modes of transport in a single smart card, can be an incentive for users to have more sustainable habits (Fuse, Makimura, & Nakamura, 2010).

On the other hand, the usage of modes of transport whose subscriptions are managed with different devices (i.e. paper ticket, smartcard, smartphone app) represents one of the main aspects which can complicate estimations of the Origin-Destination flows of a whole transport system.
In detail, more and more people commute from suburban and rural areas towards urban areas mainly for work and study purposes using new alternative mode of transport such as car-sharing, bike-sharing, Demand Responsive Transport (DRT) and car-pooling (Luè and Colorni, 2009; Kolenbet, 2017).

ICT (mainly smartphone app and Advanced Traveller Information Systems) changed users' travel habits and their mobility paradigm toward an easier and shared mobility. However, the high flexibility of the above-mentioned modes of transport changed users' expectations about mobility, satisfying their needs at any time and any place.
It is clear that traditional public transport it is not able to satisfy this flexible demand, especially in those places where the demand is considered weak (Ferrett , 2017).
Therefore, some users prefer to commute by car which undoubtedly is, the most flexible mode of transport. However, the choice of travelling by car is usually made

without being aware of its costs: indeed, most of the drivers only perceive the costs of the fuel and parking, while the costs related to maintenance and car itself are usually misperceived (Malecki, 1978).

Apart from private cars, taxis are characterised by high flexibility but due to their costs they cannot be used for long distance trips. On the other hand, Public Transport (subway, bus, trains, etc) can be performed for long distances but their users regard them as not flexible modes of transport.
However, even though car-sharing and car-pooling can represent a valid alternative both in terms of distance and flexibility, these modes are subject to some constraints: indeed, they can be considered competitive with Public Transport and they have high operational costs. Besides, it is important to highlight that car-sharing cannot be considered a sustainable mode of transport: these vehicles are averagely used one by one person per time. Furthermore, car-sharing operators typically work in restricted areas; to this extent, users are still bound to their private vehicles in case they want to travel out of urban areas.
Case studies proved that integration of Public Transport and alternative modes of transport, such as carpooling, can represent a solution to reduce travel and waiting times, so to improve user's travel experience.
In 2016, Moovit, the worldwide transit app leader, decided to launch a carpooling service (*Moovit Carpool*) in Roma (Italy) to improve the connection between the city centre and the suburbs where the supply of transport was particularly weak (RomaToday, 2016).
After few weeks, users started to use this platform, both as drivers and as passengers. This serviced helped the municipality to redesign the supply, reducing the travel times from averagely 100 minutes to about 60 minutes.
To this extent, since users tend to choose their mode of transport according to cost, time and flexibility, Public Transport Operators and sharing mobility partners can define agreements to improve the supply of transport, thus user's journey experience. During the last years, many cities developed hubs and gateway where users can plan their trips, choose the modes of transport and also book and buy the ticket. According to (Hensher, 2017), these platforms can be defined as Mobility as a Service (MaaS). However, the literature has conflicting opinions about this topic: Costantini (2017) believes that MaaS should aim at providing tailored mobility according to specific users' needs. To do so, MaaS has to include four main elements: "infrastructures, data providers, transport operators and trusted mobility advisors". It is clear that fare integration plays a key role and it should enable users to purchase tickets by Pay as You Go, subscriptions or mobility packages.

Although most of the MaaS experiences and trials are focused on urban areas (Kamargianni, Matyas, Li, & Schäfer, 2016), this thesis aims at designing a concept of Mobiliy as a Service in the suburban and rural areas where the demand of transport is notably weaker than in the cities.
Therefore, the solutions should aim at increasing the efficiency, the convenience and the accessibility, maintaining a sufficient level of service in the interurban and rural areas of the province of Torino (Italy). To reach this goal, a participatory design process will be used, including both mobility users (i.e. commuters and occasional travellers) and stakeholders (i.e. Policy Makers and Transport Operators).
Thus, the next sections focus on the literature reviews, the methodology, describing the survey and the data analysis design. Finally, results are discussed and conclusions and suggestions to policy makers are put forward.

2.1 The arise of Mobility as a Service (MaaS)

As described in Chapter 1, many large cities in the world are facing to manage their transport systems due to a constant growth of the population (Edwards & Smith, 2008). Therefore, congestion, poor air quality and long travel time are just some of the main negative externalities which afflict urban areas (Hayashi et al., 2004; Taipale et al., 2012; Zavitsas et al., 2010; Jittrapirom et al., 2017).
In particular, until last decade, mobility performance was evaluated essentially according to the speed and the affordability of a specific mode of transport. This approach indirectly generated consequent improvements focused on private vehicles due to the fact that this old paradigm aimed at maximizing distances and maximizing the travel speed.
Opportunities to improve the transport services are arising from the introduction of the IT and digitalization and the rising of sharing economy (CIVITAS, 2016; Holmberg et al., 2016). In particular, several authors claim that the popularity of MaaS is correlated to the born, in turn, of packages of services, such as mobile phone packages, Netflix and Spotify (Polis Network, 2017; Pöllänen, 2017; Wray, 2018).

Therefore, MaaS opens to a new mobility paradigm focused on improving the mobility access, including more modes of transport and services aimed, in turn, at offering a convenient and tailored solutions for its users.

Besides, the popularity of Mobility as a Service was facilitated by a change of the user's travel behaviours. In particular recent researches pointed out that public transport users have less and less routine travel behaviour and that they are less attached to a specific mode of transport; indeed, users perform their modal choice according to the route which let them have the most practical use of modes of transport (Lima et al., 2016; Levinson & Zhu, 2013; Anker Nielsen, Daly, & Frederiks, 2002).

Although in this era the mobility paradigm is moving from being *car-ownership based* to the consumption of the mobility service which should include alternative modes of transport several authors claim that this new era will not necessarily lead to have less vehicles on the road (Mulley, 2017; Sochor J. et al., 2017).

Indeed, Giesecke, Surakka, & Hakonen (2016), and Holmberg et al., (2015) emphasise the importance of configuring MaaS in a way that ensures its contribution towards the overall sustainability of the transport system.

Besides its popularity, it is evident that there is a lack of common sense regarding what Mobility as a Service is and what *service* stands for.

2.2 Mobility as a Service (MaaS): a great misunderstanding

In the recent years, the word "*integration*" became at the core of the new mobility paradigm of MaaS. Many projects related to Mobility as a Service were launched focusing on the incorporation several modes of transport in a unique platform. However, due to an unclear definition of MaaS, many projects aimed to simply improve the level of integration rather than deliver a new mobility paradigm which reflects traveller's needs and behaviours. Indeed, integration can be considered a necessary but not sufficient condition for the success of a Mobility as a Service.
To this extent, Kamargianni et al. (2016) catalogued the main MaaS projects according to their levels of integration on the following main three categories:

1. Ticket and payment integration;
2. Mobility package
3. ICT integration.

The first category refers to those transport systems where a device (such as a smartcard or a smartphone) can be used to travel with all the modes of transport and only one account is charged.

Mobility packages enable customers to pre-purchase a specific combination of services, choosing a number of minutes or kilometres to travel. Therefore, customers are able to travel with different modes of transport, using one single mobility device.
Finally, we can talk about ICT integration when a unique online platform is available for users to get information about all the modes of transport and purchase their ticket or mobility package.
Among the most famous case studies of ICT, Octopus Card (Hong Kong) and Oyster Card (London), definitely generated a growth of the use of public transport. In particular, the Octopus Card was launched more than twenty years ago and it incorporated the main modes of transport (train, tram, ferry, bus, taxis, etc.), eliminating the payment barriers among different operators and modes available in the network. In this way, the customers could experience smoother trips. To this extent, ticket and fares integration, enabled users to use more public transport.
Considering these three integration categories, the main Mobility as a Service systems can be grouped according to their level of integration:

a. partial integration;
b. advanced integration
c. advanced integration with mobility packages.

2.2.1 Examples of MaaS according to different level of integration

Below, a few examples of different level of integration are given.
At the first level of integration (*partial integration*), the modes of transport are not sufficiently integrated, so that travellers cannot perceive the real potential of an integrated mobility.
Cambio (car-sharing company), STIB (public transport operator) cooperate with taxi and bike-sharing in Brussels (Belgium). Even if a smartcard can be used to validate on STIB buses and to drive Cambio's cars, there is neither an ICT nor a payment integration. On the other hand, Qixxit, in Germany, provide an ICT integration by a smartphone app which can offer route planning, booking, trip-advice in real-time, integrating rail, urban public transport, bike-sharing, car-sharing, car-rental, taxi, coach and flight. However, apart from ICT, Qixxit does not provide any other forms of integration. Similarly, still in Germany, Moovel is a smartphone app which includes different modes of transport. This app aims at facilitating intermodal route planning, booking and payment. Therefore, there is ICT integration but not ticket integration among the different modes of transport.

Hannovermobil, instead, can be considered as part of the second level of integration (*advanced integration system*). People who buy a Hannovermobil pay slightly more than the usual price for public transport subscription and through a single smartcard, they can access to urban public transport, car sharing and get discounts for taxis, car rental and long-distance rail. To this extent, this device provides a ticketing integration between the public transport and the car-sharing operators. Besides, also an integrated bill is delivered every month to the users. The ICT integration is provided by a smartphone app which provides real-time multimodal information.
Another example of advanced integration system is EMMA which was developed in Montpellier (France). TAM (*Transports de l'agglomération de Montpellier*) is the main operator in Montpellier and it operates urban public transport, bike-sharing and car parks. EMMA users can choose to buy a monthly or yearly mobility subscriptions, which enable them to use all the modes of transport operated by TAM.
EMMA subscriptions are differentiated according to two main user groups: Young and Senior. Customers can access to the mobility services through a single smartcard and they can also consult a real-time multimodal app, to collect information about TAM services. TAM established a cooperation with Modulauto (car-sharing provider); indeed, users can purchase an annual on monthly subscription and travel with the urban public transport, access to the bike and car parks and rent cars and bikes. However, the cost for car and bike sharing is not included in the subscriptions and so it has to be paid separately.
EMMA also offers an online journey planner containing real-time information and the EMMA card is the single key to access all services. Both EMMA Contracts and

Mobility Subscriptions show payment, ticketing and ICT integration. The main difference is that the EMMA contract only includes services that are within the institutionally integrated TAM, while the subscription also includes the partner Modulauto car sharing.
In the Netherlands, three MaaS systems addressed to business travellers were developed: Mobility Mixx; NS-Business Card and Radiuz Total Mobility.
These three systems enable users to access to different modes of transport, including car and bike sharing, through a unique smartcard. Payment integration is provided by a single invoice which is delivered monthly and includes all the modes. However, there are significant differences regarding ICT integration: indeed, Radiuz Total Mobility provides an application which can be consulted to have real-time multimodal information, while NS-Business Card offer the same service but just through a website.
Mobility Mixx does not provide neither an app nor a website but, instead, offers a call-center service which is available 24/7 for route and trip planning and booking.

The third category of MaaS scheme, Advanced integration with mobility packages, includes systems like UbiGo and the Helsinki Model. UbiGo is a project which was initially tested in Gothenburg (Sweden) and then launched also in Stockholm and other cities in Sweden. UbiGo involves the cooperation of several transport operators: urban public transport, bike-sharing, car-sharing, car rental and taxi. The ICT and ticket-payment integrations are provided through one single application. About the payment integration, packages can be purchased and their prices can vary according to the distance and time of each selected mode. For example, the price of a public transport subscription counts the number of days in one or more zones of the network, while taxi considers the distances.
Therefore, the customer can compose his/her mobility package and its price will be cheaper than the sum of the single subscriptions. If the subscription expires and runs empty, customer can still travel and the additional trips will be billed after. the, customers can collect bonus points if they choose to perform their trips with sustainable modes (i.e. bike-sharing and electric vehicles).
The Helsinki Model is known as *the first MaaS project* and aims at creating a mobility service which can be door-to-door. The Helsinki Model count 23 partners, including several research associations. The mobility packages are tailored towards groups of users according to their socio-demographic characteristics: i.e. commuters, families, business, etc. Besides the above-mentioned modes of transport, this project includes also on-demand transport services which are tailored on the real time needs of the users.
Most of the projects related to MaaS, focuses on changing the paradigm of car which, according to Finnish initiative, should become a vehicle to rent and not to own. Besides, the above-mentioned projects, to reach this goal, seem to focus more on the aspect of *Combined Mobility*, rather than the word *Service* which should be contained in MaaS. However, also the definition of Service in MaaS is quite fluid.
Indeed, integrating alternative modes of transport such as bike-sharing, car-sharing, car-pooling and taxis with the traditional transport supply can be mistaken for MaaS. The concept of Mobility as a Service is wider than this. As previously said,

the definitions of Mobility as a Service usually merely refer to integration, interoperability and sustainability, while actually should include other aspects such as customer's needs, tailored solutions, an interface/platform, integrated payment, a service offer, a business model and a service provider (Karlsson et al, 2018).
About these last items, it is still complicated answering to the question "*who should be the Mobility as a Service provider*?" and defining a MaaS business model.
In order to avoid conflicts of interest among different transport operators and avoid a mode-centric system, the development of a Mobility as a Service requires a unique provider (Li & Voege, 2017).
Therefore, since the MaaS provider needs to be remunerated for delivering services, it is still unknow who will have to face these costs. In both cases if the costs are covered by the customers or the transport operators, the prices will have to remain affordable in order to make public transport an attractive option (Polis Network, 2017). Consequently, if MaaS would be led by transport authority, then it could more easily monitor the performances of the transport operators and adopt fares' policies which, for instance, could vary according to the time of the day (peak and off-peak).
To this extent, Karmargianni and Mayas (2017) proposed a MaaS business model and ecosystem, based on feedback data collected from several sources (Focus groups with CEOs, Policy Makers, users and senior managers).
As shown in Figure 4, MaaS ecosystem should include several stakeholders, divided in different layers, which correspond to different levels of contribution to the MaaS provider.

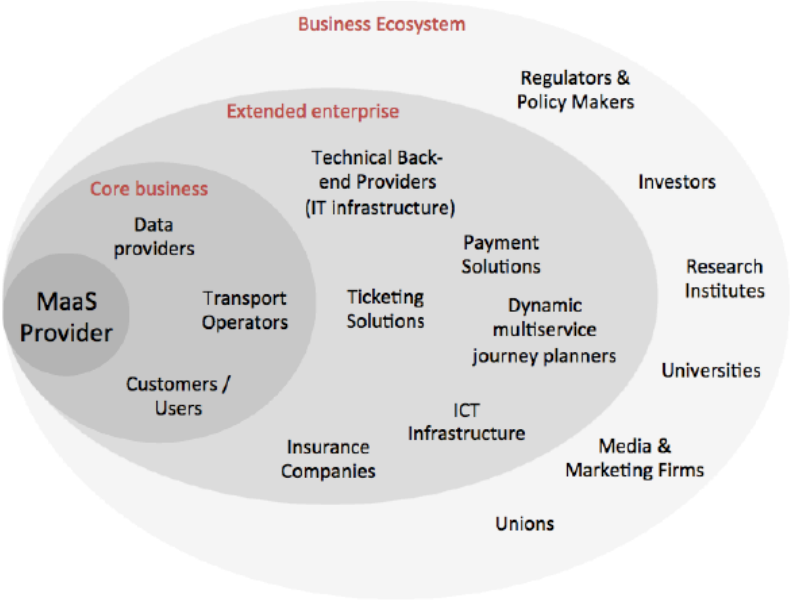

Figure 4 - Mobility as a Service Ecosystem (Kamargianni & Matyas, 2017)

At the core layers, the main customers (i.e. users) and the supplier (data providers and transport operators) are included. The extended enterprise layer includes the complementors, the technical back-end providers, ICT infrastructure, insurance companies and companies which offer ticketing and payments.

It is important to understand who is the MaaS operator. Kamargianni and Matyas (2017) claim that the MaaS provider could either be the transport authority (or an equivalent public body) or a private firm. In the case the MaaS provider is represented by the public transport authority, then it will be easier to include and authorize all the available modes of transport into the new service.

Besides, since the public transport authority usually is the body which regulate the transport policies, then it may facilitate the regulation to deliver the Mobility as a Service concept.

On the other hand, being a public body, the Transport Authority may be subjected to long bureaucracy times and, moreover, since it is not a for-profit organization, it does not have enough incentives to develop a Mobility as a Service that could really improve user's journey experience. Furthermore, including other services which are not strictly related with mobility (i.e. discounts at museums, restaurants, gym, etc.) or collaborations with other cities/regions/countries may not be an easy task for a public transport authority. Instead, in the case MaaS provider is represented by a private firm, the above-mentioned task could be easier. Indeed, under this scenario, the delivery of a MaaS market would be reached faster due to the fact that private firms are driven by profit maximization.

Moreover, Kamargianni and Matyas (2017) found out that car-sharing companies and on-demand modes (DRT) would prefer to provide their services through a private MaaS operator due to the fact that, in this case, the provider would be more encouraged to promote their services.

Nevertheless, this scenario does not guarantee that the transport operators join the MaaS scheme in short term period; besides, the transport authority could not agree to let the operators join a private firm with not clear visions and policies.

2.3 Is there a definition of Mobility as a Service?

It is clear that, in order to develop a new mobility paradigm which is MaaS based, it is necessary to have a clear definition of what Mobility as a Service is and, subsequently, verify which are the requirement and the effect (Sochor, Arby, Karlsson, & Sarasini, 2017).

There is currently no established definition of MaaS (or Combined Mobility or Integrated Mobilty Service), and, as discussed above, it is likely premature to provide 'one definition' at this early stage of MaaS development. Different descriptions and definitions highlight some common and some different central elements, although, no matter the term, it is about:

- Offering a service with customer/user/traveller transport needs as the main focus;

- Offering mobility rather than transport:
- Offering integration of transport services, information, payment and ticketing.

In terms of integration, there needs to be a clearer characterization of different types of integrated services. The challenges faced in the development of integrated services are at least partially related to which types of service elements are to be integrated and to which degree. Despite this, and although various analyses have explored barriers of MaaS (e.g. Holmberg et al., 2015; Mukthar-Landgren, 2016; Sochor et al., 2016a; Transport Systems Catapult, 2016), there is not yet any thorough analysis of the connections between the different types of integrated services and the services' challenges and potentials. Integration can, for example, comprise:

- Integrated information services / multimodal travel information. This apsect, together with integrated payment services, can be considered the MaaS' 'core';
- Integrated booking or ticketing, e.g. a 'smartcard' or a mobile app that can provide access to different modes;
- Integrated payment or invoicing;
- Organizational integration. Collaboration between different transport providers (car- and bikesharing, taxi, bus, train, etc.) is a prerequisite for integrated mobility, but how that collaboration occurs will differ between MaaS services.
- Bundling, which entails e.g. a subscription to trips with different modes. This type of integration has so far been the exception rather than the norm, but this may change in the future. Analyses of the success factors of the UbiGo pilot in terms of both customer satisfaction and behavioural change showed the importance of developing the service and its offer to the customers (Sochor et al., 2016)

If we do not know what MaaS is, how can we know what a MaaS-based transport system can or will deliver in terms of sustainable outcomes? One way to deal with this uncertainty is to develop a characterization of MaaS that embraces the fluidity of the concept (Sochor, Arby, Karlsson, & Sarasini, 2017).

In 2015 MaaS Alliance was instituted after the launch of the concept of MaaS in Helsinki in 2014 to develop a common line about Mobility as a Service.
According to MaaS Alliance, Mobility as a Service means enabling users to purchase mobility services which are designed in accordance with user's needs. Therefore, MaaS users do not have to buy separate tickets from different platform

for each mode of transport they use; instead, MaaS ecosystem should deliver a unique user-centric interface (MaaS Alliance, 2017).

However, since the world of transport is largely regulated according to the mode of transport, based on historic and conventional conception and assumption, the development of a MaaS is not always an easy process. Indeed, beyond the technical agreement between modes of transport, the standardisation of the information and the data, whose access has to be open, represents a fundamental requirement to develop a MaaS. Therefore, the users who want to plan their trips and purchase tickets, should be able to do it through a Smartphone which has to provide accurate real-time multimodal information, in accordance with user's preferences.
In this sense, the development of a Mobility as a Service requires a "cultural" infrastructure: indeed, users should shift their mindset replacing their cars with their smartphone which should be able to propose them all the available alternatives, in accordance with their preference, to go from an origin to a certain destination.
For example, if a user is available to give a ride with his/her car, then the device should show all the users who are looking for a ride.
A second important requirement to develop a Mobility as a Service, is the integrations of fares and ticketing systems. To this extent, users should be able to purchase mobility packages or their mobility solution through a unique platform and so the ticket has to be valid on different modes of transport.

According to MaaS Alliance (2017), a Mobility as a Service can be successful only under the following conditions:

- The MaaS operators and service providers, must operate in an *open market* and with *fair conditions* which, therefore, do not exclude alternative modes of transport. To this extent, the above-mentioned actors need to have an open access to APIs thus to provide and integrate their information according to defined standard;
- In order to provide multimodal real-time information, there must be a connection among the information of different modes of transport so that, for example, users can decide to shift to an alternative mode of transport in case the one they chose is not available or in late.

To this extent, all citizens should have the right to consult a Mobility as a Service platform to know which modes of transport are available and purchase a ticket or a transport service. Besides, a MaaS should be able to provide also cross border solutions. The public administrations which want to support MaaS should, therefore, avoid closed systems and monopolies: all the transport operators need to have the right to access to the Mobility as a Service. In detail, policy makers should ease the collaboration between public transport operators and private industry to develop innovative business models. Regarding regulations, Finland was the first country which promoted a new policy for Mobility as a Service and made a step

forward through the so-called Transport Code which was adopted in April 2017. The above-mentioned Act aims at promote open and secure IT architectures to support the various members of Mobility as a Service to cooperate with each other, exchanging the data.

The MaaS alliance describe Mobility as a Service as an *access promise*, meaning that users should not only be able to choose the fastest solution to go from an origin to a certain destination, but also, they could choose the safest, healthiest, the most environmentally friendly, according to their needs and preferences. Therefore, it is important to analyse and understand user's expectations towards MaaS before develop it. However, in order to develop a MaaS which provides users the freedom to choose in accordance with their preferences, the fare integration and payment interface have to be well designed.

The modes integration has to consider the area where the Mobility as a Service has to be developed. To this extent, depending if the MaaS will be developed in a Suburban or Rural Area rather than Urban area, different business models are proposed. In particular, in case of MaaS in suburban area, the main objective is to avoid users to purchase and have a second car and to improve the accessibility of the last mile of their trips. In this case, the business model has to aim at improving the existing transport service, extending it with car-sharing and bike-sharing.

On the other hand, in rural areas, the main objective of a MaaS business model should be focused on maintaining a discrete level of service and improving users' accessibility to mobility. This objective can be reached by alternative modes of transport such as DRT (Demand-Responsive Transport), car-pooling but also by taxis and long-haul transport (Costantini, 2017).

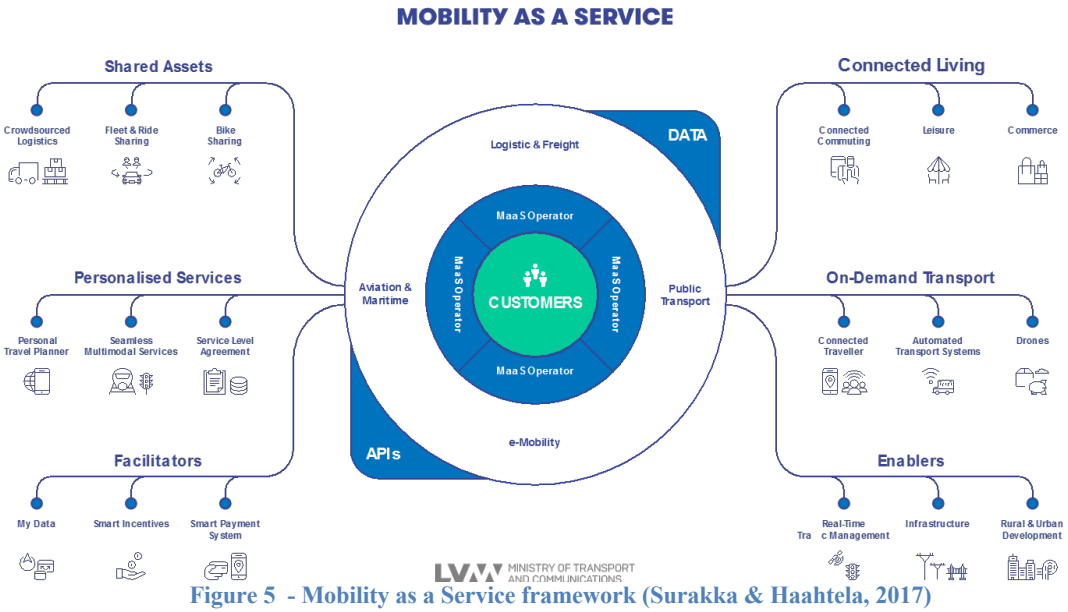

Figure 5 - Mobility as a Service framework (Surakka & Haahtela, 2017)

A Mobility as a Service scheme should include therefore the process of registration, journey planning, booking, payment and, obviously, journey.
The Journey Planning stage should provide a list of services, combining optimal use of the modes of transport according to specific criteria (i.e. price, sustainability, time, etc.).
At the booking stage, the user of the Mobility as a Service platform chooses the services that he/she wants to purchase. At the same time, the MaaS provider delivers the travel documents to the user and it informs the transport providers so they can provide the enough capacity.
Then, the users purchase the ticket, choosing among different payment schemes. In particular the transport operator should be able to provide prices in accordance with the available capacity in order to encourage users to book their ticket in advance, thus to use more public transport.
Therefore, MaaS users can access to the mobility services both using Pay-As-You-Go or purchasing personalised mobility packages in accordance with the modes of transport that are available and that they want to use.
Finally, the MaaS user should travel smoothly and seamlessly with real-time multimodal information.

After the first pilot project in Finland, MaaS has expanded in many other countries. Nevertheless, even if technology play a key role for the development of a Mobility as a Service system, governance and policies must define the rules and the business model for it.
Indeed, the success of the Helsinki model was mainly due to well-functioning institutions and the support from the national government (Sipe & Pojani, 2018).
Chick (2017) claims that a wrong MaaS business model can potentially ruin the entire transport ecosystem if the responsibilities of the different actors (MaaS provider, transport providers and transport authority) are not clearly defined. Therefore, the correct relationship between MaaS providers has to be investigated, as well as the organizational structure, legal agreements, the service design and the revenue models (Kamargianni et al., 2016).
Regarding the revenue models, it is not clear who will pay for MaaS provider's costs: will users of Mobility as a Service have to pay a subscription fee or will transport operators give up to a part of their revenues?
Therefore, financial challenges might arise for the implementation of a Mobility as a Service. Indeed, since in many countries the transport service is subsidised, if MaaS provider wanted to make profits by selling transport operator's tickets, then the transport operators would need to receive more subsidies from the government to fill the gap generated by the less tickets purchased by users (Li & Voege, 2017). To this extent, local authorities and governments are in charge to define the correct business model.
Hensher (2017) claims that most of the existing business models are not suitable for the development of a Mobility as a Service. Indeed, if MaaS aims to shift the mobility paradigm towards a model where transport operators can also provide bookable trips, then transport operators have to find strategies to incentivise travellers to use their services. To this extent, this would imply the existence of an

agency (MaaS provider) which should aim at matching the demand and supply in a hybrid context where the existing transport services live with *point-to-point services*.

Osterwalder and Pigneur (2009) claim that a business model describes "how an organization, creates, delivers, and captures value".
Mobility as a Service can play the role of the reseller or the integrator, according to a specific business model. In particular, in case of the *reseller model*, an interface is generally used to provide the services provided by different Transport Service Providers. On the other hand, the *integrator model*, combines traditional services with extra features, such as mobile ticketing and payment, provided by a Mobile Service Provider (MSP) (Aapaoja & Eckhardt, 2017).
In particular, Mobility as a Service provider might be referred as a Public-Private-Partnership (PPP) in case it integrates other Logistics Service Providers, such as car-pooling, bike-sharing, Demand Responsive Transport (DRT).

Public-Private-Partnerships can be particularly suitable for those areas (i.e. rural areas, suburbs) where the transport supply is low and the travel distances long.Therefore governance and public authorities are in charge to improve the travel experience for those commuters who do not live in urban areas and so, who do not have a wide range of choice of transport supply.

Chapter 3

Objective and Methodology

Chapter 2 highlighted the key role of Mobility as a Service as a system which can improve the quality of users' daily mobility, possibly by reducing the dependence of car.
Therefore, Mobility as a Service can improve decision process of users through the inclusion of alternative modes of transport in those areas where the supply of public transport is particularly weak. Besides multimodal real-time information, integrated fares enable users to choose their modes of transport and purchase tickets according to their own needs (i.e. cost; flexibility; speed; etc.).
Several projects and researches have been carried out to design new forms of Mobility as a Service. These pilot projects, which focused on urban areas, mainly aimed at integrating alternative modes of transport in one single platform.
Although Mobility as a Service represents an innovative solution which can help to reduce car's usage and improve user's journey experience, there is no guarantee that it can be a suitable solution for any environment.
To this extent, as observed in Chapter 2, it is important to understand which are the main regulatory conditions for the development of a MaaS.
Besides, even if the regulatory conditions support the development of a MaaS provider, the success of this new mobility paradigm lies on people's travel behaviours, attitudes and preferences.
Indeed, even if a transport system provides packages which can include alternative modes, such as carpooling or car-sharing, there is no guarantee that users would use it.
This thesis will focus on the area of Torino and its province, where the Public Road Transport service is assigned to the Public-Private-Partnership consortium *Extra.To*. Apart from the consortium, other modes of transport, such as train, car-sharing and bike-sharing, are present in this context. The latest transport demand survey (IMQ - *Indagine sulla Mobilità delle persone e sulla Qualità dei trasporti*) of the study area of this research, date back to 2013 where the mobility context was substantially different from how it is now. Indeed, the IMQ survey did not include the new modes of transport which have arisen in the latest years, neither consider some important social variables and mobility preferences which can affect people's willingness to use a Mobility as a Service.

To this extent, the main objective of this research is to understand how the people living in this study area currently travel and if the new mobility paradigm (MaaS) can effectively be a solution to improve their mobility. The province of Torino is a

very heterogeneous area in terms of environment and socio-economical features; therefore, also mobility habits vary across the study area.
The public transport services of the main hubs, such as Torino and Pinerolo, differ considerably from the ones in other cities in the rural areas.

In particular, this thesis aims to assess if Mobility as a Service can represent a solution for those areas where the supply of Public Transport service is not sufficient and does not satisfy the transport demand.

A survey has been designed to better understand people's mobility patterns and their opinion regarding their most important trips. Information about their attitudes toward Mobility as a Service was used to carry out a cluster analysis.

In particular, each cluster described the user's characteristics and which are their favourite *mobility packages*.
Subsequently, selected and representative respondents, belonging to different clusters, taken part to Focus Groups to sharpen and improve the concept of Mobility as a Service and the features of the mobility packages.
The outcomes from the Focus Groups have been be eventually shared with the Local Authorities and policy makers in order to assess the feasibility of the proposed solutions.
Therefore, this dissertation can be considered innovative due to its participatory approach which involves both users and policy makers, in order to develop a Mobility as a Service.
As shown in Figure 6, the methodology of this thesis involves the following steps:

1. definition of the study area and socio-economic analysis;
2. analysis and visualisation of transport supply;
3. analysis and visualisation of transport demand;
4. definition of Weak Demand Areas;
5. design of the survey;
6. dissemination of the survey;
7. data analysis design;
8. design of the users' Focus Groups;
9. definition of Mobility as a Service and mobility packages;
10. focus Groups with Local Authorities and Policy makers;

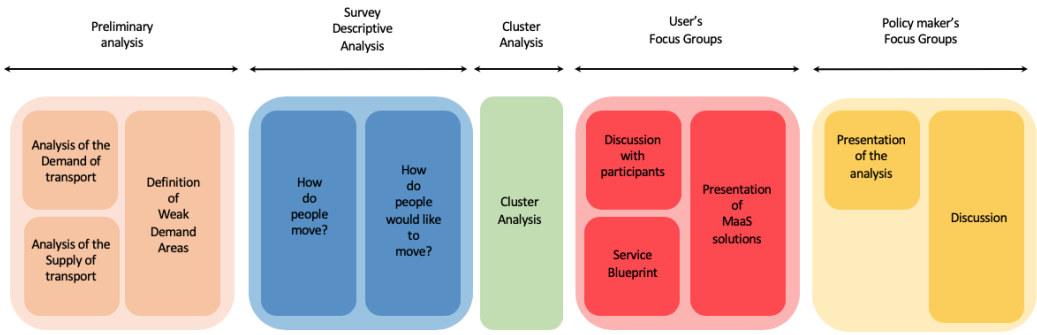

Figure 6 - Steps of the research

3.1 Definition of the study area and socioeconomic analysis

As described in Chapter 2, the success of Mobility as a Service, strongly depends on user's travel behaviour and their willingness to use this new mobility system. Therefore, in order to assess what people living in the province of Torino expect from Mobility as a Service, a study area was defined.

The study area generally includes the population living in zones where the main transport lines are considered by them as a useful option to satisfy their mobility demand. Nevertheless, without comprehensive information related to the usefulness of the transport lines which insist in the area, it was necessary to consider the accessibility to the main transport lines in spatial terms (*reachability*), temporal terms and territorial coverage.

To this extent, the accessibility was defined through the smartcard validation data, by calculating the average distance between the residence of users and the bus stops where they validate their smartcards. In particular, a study carried out by Pronello et al. (2018), which focuses on the same study area, highlights which are the bus lines with the highest demand in terms of smartcard (Figure 7). Therefore, the average distance was calculated for all the bus stops, which belong to the lines which directly link Torino to Pinerolo, the two main hubs that showed a high transport demand.

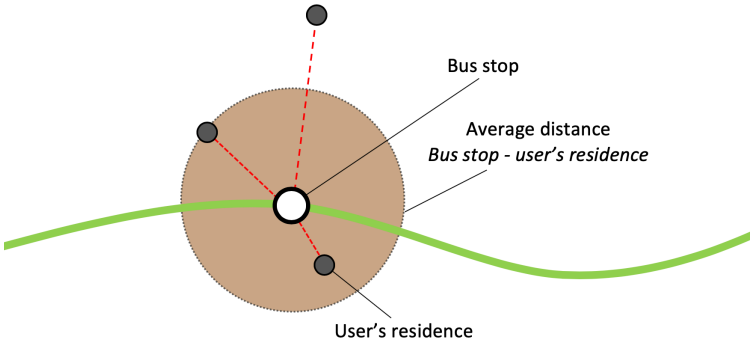

Figure 7 - Definition of the study area

The average distance between stops and users' residences was calculated considering two sample weeks both in 2016 and 2017. Therefore, the average distances were compared thus to obtain a unique value for each bus stop (Figure 8). The results were used to create a buffer for each bus stops and all the municipalities included in this buffer were considered part of the study area.

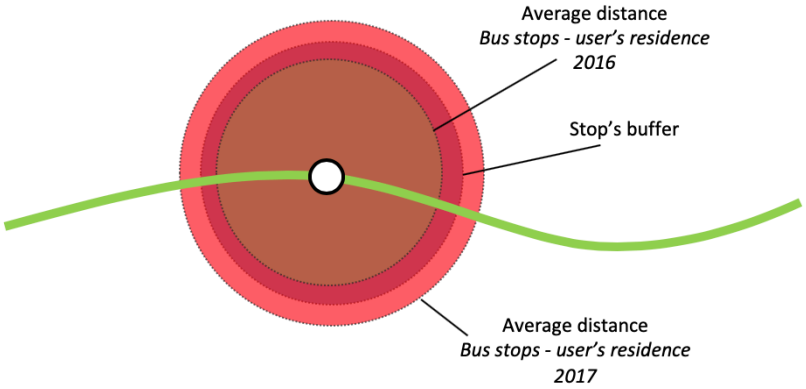

Figure 8 - Buffer of bus stop

In order to understand the main mobility needs, it is necessary to compare the transport demand with the territorial framework; in this way it will be eventually possible to redesign bus lines especially in those municipalities where transport supply cannot completely satisfy users' needs.
In this step of the methodology, the main aspects of the territory are analysed: population, demography, percentage of elderly people, percentage of students, workforce deficit. The aforementioned information provides a general indicator for each municipality expressing the capacity of attracting and generating trips. ISTAT (Istituto Nazionale di Statistica) was the main source of data; however, the cut-off date for the data provided by ISTAT is 2011.

Such data are aggregated at municipality level, nevertheless this level of detail was considered sufficient for the objectives of the research.

About population, ISTAT provides the number of people living in a specific municipality. Therefore, the total amount of people, grouped by age intervals (5 years) and gender, was calculated to depict the age-pyramid.

The surface (km^2) of each municipality allowed to describe the density of population. To this extent, QGIS was used to represent the density of the study area, by using the *natural breaks optimization* method. Natural break optimization is a cluster method that is used to find out the best arrangement of values into different classes; it reduces the variances within the classes and maximise the variance between the different classes.

On the other hand, the analysis related to the workforce deficit was done by comparing the number of people who are in the working age with the number of people who are not currently working. Two classes were considered: "Workforce" and "Not workforce". All the citizens older than 18 employed and unemployed belong to the first group.
As done for the population density, classes were also defined by using the *natural breaks optimization* method in order to visualise the density of student, employed and workforce.

In particular, an analysis regarding the capacity of each municipality to attract trips was carried out by comparing the number of citizens who travel out of the municipality where they live and the local deficit (difference between the number of employed and the number of people belonging to the workforce group).

By knowing the number of people living in each family, it was possible to describe the distribution of household sizes.

3.2 Analysis and visualisation of transport supply

To describe the supply of transport in the study area, the operating schedules of both bus and train were collected. Figure 9 and Figure 10 provide an example of the operating schedule of bus and train.

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RIVA di Pinerolo	5.02	5.26	5:36	6.26	6.36	6.36	6.46	6.56	6.56	7.16	7.16			7.26	7.26	7.36		7.56				8:06	8.26
Bivio BOTTEGHE	5.07		5:41		6.41	6.41	6.51		7.01	7.21				7.31				8.01					
AIRASCA	5.10	D	5:44	D	6.44	6.44	6.54	D	7.04	7.24	D	D	D	7.34	D	D	D	8.04				D	D
Bivio NONE	5.15	I	5:49	I	6.49	6.49	6.59	I	7.09	7.29	I	I	I	7.39	I	I	I	8.09				I	I
CANDIOLO IRCCS-Centro Ricerche		R	5:54	R	6.54	6.54	7.04	R	7.14	7.34	R	R	R	7.44	R	R	R	8.14				R	R
STUPINIGI - Palazzina di Caccia	5.25		6:04		7.04	7.04	7.14		7.24	7.44				7.54				8.24					
TORINO - p.zza Carducci							7.34							8.14									
TO-c.so V.Eman. II-Porta Nuova	5.46	6.14	6:32	7.14	7.32	7.32	7.42	7.45	7.52	8.12	8.04	7.43	8.03	8.22	8.14	8.24	8.23	8.52				8:54	9.14
TO - Autostazione c.so Bolzano	**5.51**	**6.19**	**6:37**	**7.19**	**7.37**	**7.37**	**7.47**	**7.50**	**7.57**	**8.17**	**8.09**	**7.48**	**8.08**	**8.27**	**8.19**	**8.29**	**8.28**	**8.57**				**8:59**	**9.19**

Figure 9 - Bus operating schedule [Line 275]

sfm servizio ferroviario metropolitano — REGIONE PIEMONTE — AMP AGENZIA MOBILITÀ PIEMONTESE

sfm2 Pinerolo-Chivasso - Orario in vigore dal 13 Dicembre 2015

4232	PINEROLO	16:17	CHIVASSO	17:31	468	FER6
4234	PINEROLO	17:17	CHIVASSO	18:31	468	FEST
4236	PINEROLO	17:46	CHIVASSO	19:04	468	FER6
4240	PINEROLO	18:46	CHIVASSO	20:04	468	FER6
4242	PINEROLO	19:17	CHIVASSO	20:31	468	FER6
4246	PINEROLO	21:17	CHIVASSO	22:31	468	FEST
4249	TORINO LINGOTTO	22:31	CHIVASSO	23:04	468	FER6
4250	CHIVASSO	5:12	PINEROLO	6:41	468	FER6
4258	CHIVASSO	7:27	PINEROLO	8:41	468	G
4260	CHIVASSO	7:52	PINEROLO	9:10	468	FER6
4262	CHIVASSO	8:27	PINEROLO	9:41	468	FER6
4264	CHIVASSO	9:27	PINEROLO	10:41	468	FEST
4268	CHIVASSO	11:27	PINEROLO	12:41	468	G
4272	CHIVASSO	12:52	PINEROLO	14:10	468	FER6
4274	CHIVASSO	13:27	PINEROLO	14:41	468	FEST
4280	CHIVASSO	15:27	PINEROLO	16:41	468	G
4284	CHIVASSO	16:52	PINEROLO	18:10	468	FER6
4286	CHIVASSO	17:27	PINEROLO	18:41	468	FER6
4290	CHIVASSO	18:27	PINEROLO	19:41	468	FER6
4292	CHIVASSO	19:27	PINEROLO	20:41	468	G
4296	CHIVASSO	21:27	TORINO LINGOTTO	22:00	468	FER6

Figure 10 - Train operating schedule [SFM2]

Although the bus operating schedules include information about the arrival and departure times for each stop of all the bus lines, they do not provide information about the number of available seats. In particular, bus lines are operated by different bus typologies according to the day of the week and time of day.
To this extent, the bus rides have been monitored for two weeks in order to calculate the average number of available seats for each line.
Besides, each bus ride is characterised by a frequency which refers to the number of rides in a calendar year (i.e. "*GIOR*" frequency indicates that a specific ride is performed 364 days in a year).
Therefore, the average number of seats available (a.s.a.) was defined as the product between the number of available seats offered for each line and the ratio between the days associated to a ride frequency and the days in a calendar year (365) [Eq. 1].

$$a.s.a. = line\ seats \cdot \frac{Freq.}{365} \qquad \text{Eq. 1}$$

On the other hand, the train operating schedules already included the information about the typology of the train used for each specific ride, therefore it was possible to calculate the number of available seats for each time range (Agenzia della Mobilità Piemontese, 2016).

Therefore, the data were aggregated at municipality level and the average seats available between two municipalities for each time interval was calculated.
Table 1, which shows the average available seats, was uploaded on QGIS to visualise the transport supply between municipalities.

ID Origin	ID Destination	a.s.a. Time Range 1	a.s.a. Time Range 2	a.s.a. Time Range 3	a.s.a. Time Range 4	a.s.a. Time Range 5	a.s.a. Time Range 6	a.s.a. Time Range 7
1002	1024	0	23	0	0	0	25	0
1002	1025	0	30	0	0	0	0	0
1002	1164	0	0	32	32	0	0	32
1002	1168	157	480	226	281	63	213	271

Table 1 - Average Seats Available per time intervals

In particular, the QGIS Plugin AequilibraE (Camargo, 2019) was used to visualise the desire lines.
This tool is able to represent the desire lines by simply inputting the coordinates of the origin and destination and a specific value that can be used to categorize the line.
The visualisation of the transport supply (number of available seats between two municipalities) was differentiated by time ranges and by weekdays and weekend.

3.3 Analysis and visualisation transport demand

The demand of transport refers to the quantity and typology of trips, carried out by users, from an origin zone to a destination zone. In particular, it is important to consider that transport demand varies according to users' categories and their purposes.
To this extent, the analysis of transport demand should provide, for each typology of user, purpose and time interval the following information:

- number of trips;
- origin and destination of the trips;
- time (information about the start and end of the trip);
- mode of transport used;
- route or line (in case of Public Transport service).

Unfortunately, the latest regional travel survey IMQ 2013 (*Indagine sulla Mobilità delle persone e sulla Qualità dei trasporti),* besides having not been updated for six years, it does not even provide a detailed information for the above-mentioned items.
Indeed, IMQ 2013 provides information about transport demand on an area of 1181 municipalities which have been aggregated to create 208 zones. In particular, the main municipalities like Torino, have been divided in sub-areas. To this extent, Torino is divided in 23 zones; the hinterland was divided in 31 zones, coinciding with the number of the municipalities. The rest of the province, which counts 284 municipalities, was divided in 40 zones.
Therefore, even though the level of detail of this survey is not high (see Table 2), an analysis of the transport demand was carried out.

Table 2 - Example IMQ data

ID respondent	Gender	Age range	Residence ID	Trip purpose	Origin ID	Destination ID	ISTAT Origin ID	ISTAT Destination ID	OD Municipalities	Departure	Arrival	Time range	Mode of transport	Sampling rate
8365559	1	3	C003	11	E030	C003	1045	1090	1045_to_1090	06:00:00	06:30:00	Time Range_1	1	3,09
7551821	2	2	R701	11	R701	R701	6054	6054	6054_to_6054	05:00:00	05:15:00	Time Range_1	4	1,03
7598499	1	2	R300	11	R306	R300	3016	3106	3016_to_3106	08:00:00	08:30:00	Time Range_2	3	1,08
8462293	1	2	E046	11	E046	E046	1081	1081	1081_to_1081	08:00:15	09:30:00	Time Range_2	1	1,06
7264442	1	2	T000	11	Q019	Q019	1272	1272	1272_to_1272	12:00:00	12:15:00	Time Range_3	2	0,99

In order to visualise the transport demand, the municipalities have been aggregated according to their IMQ zone ID.
Therefore, an Origin Destination matrix has been created according to the number of trips within and between the different zones of the study area.

The visualisation of the demand of transport has been carried out by using the QGIS Plugin AequilibraE.
As done for the visualisation of the supply of transport, the visualisation of the demand of transport was differentiated by time intervals and by weekdays and weekend.
However, trips made by bus, tram and underground have been aggregated and considered made by *Public transport*.

3.4 Definition and visualisation of Weak Demand Areas

Besides the areas where there is a gap between the demand and the supply of transport, to understand where else it would be possible to develop a MaaS, weak demand areas were identified. In particular, those areas could adopt, for example, solutions such as Flexible Transport Services, Demand-Responsive Transport or car-pooling.

Weak demand areas are considered those municipalities that, due to their supply and demand characteristics, do not facilitate the development of traditional Public Transport services.

The weak demand areas were defined by using different criteria, following the definition given by the Italian national Transport Regulation Authority (ART, 2017).

To this extent, a *weak* demand can be related to different circumstances, which can be potentially linked to each other:

- orography: altitude
- population distribution and density;
- societal and demographical structure of the population: minors, elderly, disabled people
- economic conditions: employment rates;
- urbanisation and accessibility.

ISTAT provides the information related to the above-mentioned items, for each municipality (Table 3).

Table 3 - Example ISTAT data

ISTAT ID Municipality	Name municipality	Surface (Km^2)	Inhabitants (2011)	Density (inhabitants/Km^2)	Altitudes (m)	Level of urbanization (1-3)	unemployment rate (%)	taxable income/resident (€)
1001	Agliè	13,15	2.644	201,12	315	2	5,81	12566
1002	Airasca	15,74	3.819	242,64	257	3	5,94	10297
1003	Ala di Stura	46,33	462	9,97	1.080	3	3,86	9044
1004	Albiano d'Ivrea	11,73	1.791	152,66	230	3	3,96	10922

In particular, the level of urbanization is classified in three classes: 1 refers to municipalities highly urbanized, 2 to an intermediate level of urbanization, while 3 refers to municipalities in rural areas.
Besides the information provided by ISTAT, other information was added to estimate an index to describe the weak demand areas. In particular, the number of buses and trains departing and arriving in each municipality were counted and normalized.
Therefore, specific weights were assigned, in order to obtain a unique index to describe the level of weak demand for each municipality.

3.5 Data Visualisation

To better understand the mobility pattern of the respondents, the data have been plotted by using QGIS.
In particular, by knowing the coordinates of all the Origin, Interchange and Destination points, the mobility patterns were represented. Indeed, as done for the analysis of the supply and demand of transport, the QGIS plugin AequilibraE was used to visualize the desire lines.

Once all the Origin-Destination were represented, they have been joined with the variables associated to the respondent. To this extent, it has been possible to filter the mobility patterns by mode of transport or to map the respondent with a higher willingness to use a Mobility as a Service platform.
The visualisation of the answers helped to better understand the user's preferences according to the territory where they travel.
On the other hand, all the interchange points were selected and, knowing the mode of transport used by the respondent, it has been possible to assess how many respondents interchange within the buffer of a train station or a bus stop.
Therefore, a classification of the interchange point was carried out.
Besides, this analysis also allowed to detect incorrect answers: indeed, all the interchange points which were outside of the buffer area of a specific train/metro station, bus stop or bike-sharing stall, were considered outliers.

3.6 Design of the survey

As explained in Section 3.3, the information about the demand of transport and user's preferences are not accurate and updated; therefore, to better identify users' mobility patterns, a survey was designed. The survey was composed by seven main sections where respondents had to answers to closed questions; which, most of them were one-choice questions. Special attention has also been given to Likert scale questions; indeed, the literature claims that a scale with many points might produce a cognitive overload and lead respondents to ignore the difference between adjacent categories (Groves, et al., 2009). On the other hand, a scale with few points might generate a loss of information, making difficult to distinguish respondents with different underlying judgments.
Moreover, symmetric Likert scale may induce respondents to choose the middle value in case they do not have a clear opinion about the answer.
For these reasons, we chose to use a 6-points Likert scale because it avoid neutral answers and it also represents the best compromise in terms of overload for the respondents. Indeed, according to Chomeya (2010), Likert scale 6 point has higher trend of discrimination and reliability than 5 points one.
Besides, the same scale was used throughout all questionnaire to avoid reporting errors (Wholey et al., 2004)

As explained before, the survey was designed to understand users' attitudes and behaviour toward the mobility. This type of information is extremely important for the design of a Mobility as a Service; therefore, the design of this survey represents a crucial step for the goal of this research.
The survey aims to responds to the following points:

1) **Understand respondents' mobility patterns**
   - How respondents travel (the modes of transport that they use; the main Origin-Destination trip; frequency and purpose of trip).
   - Why respondents choose a particular mode of transport.

2) **Understand what respondents thinks about current transport supply**
   - Assess how the current transport supply can be improved with traditional and alternative modes of transport.

3) **Assess differences among users' behaviour**
   - Assess if there are particular reasons which influence respondents to use some particular modes of transport.
   - Define the users' attitudes related to the mode of transport they use.

4) **Understand users' preferences about Mobility as a Service**
   - Understand which modes of transport respondents want to integrate in the "Service"
   - Understand if respondents want to integrate other services in MaaS.
   - Understand how they want to purchase the ticket/subscription.

The survey, available at www.my-moby.com, contains several logical kips according to respondents' preferences and answers, therefore the length and the number of questions included in the seven parts of the survey can vary.

Section 1 - Mobility in a Standard week (4 questions)

The first section of the survey is related to the users' "standard" week and aims at understanding which are the main purposes and relative frequencies for users' trips and which mode of transport travellers use. At the end of the first section of the survey, respondents have to choose which is their most important trip.

Section 2 - Diary of most important trips (14 questions)

The second section of the survey focuses on the most important trip. In this section respondents have to specify if they used other modes of transport for their most important trip. Subsequently they have to specify their origin and destination (if they have a specific one) through a map, indicate the departure and arrival times and when they started to perform this trip.
In particular, users have to specify how many minutes they would like to save to perform their trip. In this section, users also have to assess the quality of the mode of transport they use (in terms of speed, reliability, comfort, etc.).

Section 3 - Integrated mobility (11 questions)

The third section of the survey is related to the inter-modality: in this section, users have to declare how much they spend for their trip and how much they would be willing to spend for being able to save the number of minutes that they declared in the previous section and also for being less pollutant.
Some questions (Likert-scale questions) of this section aims to understand why respondents use that particular mode of transport for that purpose; which are the main activities that they can perform during the trip and what they would do if they could perform their trip with a 100% autonomous vehicle. To this extent, a brief explanation of what an autonomous vehicle is, was provided in the web-questionnaire.
Other Likert-scale questions of this section aim at assess what could drive travellers to use different modes of transport according to what they currently use.

Section 4 - Mobility as a Service (8 questions)

The fourth section of the survey focuses on Mobility as a Service. Respondents have to declare if they have ever used car-sharing and if it is available in all the municipality where they travel; if they are willing to buy a car through a purchasing group; if they ever travel by car-pooling (both driver and passenger). About car-pooling, users have to specify if they would use more car-pooling in case they could have advantages and/or discounts for the other modes of transport. Therefore, we asked respondents to declare if they are interested in using Mobility Packages and Pay as You Go and, if yes, to specify which modes of transport they want to include and how much they want to spend. About MaaS, respondents have to choose which support they want to use to manage their subscription (i.e. paper ticket, smartcard, smartphone). As shown in Table 7 (Chapter 3.8), several questions from this section have been used to carry out the Cluster Analysis.

Section 5 - Attitudes and Preferences (3 questions)

The fifth section of the survey includes questions related to the attitudes toward the mobility aimed to understand the level of sustainability of the respondents.
Indeed, this section is composed by a group of question which focuses on the attitudes of users related to cars and driving and a second one which focuses on the General Ecological Behaviour (GEB) (Gaborieau, 2016; Duboz, 2017).

Section 6 - Availability towards research (3 questions)

The sixth section of the survey includes few questions aimed to understand if respondents are willing to answer to a second questionnaire and to take part to the Focus Groups. In this section we also asked if respondents want to know the results of the survey.

Section 7 - Personal Data (10 questions)

The last part of the survey is about personal information; therefore, in this section we asked respondents to specify their gender, age, level of education (qualification), their job, their household income, how many cars they have and if they have any public transport subscription.

3.7 Administration of the survey

The design of the web-survey, developed with LimeSurvey, was concluded in November 2017 and from December it was disseminated through several channels. A flyer was designed and spread on board of most of the buses of Extra.To consortium (Figure 11). This flyer contained a short description of the project and a QR code to access to the web survey. The public transport operators of Extra.To also shared the link of the questionnaire on their social network pages (mainly Facebook and Twitter) and on their websites.

Figure 11 - Flyer of questionnaire

At the same time an ad hoc website (www.my-moby.com) was created: it also includes a short description of the research project, of our research group and a section which will contain the results of the questionnaire.
Emails were sent to all the students and personnel of both Politecnico di Torino and University of Torino (Università degli Studi di Torino).
During the following weeks, this survey was presented to the Regional Transport Authority (AMP – Agenzia della Mobilità Piemontese), to the Regional Authority and to the municipalities of the catchment area. To this extent, the research project was also presented during several meetings in high schools and thematic meetings of sustainability (Legambiente). The dissemination of the survey lasted six months: the survey was launched the 27th of October 2017 and was closed the 24th of April 2018 (Figure 12) and 4,417 answers were collected.

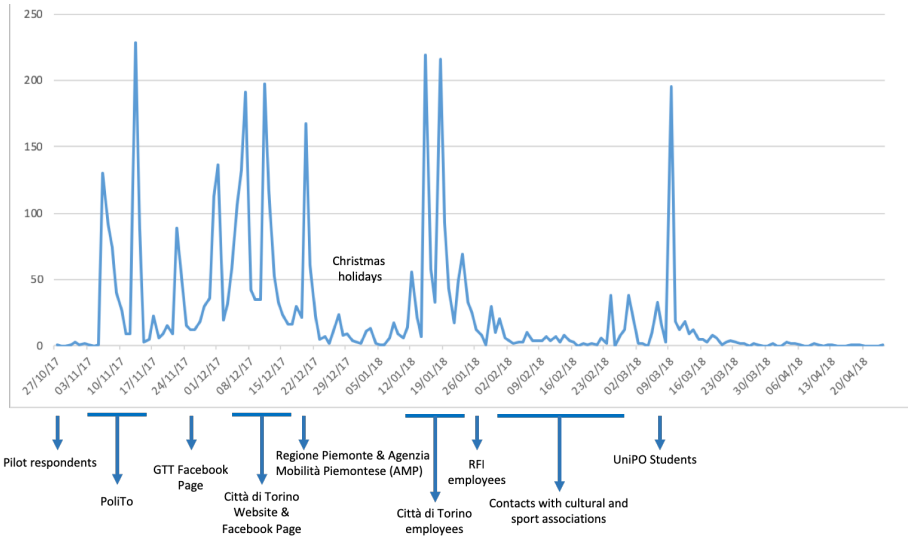


Figure 12 - Survey Campaign

3.8 Data Analysis Design

The statistical analysis described in this research is mainly composed by two stages. The first one focuses on each variable, while the second one analyses the relations among the variables.

Different techniques were used in this research in order to analyse the variables. To represent the categorial variables, pie and bars charts and frequency tables were used.

This first stage of the analysis arose some questions that required more investigation, by using different statistical techniques according to the type of variable.
Besides, to assess the existence of groups of respondents with similar characteristics, cluster analysis was carried out. To perform the analysis Microsoft Excel and SPSS softwares were used.
In addition, new variables were created: for example, the origin and destination municipalities were identified by using the coordinates. Therefore, the municipalities of the study area were classified in four categories as followed:

- Urban municipalities (Torino)
- Suburban municipalites
- Rural municipalites
- Rural or Suburban municipalites with high supply of transport

To this extent, each respondent was classified according to the combination of its Origin-Destination municipalities (Table 4).

	Urb	Sub	Rur	Urb*
Urb	Urb-Urb	Urb-Sub	Urb-Rur	Urb-Urb*
Sub	Sub-Urb	Sub-Sub	Sub-Rur	Sub-Urb*
Rur	Rur-Urb	Rur-Sub	Rur-Rur	Rur-Urb*
Urb*	Urb*-Urb	Urb*-Sub	Urb*-Rur	Urb*-Urb*

Table 4 - Classification of respondents based on their most important trip (OD)

Other variables were created to aggregate the different transport modes into two major groups: the sustainable and the pollutant modes (Table 5 and Table 6).

Table 5 - Classification of respondents based on the mode of transport used for their most important trip

Sustainable modes	Pollutant modes
Public Transport	Car
Bicycle	Motorcycle
Walking	
PT+soft modes	
PT+car	

Table 6 - Classification of respondents based on their Origin Destination (most important trip)

Internal Urban Torino	Rest of the Study Area
URB TO - URB TO	SUB - URB TO
	RUR - URB TO
	RUR - SUB
	SUB - SUB
	RUR - RUR
	URB** - URB**

The above classification allows to create a binomial variable allowing comparisons between groups.

As already mentioned throughout the questionnaire, a 6-points Likert-scale was used. Consequently, the following assumptions were made: results lower than 4 correspond to the “disagree part” of the scale, while results bigger than 3 are considered on the “agree part” of the scale.
Figure 13 graphically reports the above assumptions

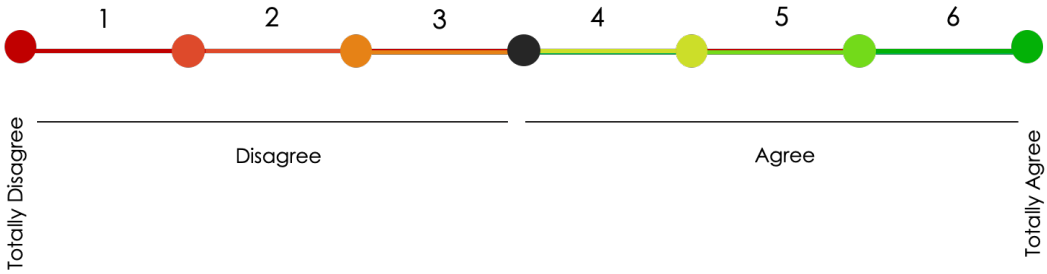


Figure 13 – 6-point Likert scale results

A cluster analysis was carried out to identify homogeneous groups of respondents within the sample, with similar characteristics. Indeed, cluster analysis is an exploratory analysis that tries to identify structures within the data (Anderberg, 2014)

Therefore, because it is exploratory, it does not make any distinction between dependent and independent variables. Moreover, this kind of analysis is broadly used in marketing research to group data which have similarities in order to create more distinct clusters (Tuma et al., 2009).

To reach this aim, the selection of variables needs to be strongly related to objectives of Cluster Analysis.

Moreover, this analysis is extremely sensible to outliers, therefore the inclusion of one of these values can compromise the performance of the analysis (Milligan, 1980).

Fort this reason, the outlier values were excluded from this analysis.

In particular, frequency distributions have been calculated for variables related to distance and times. Thus, those values which presented unrealistic speed (distance/time) for the selected mode of transport were delated.

To perform a cluster analysis, only the respondents who travel in the study area and who declared to be interested in using the Pay as You Go for at least one mode of transport, as well as those who declared to be interested in using the Mobility Packages (Likert scale ≥ 4), were selected (2305 respondents).

Since this thesis aims to assess the respondent's opinions about MaaS and understand why they could shift to a more integrated mobility, variables related to MaaS and respondent's opinions about the current mode of transport used for their most important trip, were included in this analysis. To this extent a correlation matrix was performed in order to assess the level of correlation among variables (**Errore. L'origine riferimento non è stata trovata.**). Therefore, Table 7 shows the variables included in the Cluster Analysis.

		Pay as You Go							Most important trip								
		PT Urban	Regional Buses	Regional Trains	Taxi	Bike Sharing	Car Pooling	Car Sharing	Cheap	Ecological	Fast	Secure	Flexible	On time	Comfortable	Pick up someone	Pleasant
Pay as You Go	PT Urban	1,000	0,294	0,228	0,117	0,232	0,180	0,155	-0,036	-0,033	0,063	0,024	0,093	0,046	0,074	0,018	0,048
	Regional Buses	0,294	1,000	0,606	0,418	0,347	0,409	0,344	-0,062	-0,074	0,024	0,048	0,022	0,006	0,031	0,046	-0,007
	Regional Trains	0,228	0,606	1,000	0,406	0,344	0,394	0,353	-0,021	-0,009	0,029	0,005	0,036	0,008	-0,011	-0,001	0,028
	Taxi	0,117	0,418	0,406	1,000	0,389	0,488	0,470	-0,008	-0,056	0,003	0,003	0,014	-0,009	0,009	0,054	-0,001
	Bike Sharing	0,232	0,347	0,344	0,389	1,000	0,566	0,601	0,063	0,013	0,076	0,028	0,095	0,080	0,065	0,009	0,068
	Car Pooling	0,180	0,409	0,394	0,488	0,566	1,000	0,696	0,037	-0,015	0,056	0,016	0,055	0,059	0,056	0,057	0,043
	Car Sharing	0,155	0,344	0,353	0,470	0,601	0,696	1,000	0,062	-0,005	0,059	0,013	0,080	0,077	0,060	0,051	0,073
Most important trip	Cheap	-0,036	-0,062	-0,021	-0,008	0,063	0,037	0,062	1,000	0,637	0,164	0,021	0,193	0,308	0,110	-0,194	0,370
	Ecological	-0,033	-0,074	-0,009	-0,056	0,013	-0,015	-0,005	0,637	1,000	0,058	-0,081	0,067	0,190	-0,012	-0,332	0,309
	Fast	0,063	0,024	0,029	0,003	0,076	0,056	0,059	0,164	0,058	1,000	0,384	0,616	0,650	0,637	0,392	0,582
	Secure	0,024	0,048	0,005	0,003	0,028	0,016	0,013	0,021	-0,081	0,384	1,000	0,410	0,381	0,506	0,396	0,375
	Flexible	0,093	0,022	0,036	0,014	0,095	0,055	0,080	0,193	0,067	0,616	0,410	1,000	0,662	0,624	0,417	0,552
	On time	0,046	0,006	0,008	-0,009	0,080	0,059	0,077	0,308	0,190	0,650	0,381	0,662	1,000	0,667	0,320	0,629
	Comfortable	0,074	0,031	-0,011	0,009	0,065	0,056	0,060	0,110	-0,012	0,637	0,506	0,624	0,667	1,000	0,533	0,627
	Pick up someone	0,018	0,046	-0,001	0,054	0,009	0,057	0,051	-0,194	-0,332	0,392	0,396	0,417	0,320	0,533	1,000	0,273
	Pleasant	0,048	-0,007	0,028	-0,001	0,068	0,043	0,073	0,370	0,309	0,582	0,375	0,552	0,629	0,627	0,273	1,000

Figure 14 - Correlation Matrix

Table 7 - Variables included in the Cluster Analysis

ID question	Section of the survey	Question	Detail	Scale	Variable's typology
q27y_SQ001	MaaS	Would you use Mobility Packages?		1-6 (1 = absolutely disagree; 6 = absolutely agree)	Discrete Variable
q37_1	MaaS	According to your usual monthly trips, would you use a Pay as You Go as a payment system for the following modes of transport?	Urban PT		
q37_2	MaaS		Regional Buses		
q37_3	MaaS		regional Trains		
q37_4	MaaS		Taxi		
q37_5	MaaS		Bikesharing		
q37_6	MaaS		Carpooling		
q37_7	MaaS		Carsharing		
q11_1	Most important trip	what do you think about your most important trip?	Cheap		
q11_2	Most important trip		Ecological		
q11_3	Most important trip		Fast		
q11_4	Most important trip		Secure		
q11_5	Most important trip		Flexible		
q11_6	Most important trip		On time		
q11_7	Most important trip		Comfortable		
q11_8	Most important trip		Pick up someone/Drop someone		
q11_9	Most important trip		Pleasant		

As shown in Table 7, all the variables used for the Cluster Analysis are discrete and with the same Likert scale (1-6). In particular, these variables allowed in the first instance to understand users' attitudes toward MaaS. Therefore, once the Cluster analysis was carried out, the groups were analysed according to the socio-demographic characteristics as well as the characteristics of their most important trip.

For this research, the k-means cluster analysis was used. In particular, this method assigns all the dataset's observation to a cluster having the nearest mean (centroid), to minimise the variance within each cluster (Punj & Stewart, 1983).

To optimise the cluster homogeneity, this method reassign data until the final solution is reached (Hair et al., 2010), indeed it uses iterative reallocation with the sum of square criteria.

Moreover, as claimed by Bejarano (2011), k-means cluster analysis is recommended when the sample is relatively large, as in this case.

Finally, the right number of clusters had to be defined. With a higher number of clusters, there is a loss in terms of heterogeneity among different clusters.

The optimal number of clusters in a dataset is a core issue in this analysis, especially in k-means clustering, since it asks the user to input the number of clusters to be created.
There is not one method to determine the number of clusters and therefore it might be subjective and dependent on the method used for the cluster analysis.
For this thesis, Elbow Method was used to determine the number of clusters. To this extent, since the total within-cluster sum of square (WSS or total intra-cluster variation) needs to be minimized, this method considers the WSS as a function of the number of clusters. Indeed, the right number of clusters will be the one that, adding another cluster, it doesn't improve the total intra-cluster variation (Kodinariya & Makwana, 2013).
Consequently, once performed the cluster analysis, the mean of each variable included in the analysis for each cluster were calculated in order to better understand the characteristics of each group.
However, the interpretation of the clusters was confirmed through the Focus Groups with the respondents of the survey.
The participants of the Focus Groups were selected from the respondents which belonged to a specific cluster: in this way it was possible to confirm the interpretation of the Cluster Analysis.

3.9 Design of the user's Focus Groups

Once the descriptive and quantitative analysis have been completed, a sub-group of respondents was selected to collect qualitative information through Focus Groups.

Focus Groups, and in particular the interactions among participants, are considered a useful tool to understand people's opinions about a specific topic (Kitzinger, 1995; Marshall and Rossman, 2006). Indeed, giving the participant a topic to discuss about, they can be guided by a facilitator and so they are able to develop their viewpoints.
To this extent, Focus Groups allow to extract aspects which are less evident and which could not be gather from a traditional survey; moreover, as said in Section 3.7, Focus Groups have been used also to confirm the outcomes of the Cluster Analysis.

To this extent, the selected sample was stratified according to the Cluster Analysis previously carried out, their gender, job title, income and type of trip.

Table 8 - Variables used to select the participants to the Focus Groups

Gender	F	Female	M	Male				
Children < 14 years old	Y	Children < 14 years old	N	No children < 14 years old				
Age	L	Low - Under 30	M	Medium: Between 31-65	H	High: More 65		
Education	L	Low: none, secondary school, work licence	M	Medium: High school	H	High: Bachelor, Master, Phd;		
Salary	L	Low: <1500 if lives alone / 2000 if live with other people	M	Medium: 1500-3000 / 1500-4000 according to the number of people living in the family	H	High: > 3000 / 4000 / 5000 according to the number of people living in the family		
Origin	U	Urban	S	Suburbs	R	Rural areas		
Destination	U	Urban	S	Suburbs	R	Rural areas		
Job	W	Worker	HW-HH	Housewife/household	Un	Unemployed	I-R	Retired
Mode of transport	C	Car	B	Bike+bike sharing	W	Walk	PT	Public Transport

Therefore, six Focus Groups involving up to nine participants, were organized. These Focus Groups were carried out to explore people's points of view about MaaS and, in particular, to examine how and why they think in a certain way and if different sections of the population have different points of regarding the Mobility as a Service. To do so, people with similar travel patterns but belonging to different clusters, were grouped together.
To collect the information, a video camera and a recorder were used.

Focus groups were organised as following:

1) **Introduction of the research group and description of the research project**
   In this part, the research group TRIS (Transport Research on Innovation and Sustainability) introduced itself and its previous projects. In this phase, the research group also described the main goals of the research project and why qualitative analysis is useful for the design of a Mobility as a Service.

2) **Presentation of the participants**
   The second phase aimed to gather participant's personal information: name; age; occupation/profession; family composition; where they live; characteristics of their most frequent trip (origin, destination and mode of transport used).
   Moreover, participants were asked to describe what they appreciate and what they do not about their daily mobility.

3) **Personas and Service Blueprint**

After participants' introduction, the research group divided the participants into smaller sub-groups according to their common features. In particular participants who had similarities in terms of the areas of their trips (Table 4) and the modes of transport used, were grouped together.
Three main groups were defined:

- Urban: including participants who mainly travel in the urban area of Torino
- Suburban: including participants who arrive and/or depart in the suburban area of Torino
- Rural: including participants who arrive and/depart in one of the rural municipalities.

Therefore, a *Persona* was assigned by the researchers to each group.
Personas are a tool used in the field of User Experience Design (UX Design) (Aquino & Leite Fi, 2005). In particular they are used to play a role and represent a specific segment of users. Furthermore, personas have to be created following a careful methodology in order to feel real and "alive" to the participants. It is important that personas contain information about their needs, desires and aspiration. Even though personas have to represent a class of users, they do not have to be interpret stereotypes (Hisham, 2009). For these reasons, we decided to use real answers from the questionnaire to create the personas. The answers which were selected to build the personas were stratified according to gender, age, number of households, income, education level, job title and modes of transport used. Besides 3 groups of personas were defined according to the area where they travel for their most important trip: *Urban*, *Suburban* and *Rural*.
These personas had a short description of their mobility habits and preferences and what they appreciate and dislike about the mode of transport they use.
Each persona also had a short description about how they want to feel and what they expect from a Mobility as a Service (Figure 15).

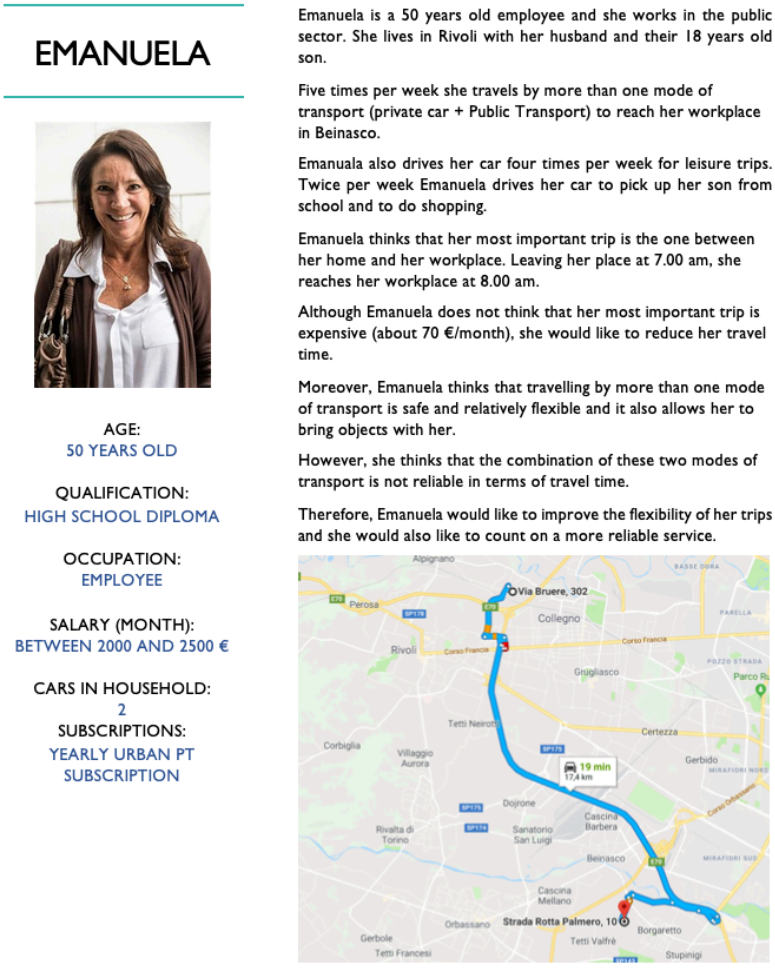


Figure 15 - Example of persona

During the Focus Groups, these personas were assigned to each sub-group according to the participants features.

The participants were asked to read carefully the description of the persona and produce a Service Blueprint of its current mobility.

Service Blueprint is another User Experience Design tool. This tool is helpful to visualize the components of a service in detail to improve, analyse and maintain it. In particular, Blueprinting is considered as a tool to develop service and it has been invented in the early 1980's by Shostack (1982) to design services with higher level of detail than how it was previously done.

Therefore, Service Blueprints are used to better label and define existing services or to create new ones. In particular, they allow to visualize all the steps and actions that need to be undertaken to operationalise a service.

In terms of actions, Shostack highlighted the importance to describe all the aspects which are involved to deliver a service. In particular, she speaks about “aspects which aren’t perceived by the customers as well as the ones which are” (Wreiner, et al., 2009) .
However, Service Blueprint technique has substantially changed from the model described by Shostack. Indeed, Figure 16 shows that, according to Bitner et al (2008), Service Blueprint has evolved from being a two stages model (frontstage and backstage), to include five stages: physical evidence, customer action, onstage, backstage and support processes.

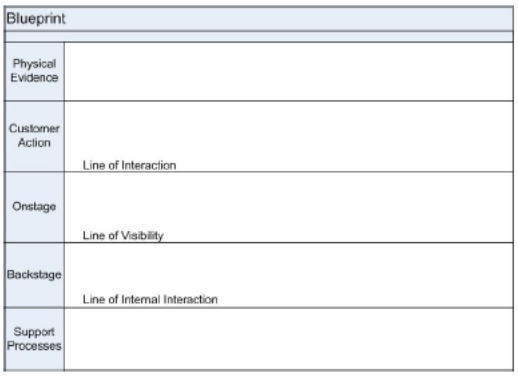


Figure 16 - Model of blueprint

In this case, Service Blueprints were used to implement new services.
During the respondents’ Focus Groups, we decided to focus on the frontstage. Therefore, we focused on the *customer actions*, the *touchpoints* and the *staff action.*
The customer action is composed by all the action performed by the users and related, in this case, to his/her mobility patterns.
Touchpoints are in the middle between the customer and the service: they can vary from technology to conversation with the staff of the service.
Staff action in the case of this project, referred to the mobility system, thus all the actions performed by it.

Once participants designed a service blueprint for the persona’s current mobility, we asked them to identify the weaknesses of persona’s service blueprint and imagine how the its journey experience could be improved. The participants had to design a second service blueprint, using their concept of Mobility as a Service.

4) **Description of the solutions**
   During the fourth phase of the Focus Groups, participants described to their Service Blueprint, so their idea of MaaS.

5) **Discussion**
   Finally, participants discussed together about the feasibility of their ideas and about the involvement of stakeholders.

3.10 Discussion with Local Authorities

Once all the Focus Groups were carried out, the Local Authorities and the main public transport operators were invited to a final Focus Groups to discuss about the feasibility of the suggestions proposed by the users.

In particular, the most representative solutions suggested by the participants were presented and discussed with the participants of this last Focus Group.
The Focus Group with the Local Authorities was organized as followed:

1) **Introduction of the research group and description of the research project**
   As did for the Focus Group with the respondents, the research group TRIS introduced itself and the survey. In particular the research group describe the purpose of the research. Special attention was given to the importance of data. Indeed, the research group explained that without up to date information about how people move, it is impossible to design a supply of transport that reflects the user's needs.

2) **Presentation of the participants**
   The second phase aimed to know participant's personal information and their roles in the Local Authority. Therefore, each participant introduced himself/herself.

3) **Presentation of the results of the survey**
   After the introduction of the participants, the research group described the results of the survey. In particular they shown the descriptive analysis, how respondents declared to move in the study area. Subsequently the outcomes of the Cluster analysis were shown as well as the results of the Focus Groups with the respondents of the survey. Finally, the definition of Mobility as a Service and the most rated mobility packages and their prices were discussed with the Local Authorities.

4) **Local authority's definitions of Mobility as a Service**
   During this fourth phase of the Focus Groups, Local Authorities described their definitions of Mobility as a Service to understand if there are some touch points with the definition provided by the respondents.

5) **Discussion**
   Finally, Local Authorities and the research group discussed the main outcomes of the participants and assess if MaaS can effectively be developed in suburban and rural areas.

Chapter 4

Results

The results of this thesis are presented in the following steps: 4.1) definition of the study area and socio-economic analysis, 4.2) visualization of transport supply, 4.3) visualization of transport demand, 4.4) definition of Weak Demand Areas and 4.5) comparison between transport supply and transport demand

4.1 Definition of the study area and socioeconomic analysis

As explained in Section 3, the definition of the study area was carried out through the calculation of the average distance between the residence of users and the bus stops where they validate their smartcards. As shown in Figure 17, the average distance between stops and users' residences was calculated considering two sample weeks both in 2016 and 2017.

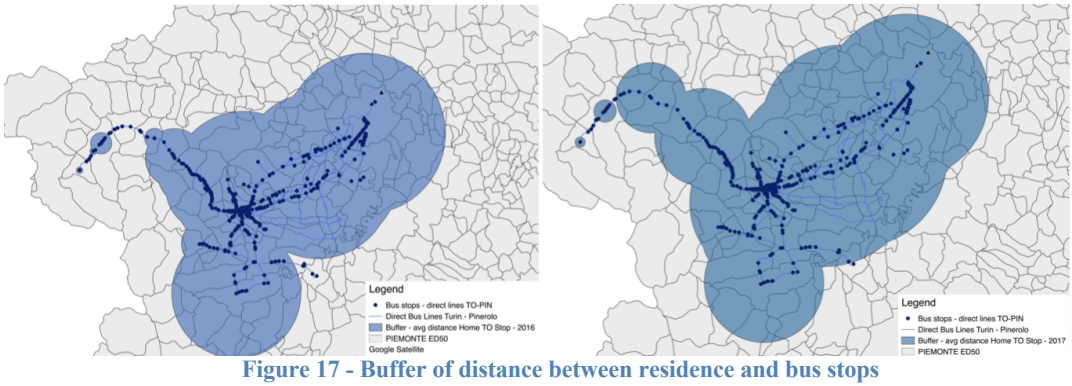


Figure 17 - Buffer of distance between residence and bus stops

The average of the distances between stops and users' residences of both 2016 and 2017 allowed the definition of the study area, which contains 146 municipalities, including Torino and Pinerolo.
It is important to highlight that the study area counts four cities which have Bike-sharing systems and 32 train stations.
As shown in Figure 18 the centroids were located in the gravity centre of each municipality. Municipality centroids were used to analyse transport supply, while IMQ zoning and their centroids were used to analyse transport demand (Figure 19).

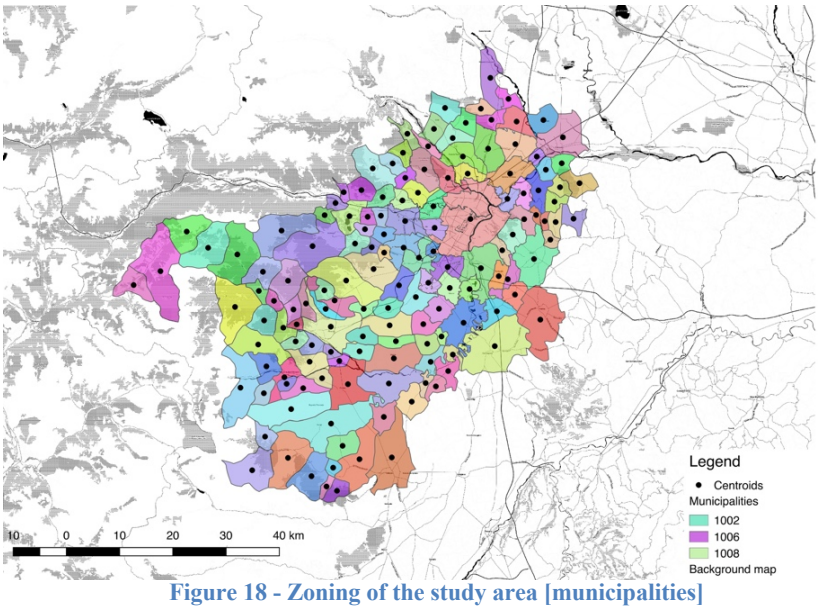


Figure 18 - Zoning of the study area [municipalities]

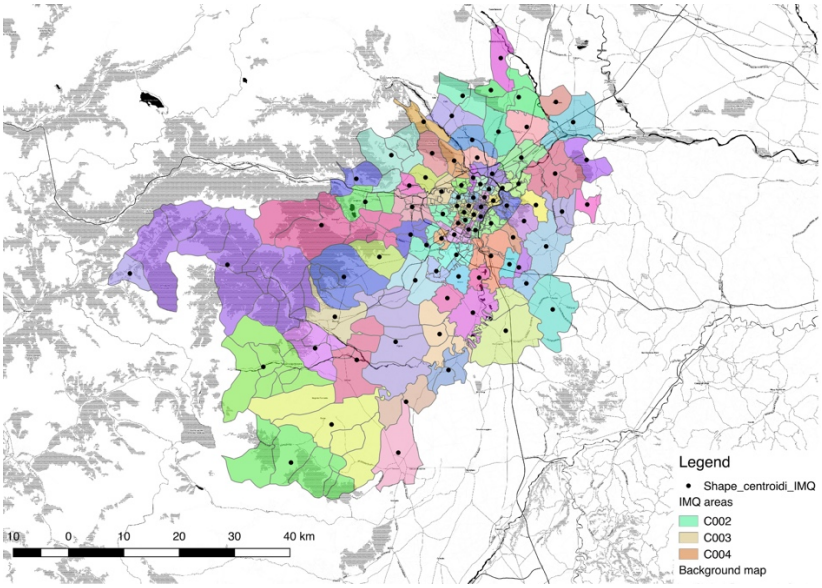


Figure 19 - Zoning of the study area [IMQ 2013 zones]

Socio-economic analysis was carried out to assess the distribution of inhabitants who travel on a daily basis (commuters as employed and students). ISTAT census (2011) reports that 1,996,928 people live in the municipalities of the study area. Population data, shows that the age distribution is quite symmetric for the different age range; the only exception is the age range which include people older than 74 years old: as shown in Figure 20 in this range there is a majority of women.

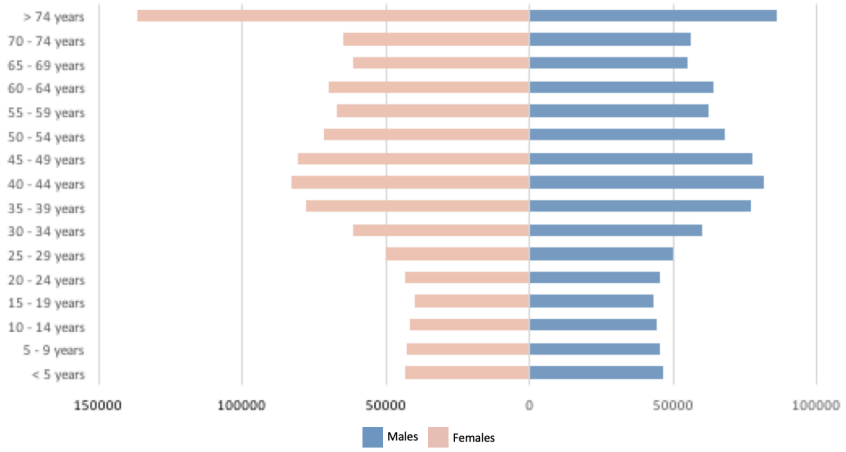


Figure 20 - Age distribution

Table 9 - Age distribution (comparison)

	Population		
	Males	**Females**	**Total**
Study Area	959.369	1.037.468	1.996.928
	(48.1%)	(52.9%)	(3.3% of Italian population)
Piedmont	2.104.988	2.258.928	4.393.916
	(48.2%)	(51.8%)	(7.2% of Italian population)
Italy	29.229.148	31.228.761	60.457.909
	(48.3%)	(51.7%)	100%

Figure 21 shows the density distribution of inhabitants for each municipality. The zone with highest density is Torino, while only few other municipalities show a density above 2800 pop./km^2.

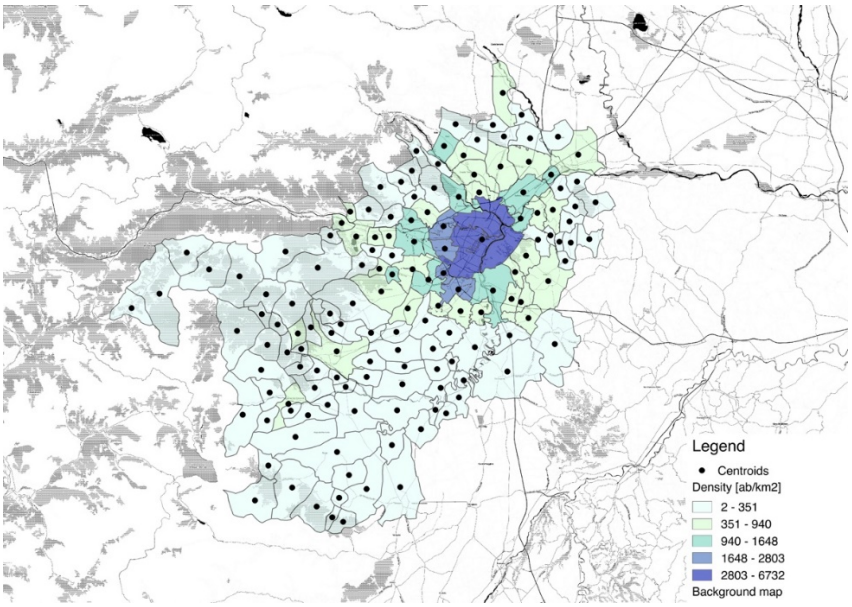


Figure 21 - Density distribution of the study area

Figure 22 shows the distribution of population older than 70 years old. Results shows that the higher percentages are located in the mountain and rural municipalities.

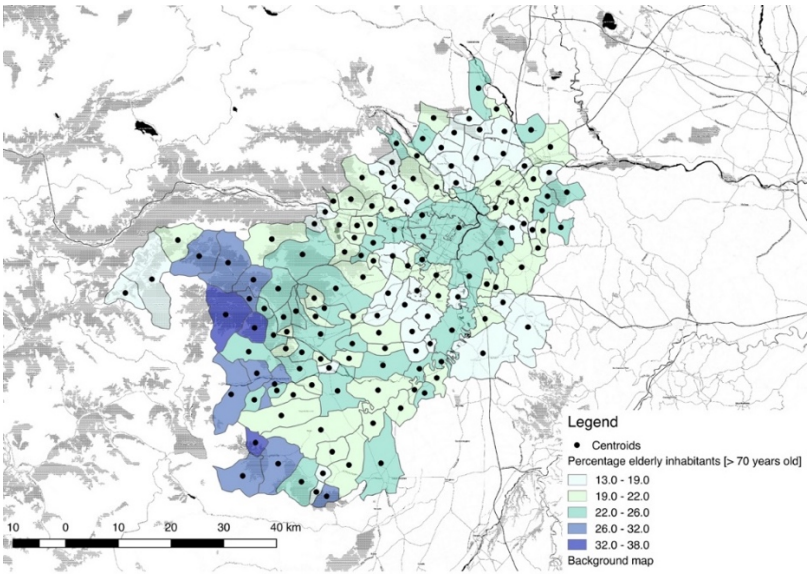


Figure 22 - Distribution of population > 70 years old

The assessment of nuclear households shows that about 80% of households located in the study area is composed by no more than three persons (Figure 23). 16% of the inhabitants of the study area belongs to mononuclear households, while about 75% of citizens live in households with 2, 3 or 4 persons.

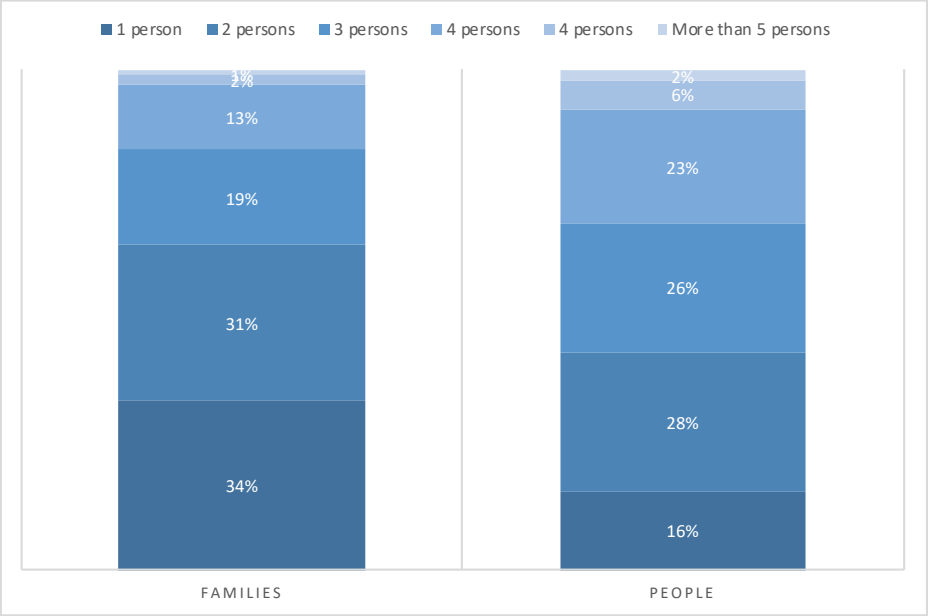


Figure 23 - Distribution of nuclear families

The analysis to understand the employment rate was carried out considering two main classes: "Workforce" and "Not workforce". All the citizens older than 18 years old, employed and unemployed, belong to the first group. Figure 24 shows that in the unemployed group, students are about one sixth of the population.

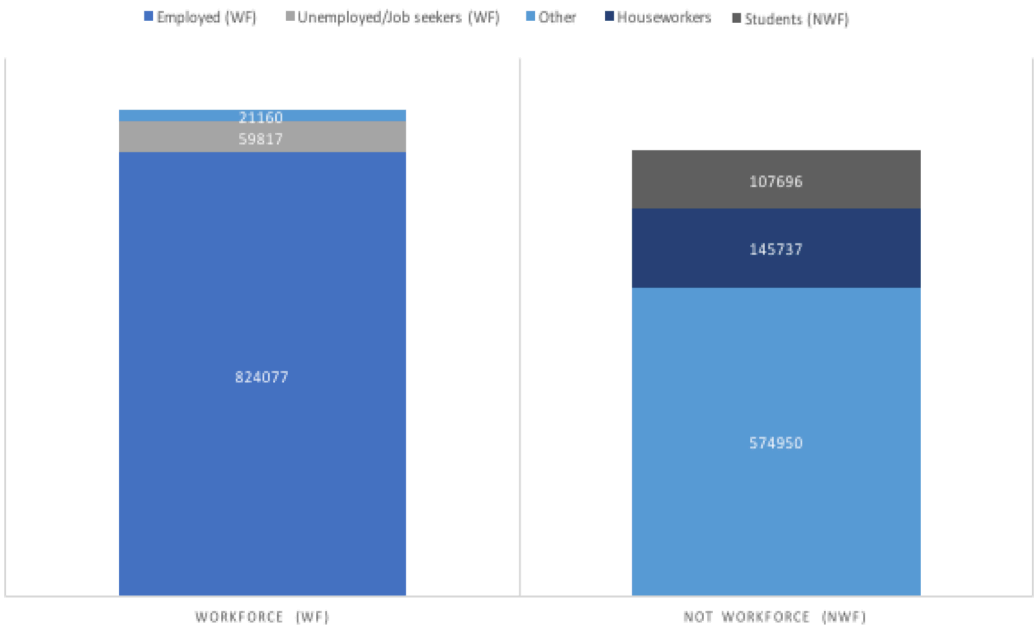


Figure 24 - Employment distribution

The visualizations of the density of students (Figure 25), employed people (Figure 26) and density of workforce (Figure 27), show similar results for Torino and the cities with the highest densities.

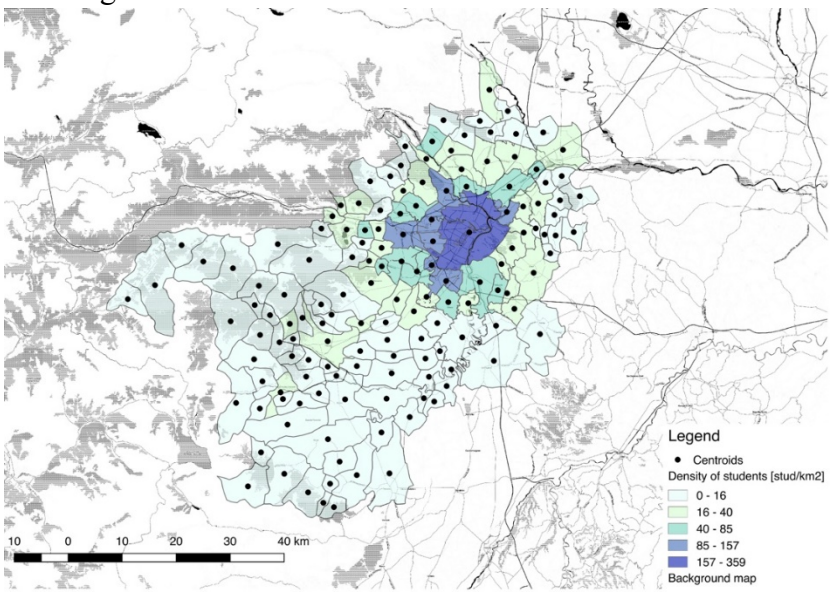


Figure 25 - Density of students

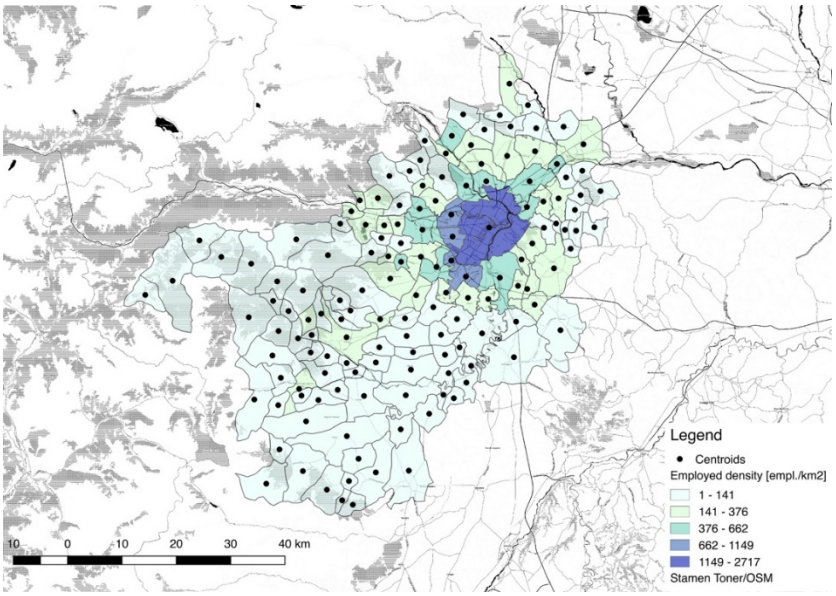


Figure 26 - Density of employed people

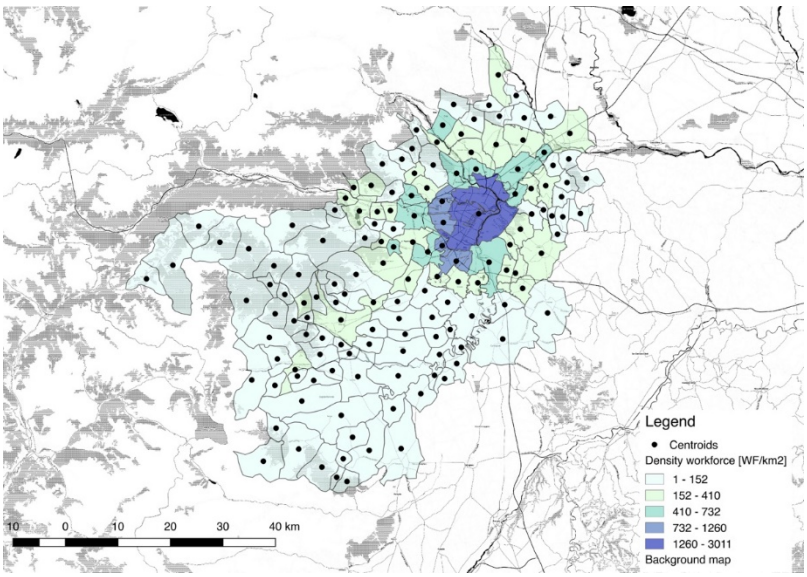


Figure 27 - Density of workforce

Considering the demographic and employment data, it has been possible to assess the attractive capacity of each municipality in terms of trips. The results are shown in Figure 28, which shows two different layers of information:

- "citizens who **daily travel** out of the municipality where they live", in scale of blue (ISTAT, 2011). Dark blue shows a higher number of **trips generated** in that specific municipality;
- **local deficit** in terms of workforce for each municipality calculated as the difference between the number of employed and the number of people who are considered workforce. High values show that the number of employed is less than the number of workforces of a certain municipality. This information is visualized with a net. Dense and thick nets show that the municipality has a **high attractive capacity**.

The results show that Torino and few other municipalities in its hinterland have a high capacity of both attracting and generating trips. Besides that, also Pinerolo, Chivasso and Carmagnola show a discrete level of attractiveness.

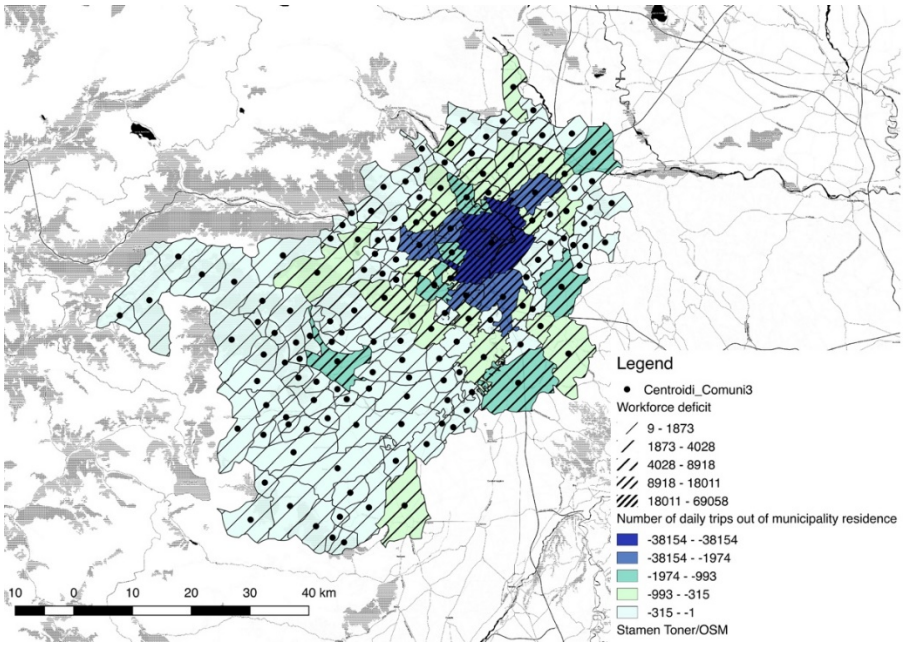


Figure 28 - Capacity of attract trips in the municipalities of the study area

4.2 Visualisation of transport supply

As described in Section 3.3, the transport supply was analysed in order to show which are the municipalities with a higher number of rides both by train and bus in terms of average seats offered.
Therefore, the matrices of trains and buses operating schedules were imported on QGis in order to map this information and verify how the supply of transport changes according to the different time slots.
Figure 29 shows that, in the morning peak period (06:00 – 08:29 a.m.), the supply of transport (average number of seats) is high between Torino and Chivasso. Indeed, along this trajectory there are several train and bus lines serving these municipalities.
Also, there is a relatively high offer between Torino and Pinerolo; Torino-Chieri, and Torino and Susa Valley (Sant'Ambrogio).
However, Figure 29 also shows that the level of supply between the other municipalities of the study area, is weak. To this extent Section 4.3 focus on the demand of transport to highlight those municipalities where there is an evident gap between the demand and the supply.

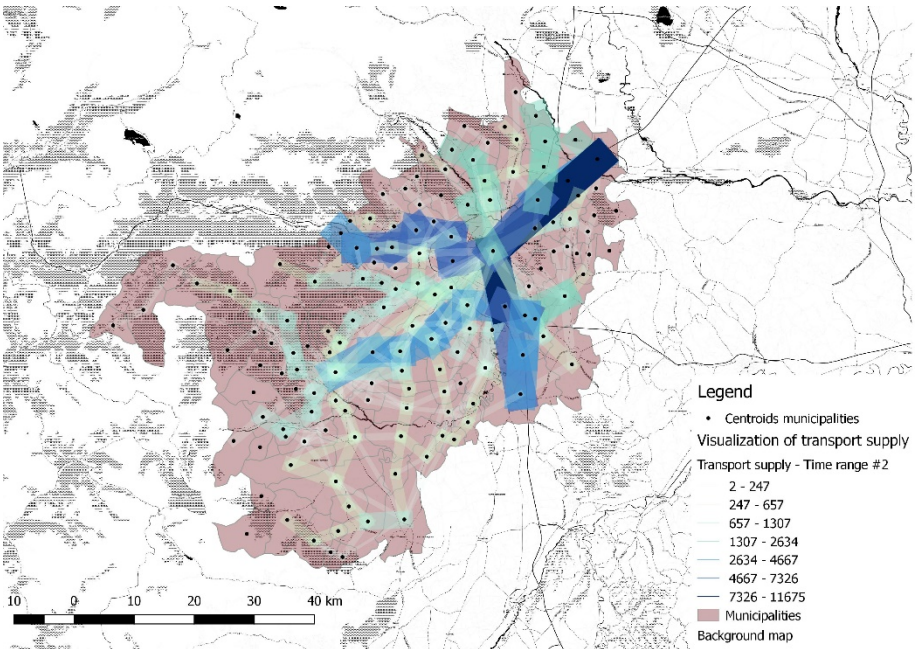


Figure 29 - Transport supply -time range #2 [06:00 – 08:29]

4.3 Visualisation of transport demand

As mentioned in Section 3.5, IMQ 2013 data were used in order to describe the transport demand. In particular, IMQ zoning aggregates municipalities in zones. Therefore, the data were imported on QGis in order to visualize how the demand of transport varies according to the different time ranges.
Figure 30 represents the demand of transport in the morning peak period. In this time range the demand of transport is mainly focused between Torino and its hinterland, especially in the West of Torino. Besides, as shown in Figure 31, a high level of demand is evident also between the following municipalities:

- *Pinerolo – Torre Pellice*
- *Pinerolo Cumiana*
- *Pinerolo – Fenestrelle-Roure*
- *Ciriè – Marentino*
- *Ciriè – San Carlo Canavese*

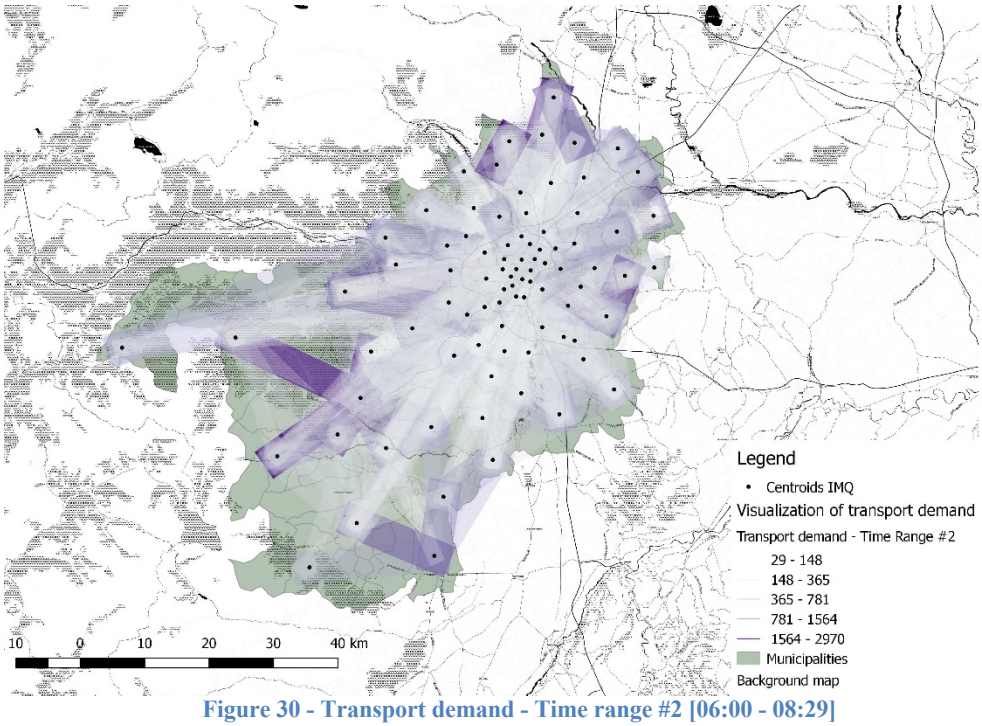


Figure 30 - Transport demand - Time range #2 [06:00 - 08:29]

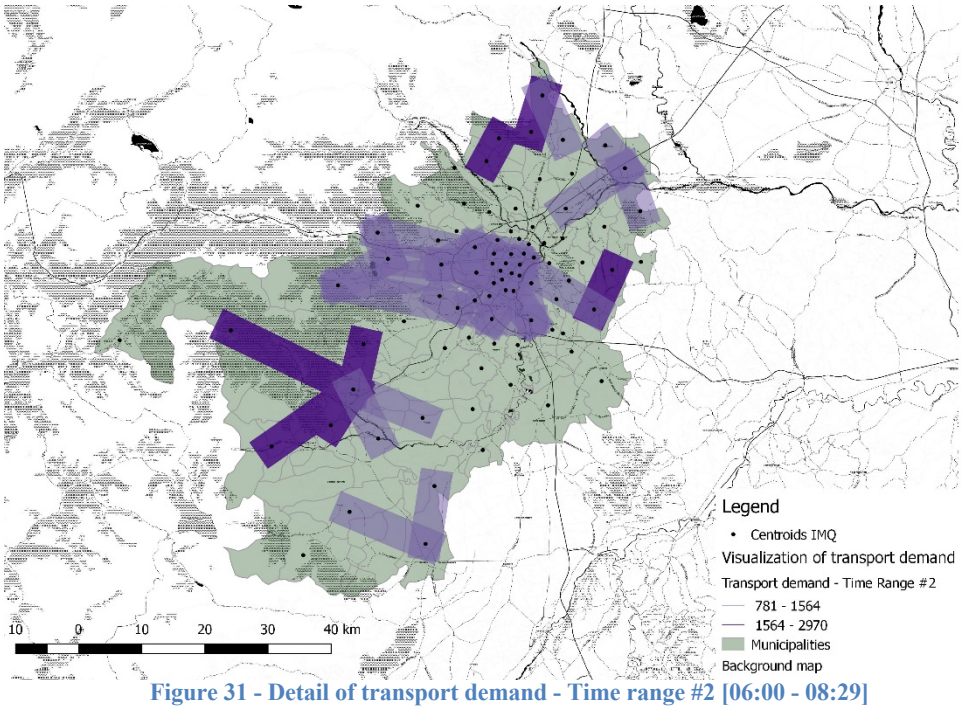


Figure 31 - Detail of transport demand - Time range #2 [06:00 - 08:29]

The comparison of Figure 29 and Figure 31 shows an evident gap between the supply and demand of transport. In particular, it seems that there is not enough offer between Pinerolo and the neighbouring municipalities.

4.4 Definition of weak demand areas

As described in Section 3.4, seven classes were defined to describe the weak demand areas, using different criteria.
Figure 32 shows that the mountain and rural municipalities are classified as weak demand areas, while Torino and other few other cities, notably those crossed by the railway provide a higher offer. It is important to highlight that even though Pinerolo has a high level of supply, the municipalities around, are considered weak demand areas.

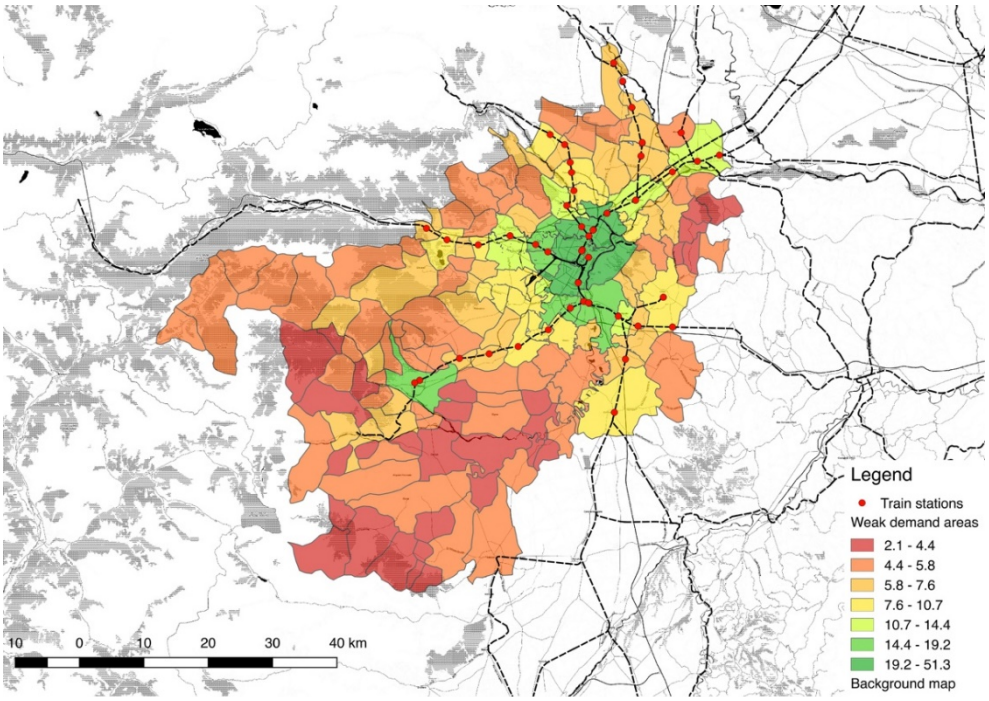


Figure 32 - Weak Demand Areas

4.5 Visualisations of respondents' preferences

As said in Section 3.5, the respondent's answers have been plotted in order to visualise their travel patterns. In particular, knowing the coordinates of the origins, destinations and interchange points, it has been possible to represent where these points are located, according to the when these trips were made (time range).

In this section, the total number of answers was plotted in order to have a general framework about where the respondents travel and where the main interchange points are located.

QGIS was used to show the main OD flows and where users mainly prefer to develop Mobility as a Service.
To this extent, users who declared to use more than one mode of transport for their most important trip, have been disaggregated in order to visualize in detail the origin, the destination and the interchange points.
In particular, Figure 33 shows that most of the interchange points are located nearby the multimodal location such as train stations, and car-parks.

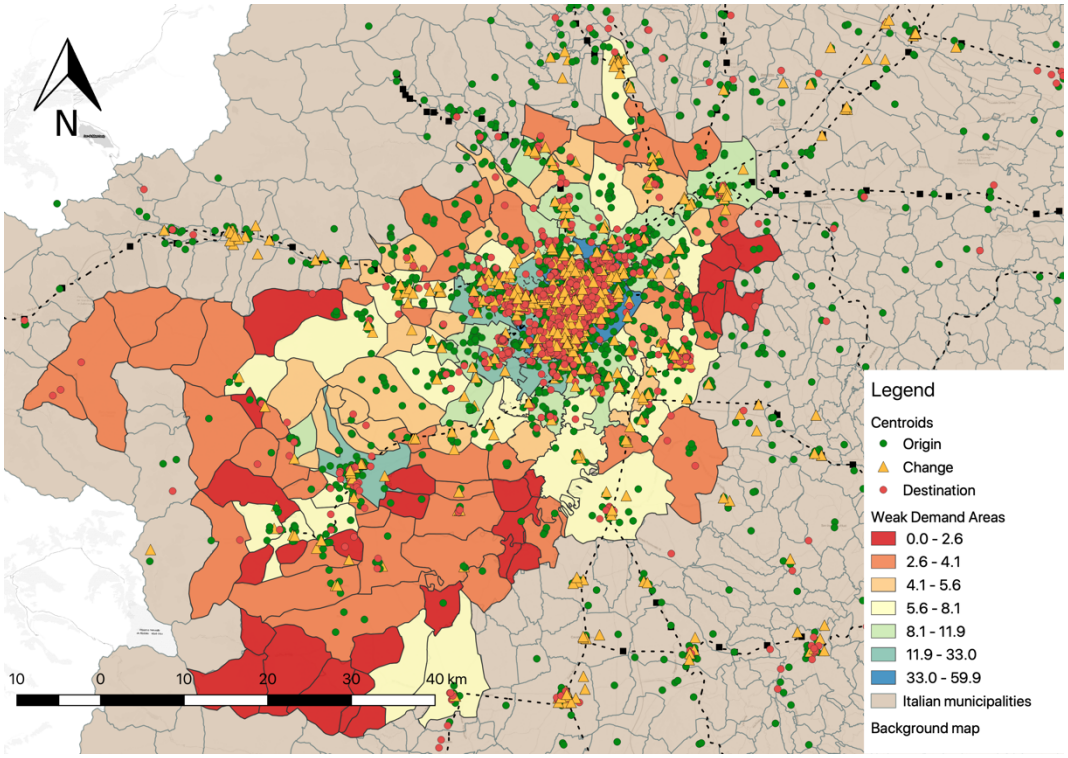


Figure 33 - Origin, destination and change points

To this extent, the visualisations refer to the users' most important trips because it has been considered as the one which mainly characterise the mobility of the users.
As described in Section 3.8, a classification of the most popular interchange points was carried out to show where respondents mainly change their modes of transport.
As shown in Table 10, the municipality with the highest number of interchange points is Torino. In particular, 128 respondents declared to interchange in Torino Porta Nuova where there is the main train station of the city, underground metro station, a bike-sharing hub and bus stops both for urban and long-distance trips.
Out of Torino, respondents declared to interchange also in Collegno, Pinerolo and Avigliana. To this extent the analysis of the interchange points might help to improve the intermodality of the user's trips so that they will be less dependent on their private cars.

Table 10 - Classification of interchange points

Municipality	Interchange Point	N° of respondents	Chain description	N° of respondents (Chain)
Torino	Torino Porta Nuova	128	Urban PT + walk	68
			Urban PT + Bike/Bike Sharing	29
			Urban PT + Train	17
			Walk + Regional Bus	14
	Torino Porta Susa	89	Train + Urban PT	37
			Train + Walk	21
			Urban PT + Regional Bus	16
			Regional Bus + Walk	15
Collegno	Fermi - Underground Station	44	Car + Urban PT	36
			Walk + Urban PT	8
Torino	Torino Lingotto	33	Train + Urban PT	19
			Urban PT + Regional Bus	8
			Walk + Train	6
Pinerolo	Pinerolo Train Station	19	Car + Train	9
			Walk + Regional Bus	5
			Car + Regional Bus	5
Avigliana	Avigliana Train Station	13	Car + Train	8
			Walk + Train	5

Therefore, the QGis plug-in "AequilibriaE" was used to visualize the main OD flows. In particular, Figure 34 shows all the mobility patterns of the users. Since the majority of the respondents declared to start and end their trip in Torino, the majority of the OD lines are located inside the city. However, among the other municipalities, there is a high number of trips between the first ring of Torino and Torino itself, but also between Pinerolo and Torino.
Outside of the study area, the main trips occur between Torino and the other main Piemonte's provinces (Novara, Vercelli and Cuneo).

Figure 34 also shows that the Origin-Destination flows have similar patterns if compared with data form IMQ 2013 (Figure 30 and Figure 31).

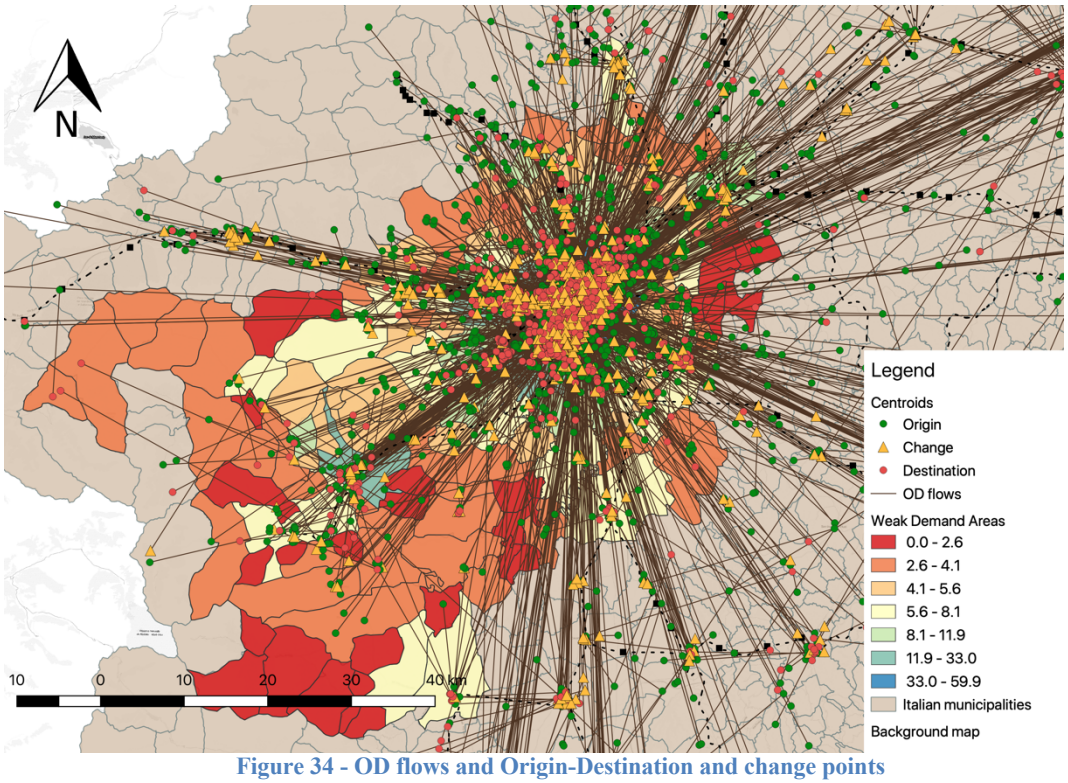


Figure 34 - OD flows and Origin-Destination and change points

Figure 35 shows the distributions of the origins, destinations and interchange points, according to the mode of transport used for the most important trip.
In particular, the dimensions of the circles represent the frequency of the trips.
It is possible to notice that the majority of the respondents travel by car and bus.

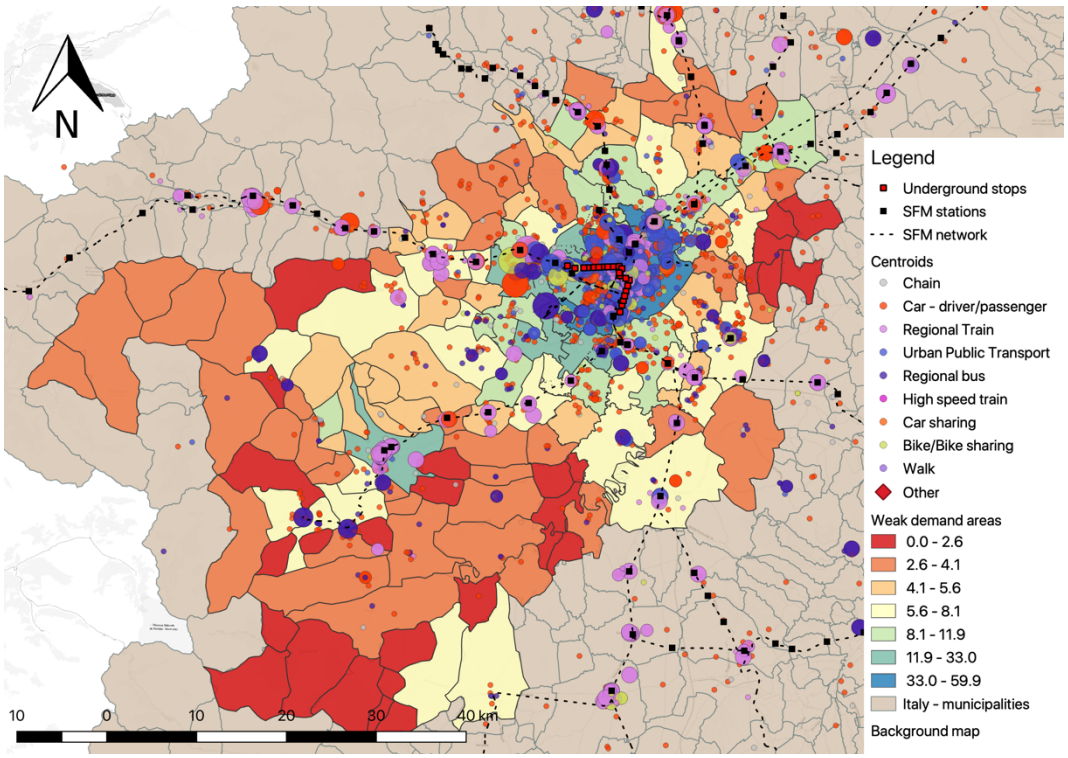


Figure 35 - Usage of modes of transport

Subsequently, respondents have been grouped according to the municipalities where they start and end their trips in order to show which are the most used modes of transport for each municipality.
To visualize the outcomes of this analysis, the modes of transport used by the respondents have been aggregated as shown in Table 11.

Table 11 - Aggregation of modes of transport

Mode of transport	Aggregated mode of transport
Chain	Chain
Car (driver)	Car
Car (passenger)	
Car-sharing	
Urban PT	Public Transport
Regional Bus	
Regional Train	Train
High Speed Train	
Private Bike	Bike
Bike-Sharing	
Walk	Walk

Moreover, the municipalities where there are no respondents who declared to depart from or arrive to, have been left blank. Thus, 107 municipalities have been included in this analysis. Besides, since this analysis aims to show the percentages of the respondents, municipalities that registered few respondents, might not be representative.

Figure 36 shows the percentages of the respondents who depart from each municipality, using more than one mode of transport. In particular, 18% of the respondents who depart from Torino declared to use more than one mode of transport for their most important trip. Furthermore, also municipalities such as Airasca, Cavour, Rivoli, Poirino and Rivalta di Torino show a relatively high percentage of respondents who use more than one mode of transport.

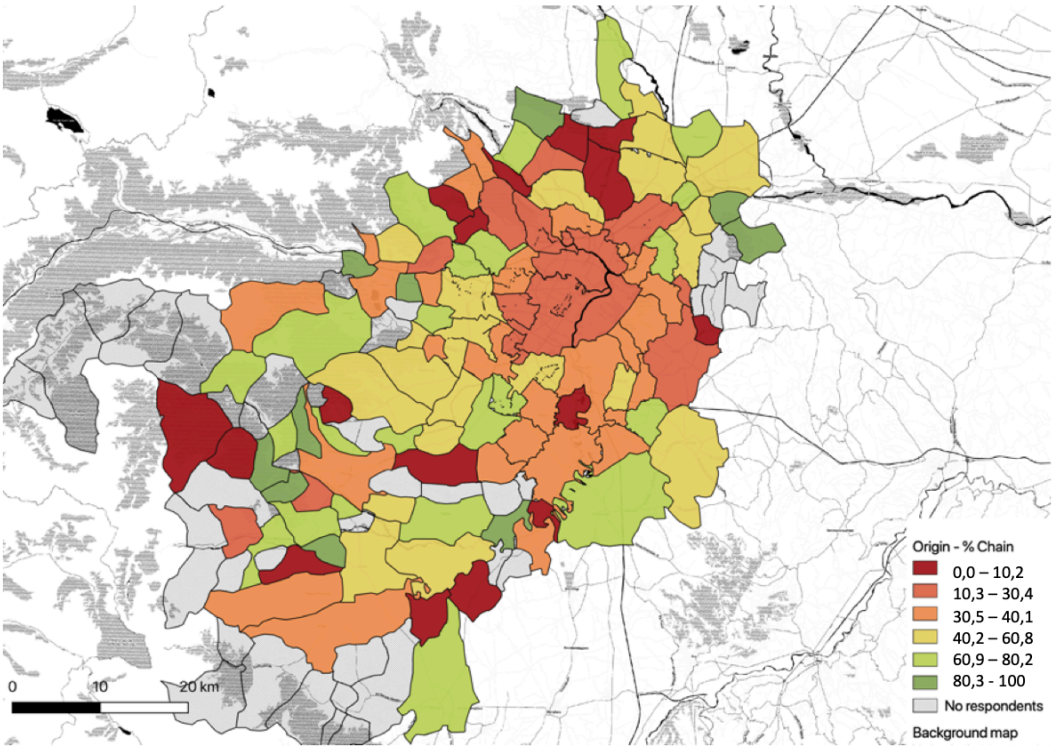


Figure 36 - Percentage of chain trips per municipality (Origin)

Considering the destinations, only 58 municipalities have been included in this analysis. Figure 37 shows the percentages of the respondents who arrive in each municipality, using more than one mode of transport. Almese, Buttigliera Alta, Chivasso and Trofarello are some of the destination municipalities with the highest percentages of respondents who travel with more than one mode of transport.

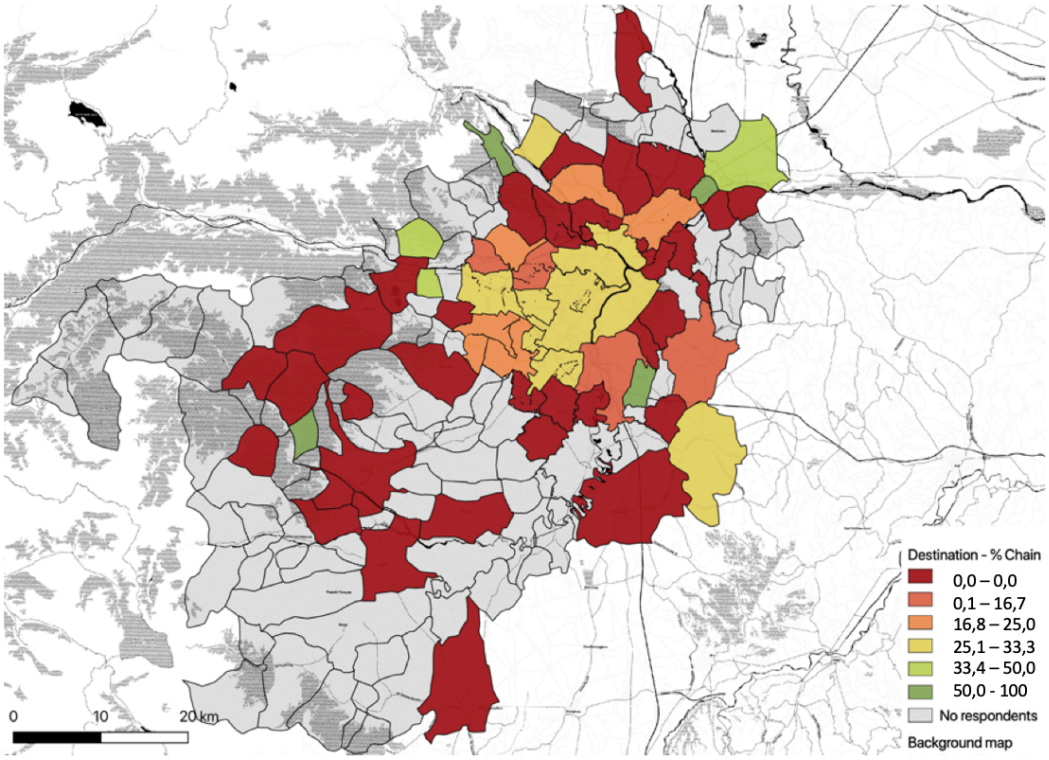


Figure 37 - Percentage of chain trips per municipality (Destination)

Figure 38 shows the percentages of the respondents who depart from each municipality, travelling by car. Bibiana, La Loggia, Pramollo and Scalenghe are some of the municipalities with the highest percentages of respondents travelling by car. On the other hand, Rivarolo Canavese, San Germano Chisone, Sant'Ambrogio di Torino and Trofarello show low percentages of respondents travelling by car.

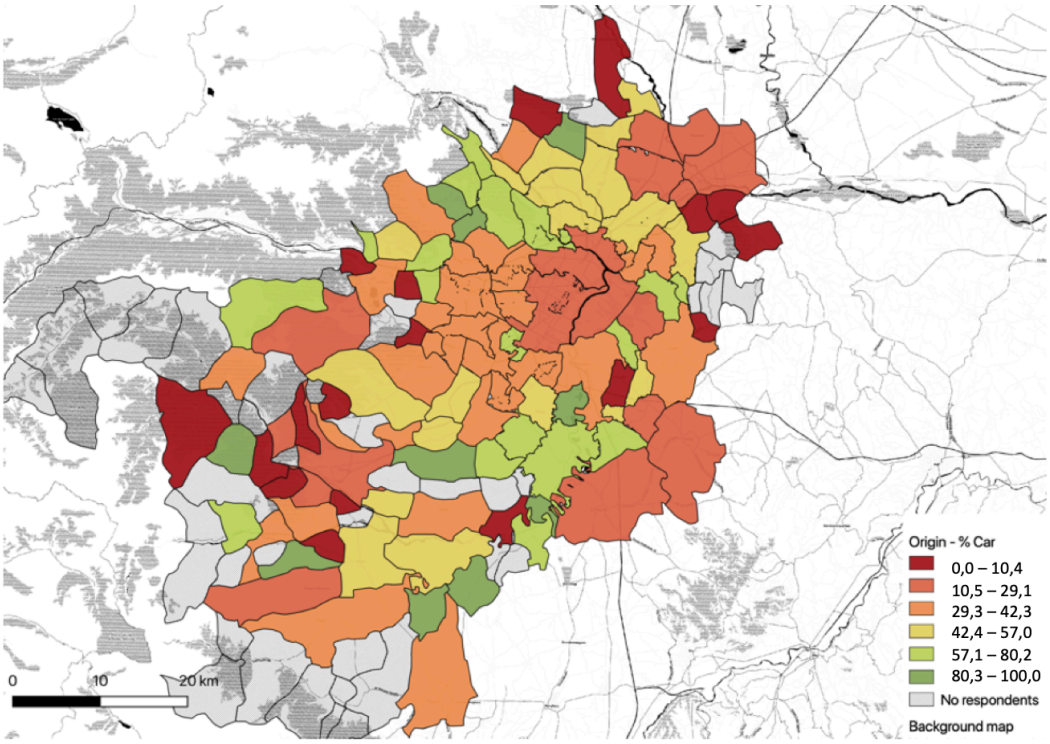


Figure 38- Percentage of car trips per municipality (Origin)

Figure 39 shows the percentages of the respondents who arrive in each municipality, travelling by car. Caselle Torinese, Ciriè, Collegno, Nichelino and San Mauro Torinese are the main destination-municipalities with the highest percentages of respondents who declared to travel by car for their most important trip. On the other hand, Giaveno, San Secondo di Pinerolo and Villar Perosa are the main destination-municipalities with the lowest percentages of respondents who travel by car.

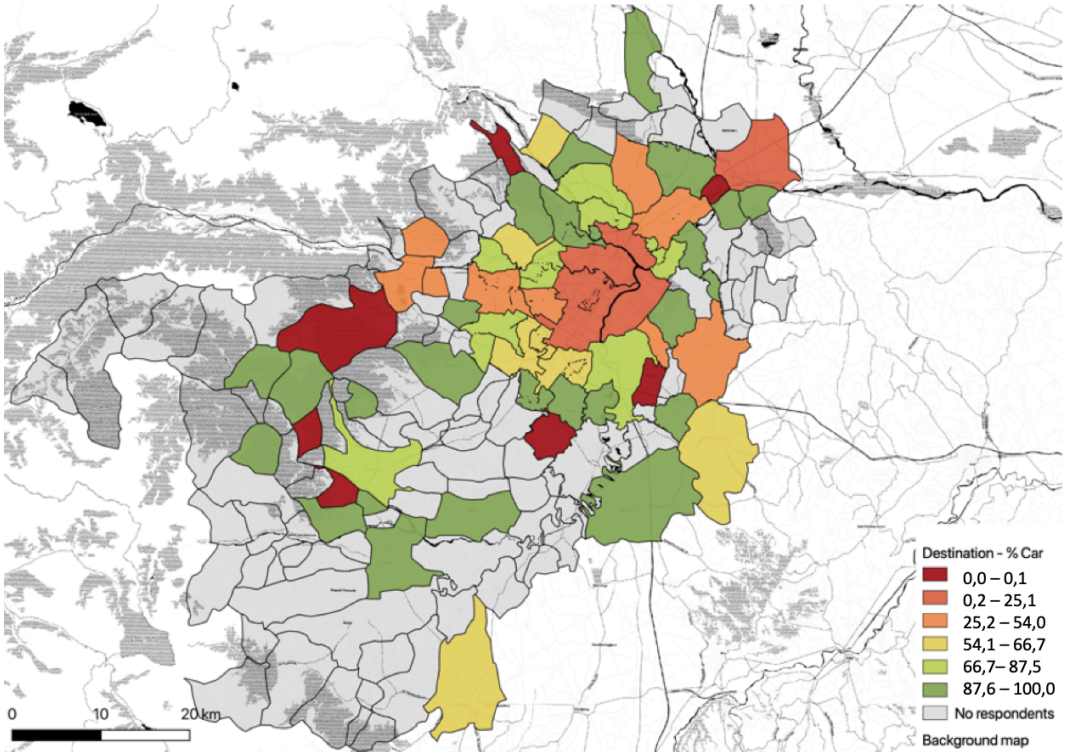


Figure 39 - Percentage of car trips per municipality (Destination)

Figure 40 shows the percentages of respondents who depart from each municipality, using Public Transport. Torino, Leinì, Pino Torinese and San Secondo di Pinerolo are the municipalities with the highest percentages of respondents who travel by Public Transport.

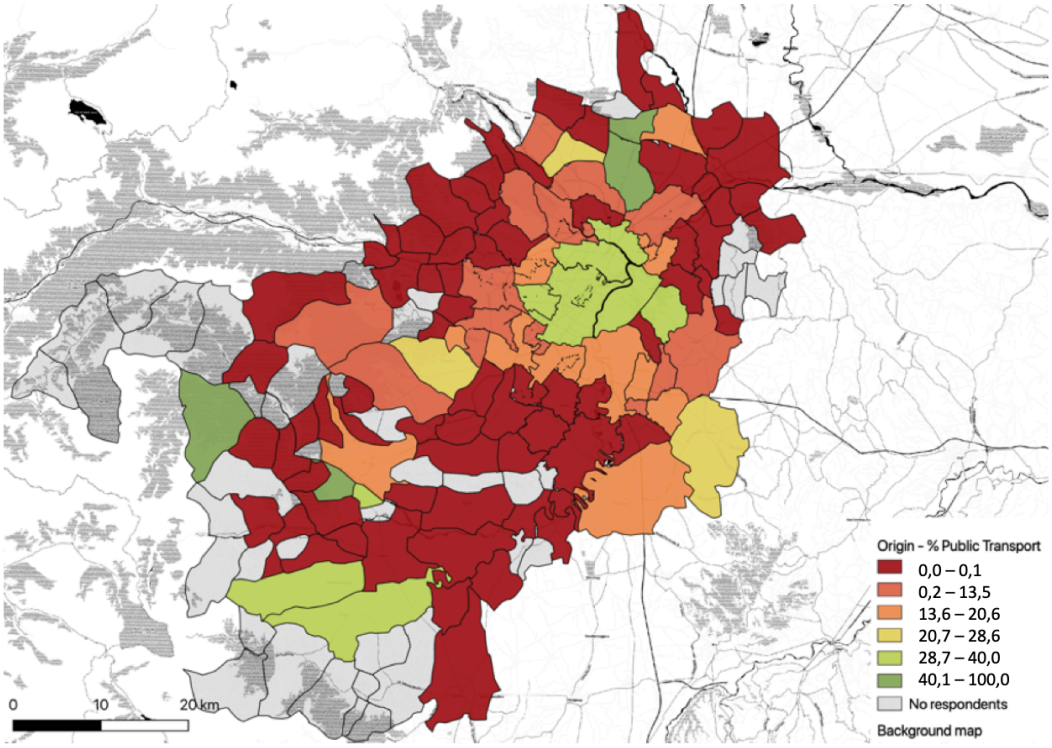


Figure 40 - Percentage of Public Transport trips per municipality (Origin)

Figure 41 shows the percentages of the respondents who arrive in each municipality, travelling by Public Transport. Giaveno, Torino, Pecetto and Saluzzo are the main destination-municipalities where respondents declared to travel by Public transport.

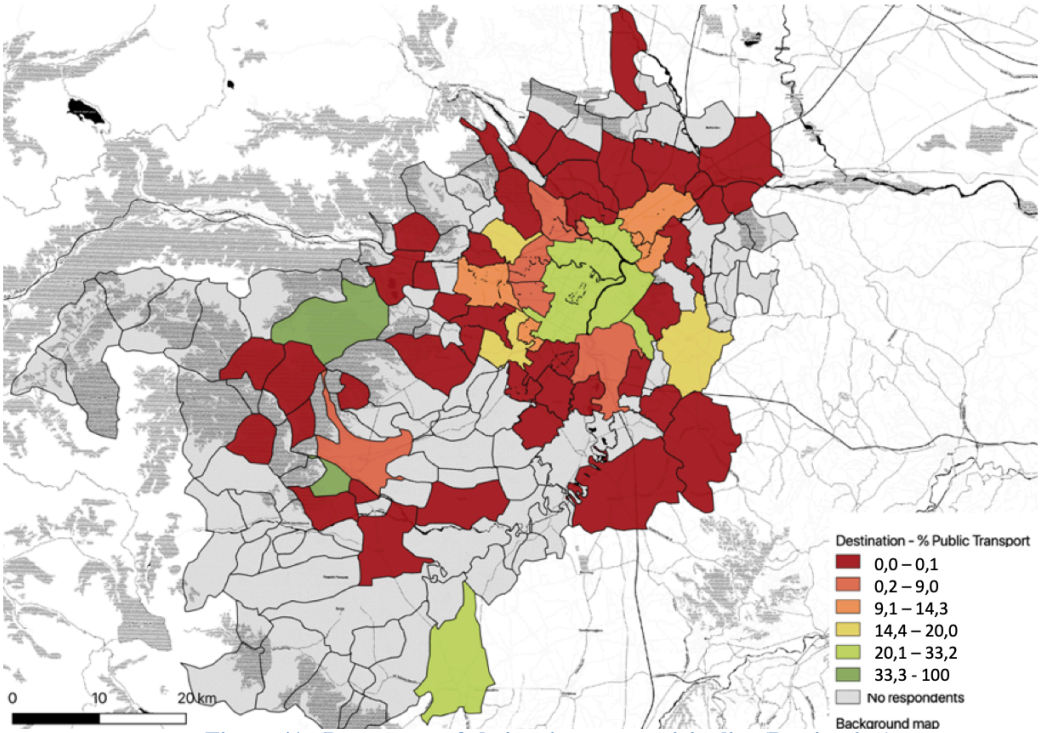


Figure 41 - Percentage of chain trips per municipality (Destination)

Figure 42 shows the percentages of the respondents who depart from each municipality, travelling by train. Chivasso, Trofarello, Brandizzo and Volpiano are the municipalities with the highest percentages of respondents who travel by train while the rest of the respondent of the study area do not travel by train.

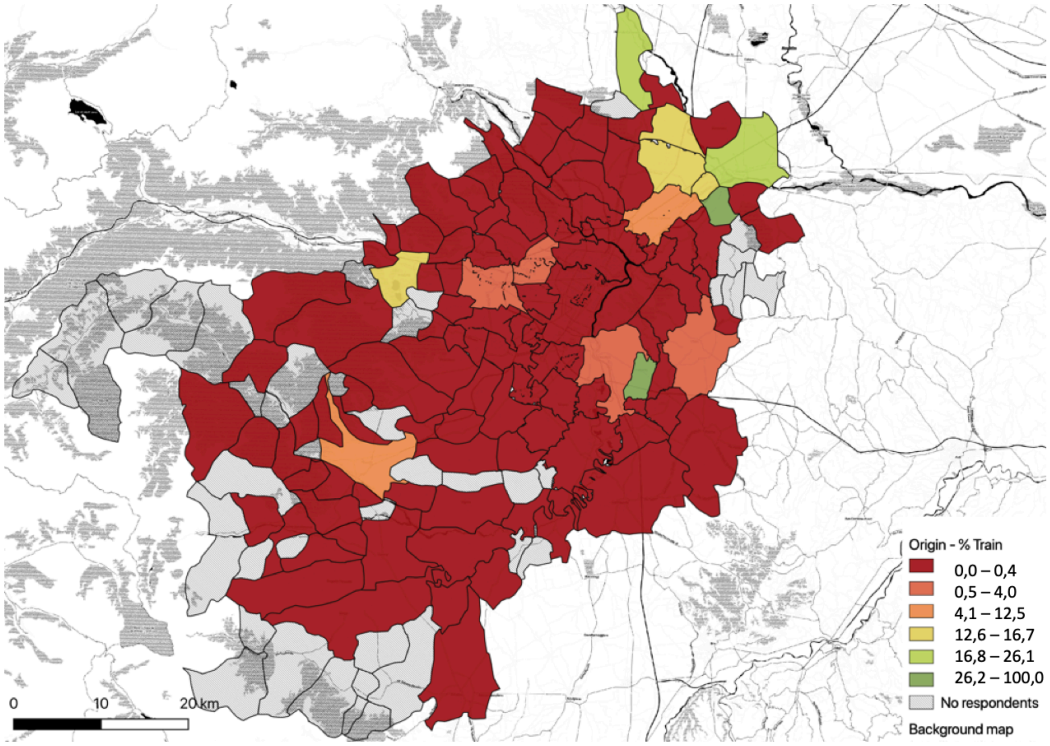


Figure 42 - Percentage of train trips per municipality (Origin)

Figure 43 shows the percentages of the respondents who arrive in each municipality, travelling by train. In this case only Torino, Chieri and Settimo Torinese are the destination-municipalities where a discrete number of respondents declared to travel by train.

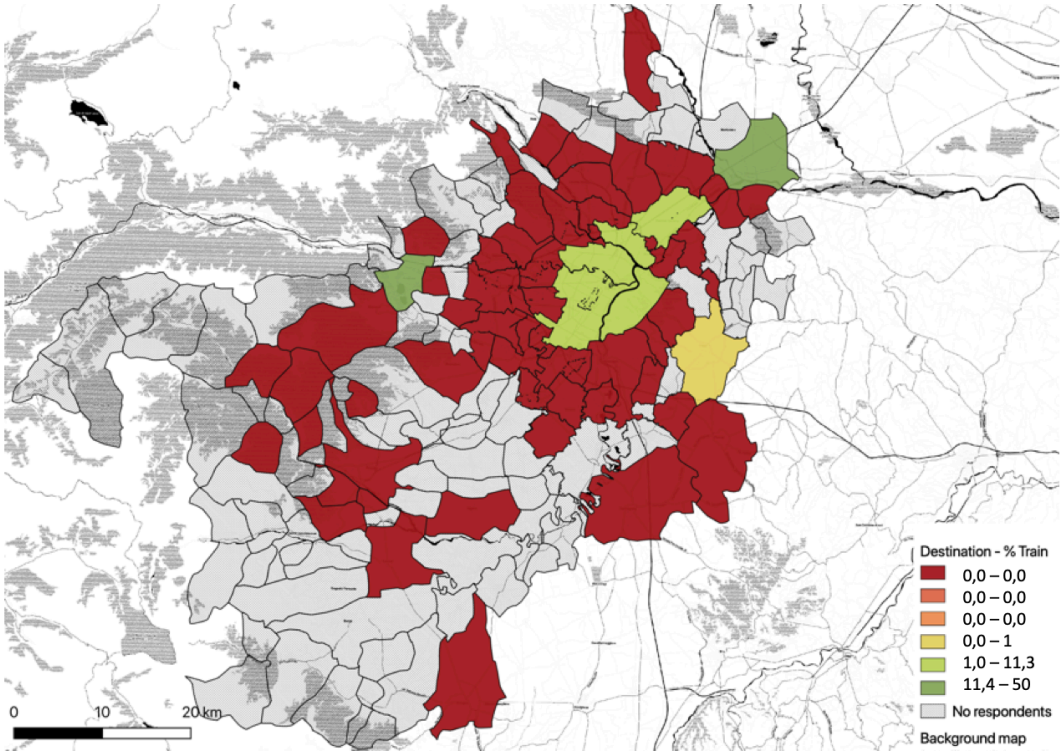


Figure 43 - Percentage of train trips per municipality (Destination)

Figure 44 shows the percentages of respondents who leave from each municipality, travelling by bike. As shown, the percentages of respondents travelling by bike are generally quite low; however, Torino, Robassomero and Sangano are some of the municipalities with the highest percentages of respondents who travel by bike.

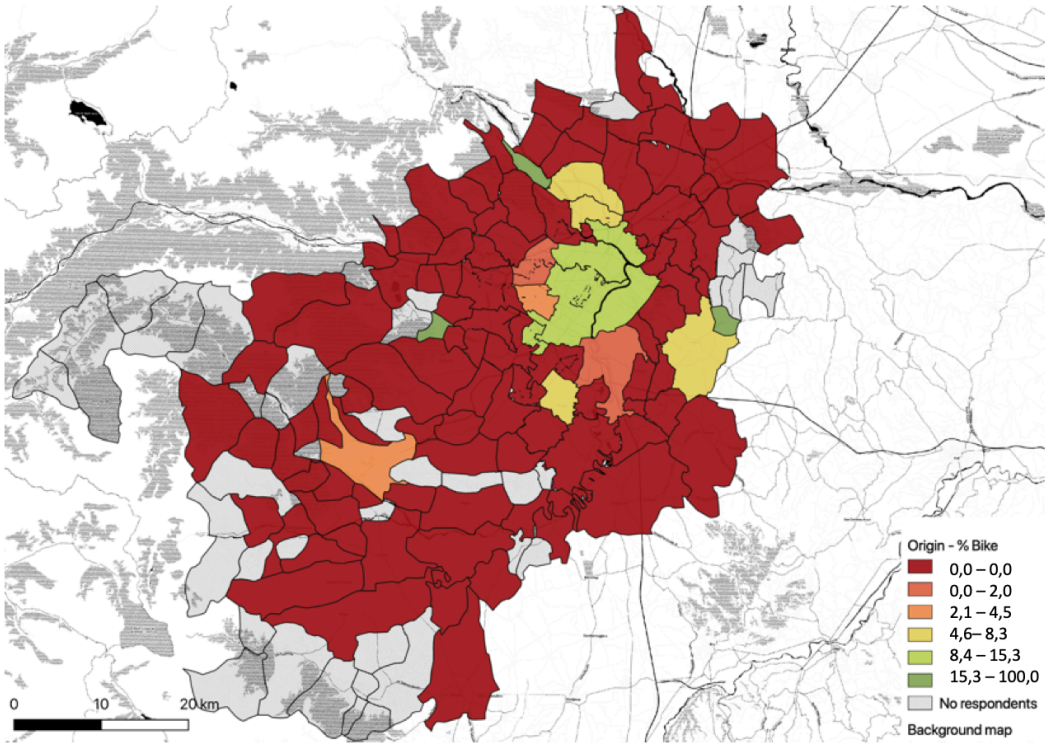


Figure 44 -Percentage of bike trips per municipality (Origin)

Figure 45 shows the percentages of the respondents who arrive in each municipality, travelling by bike. Again, only Leinì, Piobesi, Borgaro Torinese, and Pecetto are the destination-municipalities where there a significantly percentes of respondents who declared to travel by bike.

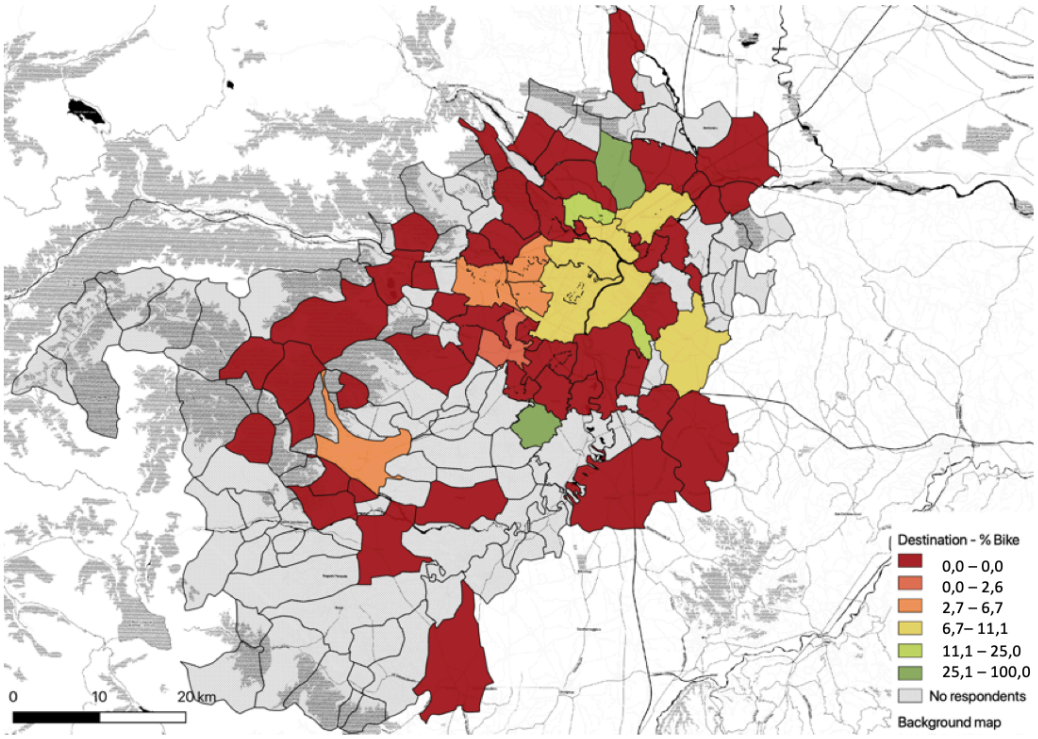


Figure 45 -Percentage of bike trips per municipality (Destination)

Figure 46 shows the percentages of the respondents who leave from each municipality, by walk. In this case, only Chieri, Grugliasco, Cantalupa and Torino are the municipalities that count some respondents who walk for their most important trip.

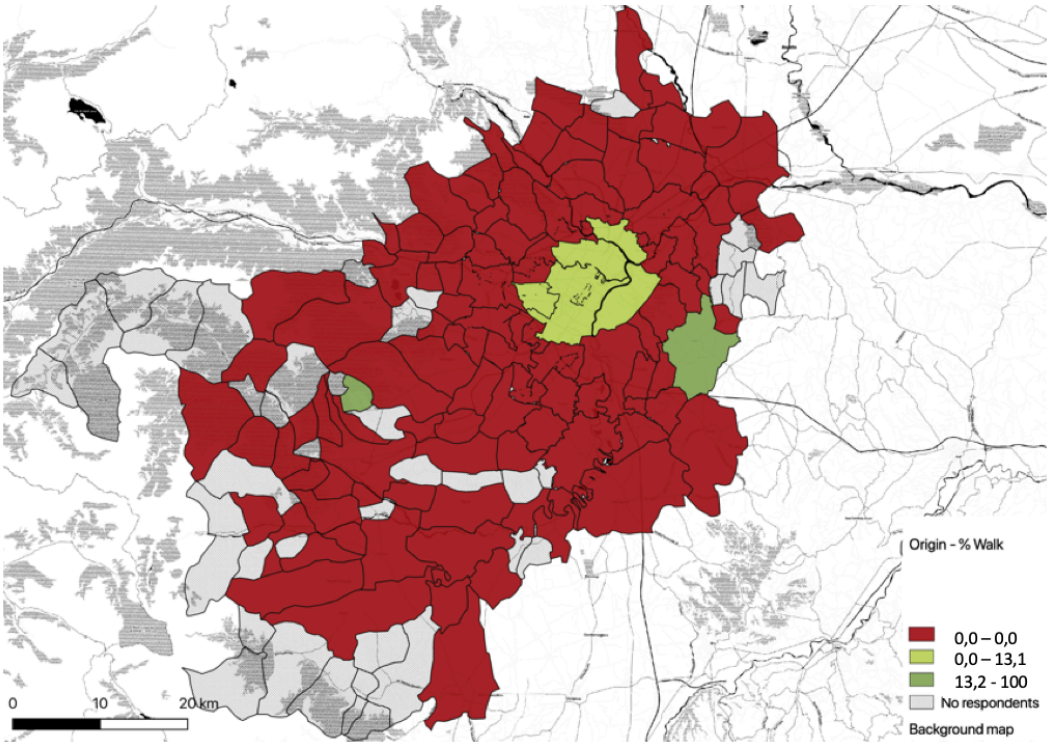


Figure 46 -Percentage of walk trips per municipality (Origin)

Figure 47 shows the percentages of the respondents who arrive in each municipality, by walk. In this case, only four destination-municipalities have significant percentages of respondents who declared to travel on foot: Chieri, Grugliasco, Pinerolo and Torino.

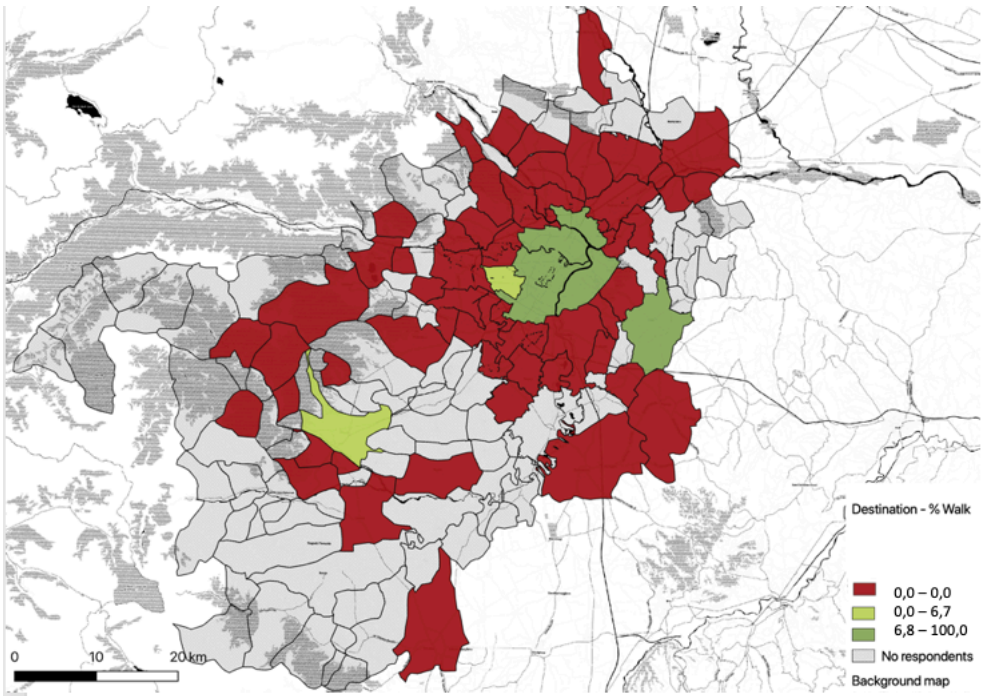


Figure 47 - Percentage of walk trips per municipality (Destination)

Finally, a more detailed analysis has been undertaken in order to visualize users' mobility pattern, according to different time range.
In particular, Figure 48 shows the Origin-Destination flows of users who travel between 8.00 and 9-59 a.m.
Even though most of the users commute by car both in the urban area and in the rest of the study area, there is still a high number of respondents who declared to use alternative modes of transport for their most important trip.

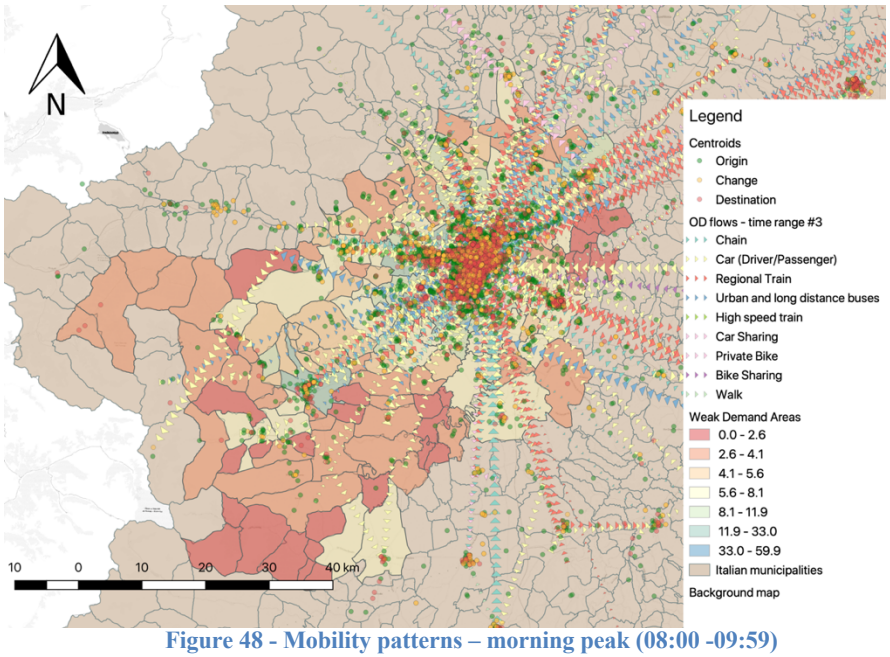


Figure 48 - Mobility patterns – morning peak (08:00 -09:59)

Flexibility is definitely one of the main variables which affect the modal choice. To this extent, Figure 49 shows the differences among respondents who declared to travel by Public Transport for their most important trip. In particular the map on the left shows the Origin-Destination lines of the respondents who declared that the flexibility of Public Transport is good (Likert scale > 4), while the map on the right shows the Origin-Destination lines of the respondents who are not satisfied by the flexibility of Public Transport. It is clear that the respondents who travel from and to the suburban and rural area of Torino are less satisfied about the flexibility than those who travel within the urban area of Torino.

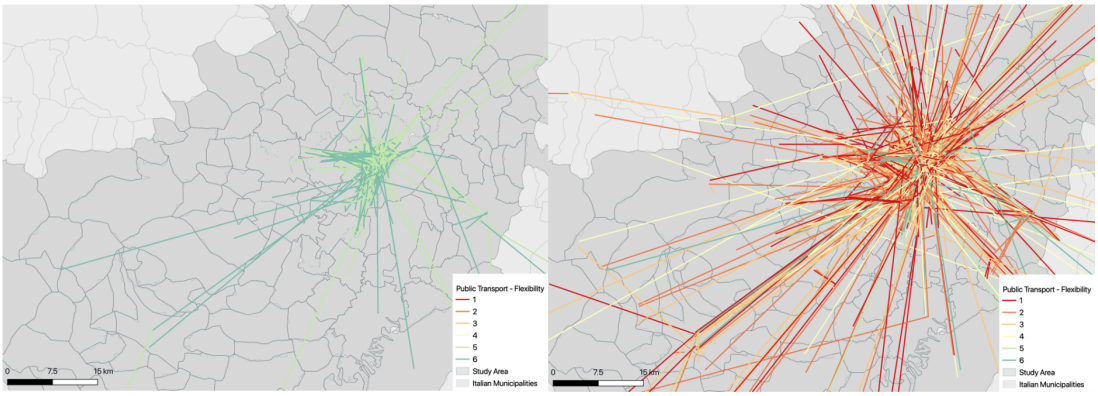


Figure 49 - Respondent's opinion about the flexibility of Public Transport

4.6 Descriptive analysis of the survey's results

In this section of the thesis, the results of the survey are shown, following the structure of the questionnaire, as described in Section 3.6.

4.6.1 Most important trip

To this extent, focusing on the most important trip, Figure 50 shows that the most frequent purposes for the most important trips are "Home-Work" and "Home-School/University".

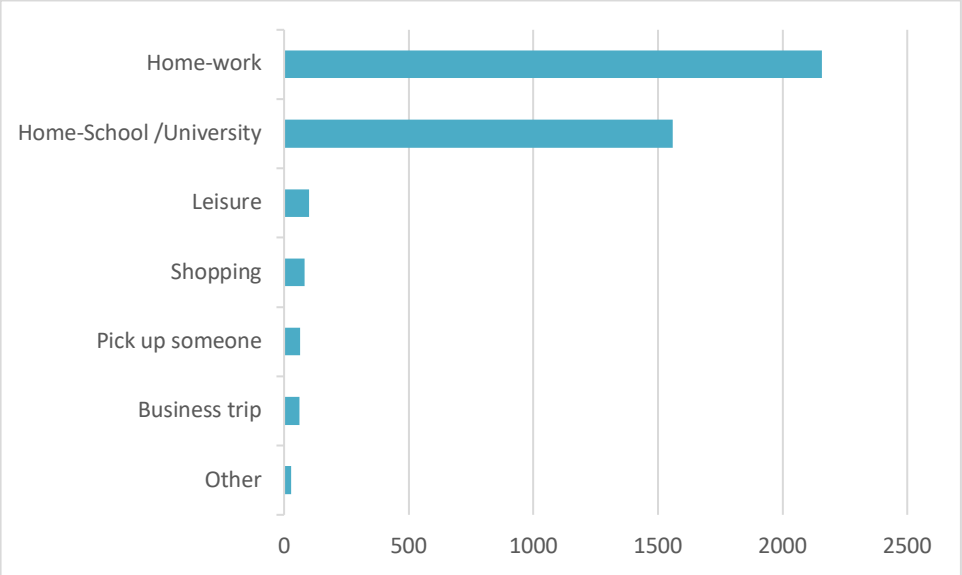


Figure 50 - Most important trip

Figure 51 shows the distributions of modes of transport according to the purposes. Car (as driver), which is the most used mode of transport, is mainly used for picking up people, leisure and shopping. Besides Urban Public Transport is mainly used for leisure but it is also frequently used for home-work and home-school/university purposes.

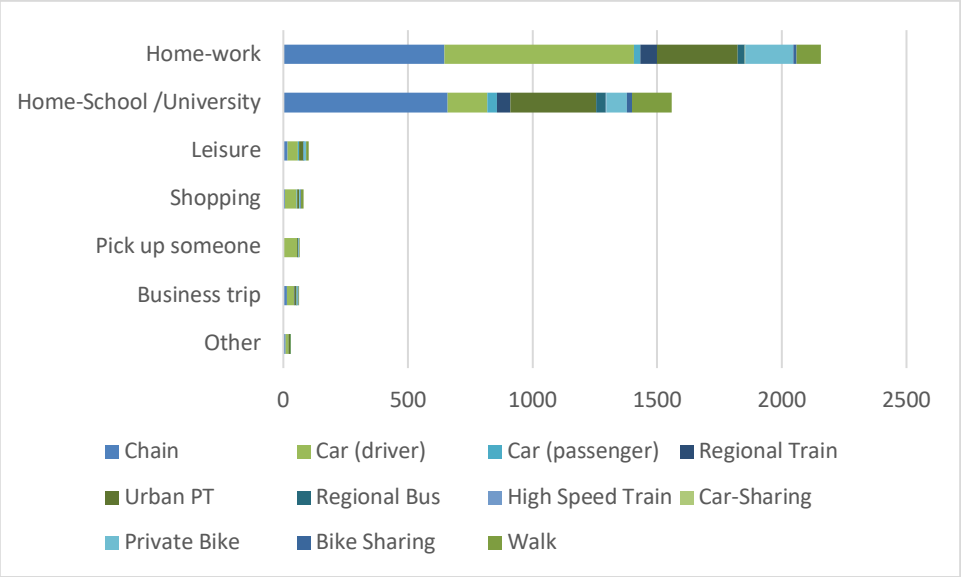


Figure 51 - Purposes and modes of transport

On the other hand, Figure 52 shows the rate of usage of the different modes of transport. Urban public transport is the most used mode with the highest rate of "5 times per week" and "more than 5 times per week".

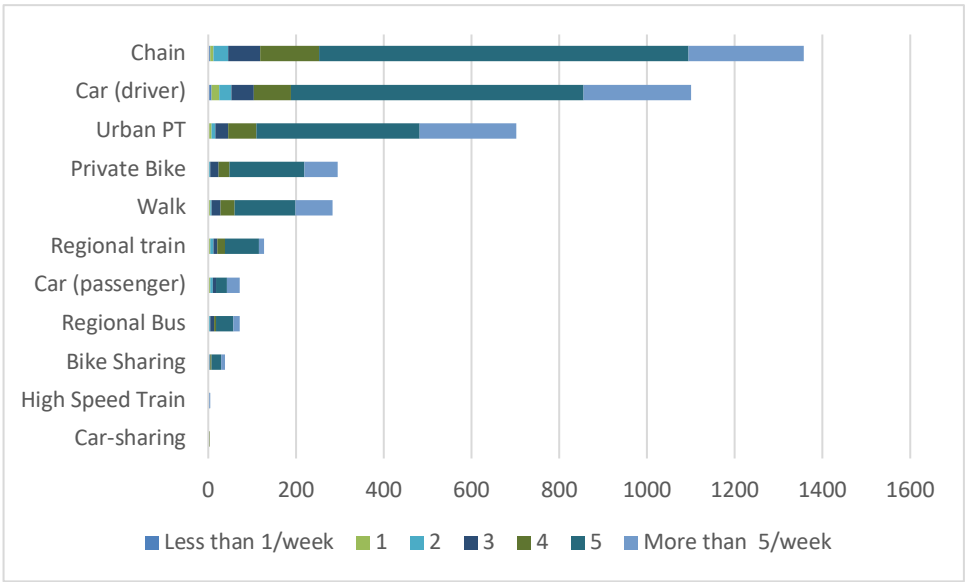


Figure 52 - Frequencies for modes of transport

Figure 53 shows that about 60% of the respondents used, in some occasions, other modes of transport. In particular, Figure 54 shows that a high number of respondents which generally drive their car, declared to have used Urban Public transport mainly because they could not use their car and due to weather conditions. Besides, also a high number of respondents who usually travel by Urban Public Transport, regional buses and regional train declared that they travelled by car due to fact that their mode of transport was not available or that there was a strike and because they needed to reach their destination on time.

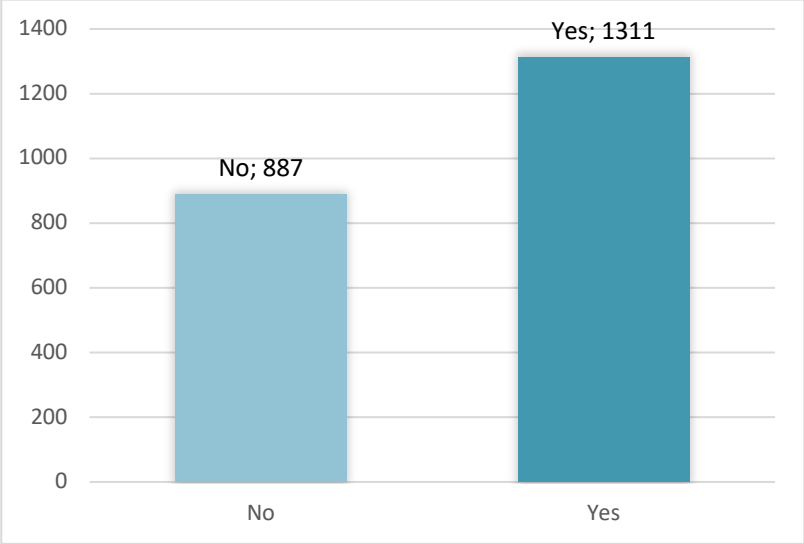


Figure 53 - Used alternative of mode of transport

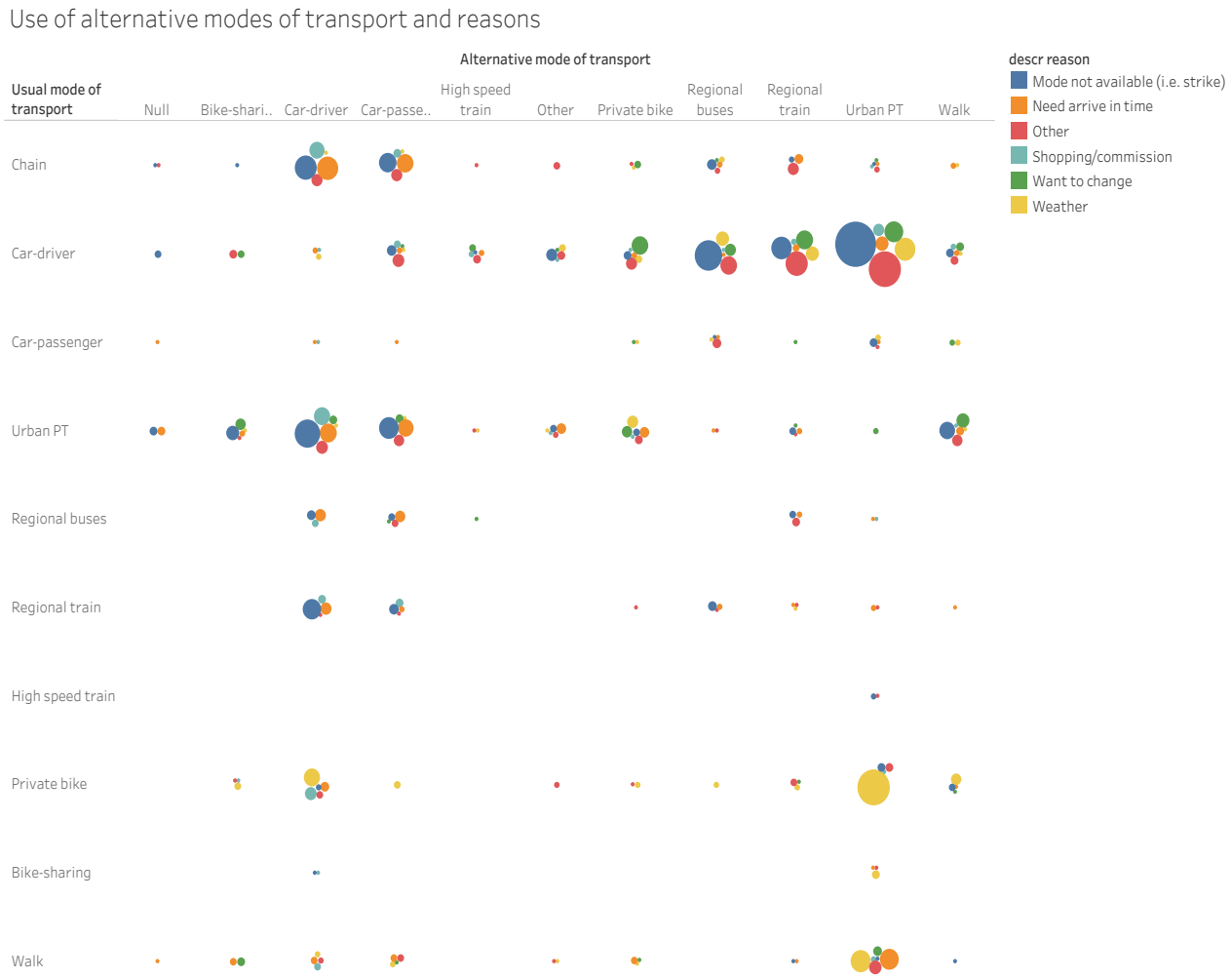


Figure 54 - Reasons for travelling with alternative modes of transport

Figure 55 shows respondents' opinions about their most important trips. Most of them think that the mode of transport they use does not allow them to pick up someone and it does not allow them to have free time during their journey. However, there is a high number of respondents who declared that the mode of transport used for their most important trip is ecological (N=2117), cheap (N=2013) and flexible (N=1638).

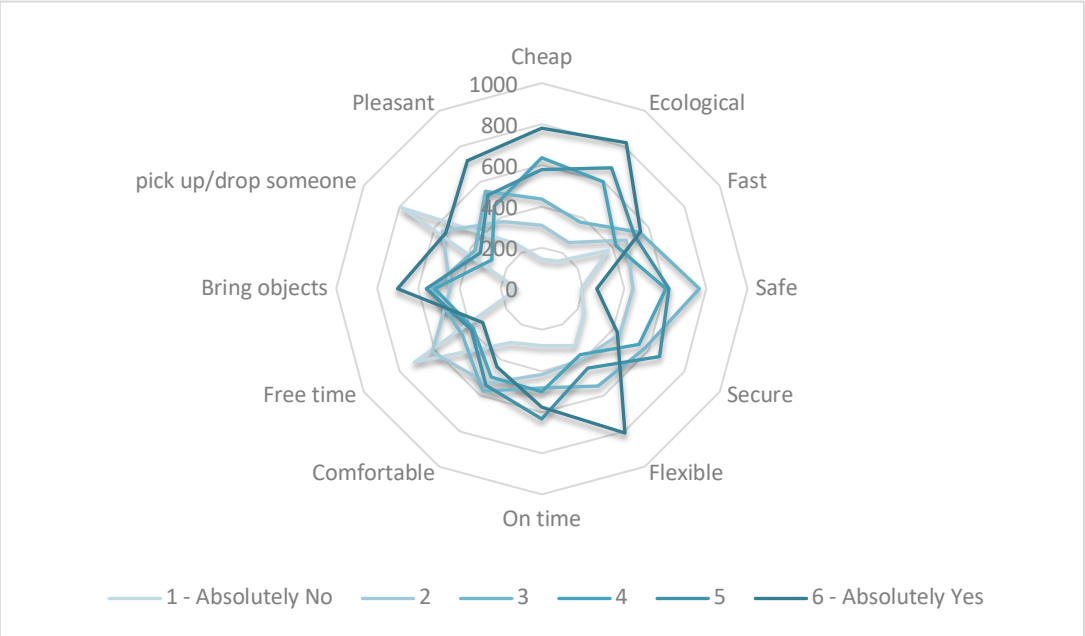


Figure 55 – Respondents' opinions about the most important trip

Focusing on specific modes of transport, Figure 56 shows respondents' opinions about travelling by train. About 60% of respondents declared that the level of cleanliness on trains is bad (Likert scale ≤ 3), and more than 50% thinks that the frequency of trains is low (Likert scale ≤ 3). On the other hand, about 50% of respondents thinks that the quality of both on-board and station facilities is good (Likert scale ≥ 4).

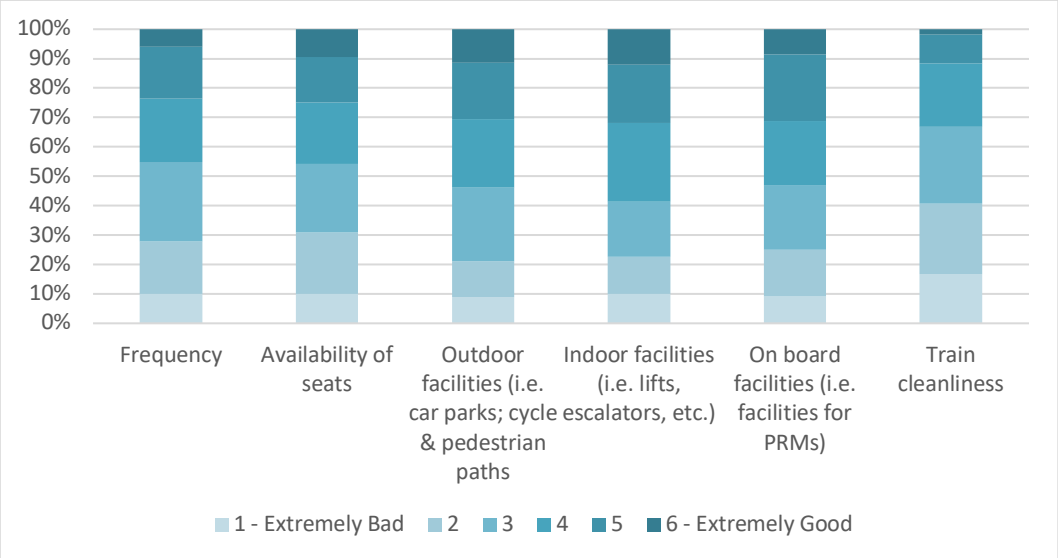


Figure 56 – Respondent's opinions about train

The opinions of the respondents who declared to use urban Public Transport for their most important trip were analysed. As shown in Figure 57, respondents who

travel by bus are generally not satisfied about this mode of transport; indeed about 80% of the respondents thinks that the availability of seats is low (Likert scale ≤ 3), about 70% of the respondents thinks the buses are not sufficiently clean (Likert scale ≤ 3) and 62% of them thinks that the bus frequency is poor (Likert scale ≤ 3). Moreover, about 40% of the respondents believes that the on-board facilities for People with Reduced Mobility (PRM) are not adequate.

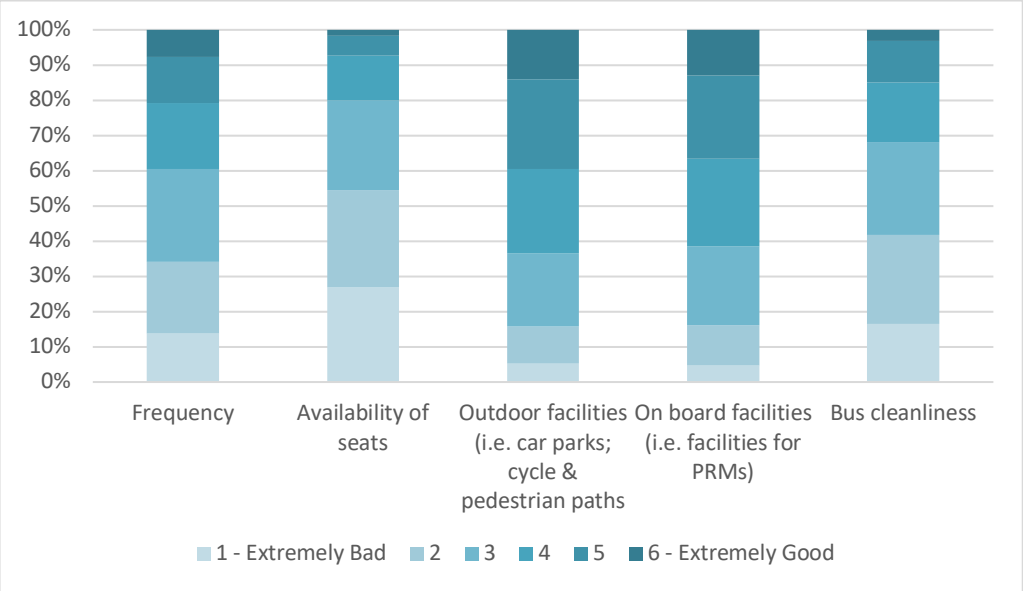


Figure 57 – Respondent's opinions about urban public transport

Subsequently, the opinions of the respondents who declared to travel by regional buses for their most important trips, were analysed. In Figure 58 it can be observed that, similarly to users of urban public transport, they are generally not satisfied with this regional buses. In detail, about 80% of the respondents declared that the

frequency of regional buses is poor (Likert scale ≤ 3), 70% claims that there is not enough availability of seats and that the stop's facilities are not sufficient.

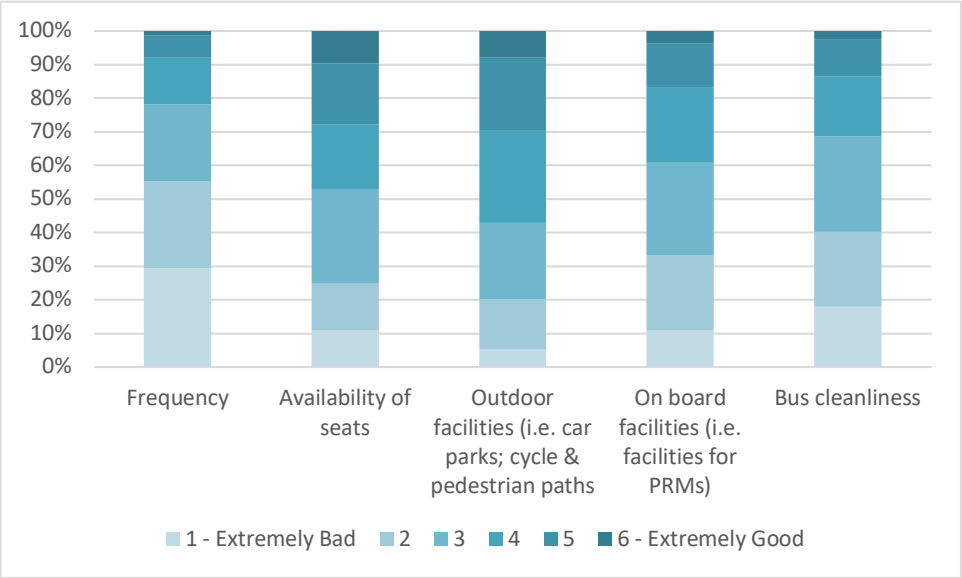


Figure 58 – Respondent's opinions about regional buses

Finally, in Figure 59 the opinions of respondents travelling by private bike and bike-sharing for their most important trip, are depicted It can be seen that about 70% of respondents think that the quality of cycling path is low (Likert scale ≤ 3), while only 50% of them believes that the availability of bike park is good (Likert scale ≥ 4).

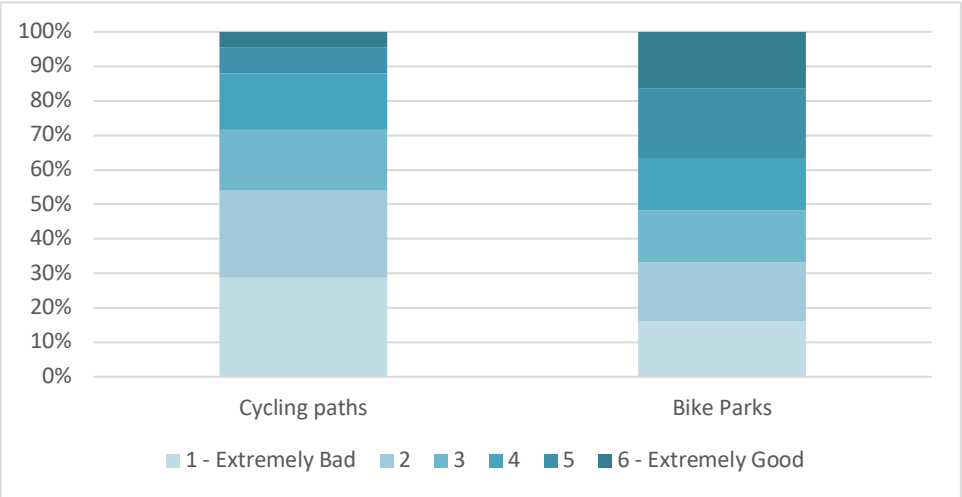


Figure 59 – Respondent's opinions about bike

Since a high number of respondents declared to use the car for their most important trip, it is important to assess what improvements could let the respondents to switch

to a more sustainable mode of transport (Public Transport and Bike). Figure 60 shows that about 90% of the respondents who travel by car would use more often by Public Transport if the service was more frequent (Likert scale ≥ 4), while 75% of the respondents if the service was more integrated.

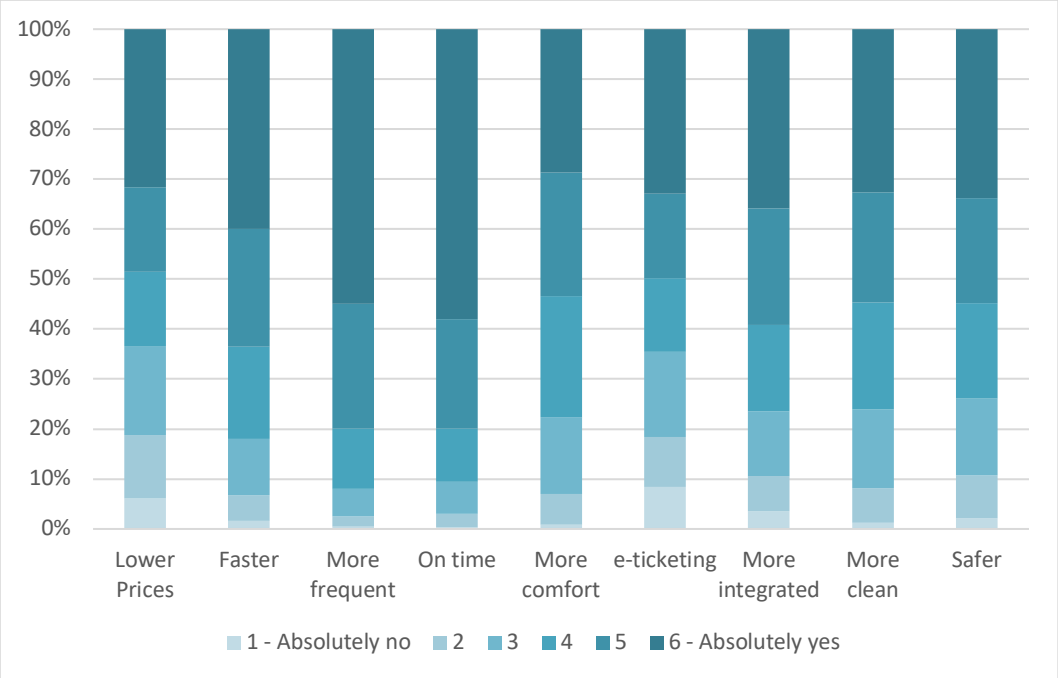


Figure 60 - Desired improvements on Public Transport trips

Figure 61 shows that 65% of respondents would travel more frequently by bike if roads were safer (Likert scale ≥ 4), while 70% if the air quality was better.

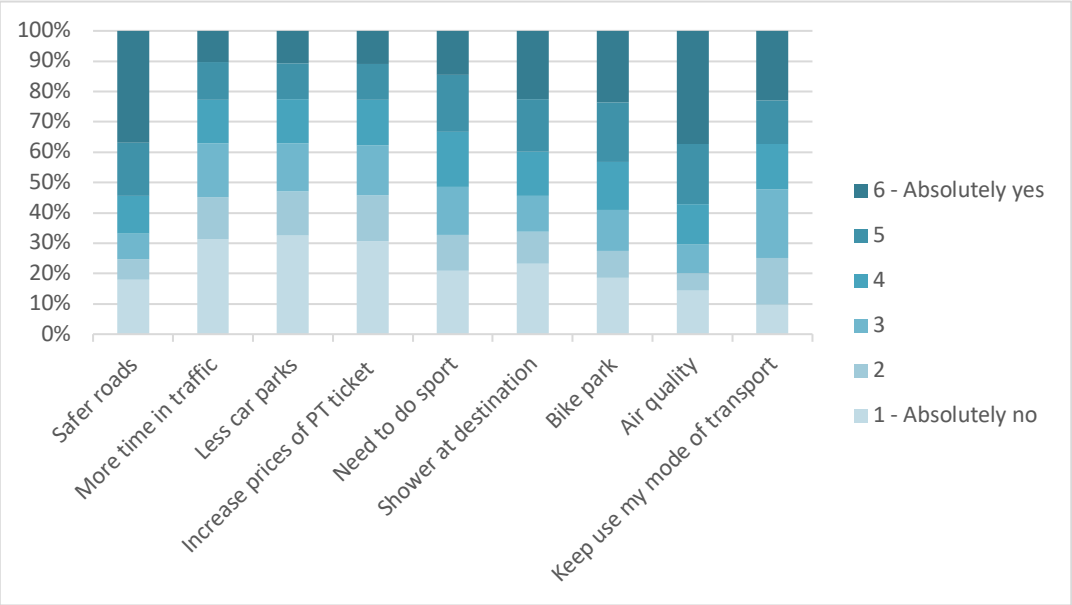


Figure 61 - Desired improvements on bike trips

Subsequently, to understand if respondents are willing to use Mobility as a Service or at least to change their current daily mobility and reduce the usage of private car, only the respondents who declared to travel within the study area and that would like to use Pay as You Go at least on one mode of transport were analysed. This sub-sample is formed by 2305 respondents.

4.6.2 Mobility as a Service

Besides, since one of the main goals of Mobility as a Service is to reduce the dependency on the car, it has been considered important to assess what respondents think about car-sharing.
Although only 17% of the respondents declared to have used car-sharing, Figure 62 shows that the majority of them (667 respondents) believes that the quality of car-sharing is good.

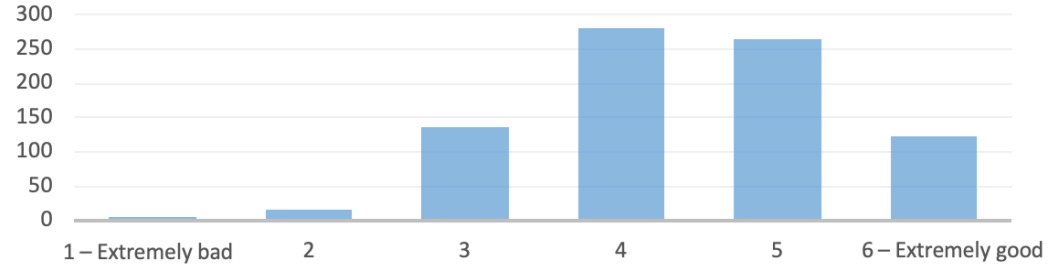


Figure 62 - Respondents' opinions about car-sharing

On the other hand, Figure 63 shows the main reasons why respondents did not use car-sharing. Almost 80% of the respondents believes that car-sharing is not easy to use, while about 50% of respondents think to not have enough information about this mode; finally, 50% are willing to use car-sharing in the next future. Surprisingly, only 30% of the respondents said that car-sharing is expensive.

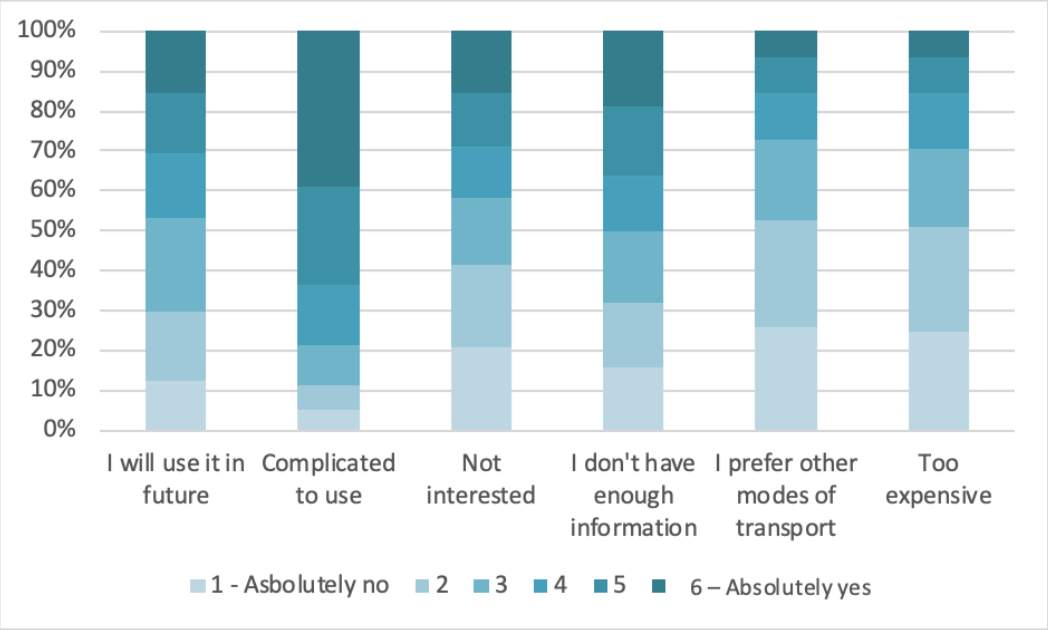


Figure 63 - Reasons for not having used car-sharing

Also car-pooling can play a key role in terms of reducing the car-ownership. However, this mode of transport seems to be still not very well known in Italy. To this extent, Figure 64 shows the age distribution of people who know what car-pooling is; it is relatively well known among respondents who are between 26 and 65 years old. On the other hand, people under 20 years old are those who know less car-pooling.

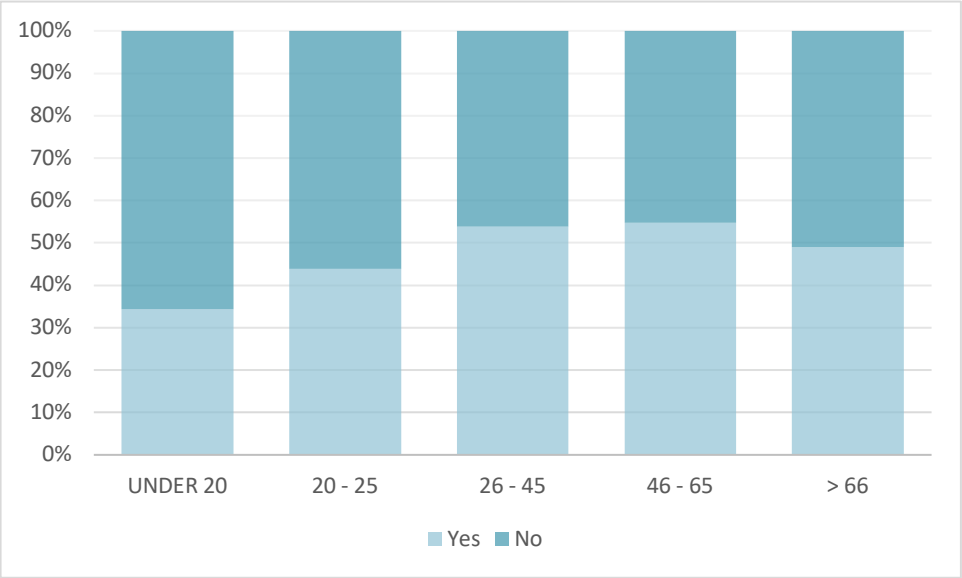


Figure 64 - Know car-pooling

In detail, Figure 65 shows the percentages of respondents who used car-pooling; the 25% of the respondents travelled by car-pooling and only 12% both as a driver and as a passenger.

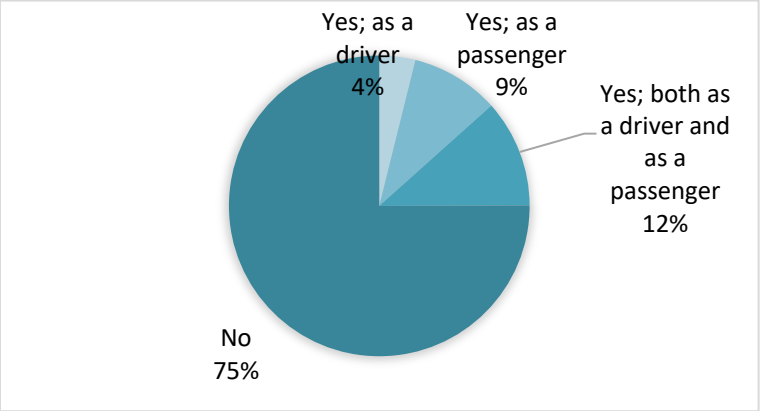


Figure 65 - Percentage of respondents who used car-pooling

Among the respondents who declared to have travelled by car-pooling, the majority (80%) is satisfied (Figure 66).

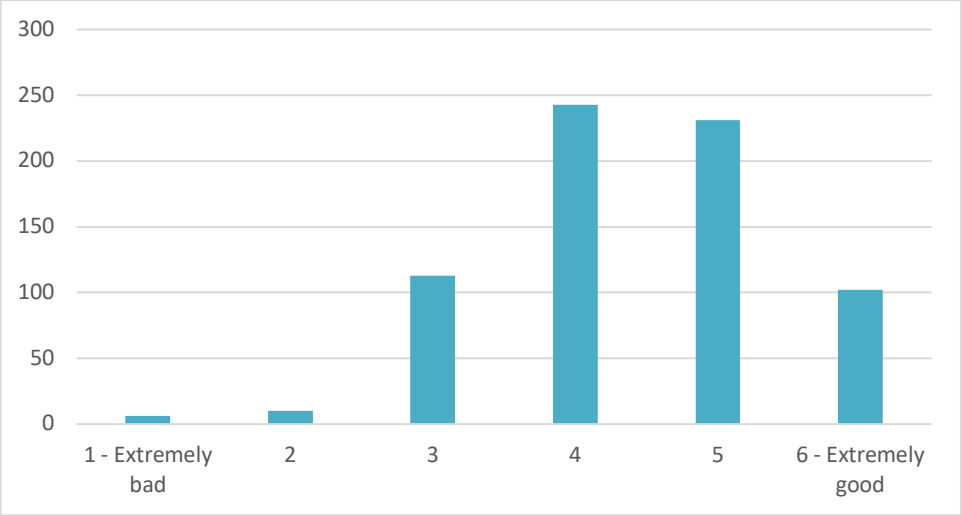


Figure 66 - Respondents' opinions about car-pooling

Concerning Mobility as a Service, Figure 67 shows that 51% of the respondents is willing to use Mobility Packages (Likert scale ≥ 4).

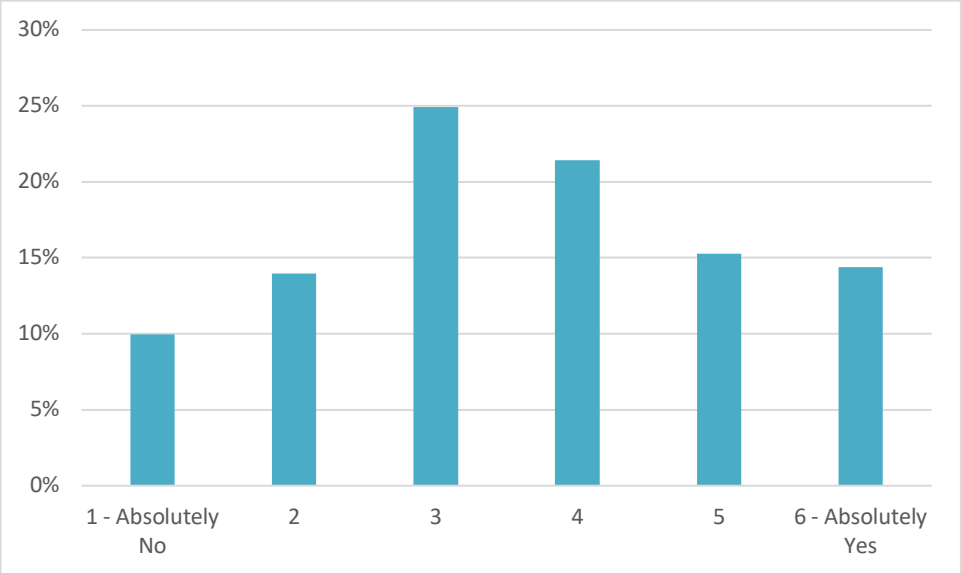


Figure 67 - Willingness to use mobility packages

On the other hand, Figure 68 shows that the majority of them wants to use a smartcard or eventually a smartphone to manage their travel subscription.

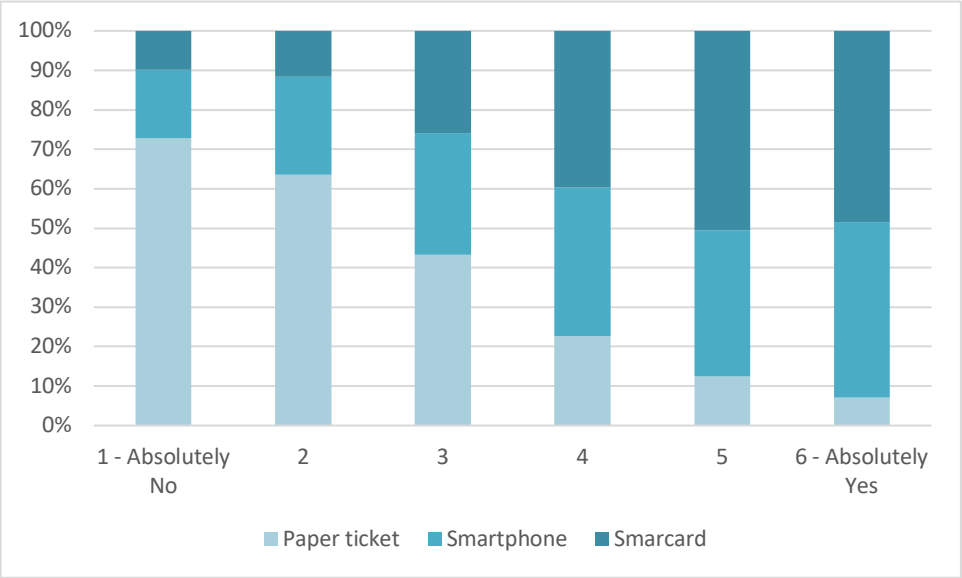


Figure 68 - Devices for managing the subscriptions

As described in Table 5 (Section 3.8), respondents have been divided in two groups, Polluting (631) and Sustainable (1674) according to the mode of transport used for their most important trip. This allowed to identify differences among groups of respondents about questions related to Mobility as a Service.
Figure 69 shows that the sustainable respondents are more interested than the polluting ones in using the Mobility Packages (Sust.: Mean = 3,72; St. Dev = 1,50 ; Poll.: Mean = 3,33; St. Dev = 1,49). However, the mobility packages seem to not be particularly appealing for both groups of respondents.

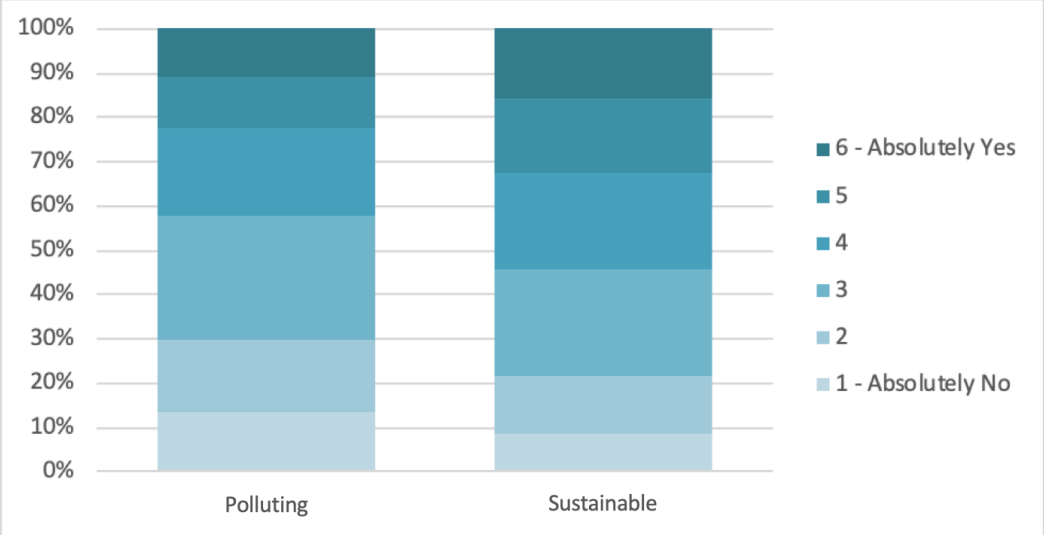


Figure 69 – Willingness to use mobility Packages (Sustainable VS Polluting)

Then (Table 6), respondents have been divided in two groups according to the origin and destination of their most important trip.
The definition of these two groups helps to identify where the Mobility as a Service has more chance to be successful. The group "Urban Torino" counts 1352 respondents, while the other group counts 953 respondents.
Figure 70 shows that the respondents who travel within the urban area of Torino for their most important trip seem to be more interested in using the Mobility Packages than those who travel out of the city of Torino (Urb-To: Mean = 3,69; St. Dev = 1,51; Others: Mean = 3,50; St. Dev = 1,50).

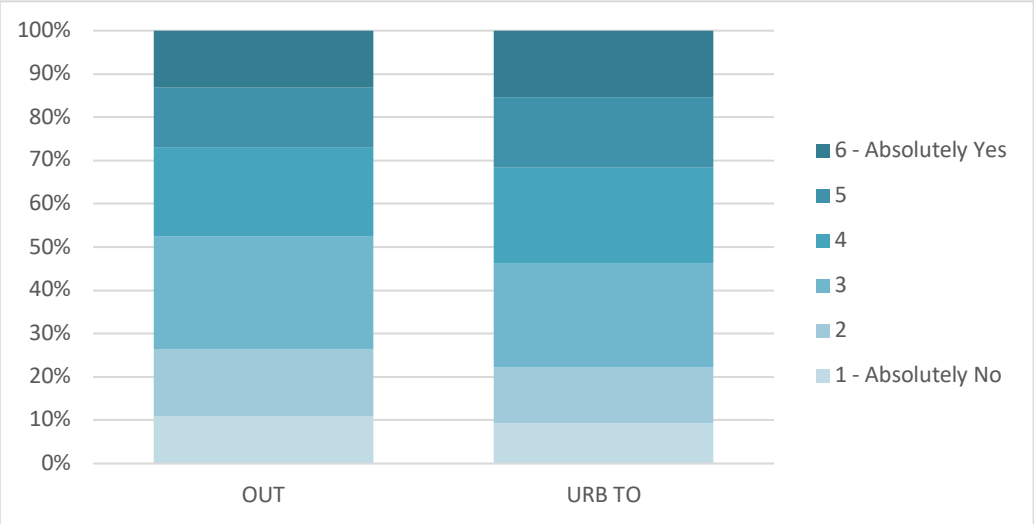


Figure 70 – Willingness to use mobility Packages (Urban Torino VS Others)

Another key question related to Mobility as a Service is the willingness to pay a specific mode of transport through a Pay as You Go system.
Figure 71 shows the willingness to use Pay as You Go on the different modes of transport. Respondents declared to be interested in using Pay as You Go on Urban Public Transport (81%; Likert scale ≥4) and Regional trains (64%; Likert scale ≥ 4).

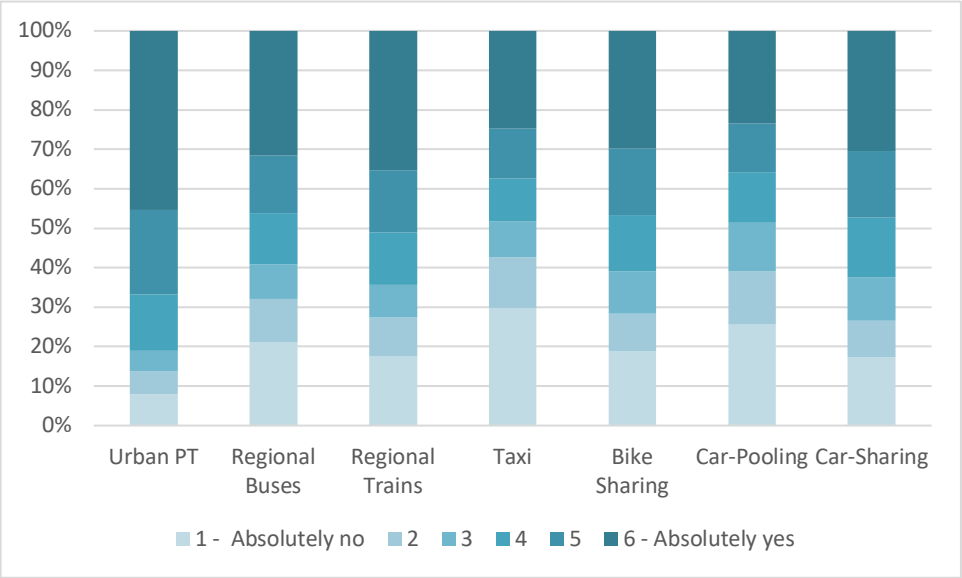


Figure 71 - Willingness to use Pay as You Go (modes of transport)

Focusing on Pay as You Go on Urban Public Transport, Figure 72 shows that the group of pollutant is more interested in using this payment system (558 out of 631 respondents; 88%; Likert scale ≥ 4) than the group of sustainable respondents (1312 out of 1674; 78%; Likert scale ≥ 4). (Polluting: Mean = 4,96; St. Dev = 1,34; Sustainable: Mean = 4,62; St. Dev. = 1,66).

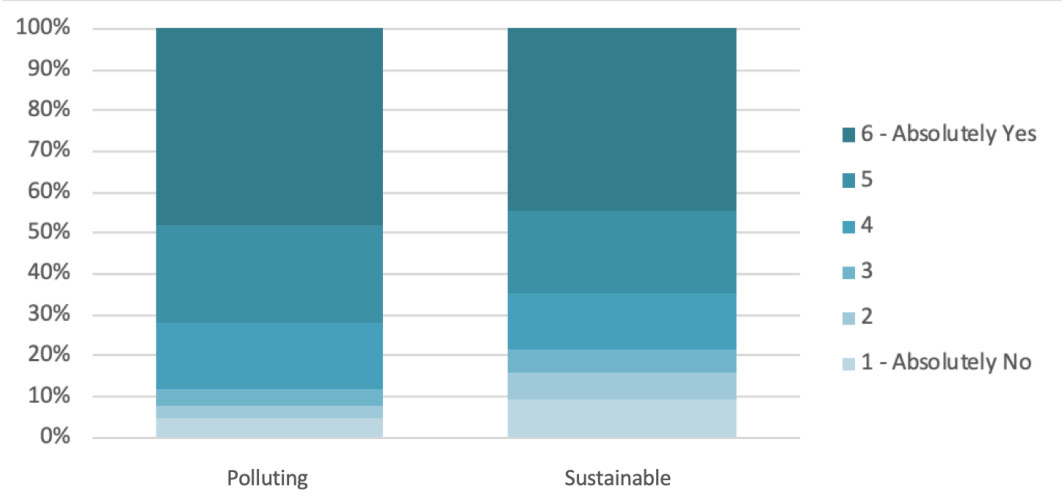


Figure 72 - Willingness to use Pay as You Go on Urban Public Transport (Polluting VS Sustainable)

To understand the reason why respondents want to use Pay as You Go, the opinions about the modes of transport used for the most important trip have also been grouped according to the classification described in Table 5.

Therefore, Figure 73 shows that more than 40% of the polluting respondents believes that their mode of transport is expensive (Likert scale ≥ 4). On the other hand, about 25% of the sustainable respondents believe that their mode of transport is expensive.

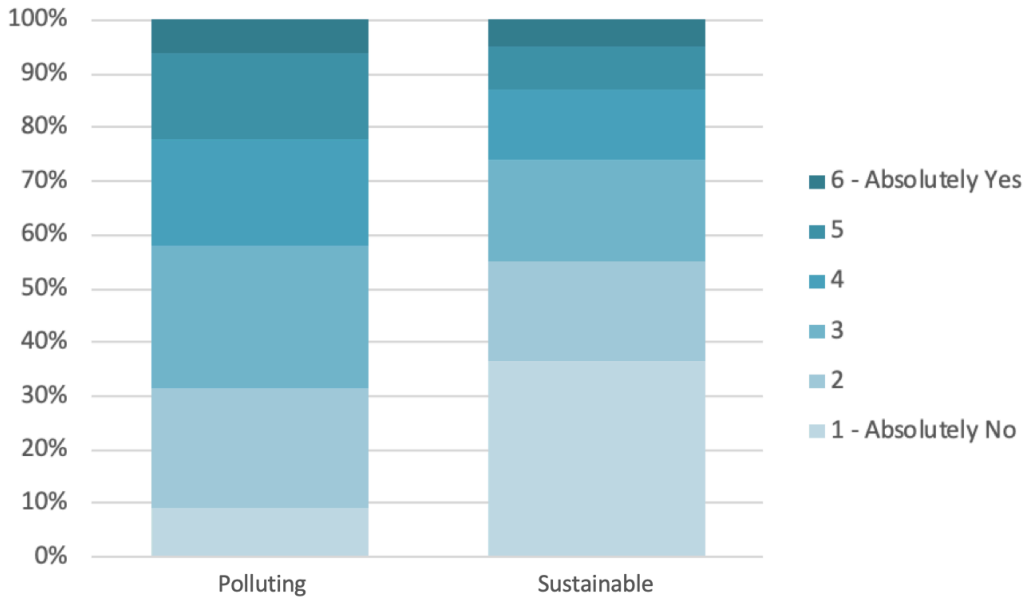


Figure 73 - Mode used for most important trips - Expensive (Polluting VS sustainable)

(Polluting: Mean = 3,30; St. Dev = 1,38; Sustainable: Mean = 2,52; St. Dev. = 1,51).

Similarly, Figure 74 shows that 76% of polluting respondents believe that their mode of transport is fast, while only 43% of the sustainable respondents think so. (Polluting: Mean = 4,59; St. Dev = 1,40; Sustainable: Mean = 3,33; St. Dev. = 1,65).

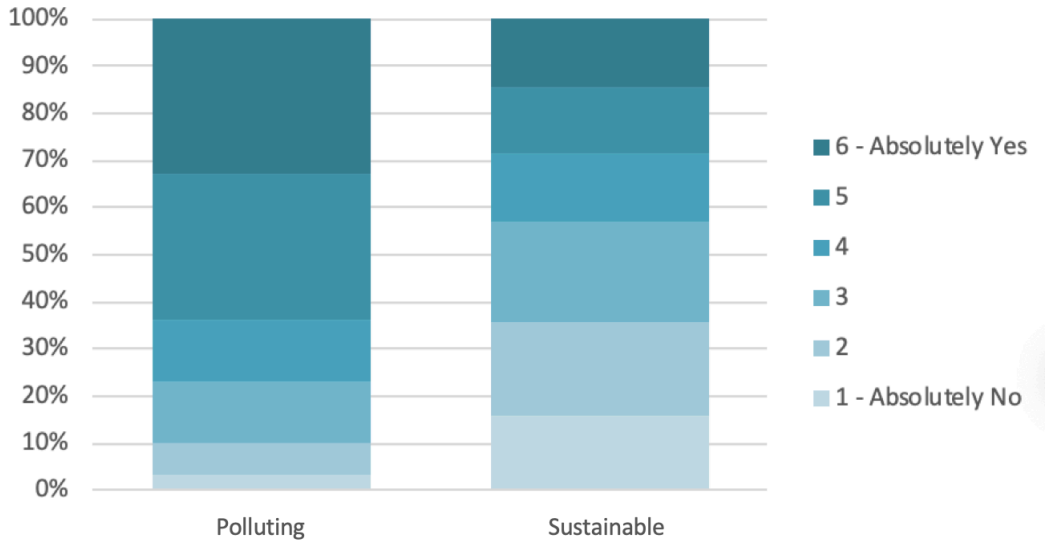


Figure 74 - Mode used for most important trips - Fast (Polluting VS sustainable)

Finally, Figure 75 shows that 83% of polluting respondents believes that their mode of transport is flexible, while only 47% of sustainable respondents think so. (Pollutant: Mean = 5,00; St. Dev = 1,31; Sustainable: Mean = 3,56; St. Dev. = 1,69).

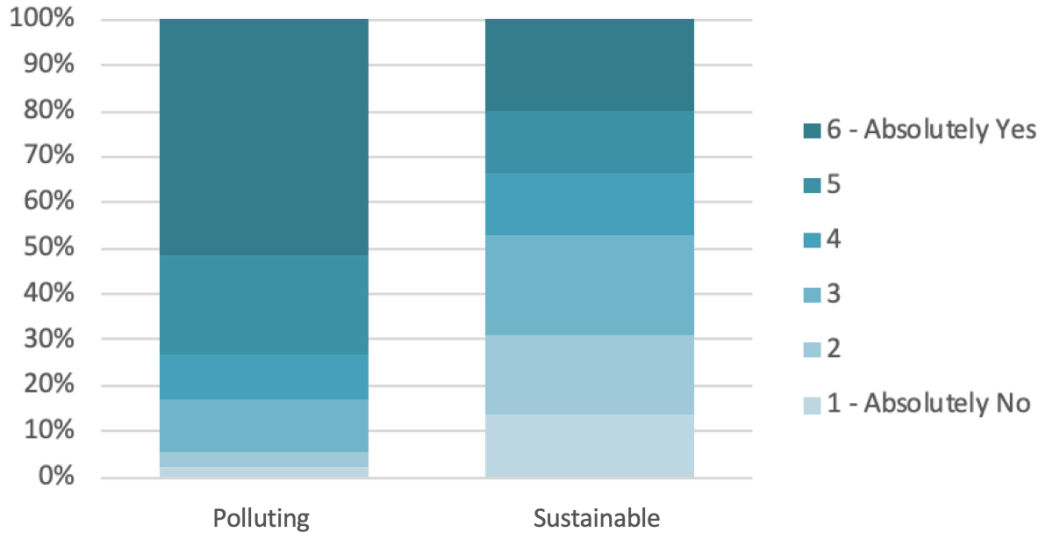


Figure 75 - Mode used for most important trips - Flexible (Polluting VS sustainable)

4.7 Cluster Analysis

As discussed in Section 3.8, a cluster analysis was performed to find homogeneous groups to which tailor potential mobility services. Cluster analysis was performed six times, increasing the number of clusters (from 2 to 8); the outcomes of the

above-mentioned iterations are described in Table 12 where, for each iteration, counts, means and standard deviations are shown.

Table 12 - Outcomes of cluster analysis

Cases	Statistics	Clusters								All Clusters
		1	2	3	4	5	6	7	8	
2 clusters	Count	1320	985							2305
	Mean	0,79	0,56							0,677
	Std Dev	1,38	1,32							1,349
3 clusters	Count	811	793	701						2305
	Mean	0,44	0,47	0,37						0,424
	Std Dev	1,24	1,37	1,20						1,270
4 clusters	Count	506	720	527	552					2305
	Mean	0,29	0,38	0,29	0,29					0,313
	Std Dev	1,32	1,23	1,26	1,21					1,255
5 clusters	Count	415	485	497	479	429				2305
	Mean	0,24	0,29	0,28	0,31	0,28				0,278
	Std Dev	1,20	1,23	1,13	1,33	1,33				1,243
6 clusters	Count	385	428	370	362	282	478			2305
	Mean	0,21	0,25	0,19	0,20	0,16	0,24			0,206
	Std Dev	1,24	1,34	1,18	1,28	1,28	1,14			1,243
7 clusters	Count	397	319	223	276	344	475	271		2305
	Mean	0,23	0,16	0,11	0,16	0,15	0,25	0,16		0,173
	Std Dev	1,33	1,14	1,10	1,33	1,03	1,21	1,34		1,212

To define the right number of clusters, the Elbow Method was used. To this extent the intra-cluster variation was calculated. Figure 76 shows that the variance increases with the reduction of the number of clusters, apart from the case with four clusters. Thus, four was selected as the right number of clusters.

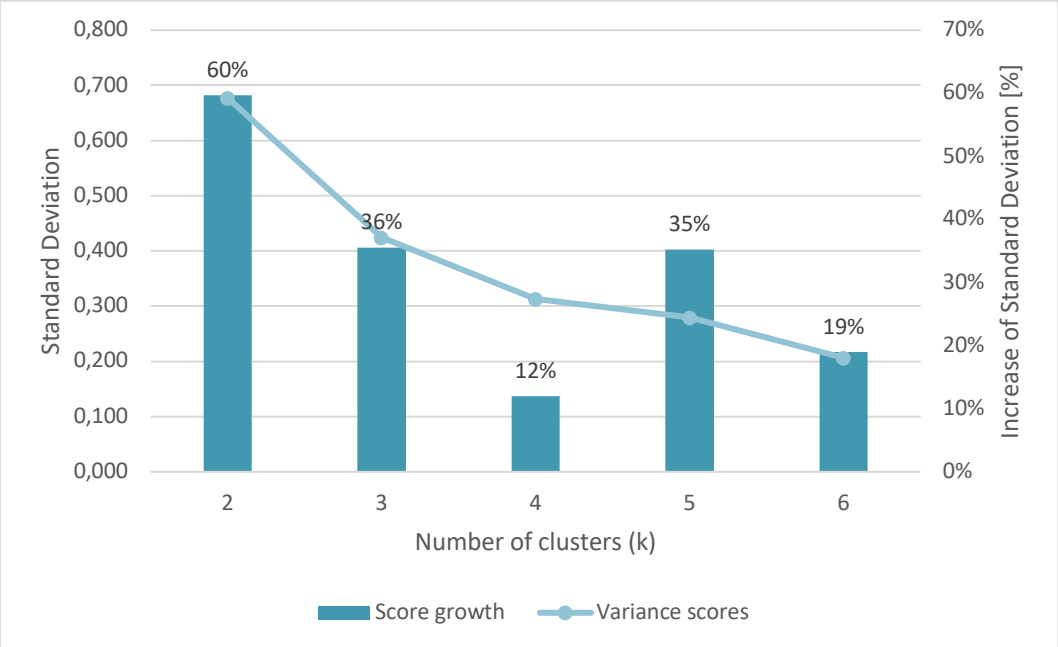


Figure 76 – Standard deviation analysis for cluster solutions

As shown in Figure 77, Cluster 1 counts 506 respondents (22%), Cluster 2 counts 720 respondents (31%), Cluster 3 counts 527 respondents (23%) and Cluster 4 counts 552 respondents (24%).

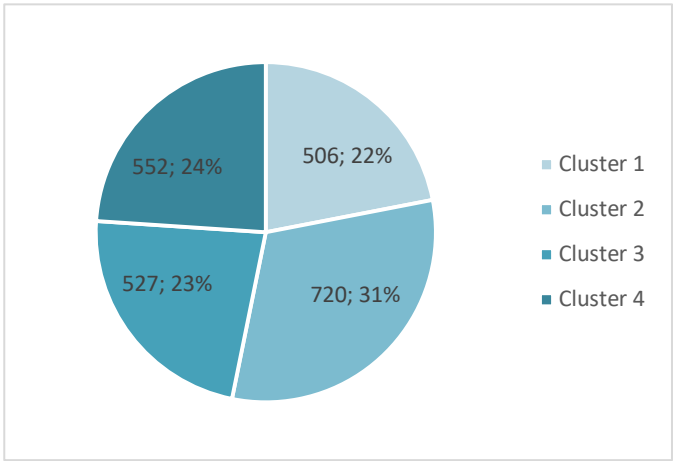


Figure 77 - Composition of clusters

Table 13 shows the final centres of each cluster that have been provisionally labelled. The first Cluster shows that the means of the variables related to the usage of Pay as You Go on the different modes of transport and the willingness to use Mobility Packages are generally high. On the other hand, the means of the variables related to the respondent's opinion about the mode of transport used for the most important trip show low values. For this reason, the respondents of this cluster have been provisionally labelled as "*MaaS confidents*", to describe users who are generally not satisfied with their daily mobility but they hope that MaaS can improve the quality of their journey.

The second cluster shows the opposite situation of Cluster 1. Indeed, respondents seem generally satisfied with their current mode of transport and they seem to not be particularly interested in adopting Pay as You Go as a payment system for any mode of transport apart from Urban Public Transport. Besides, the respondents of this cluster also seem to not be interested in mobility packages. For these reasons, the respondents who belong to this cluster have been labelled as "*Satisfied with their current mobility".*

On the other hand, the respondents who belong to the third cluster generally declared to not be satisfied with their current mobility, which they just consider it relatively cheap and ecological, and they also seem to not be interested in adopting a Pay as You Go apart from Urban Public Transport. Besides they seem to not be interested in using Mobility Packages.

For these reasons, the respondents of this cluster have been labelled as "*Unsatisfied*".

Finally, the respondents of the fourth cluster seem generally enthusiast about the idea of adopting a Pay as You Go on all the modes of transport and they are also quite satisfied about the mode of transport they use for their most important trip.

For these reasons, the respondents of the fourth cluster have been labelled as "*MaaS enthusiast*".

Table 13 - Final Cluster centres

		MaaS confidents	Satisfied with their current mobility	Unsatisfied	MaaS Enthusiast
		1	2	3	4
Pay as You Go	Urban PT	4,81	4,28	4,40	5,50
	Regional buses	4,75	2,66	2,98	5,36
	Regional trains	4,94	3,01	3,23	5,41
	Taxi	4,62	2,33	2,13	4,80
	Bike Sharing	4,87	3,01	2,62	5,40
	Carpooling	4,59	2,37	2,03	5,09
	Car Sharing	5,05	3,07	2,54	5,49
Opinions about mode used for most important trip	Cheap	3,99	4,65	3,80	4,46
	Ecological	4,31	4,66	4,10	4,22
	Fast	2,42	4,68	2,33	4,83
	Secure	3,03	4,43	2,95	4,35
	Flexible	2,56	5,05	2,50	5,19
	On time	2,68	4,92	2,56	4,99
	Comfortable	2,33	4,58	2,41	4,73
	Pick up someone	2,11	3,79	2,18	4,10
	Pleasant	2,90	4,97	2,72	4,89
	Use Mobility Packages	3,90	3,31	3,49	3,86

Socioeconomic characteristics related to each cluster are described in Table 14.
The four clusters are similar in terms of gender, age, professional status, education, characteristics of the household and number of cars. However, Cluster 1 and 3 are those showing the highest percentage of respondents not owning a car (9%).

Instead, significant differences can be appreciated considering the travel habits. Cluster 1 and 3 are the most "multimodal" groups; indeed, these clusters show the highest percentages of respondents travelling with more than one mode of transport for their most important trip (respectively 38% and 41%). Then, they record the highest percentage of respondents travelling with Urban Public Transport (Cluster 1 = 38%; Cluster 3 = 40%). On the other hand, Cluster 2 and 4 count the highest number of respondents travelling by car (Cluster 2 = 36%; Cluster 4 = 45%) and do not have urban or regional bus subscription. Cluster 1, 2 and 4 have similar percentages of respondents who purchased a Bike-sharing annual subscription (respectively 19%, 17% and 20%).
Respondents who belong to Cluster 1 are those who, on average, travel for the longest distance (12 km), while respondents from Cluster 2 only 8,5 km.
In terms of trip's purposes, the four clusters show similar characteristics, even though Cluster 4 is the one with the highest percentage of "home-work" trip (62%) and only 28% of respondents travel from home to school/university.
Finally, Cluster 1 and 2 are those who have the highest percentages of respondents travelling within the urban area of Torino (respectively 61% and 63%).

Table 14 Socioeconomic characteristics of the four clusters

		Cluster 1	Cluster 2	Cluster 3	Cluster 4
	N	506	720	527	552
	%	22%	31%	23%	24%
Gender	Male	45,3%	57,9%	44,2%	55,6%
	Female	54,5%	41,8%	55,6%	44,4%
	Other	0,2%	0,3%	0,2%	
Age	Mean	34,17	36,56	33,44	37,67
Professional Status	Unemployed	3%	2%	2%	3%
	Retired		1%	1%	1%
	Student	49%	42%	54%	34%
	Worker		1%	1%	1%
	Employee	42%	43%	36%	49%
	Manager		2%	2%	3%
	Teacher	2%	5%	2%	3%
	Self Employed	4%	5%	1%	6%
Education	Secondary School	3%	4%	4%	3%
	High School	47%	43%	50%	42%
	Bachelor Degree	19%	18%	18%	16%
	Master Degree	27%	28%	24%	33%
	PhD Degree	4%	6%	3%	6%
	Other		1%		1%
Household size	1	10%	12%	9%	16%
	2	19%	22%	17%	23%
	3	26%	23%	25%	25%
	4	31%	35%	35%	28%
	5 or more	14%	8%	13%	8%
Children in the household	0	30%	33%	26%	39%
	1	29%	23%	24%	24%
	2	29%	37%	37%	31%
	3 or more	12%	7%	12%	6%
Cars in the household	0	9%	6%	9%	7%
	1	34%	35%	29%	37%
	2	44%	42%	44%	40%
	3 or more	13%	17%	18%	16%
Driving License	Yes	95%	95%	92%	97%
	No	5%	5%	8%	3%
Urban PT subscription	No subscription	29%	63%	28%	69%
	Weekly subscription	3%	3%	3%	3%
	Monthly subscription	14%	5%	16%	5%
	Annual subscription	51%	26%	51%	18%
	Staff Pass	3%	3%	2%	4%
Regional Buses subscription	No subscription	81%	92%	76%	92%
	Weekly subscription	1%	1%	2%	1%
	Monthly subscription	8%	3%	11%	4%
	Annual subscription	8%	4%	11%	2%
	Staff Pass	1%	1%	1%	1%
Bike-sharing subscription	No subscription	80%	82%	87%	79%
	Monthly subscription	1%	1%	1%	1%
	Annual subscription	19%	17%	12%	20%
Most important mode	Multimodal	38%	15%	41%	13%
	Car driver	8%	36%	7%	45%
	car passenger		4%	1%	2%
	Regional train	2%	1%	2%	1%
	Urban PT	38%	11%	40%	8%
	Regional buses	4%		4%	1%
	Bike	5%	18%	1%	18%
	Walk	4%	16%	5%	12%
Distance [km]	Mean	12,081	8,526	13,339	10,105
Purpose of trip	Home-work	50%	56%	44%	62%
	Business trip	1%	1%		1%
	Home-school/university	45%	37%	52%	28%
	Shopping/errands	1%	2%	1%	3%
	Leisure	2%	2%	2%	3%
	Pick/drop someone	1%	3%	1%	2%
Weekly frequency	Less than 1 time per week				
	1 time	1%	1%		1%
	2 times	1%	2%	2%	2%
	3 times	6%	5%	5%	3%
	4 times	8%	8%	9%	9%
	5 times	56%	60%	58%	59%
	More than 5 times	29%	25%	25%	26%
Origin- Destination	RUR - RUR		2%	1%	3%
	RUR - SUB	2%	2%	2%	3%
	RUR - URB TO	14%	6%	17%	9%
	SUB - SUB	3%	5%	3%	7%
	SUB - URB TO	21%	22%	22%	24%
	URB TO - URB TO	61%	63%	55%	54%

Table 15 shows the results of the Analysis of Variance (ANOVA). F-Ratios are calculated to estimate the differences between two clusters and understand the role of average values of different variables in the formation of clusters. In the analysis of variance (ANOVA) table, significance level of F-ratio holds importance: variables with high value of significance are those which contribute less to distinguish the clusters.

Table 15 ANOVA outcome of the Cluster Analysis

Variables	Cluster		Error		F	Sign.
	Mean Square	df	Mean Square	df		
Urban PT	178,98	3	2,283	2301	78,387	0,000
Regional buses	1027,55	3	2,472	2301	415,633	0,000
Regional trains	849,88	3	2,517	2301	337,599	0,000
Taxi	1164,86	3	2,510	2301	464,067	0,000
Bike Sharing	1048,50	3	2,174	2301	482,371	0,000
Carpooling	1349,99	3	1,949	2301	692,524	0,000
Car Sharing	1175,34	3	1,902	2301	617,911	0,000
Cheap	94,01	3	2,196	2301	42,820	0,000
Ecological	37,88	3	2,236	2301	16,936	0,070
Fast	1067,58	3	1,440	2301	741,475	0,000
Secure	375,81	3	1,796	2301	209,251	0,000
Flexible	1268,73	3	1,333	2301	951,434	0,000
On time	1032,96	3	1,247	2301	828,274	0,000
Comfortable	983,72	3	1,166	2301	843,825	0,000
Pick up someone	610,22	3	2,715	2301	224,771	0,000
Pleasant	863,50	3	1,489	2301	580,017	0,000
Use Mobility Packages	49,47	3	2,225	2301	22,240	0,000

Therefore from Table 15 it is evident that "q11_2_Ecological" (*The mode of transport that I used for my most frequent trip is ecological* – Likert scale [1-6]) has the least impact on the formation of clusters (high significance level: 0.0701), while the other variables have a comparable effect.

Focusing on the characteristics of each cluster, Figure 78 and Figure 79 show, respectively, the distribution of the age of the respondents of each cluster and the distribution of the distance of the most important trip.
Figure 78 shows that Cluster 3 records the highest number of young respondents (between 18 to 30 years old). The majority of respondents between 35 to 55 years old belong to Cluster 4, while Cluster 2 is that having the highest number of respondents over 60.

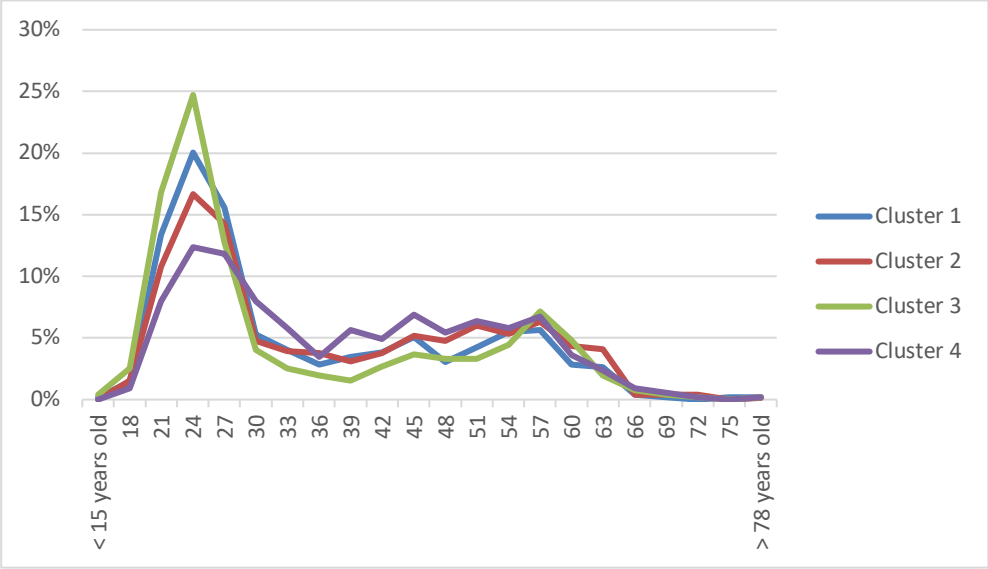


Figure 78 - Age distribution among clusters

Similarly, Figure 79 shows that Cluster 2 records the highest percentage of respondents travelling short distances (< 3 km) while the distance travelled by people in Cluster 1 is mainly between 5 and 10 km. Cluster 3, instead, has the highest percentage of respondents who travel for more than 20 km for their most important trip.

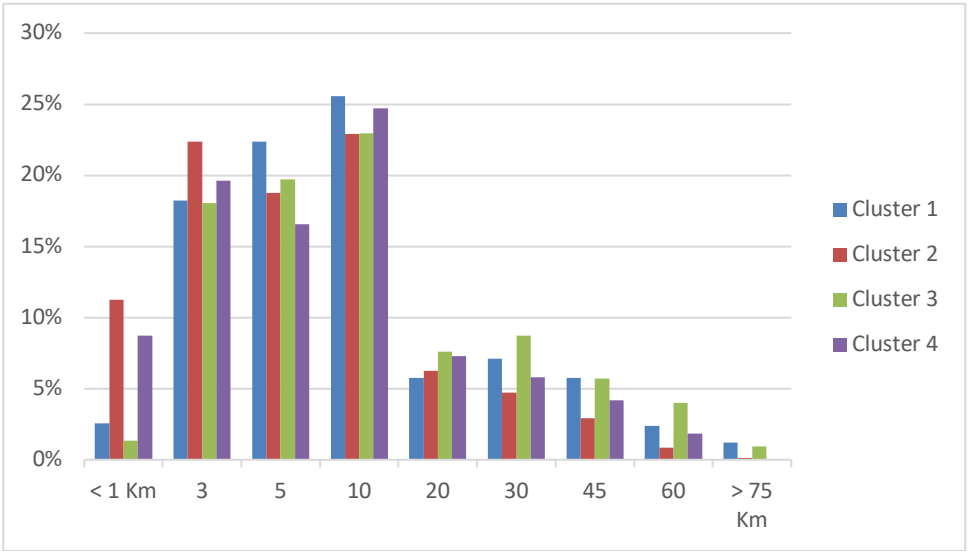


Figure 79 - Distance distribution among clusters

Although Table 14 described the characteristics of the most important trips of the four clusters, Figure 80 and Figure 81 provide more information the characteristics of the overall trips.

Figure 80 shows that the respondents travel for work purposes 5 times per week, where Clusters 4 and 3 show, respectively, the and the lowest values.

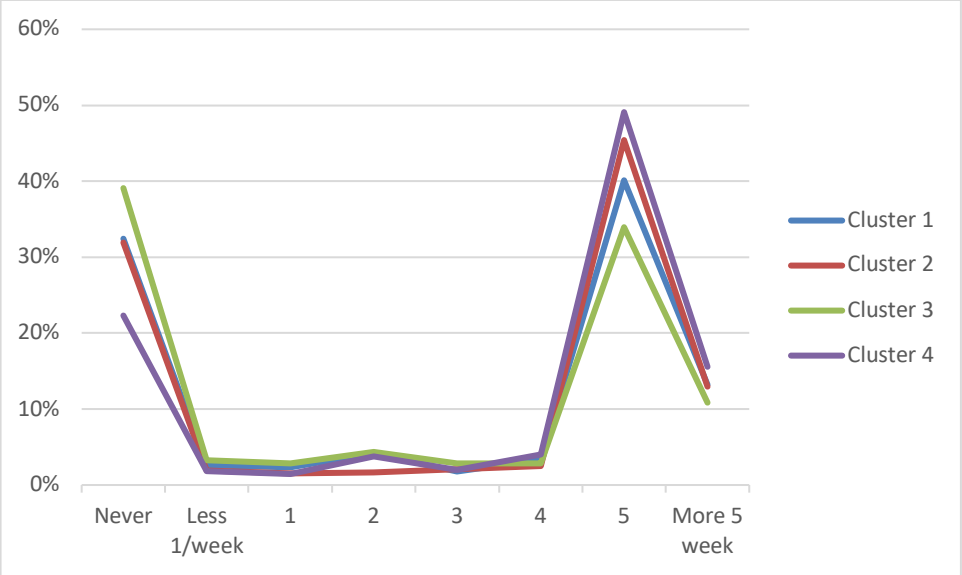


Figure 80 - Frequency of home-work trips

Figure 81 shows that Cluster 3 records the highest percentage of respondents travelling 5 times per week for study purpose.

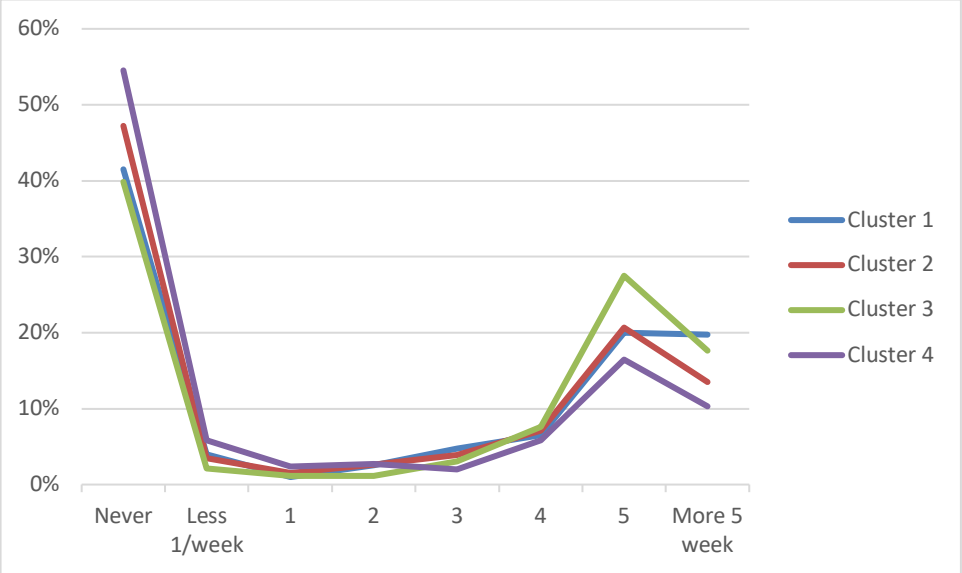


Figure 81 - Frequency of home-school/university trips

Figure 82 summarizes the opinion of the respondents about the willingness to use mobility packages. Although none of the four clusters show particularly high percentages in terms of willingness to use Mobility Packages, 58% of the respondents of Cluster 1 and 55% of Cluster 4 declared to be interested.

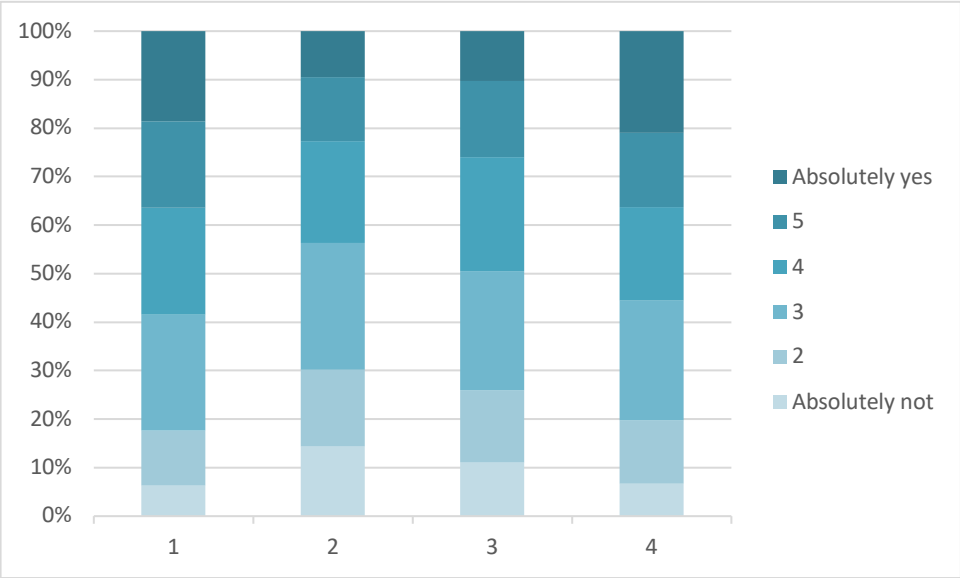


Figure 82 - Willingness to use Mobility Packages

Figure 83 shows the number of modes of transport that the respondents want to integrate in a Pay as You Go fare system. Cluster 2 and 3 want to use it only for one mode of transport; however, the majority of the respondents wants to use the Pay as You Go including 5 or more modes of transport.

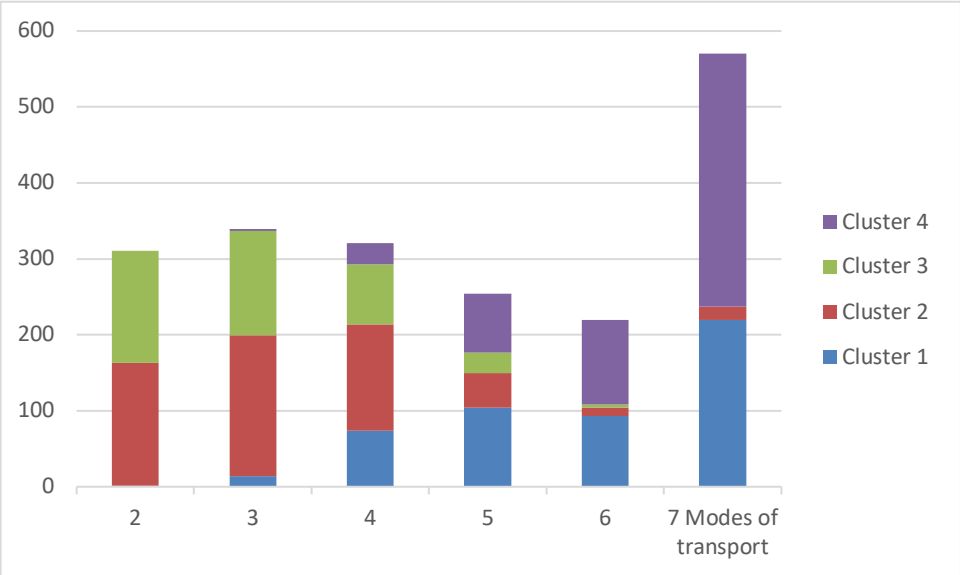


Figure 83 - Number of modes of transport to be integrated in Pay as You Go

Observing the data, the respondents seem to be more interested in using the Pay as You Go system rather than the Mobility Packages. However, since most of them declared to be willing to use Pay as You Go on more than one mode of transport, a synthesis of the favoured combinations of Pay as You Go are provided for each cluster.
Table 16 shows that the most selected combinations of Pay as You Go, chosen by 220 respondents, include all the modes of transport (Urban Public Transport, Regional Bus, Regional Train, Taxi, Bike Sharing, Car Pooling and Car Sharing). The average price for this combination is 118,49 €.
Similarly, the second most voted Pay as You Go combination includes all the modes of transport except taxi, while the third most voted combination does not include Urban Public Transport. The average prices of these combinations are, respectively, 110,52€ and 88,62 €, selected only by 31 and 26 respondents.

Table 16 - Pay as You Go combinations - Cluster 1

Cluster 1									
	Urban PT	Regional Buses	Regional Trains	Taxi	Bike sharing	Car Pooling	Car Sharing	Average price (€)	N° of respondents
PaYG 1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	118,49	220
PaYG 2	Yes	Yes	Yes	No	Yes	Yes	Yes	110,52	31
PaYG 3	No	Yes	Yes	Yes	Yes	Yes	Yes	88,62	26
PaYG 4	Yes	Yes	Yes	Yes	Yes	No	No	118,45	16
PaYG 5	Yes	Yes	Yes	Yes	No	Yes	Yes	148,71	14
PaYG 6	Yes	No	No	No	Yes	Yes	Yes	68,93	14
PaYG 7	Yes	Yes	Yes	Yes	Yes	No	Yes	111,31	13
PaYG 8	No	No	Yes	Yes	Yes	Yes	Yes	83,18	11
PaYG 9	Yes	Yes	Yes	No	Yes	No	Yes	146,50	10
PaYG 10	Yes	No	No	Yes	Yes	Yes	Yes	71,50	10

As shown in Table 17 most of the respondents of Cluster 2 declared to be interested in using Pay as You Go only on Urban Public Transport (96 respondents) with an average price of 28,52 €.
Therefore, the second most rated Pay as You Go combination selected by people forming Cluster 2, includes 3 modes of transport: Urban Public Transport, Regional Bus and Regional Train (40 respondents) with an average price of 99,58 €.

Table 17 - Pay as You Go combinations - Cluster 2

Cluster 2									
	Urban PT	Regional Buses	Regional Trains	Taxi	Bike sharing	Car Pooling	Car Sharing	Average price (€)	N° of respondents
PaYG 1	Yes	No	No	No	No	No	No	28,52	96
PaYG 2	Yes	Yes	Yes	No	No	No	No	99,58	40
PaYG 3	Yes	Yes	No	No	No	No	No	77,36	33
PaYG 4	Yes	No	No	No	Yes	No	Yes	56,30	28
PaYG 5	Yes	No	No	No	Yes	No	No	27,17	24
PaYG 6	Yes	No	Yes	No	No	No	No	66,39	23
PaYG 7	Yes	No	No	No	Yes	Yes	Yes	58,76	21
PaYG 8	Yes	Yes	Yes	Yes	No	No	No	117,56	18
PaYG 9	No	No	Yes	No	No	No	No	61,11	18
PaYG 10	Yes	No	No	No	No	No	Yes	65,18	17

Similarly, as shown in Table 18 respondents of Cluster 3 declared that they are mainly interested in using Pay as You Go on Urban Public Transport (82 respondents). However, even though respondents of this Cluster are mainly students, they have a higher Willingness to Pay compared to the respondents of Cluster 2. Indeed, the average price for using the Pay as You Go for Urban Public Transport is 34,46 €. As for Cluster 2, respondents of Cluster 3 declared to be interested in using Pays as You go for a) Urban Public Transport, Regional Bus and Regional Train (43 respondents) and for b) Urban Public Transport and Regional Bus (30 respondents), paying, respectively 132,37 € and 61,10 €.

Table 18 - Pay as You Go combinations - Cluster 3

Cluster 3									
	Urban PT	Regional Buses	Regional Trains	Taxi	Bike sharing	Car Pooling	Car Sharing	Average price (€)	N° of respondents
PaYG 1	Yes	No	No	No	No	No	No	34,46	82
PaYG 2	Yes	Yes	Yes	No	No	No	No	132,37	43
PaYG 3	Yes	No	Yes	No	No	No	No	61,10	30
PaYG 4	Yes	Yes	No	No	No	No	No	70,45	29
PaYG 5	Yes	No	No	No	Yes	No	No	30,43	21
PaYG 6	No	Yes	No	No	No	No	No	67,96	14
PaYG 7	Yes	Yes	Yes	No	Yes	No	No	120,88	13
PaYG 8	Yes	No	Yes	No	Yes	No	No	133,38	13
PaYG 9	Yes	No	No	No	No	No	Yes	55,00	13
PaYG 10	No	Yes	Yes	No	No	No	No	78,50	12

Finally, Table 19 shows the Pay as You Go combination for Cluster 4. The most highly rated combination includes all the modes of transport (333 respondents) with an average price of 179,38 €. The second most favoured combination includes all the modes of transport except taxi (59 respondents), while the third combination does not include Taxi and Car-Pooling (21 respondents), with an average price, respectively, of 127,72 € and 109,60 €.

Table 19 - Pay as You Go combinations - Cluster 4

Cluster 4	Urban PT	Regional Buses	Regional Trains	Taxi	Bike sharing	Car Pooling	Car Sharing	Average price (€)	N° of respondents
PaYG 1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	179,38	333
PaYG 2	Yes	Yes	Yes	No	Yes	Yes	Yes	127,72	59
PaYG 3	Yes	Yes	Yes	No	Yes	No	Yes	109,60	21
PaYG 4	Yes	Yes	Yes	Yes	Yes	No	Yes	118,86	18
PaYG 5	No	Yes	Yes	Yes	Yes	Yes	Yes	106,88	16
PaYG 6	Yes	Yes	Yes	Yes	No	Yes	Yes	81,00	10
PaYG 7	Yes	Yes	Yes	Yes	Yes	No	No	98,56	9
PaYG 8	Yes	Yes	No	No	Yes	Yes	Yes	91,33	9
PaYG 9	Yes	Yes	Yes	Yes	No	No	No	101,67	6
PaYG 10	Yes	No	No	Yes	Yes	Yes	Yes	50,33	6

4.8 Focus Groups with respondents

As explained in the methodology (Section 4), to validate the clusters and design Mobility as a Service tailored to the citizens, five Focus groups have been organised.
The selection of the participants who took part to the Focus Groups was made using a stratified sampling plan according to age, gender, occupation and origin-destination and mode of transport used for their most important trip. Table 20 shows the list of the participants to the five Focus Groups.

Table 20 - Selection of the participants of Focus Groups

Date FG	Name	ID respondent	Study area	Origin	Destination	Mode	Gender	Age	Education	Occupation	Cluster	Persona
12-mag	Federico	1.413	SUB_URB TO	Chieri	Torino	Train	M	22	High School	Student	3	RUR
12-mag	Giovanni	101.696	RUR_URB TO	Cavour	Torino	Chain	M	28	Bachelor degree	Employee	3	RUR
12-mag	Gabriele	4.836	RUR_RUR	Airasca	Pinerolo	Regional Bus	M	47	Master degree	Employee	4	RUR
12-mag	Francesca	104.153	URB TO_URB TO	Torino	Torino	Urban PT	F	21	High School	Student	1	URB
12-mag	Francesco	1.630	URB TO_URB TO	Torino	Torino	Urban PT	M	22	High School	Student	2	URB
25-mag	Elena	5.432	URB TO_URB TO	Torino	Torino	Car (Driver)	F	48	Master degree	Self Employed	2	SUB
25-mag	Martina	4.265	URB TO_URB TO	Torino	Torino	Walk	F	29	Master degree	Employee	1	RUR
25-mag	GianPaolo	5.094	SUB_SUB	Chieri	Chieri	Private Bike	M	48	High School	Unemployed (looking for a job)	4	RUR
25-mag	Olga	105.846	SUB_URB TO	Torino	Orbassano	Car (Driver)	F	26	High School	Unemployed (NOT looking for a job)	2	SUB
25-mag	Roberto	5.498	SUB_URB TO	Vinovo	Torino	Car (Driver)	M	62	Master degree	Manager	4	URB
25-mag	Carla	104.660	URB TO_URB TO	Torino	Torino	Urban PT	F	36	PhD	Employee	2	URB
25-mag	Simona	106.121	URB TO_URB TO	Torino	Torino	Private Bike	F	42	Master degree	Employee	2	URB
25-mag	Piero	107.283	SUB_URB TO	Torino	Grugliasco	Chain	M	63	Master degree	Teacher/professor	3	SUB
01-giu	Grazia Maria	6930	URB TO_URB TO	Torino	Torino	Car (Driver)	F	42	Master degree	Employee	1	URB
01-giu	Michele	105401	SUB_URB TO	Torino	Grugliasco	Car (Driver)	M	39	Master degree	Employee	1	URB
01-giu	Miriam	4.300	SUB_URB TO	Torino	Leini	Private Bike	F	40	Master degree	Employee	2	SUB
01-giu	Lorenzo	4427	SUB_SUB	Chieri	Chieri	Private Bike	M	62	Master degree	Teacher/professor	3	SUB
01-giu	Patrizia	6.005	RUR_URB TO	Avigliana	Torino	Chain	F	51	Master degree	Employee	4	RUR
01-giu	Marco	101832	RUR_SUB	Volvera	Grugliasco	Car (Driver)	M	62	Master degree	Teacher/professor	4	RUR
01-giu	Claudio	105659	RUR_URB TO	Torre Pellice	Torino	Chain	M	61	High School	Employee	2	RUR
08-giu	Lorenzo	4110	SUB_URB TO	ttimo Torine	Torino	Urban PT	M	15	Secondary School	Student	1	SUB
08-giu	Marta	5423	SUB_URB TO	Torino	Rivoli	Car (Driver)	F	45	Master degree	Employee	4	SUB
09-giu	José	105.646	RUR_SUB	Piossasco	aselle Torines	Car (Driver)	M	58	Master degree	Employee	2	RUR
09-giu	Sandra	3.680	SUB_URB TO	sselle Torines	Torino	Chain	F	31	High School	Employee	3	SUB
09-giu	Franco	2.996	SUB_SUB	Orbassano	Grugliasco	Urban PT	M	38	Master Degree	Employee	2	SUB
09-giu	Ercole	5.790	URB TO_URB TO	Torino	Torino	Car (Driver)	M	54	Master degree	Manager	4	URB
09-giu	Luca	4.264	SUB_URB TO	Torino	Grugliasco	Car (Driver)	M	38	Bachelor degree	Employee	4	SUB
09-giu	Fabio	3.774	URB TO_URB TO	Torino	Torino	Urban PT	M	50	Master degree	Self Employed	1	URB
09-giu	Ivan	687	URB TO_URB TO	Torino	Torino	Urban PT	M	20	High School	Student	3	URB
09-giu	Antonio	5.938	RUR_SUB	Piossasco	Orbassano	Regional Bus	M	45	Master degree	Employee	1	RUR

During each Focus Groups the participants were asked to describe their daily mobility, in particular focusing on those aspects they appreciate and dislike and that they would improve.

In the second stage of the Focus Group, sub-groups were formed according to the origins and destinations of their most important trips. A persona was assigned to

each sub-group, according to the area in which they usually travel (and they know well): urban area; sub-urban area and rural area.
The participants of each sub-group were asked to read carefully the description of the persona and summarize the mobility pattern of this persona, using a service blueprint (Figure 84).

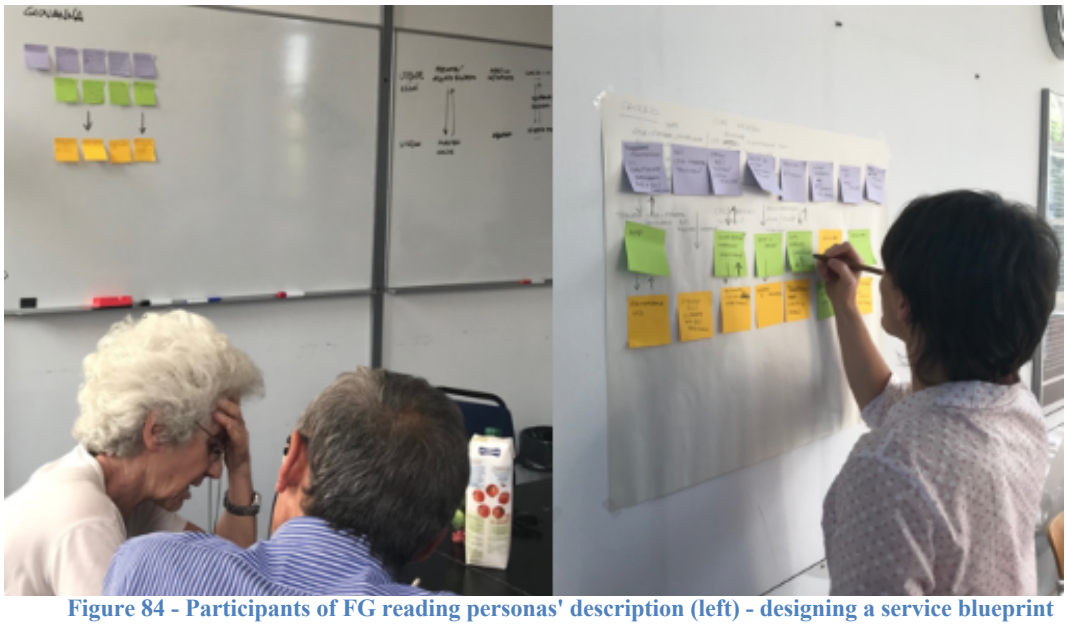


Figure 84 - Participants of FG reading personas' description (left) - designing a service blueprint (right)

To this extent, participants were asked to describe the mobility patterns of the personas by using post-it of three different colours: the iliac post-it was used to describe the action of the persona; the yellow one was used to describe the mobility system, while the green one was used to describe the interaction between the user and the mobility system.
Once the first service blueprint was designed, participants were asked to observe the mobility pattern of their persona and try to highlight the main weaknesses and the aspects to improve. They could decide to improve the mobility services proposing what they wanted, for example increasing the bus frequency, developing an app or integrating more modes of transport.
After this exercise, a second service blueprint had to be designed according to the solutions proposed by the members of each group.

4.8.1 Outcomes of the service blueprints

The results of the Focus Group that took place on the May 25th 2018 and involved 8 participants are proposed below as a concrete example of the outcome obtained thanks to the collaborative work of people involved in the focus groups.
A short description of the personas of each sub-group is provided, followed by the Service-Blueprints of both the current situation and the "solution" defined by each group.

Roberto: 62 years old (Cluster 4)
Carla: 36 years old (Cluster 2)
Simona: 42 years old (Cluster 2)

Persona's description:
Erica (group "Urban")

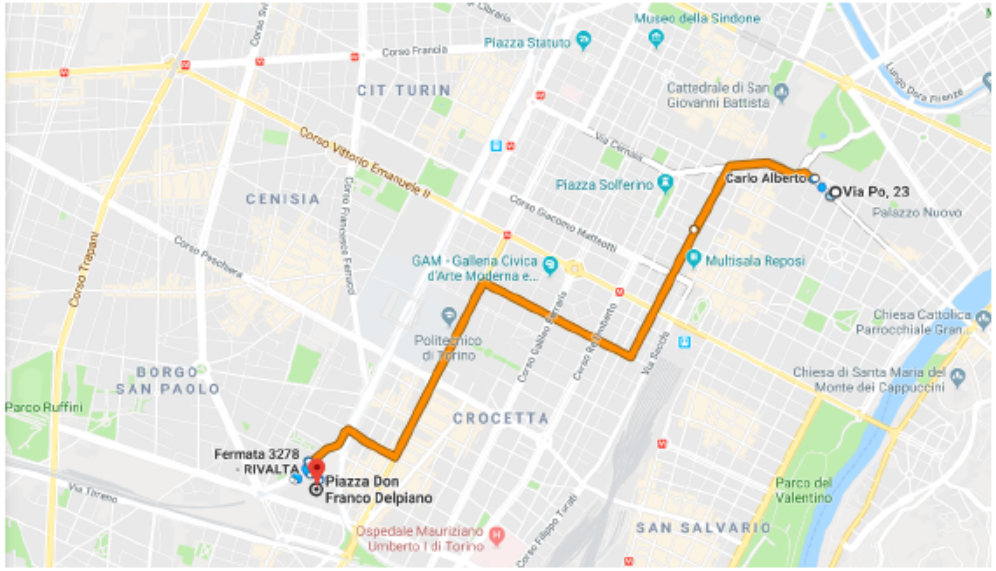
Erica is a 34 years old employee and she works in the field of Communication.
She lives in Torino and 5 times per week she travels by bus to go to work (in Torino).
She also travels 2 times per week by car to go to the University; 4 times per week to do shopping and 4 times per week for leisure.

Her most important trip is "Home-work" which averagely last 35' (from 8:15 to 8:50). She spends 25 €/month and she does not consider it too expensive, however she would like to reduce her travelling time.

She thinks that travelling on urban Public Transport is not particularly safe (especially while waiting at the bus stop), neither flexible.

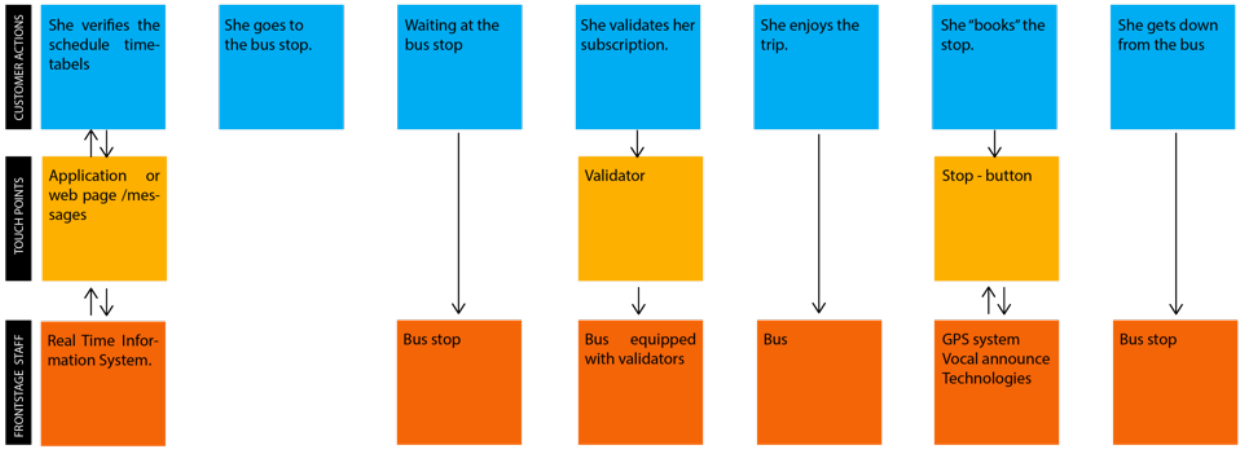
However, she thinks that it is environmentally sustainable.

Erica would like to feel safer with a Mobility Service and at the same time she would like to count on a service which could let her reduce waiting times at the bus stop and be more flexible.



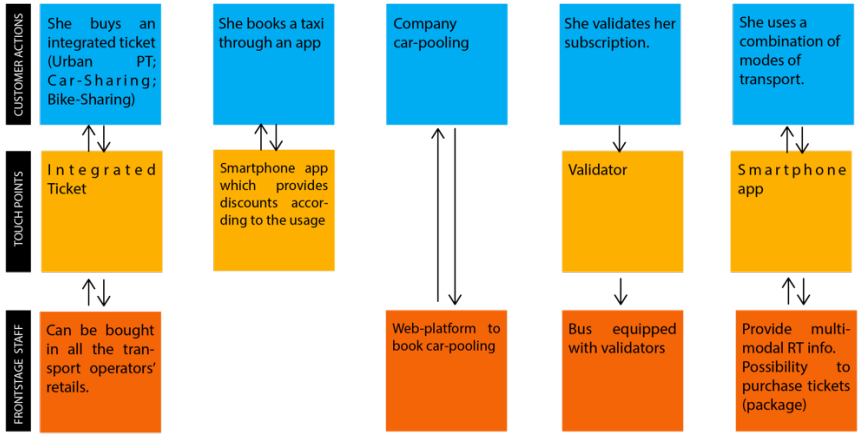
I Service Blueprint - Current trip:

At the moment, the persona checks the scheduled timetable before going to the bus stop. Once she is at the bus stop, she waits there.
According to the group, Erica is uncomfortable while she waits at the bus stop and they think that she her travel experience could be improved.



II Service Blueprint - Trip with MaaS

The solution provided by the group, consider an integrated fare which includes several modes of transport (Urban Public Transport, Car-sharing and Bike-Sharing and Taxi/Car-pooling). In case of disruption of a bus line, Erica prefers to use her subscription to travel by a carpooling which she is able to book through an app. She arrives at a bus stop so that she can take a bus and conclude her journey.



Description of the solution:

For the Urban Group, the Mobility as a Service solution is a fare and ticket agreement among different transport operators; mainly urban Public Transport, Bike-Sharing, Car-Sharing and a collective Taxi (such as Uber Pool). The group thinks that there should be a platform and/or application that provides multimodal real-time information and which allow customers to purchase tickets.

Then, the group suggested that Car-pooling, not being very popular in Italy, could be promoted by the workplaces and incentives could be given to the employees who travel to work by car-pooling or sharing the car with colleagues.
About the fare agreement, the group suggests that users who have a Public Transport subscription could have a discount when they travel on shared-taxi (car-pooling) so that car-pooling could become more attractive and be economically sustainable through an economy of scale.

Urban group's opinions about the solution proposed:

Carla: *I am quite satisfied with the solution we found. Especially because it is a solution which does not involve new infrastructure but "only" agreements between parties. It is something which involves the management and the definition of fares. However, we also thought that the bus frequency should be improved and therefore this action might be more complicated to realize especially if buses have to travel on particular bus lane.*

Simona: *I am also satisfied with the solution we proposed. As Carla said, I think that our solution does not involve engineering works on the infrastructure but only improving what we already have and trying to share a mode of transport. However, our solution is doable because the supply is higher. It would be more difficult to do it in a rural area.*

Urban group's opinions about Mobility as a Service:

Carla: *I think that Mobility as a Service can partly represent the solution to the problems related to transport.*
However, what I expect from mobility as a whole, is the improvement of the reliability and the flexibility of the journey experience.
But I also think that, if we really want to reduce the number of cars on our street, MaaS has the duty to integrate more modes of transport. In this way it would be

possible to reach those destinations that cannot be reached by the traditional Public Transport.

Simona: *For me "Reliability" is a key element of a MaaS. I mean to say that if the app which provides real-time information says that the bus should arrive in 5 minutes, then I expect that this bus will be at the bus stop in 5 minutes. In the reality this is not always the case… especially during the evening.*
About the other modes of transport like bike-sharing and car-sharing they have to be in good and safe conditions.
I believe that there are already good solutions which are available, but I think that they are not integrated enough. Therefore, I think that the Local Authority should work on the integration of the different modes of transport.

Olga: 48 years old (Cluster 2)
Piero: 63 years old (Cluster 3)
Elena: 60 years old (Cluster 3)

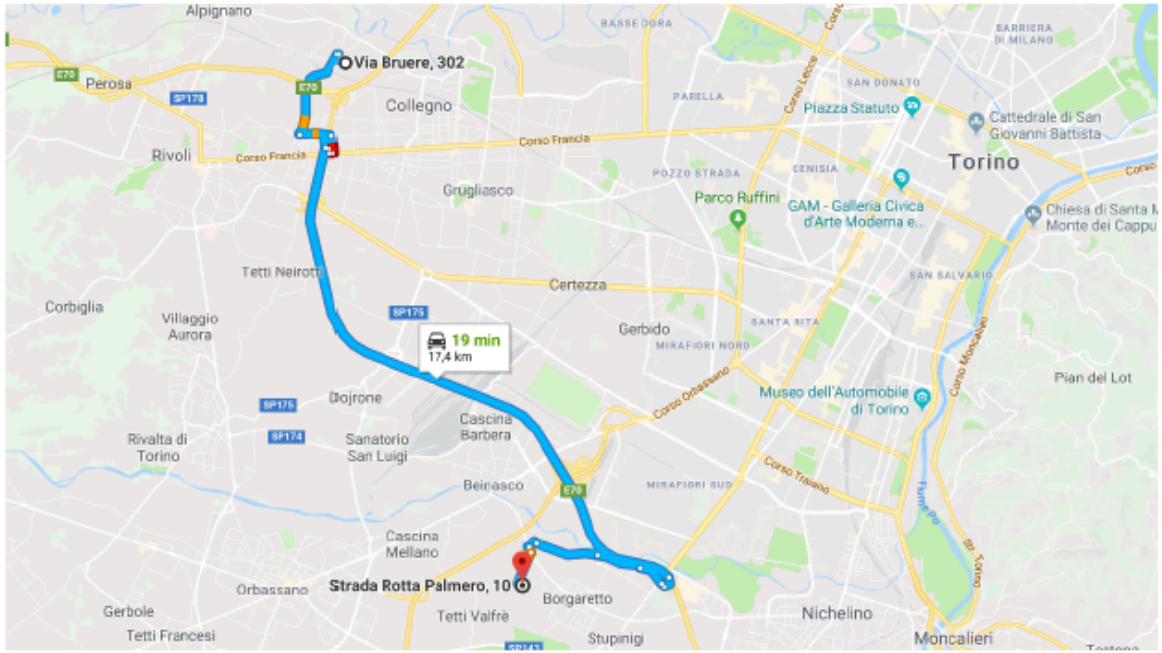
Persona's description
Emanuela (group "Suburban")

Emanuela is a 50 years old employee who works in the Local Authority. She lives in Rivoli with her husband and her 18 years old son. She travels 5 times per week using more modes of transport: car (driver) and regional buses. She also drives her car 4 times per week for leisure, twice per week to pick her son up at school and twice for shopping.

Her most important trip is "Home-work" which averagely last 1 hour (from 7:00 to 8:00). She spends 70 €/month and she thinks that it is not expensive. However, she would like to travel for no more than 40 minutes to reach her workplace.

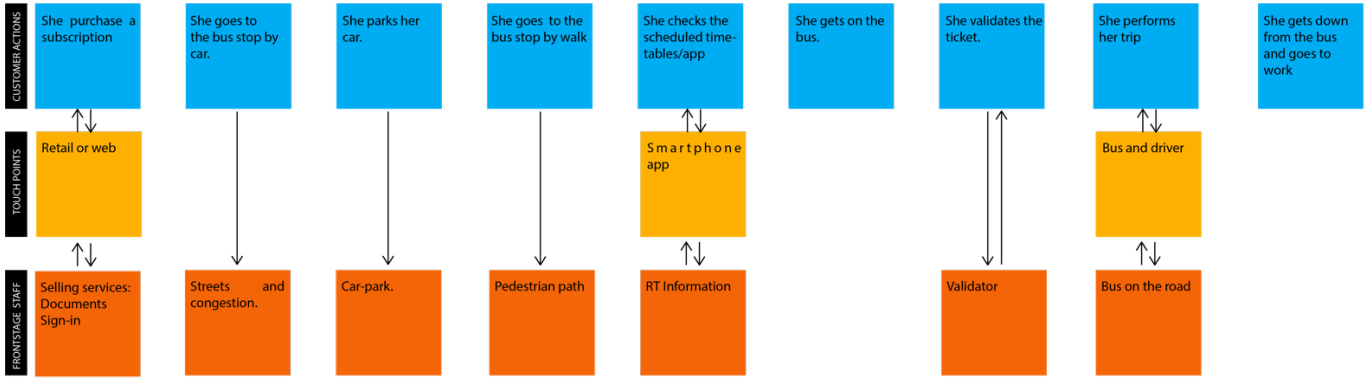
Emanuela thinks that her daily trip is safe and relatively flexible. However, she thinks that sometimes it is not reliable in terms of journey times.

Therefore, she would like to be more flexible and she would like to count on a Service which could let her save some time and have more information in case of disruption.



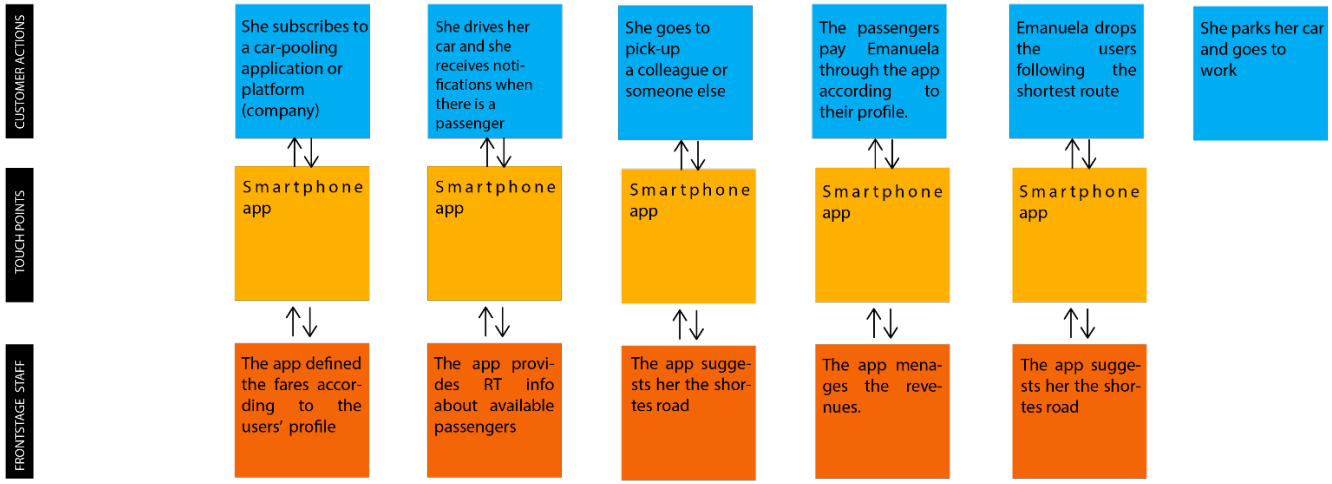
I Service Blueprint - Current trip

Emanuela goes to the bus stop by car and she walks for few minutes. She checks the timetable to know when the next bus will arrive.
When she gets down from the bus, she walks for few minutes to arrive at destination.
According to the components of this group, Emanuela's travel experience could be improved by RT information and a platform to allow her to purchase the ticket.



II Service Blueprint Trip with MaaS

Emanuela join a car-pooling platform that, through an app let her find a ride. The fares are defined tailored according to the profiles of the users and their preferences. She drives to go to work and she receives a notification when another user is looking for a lift nearby. Therefore, she is able to collect other people who pay her through the app. The app suggests the shortest and least busy road.



Description of the solution:

For the Suburban Group, there is not a real "Mobility as a Service solution". The group suggested that, for this case, the best solution is still to use the private car.
As said by the urban group, also the suburban group suggested that the enterprises should support the employees to share the cars with the colleagues. The group also suggested that a Smartphone application could help users to choose the fastest route and/or the best mode of transport.

Suburban group's opinions about the solution proposed:

Olga: *I think this solution is quite difficult to realize. Besides if this persona aimed to reduce the pollution, with this solution I think she is not going in the right direction.*

Piero: *If I had to give a mark to our solution, it would not be sufficient. I say this because, giving the assumptions of this persona, it is difficult to define alternative solution if not, using the private car.*
Therefore, this solution goes against the principle of Public Transport that should focus on the sense of community not on the segregation and the privatisation.

Elena: *The solution we proposed is not collective but it is merely focused on our persona. Therefore, from this point of view we cannot say that it is a sustainable solution.*
To this extent, I also think that Car-pooling is not very popular in our country and therefore it would be difficult to convince people to share their cars with someone else who they do not know.

Suburban group's opinions about Mobility as a Service:

Olga: *for me MaaS is just a matter of ration cost-benefit. It just depends what benefits the Local Transport Authority is looking for. If the main benefit is to reduce the negative externalities related to traffic and congestion, then transport authority could simply block the circulation for private cars.*
I personally think that the Local Authority should take in account the sustainability. Therefore, there should be policies which should discourage to use the car and on the other hand, verify that those who travel on Public Transport, really pay for the service that they are using.

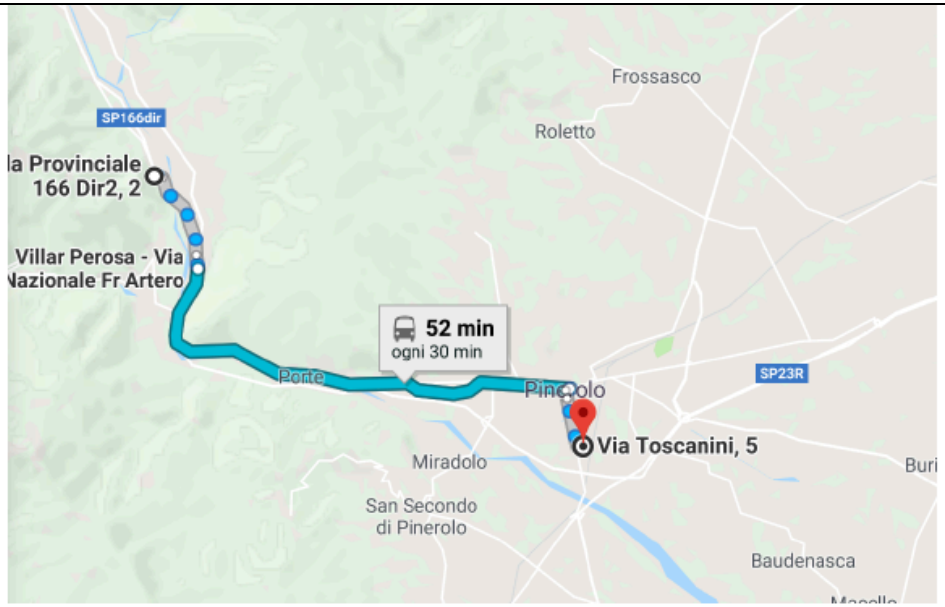
Piero: *I think that we should first of all work on the cultural aspect and customer's behaviours. If we teach citizen to not use the car and to use the Public Transport, then it would be easier to think about integrated transport and Mobility as a*

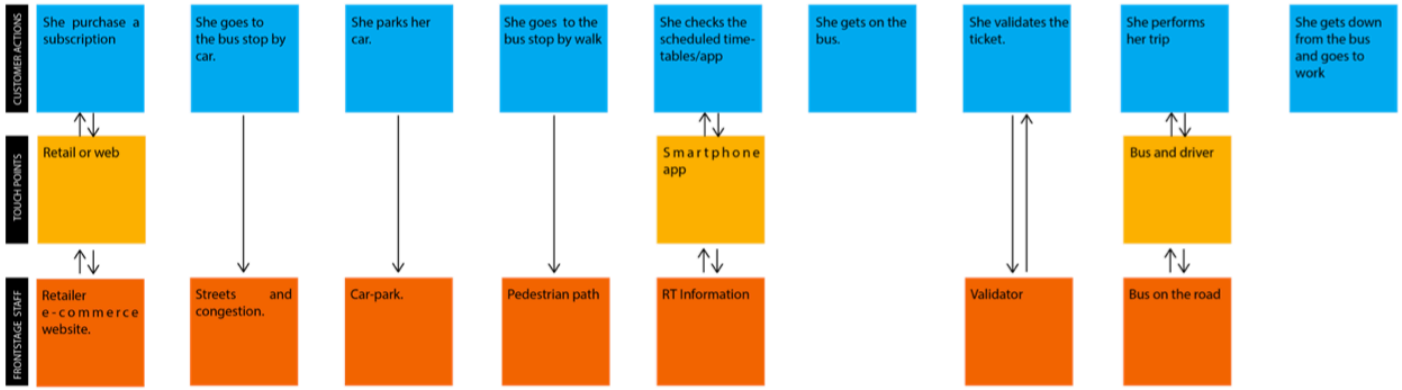
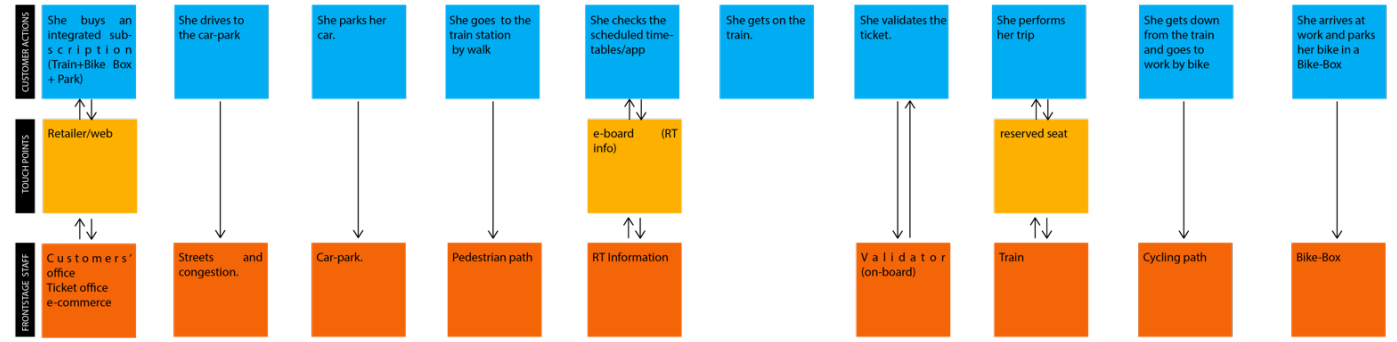
Service. It is true that the transport supply is not very efficient in Torino, but it is also true that the citizens of Torino are still very attached to their cars.
Therefore, we should get back to talk about "right of mobility": we have the right to have access to mobility and to have this right we have to work on changing the behaviours of those people who travel by car.
I think that before investing on mobility integration, the Public authority should invest on education. At the moment, people who travel by public transport are seen as they are poor people who cannot afford a car.

Martina: 29 years old (Cluster 1)
Gianpaolo: 48 years old (Cluster 4)

Persona's description
Camilla (group "Rural")

Camilla is a 60 yers old employee who works in the Local Public Authority. She lives in San Germano Chisone with her husband and 5 times per week she travels by Regional Bus to go to work in Pinerolo. She also travels by bus to do shopping. Therefore, her most important trip is "Home work" which averagely lasts 90 minutes (from 6:15 to 7:45). She spends about 30 €/month and she thinks that it is not too expensive. However she wants to reduce her journey time and spend 60 minutes to reach her destination. Moreover, Camilla thinks that travelling by Public Transport is environmentally sustainable but not flexible, neither reliable. Camilla would like to feel more comfortable travelling with a Mobility as a Service and at the same time she would like to count on a more flexible Service which could let her save journey time.



I Service Blueprint - Current trip Camilla buys a monthly subscription and every day she goes to the bus stop by car. She feels stressed because the streets are quite congested during the AM Peak. She parks her car and she walks from the car-park to the bus stop where she checks the timetable and waits for the bus. When the bus arrives she validates her subscription and once she gets down from the bus, she walks for few minutes to arrive at her workplace. Scarsa affidabilità, spostamento troppo lungo e vorrebbe miglioare la qualità dello spostamento	
II Service Blueprint - Trip with MaaS Camilla buys an integrated subscription which enables her to travel with several modes of transport. She drives to the car-park close to the train station. Before taking the train she validates her ticket. Once arrived at destination she takes her bike that she parked there and with it she goes to work and park her bike in a bike-box.	

Description of the solution:

For the Rural Group, the solution for the mobility of Camilla involves the reopening of the railway which was recently modernised but, due to cuts, it has been closed. Moreover, the Rural Group proposed an integrated subscription which could involve a free car-park for the users who travel by railway.
Besides, bike-boxes close to the main train station could help to encourage multimodality and the usage of private bike. This could be a solution for the first and last mile. Indeed, Camilla travels by train and once she alighted, she is able to pick up the bike that she parked in the bike-box. In this way, Camilla can cycle to work for the last mile.
The rural group also proposed to have discounts for those who use bike-box. To this extent, the users who already have a Public Transport or a train subscription can have a discount to use the bike-box.
According to the rural group, this solution aims at increasing the reliability and the flexibility of Camilla.

Rural group's opinions about the solution proposed:

Gianpaolo: *I think this solution is satisfying. First of all because it is based on the sense of multimodality, but also because we believe that the railway represents the best alternative for our persona.*

Martina: *I think that our solution is not difficult to realize and in particular this kind of solution has already been developed in other countries. Moreover, as Gianpaolo said, we focused on a collective solution which does not imply the usage of private car.*

Rural group's opinions about Mobility as a Service:

Giampaolo: *When I think about Mobility as a Service, I think about these four key words: Infrastructures, Services, Conventions and Incentives.*
In detail, if a transport system has to be performant, then its infrastructures had to be in good conditions and they need to let the integration of modes of transport. To me most of the services should be public, while some others might have some conventions or partnerships with private companies.
For example: why the public authority should let a bus run in a rural area just to move 4 or five people? This solution is not environmentally and economically sustainable. It would be better to have a partnership with Taxi or Mini-Van company so that the customer keeps paying the subscription or the single-ticket.

In this way the Public Transport operator could use the bus which was use on that line, on some other lines which can be more profitable.
About Incentives: the public transport needs to have incentives. Economic Incentives: European and national subsidies... but also subsidies from the citizens.
Last but not least I think that if the services were cadenced, exactly like the underground which you can take a train every 3/5 minutes, then you do not need any Real Time application…

Martina: *About Mobility as a Service I think that there are already solutions that are available, so the first step to do should be thinking about how to integrate these different modes of transport and experiment solution to verify if the users actually use these integrated services. Indeed, at the moment we might propose, for example, to integrate Urban Public Transport and car-pooling but if we do not know if users will use this service….*
Thus, according to my opinion MaaS needs to be first of all an experiment and if I had to start to develop a MaaS, I would start from the aspect of the information. Not only real time information but also communicating to the customers the information related to the fares and trying to sensitize the customers to let them travel with the Public Transport.

Summary of respondent's Focus Groups

The participants of the Focus Groups were all generally interested to the idea of Mobility as a Service. As mentioned above, the participants who took part to the people in the Focus Group on the 25th of May think that the key elements of Mobility as a Service are, mainly, the integration of more modes of transport into a unique package and a platform able to provide multimodal real-time information.
To this extent, the realization of mobility packages involves agreements between transport operators and Local Authorities.
Besides, when the participants had to define a Mobility as a Service solution for their persona, they faced several difficulties which made them aware that the implementation of a MaaS is not an easy task; some participants claimed that the best solution to travel is still the private car. Moreover, the integration of alternative modes of transport such as car-pooling is not an easy task either due to the fact there is a lack of trust.
The Urban group which was composed by two respondents from Cluster 2 and one respondent from Cluster 4, showed to be confident towards Mobility as a Service. However, this group showed to be more interested in the aspects related to the reliability (i.e. Real-Time information) which can be improved by a multimodal Real-Time application.
On the other hand, the suburban group, which was composed by two respondents from Cluster 3 and one respondent from Cluster 2, seemed to be not so confident

towards the Mobility as a Service. Indeed, the solution was not defined as sustainable but it seemed to be the only available answer to the persona's needs. However, the members of this group agreed that more effort should be made in order to improve the culture of the people and let them change their attitudes and behaviours.
The rural group was the most enthusiast about MaaS. They agreed that MaaS is already existing in terms of alternative modes of transport (i.e. bike-sharing; car-sharing, etc.) even if there should be more integration and information.

4.8 Focus Groups with stakeholders

On the 31st October 2018 a last focus group was organized to discuss the outcomes of the survey as well as the solutions provided by the citizens with the main stakeholders of the study area. The main bus operators (GTT, Sadem and Cavourese), a Bike-Sharing provider (NextBike), the Regional Transport Authority (Agenzia della Mobilità Piemontese) and the members of the city councils took part to this Focus Group.
After a short introduction of the research group and the aim of the survey, all the participants presented themselves nd their activities. Subsequently, each participant was invited to provide his/her definition of Mobility as a Service.

Maria LaPietra (Torino city councillor for transport and mobility): *There is still confusion. Probably because we still do not have a MaaS in Italy. However, there are two levels. The first level is the "platform": with a very simple app I have the possibility to check how to go from A to B. Once I decided which modes I want to use to reach my destination, I can proceed to purchase the ticket. This would mean that with one single click I can have an integrated ticket for the modes of transport that I have selected. In this way the citizens would be at the core of the transport system.*
The second level and the second aspect of Mobility as a Service is the price. How much should a user pay for the selected modes of transport? Our council wants to give to the most virtuous citizens an amount of money to spend on Public Transport. Moreover, people in some cities in Norway and Sweden can spend up to 400/500 € on public transport, which is a lot for us. But in this way people would effectively stop buying and driving their cars.
Finally, MaaS is not something easy to realize: it is not simply a platform. There are regulations and partnerships but first of all we should start from these two levels.
We should give to the citizens something that they still do not have: integration with taxi, car-pooling, car-park, etc.
I think that if a citizen is able to purchase his/her ticket through a single click, probably he/she will accept to pay it a little bit more. I personally would do so.
A solution would be that the local authority defines the packages and then pays the different providers.

Pietro Peyron (NextBike): *For me MaaS means that I have an app which tells me the fastest, the cheapest and the most ecological way to go from A to B. It should also be able to tell me the modes of transport that I can or I cannot use according to the availability or even the weather conditions.*

I imagine a MaaS as a platform which can be both travel planner and can also let the customers pay and book their trips. I am still not very confident about the distribution of the incomes among the different transport providers, but I would agree if this platform would let the customers paying for each modes of transport separately.

Pasquale D'Uva (Piemonte Region): *For me the platform is a "way" to realize the Mobility as a Service. MaaS is create a situation where the citizen can see a unique provider. When the citizen needs to travel, no matter from where to where, he/she contacts this entity (MaaS). This entity is able to give the customer a solution according to his/her preferences. Obviously, the process to create a MaaS implies some changes in the regulatory systems. In particular, the laws and regulations will be involved for the definition of mobility packages, especially because users have different preferences among each other. Therefore, if the local authority really wants to be responsible for the definition of these packages, it has to know the user's mobility preferences. Probably there will be an initial stage of calibration of few packages in order to understand how the citizens react to them.*
The distinction between mobility packages and Pay as You Go is not important at this stage.
The first thing to be done to deliver a MaaS is having an effective and complete integration and a unique platform. Then the customer has to purchase this service.

Antonio Fenoglio (Cavourese): *It is evident that a platform which help the customers to purchase their tickets or simply choose how to go to a certain destination, is a good thing. However, for (us) transport providers the income is crucial for the survival of (our) business, especially if we consider that 35% of the revenues depends on the sales of tickets and subscriptions. Due to this, we, as a transport operator, are not against MaaS or innovation but we are simply attentive since the business risk seems to be quite high. However, a platform that provides information to the users could allow us to better understand the mobility patterns and provide a more tailored supply of transport. In this way, transport operators could transform the user needs into a supply. Very often I hear customers complaining about the bus frequency or about the fact that the buses are too full or too empty: it is very easy for the customer asking for some improvements but, on the other hand, it is very difficult for the transport operator to make some change, notably because the economic situation for the transport operator is very fragile.*

Giuseppe Estivo (Torino city council): *My point of view as a private citizen. I think that a Mobility as a Service can work only if it allows the users to spend less than what they spend now. Besides the users need to have a sufficient supply of transport, thus we should focus on provide more comfort to the users. Indeed, car is the most comfortable mode of transport and if the Public Transport has to be competitive with the cars, then the user experience needs to be as seamless as possible.*
It is inevitable that cars will still be used to reach remote destinations, but Public Transport and the integration with other modes of transport can work as a Service

only under two main conditions: it has to be well advertised and kids have to be educated to have a sustainable travel behaviour.

Maurizio Arena (Cavourese): *I was thinking about those groups of people who we are not able to attract;, first of all we need to distinguish the supply of transport in Torino and the supply of transport out of the boundary of Torino. The number of passengers and the frequency of the buses are completely different.*

Bruno Carraro (SADEM): *I think that MaaS is a way to see mobility as integrated in terms of fares, an intermodal transport using shared modes of transport, both private and public which are aggregated through a platform and strategies which allow users to access to these services.*
It seems fascinating and the technological innovation can definitely ease this process. However, the economic equilibrium needs to be considered.
We are talking about an innovation which require huge investments: investments in technology since this platform needs to be intelligent if we want that it provides certain information to its customers.
Furthermore, we have to think that technology is evolving very fast: there is a risk that we invest most of our resources in terms of time and money and, then, we realize that this "innovation" is already out of date.
This is even more risky if this innovation is related to Public Transport which is recently facing a delicate economic period.
It is easy being persuasive and promise a package of modes of transport whose price is cheaper than the sum of the price of the single modes of transport. But how to do so? How to reach the equilibrium? It is necessary that who designs this business model, considers the costs of running the transport services for each modes of transport. I do not think that the customers are really willing to spend more to have an integrated mobility. The customers expect to spend "better", to have a more accessible and more frequent service with more accurate information.
Before moving from private car to Mobility as a Service we need to have a kind of cultural revolution. If we still think that travelling with Public Transport is for poor is because the governments do not invest enough money on Public Transport.
Sometimes people talk about electric buses. But the costs of these buses are not sustainable: an electric bus costs at least three times more than a traditional one.
Despite that, the bus transport operators highlighted that during the last ten years there was a rationalisation of the resources from the Region for the public transport to face the continuous cuts of the subsidies.
About the costs: I think that the average citizen does not know the costs that a transport operator has to cover. Therefore, I am not sure that there are so many people who are willing to pay more in order improve the transport supply.
It is a cultural problem when there are people who are willing to spend 50.000 or 60.000 € for a car but they expect to pay no more than 20 €/month to travel on electric buses which should arrive every 5 minutes…

For a clarification: all the ideas I've heard so far are very interesting. My only doubt is "who pay for this?".

It is evident that all the stakeholders who took part to the Focus Group agreed that MaaS is a platform that has to include a travel planner to tell users how to go from A to B and to purchase the tickets.
In the first stage, since there are not the proper regulations, this platform will probably be a smart platform which will suggest the best way to go to destination according to the user's preferences.
A platform with these characteristics was already been developed (TUeTO) within a European project (Opticities). That application was able to provide multimodal real-time information and it could have been implemented to include also ticketing. However, after the project was concluded this application has never been supported by the local authorities.
Moreover, it is important to consider that, according to the literature (Duboz, 2017), the users do not use these applications and platforms as much as we might think. Therefore, it is important to recognize that technology and Mobility as a Service might not represent a solution for all the externalities related to the mobility.
To this extent, if a MaaS needs to be delivered, it is important to analyse the economic sustainability of this Service and its Business Model.
Therefore, since this model can survive only if citizens are effectively willing to spend more to use a MaaS, before to start to design a new mobility service, it is important to understand what users expect from it and how much is their willingness to pay. However, the outcomes of the survey show that the respondents do not have a high willingness to pay to travel by Public Transport. Therefore, with this lack of funding, the proposed solutions are not easily achievable.

Before designing a MaaS, it is important to understand what users want. To this extent, a big amount of data is needed in order to understand user's needs and preferences to forecast how market will react and eventually to give inputs to the transport policies.
Moreover, it is important to understand who will eventually take charge of the Mobility as a Service platform. Indeed, we cannot pretend that MaaS will be a local platform. Thus, MaaS could not even be a regional platform but it should be recognised at national level.
The person representing the Piemonte region, during the Focus Group, suggested that, in order to improve the quality of the supply, the current contribution and subsidy should be changed. Indeed, Region should contribute proportionally to the number of tickets sold by the transport operators.
On the other hand, the transport operators who took part at the Focus Group claimed that it would be good if the transport operators could decide their routes. One of the main effects of this scenario would be that the most profitable routes will be characterised by an "over-supply", while the routes which are not particularly profitable, will be abandoned.
However, Piemonte region said that, under these circumstances, there would be a main "transport skeleton" composed by the most profitable routes, while in the

other areas start-ups could provide Demand-Responsive-Transport, car-pooling or other alternative modes of transport which can be subsidised by the Public Authority.

Subsequently, the research group asked to the stakeholders what they need in order to eventually design a MaaS.
Piemonte region said that they can provide their BIP[1] platform that will be improved in order to be multimodal. In this way the users can purchase the ticket of any transport operator included in this platform. However, Region said that it cannot define the agreements and the best fares among the different transport operators. It claimed that this platform is currently used to understand how people move and to plan the transport supply.

CSI[2] (Marina Dragonieri) claimed that public authorities are currently investing money to realize these kinds of platforms, however the realization of a platform should be done by a private which can improve the access to the information and manage the payment.

The research group pointed out that the citizens participating to the Focus Groups struggle to define their needs to create a MaaS. Therefore, the participants expressed their concerns about the development of a Mobility as a Service.

To this extent, the transport operators declared that one of the main problems is that companies like Flixbus are recently entering into the market as the "innovators", with the power of technology and with a big number of contacts. Therefore, there is a big risk that entities who run activities with no profitability and with no ROCE (Return On Capital Employed) can become top-players only because of the number of their contacts. If these entities can become top players, they could impose their market rules.
Besides the transport operators which took part to the Focus Group, the grantor (Piemonte region) as well as the transport authority in charge of regulating the mobility sector do not care about the costs of service that the transport operators have to cover. Piemonte region admitted that it covers 65% of the costs of the Public Transport operators; however, during the last years, there was still another cut of the 15% of the Regional contributions and the Regional Transport Authority (AMP) decided to cut the less profitable bus rides.
It was clear that there is a vicious circle: indeed, the transport network, which should be designed in order to be profitable and attract passengers, is designed by the Regional Transport Authority which is actually cutting the rides with low number of passengers.

[1] BIP: Biglietto Integrato Piemonte – Regional integrated Ticketing System (https://bip.piemonte.it)
[2] CSI – Consonrzio per il Sistema Informativo – Consortium for the Informative System (http://www.csipiemonte.it/web/it/)

To this extent, the 15% of the cut rides refer to those offered during the off-peak periods; therefore, it is clear that if public transport still wants to be public and to have a social value, it must guarantee a threshold below which even the minimum services are no more guaranteed to the customers.
On the other hand, reducing the resources also implies that transport operators should increase the fares to cover their costs.
Thus, if Mobiliy as a Service should aim at providing integrated fares to enable users to travel with different modes of transport with a unique subscription, it is still difficult to imagine how, in suburban and rural areas, the price of this fare could be lower than the sum of the fares of the different modes of transport included in it.

Chapter 5

Discussion

The recent years faced a change in terms of mobility paradigm. Undoubtedly, the concept of using the car and the attitudes towards the usage of car are changed during the last few years.
On the other hand, it is not very clear if and how the preferences of the users are changing and, most importantly, if the mobility providers are ready to face this transformation. It is also important to consider that people's preferences and behaviours vary across the context where people live.

Therefore, since the way people travel is apparently changing, Local Authorities need to understand the entity and the characteristics of this change through a proper data collection. However, most of the times, those data are not updated and, therefore, not representative of the current demand of transport.

Another aspect of the new mobility paradigm is the rise of platforms, apps and innovative systems that should allow the integration of different modes of transport. In this respect, apps such are CityMapper are able to provide multimodal Real-Time information and to allow users to purchase a mobility package whose price is lower than the prices of the single subscriptions. Indeed, despite the discount, this platform pays Transport for London the full price for the tickets used. As pointed out by Carlton Reid (2019), "this loss-leader tactic is believed to be a way for Citymapper to gain a first-mover advantage in one of the world's best cities for public transit".

On the other hand, in Italy there are several projects focusing on integrated mobility and Mobility as a Service. At time being, in Italy only Nugo, the app developed by the Italian national railways allows users to have multimodal real-time information and to purchase tickets for the different stages of their journey (Nugo, 2019).

Moreover, recent researches say that technology can facilitate user's daily lives and help to take more sustainable solutions. However, changing travel behaviour through technology is not an easy task. Sundararajan and Dhar claim that behavioural change can be distinguished in three different typologies (2007):

- behaviours learned through the experience;
- behaviours that involve biomechanical system;

- psychological behaviours.

Giang (2014) pointed out that the first type of behaviour is the one with the lowest chance of changing after technology and app usage. Indeed, apps and technologies can work for the second and the third types of behaviours that can be corrected and changed through training. On the other hand, the first type of behaviour is more rooted and influenced by habits. Therefore, there is a higher possibility that users will revert to their previous behaviour after using the technology and apps. Therefore, the contribution that apps and technologies can give to the behavioural change is often overestimated, while not enough attention is given to the environment and context where people interact and take their decision. Duhigg (2012) claims that the way people make choices and behave are influenced by the expectations and a "reward" for a specific action. Furthermore, people's actions are often automatic behaviours. Thus, if apps and technology can help people to keep track of their progresses on the other hand, the only way people can change their behaviour is to do it by themselves.
Hence, education plans should be able to teach citizens how to perform sustainable travel behaviours and data collection should focus on travel behaviour, on how people travel and how they would like to travel. In this way it would be possible to find market segments composed by people who can change their behaviour and become more virtuous and sustainable.

The MaaS paradigm needs to understand user's behaviours, preferences and, notably, choices and how their choices impact the environmental sustainability. To this end, the data collection of mobility patterns of travellers should to be carried out in a conscious and voluntary way that differs from predictive analytics performed by companies like Google, Facebook and Amazon that "stalk" their users (Curran, 2018). Thus, data collection has to respect the General Data Protection Regulation (GDPR) launched by the European parliament and of the council (2016).

This new mobility paradigm should be founded on the transparency between the entity who collects the data and the users providing their travel information. In particular, the entity in charge of the data needs to ask permission more often and in a clear way, explaining the purpose of the data collection.
On the other hand, users are entitled to get their information back. In this way, users are aware of what the "entity" is collecting and they can also have a reward in the form of travel suggestions according to their travel habits.
High levels of transport demand data could make clear if the supply of transport effectively meets the demand. Besides, it would be possible to better understand the decision of groups of people and assess if a station or a bus stop are too far away from them. Considering that, the analysis of the accessibility of the study area, is the first step to do to assess if Mobility as a Service can be successful or not.

The collection of these data from the transport authorities would let them and the transport operators to design a more integrated supply of transport tailored on user's

need. Indeed, the collected data could show to the transport operator where new services, in adduction to the current supply, could be introduced to help users to reach their final destinations.

An integrated supply of transport involves modes that interact with each other and that create a unique supply that allow users to travel in a seamless way.
In this scenario, as claimed by Pronello (2018), Mobility as a Service would be a synonym of "common good", because it would come from a bottom-up approach, from the users who find intelligent, sustainable and participatory solutions to improve the quality of their trips.

However, nowadays MaaS is defined as a platform where several actors and enterprises divvy up the incomes of an integrated mobility. In particular, there are no articles or business models that demonstrate how the revenues are split among the transport operators that join a MaaS. On the other hand, there are several articles claiming the advantages of Mobility as a Service, comparing the costs of car usage and ownership with the costs of mobility packages that have been defined by default for pilot tests in Sweden and Norway.
Nevertheless, the prices and the combination of modes of transport included in these packages might differ among the cities, according to many variables, such as the characteristics of the transport supply, the willingness to pay of the citizens and their behaviour and habit.
Therefore, to assess the success of Mobility as a Service, it is fundamental to know how people travel and how they would like to improve their travel experience.
To this extent, do the local authorities really have all the information they need in order to plan a supply tailored on users' needs? Do they have up to date data? Did Local Authorities improve the way to collect data?
At the time being, the Local Authorities and Regional Transport Authority (AMP – Agenzia della Mobilità Piemontese) do not have the information that they should have to plan a supply of transport based on users' needs. This aspect came out already in 2014 when a multimodal map was designed within the European project Opticities (www.opticities.com).
This map aimed to be a source of information both for the Local Authorities and the mobility managers to help them to design a more efficient and intermodal mobility in the metropolitan area of Torino which, at that time, was one of the few cities to have updated information.
However, after five years, the available information has not been updated although new ways of collecting data, such as smartcard's validations, have been recently used to understand the demand of transport.
Besides, smartcard data can only provide information related to the demand of the Public Transport users.
On the other hand, the city if Torino has recently signed an agreement with TIM, an Italian telecommunication company, in order to use the data of the cell towers to understand how people move.

However, this data, as well as the smartcard data validations, do not provide any detail about the attitudes of the users.
In this respect, this research highlights the importance of understanding how people travel but, notably, how they would like to travel in the next future.

Chapter 6

Conclusion

This thesis is part of a vision aimed to define what Mobility as a Service is and to assess its challenges through a bottom-up approach. Specifically, the aim of the thesis was to understand how people who live in Torino and its surrounding municipalities, travel and how they would like to travel in the future.

To reach this objective, a study area was defined and its demand was compared to the supply of transport to assess if the latter meets the mobility needs of the inhabitants. However, since the input data used to analyse the demand of transport were not updated, a survey was design to better understand the mobility patterns of the respondents and their attitudes towards Mobility as a Service.
The survey reached more than 4,000 respondents thank to the collaboration of the Local Authorities (Città di Torino, Agenzia della Mobilità Piemontese, Regione Piemonte), the main transport operators and associations.
Although the number of respondents was not representative of the population of the study area, the outcomes of the survey allowed updating the information of the latest regional survey (IMQ) which was carried out in 2013.
In this respect, the same survey has been administered also in the Oise department, in France. Indeed, the survey can be considered a part of a wider project called My-Moby (www.my-moby.com) which includes, besides the surveys, a smartphone app to collect mobility data and the Living Labs.
Although the French version of the web-questionnaire was launched in March 2018, the number of respondents has got only few hundreds of answers.
On the other hand, the My-Moby smartphone app, is currently available for Android and iOS on the Italian, French and Myanmar marketplaces. This app allows to track users' trips, to give information through a chat and to evaluate the quality of public transport services. In this way, Local Authorities are able to collect travel information (i.e. travel patterns and mode of transport used) from users who agreed to use the app and share their location.

The survey designed for this thesis (*Come ci muoviamo…ma soprattutto come ci vorremo muovere? - How do we move…but also how would we like to move?)* allowed to collect information that was not included in IMQ. In particular, the survey was composed by seven sections, of which two of them about, respectively, *integrated mobility* and *MaaS.*

A descriptive analysis was carried as well as a visualization of the most significant variables.
To this extent, the visualisation of these variables through QGIS allowed to spot the main differences among respondents in terms of mode of transport used and Origin-Destination municipalities.
The descriptive analysis allowed understanding what respondents generally think about Mobility as a Service and how much they are willing to spend for a mobility package.
Then, a Cluster Analysis was carried out to define market segments which could eventually be more interested to this new mobility paradigm. Cluster analysis also allowed assessing differences in terms of Willingness to Pay to purchase a mobility package.

The outcomes of the above analyses, showed that:

- a small part of the respondents is effectively willing to use mobility packages;
- respondents are apparently more interested in using Pay as You Go;
- there is a great fragmentation in terms of combinations of modes of transport to be paid through a Pay as You Go fare system;
- respondents from Clusters 1 and 4 showed to be more interested in using both mobility packages and combinations of modes of transport to be paid through a Pay as You Go fare system;
- respondents from Clusters 4 showed a higher willingness to Pay compared to respondents from Cluster 1, 2 and 3.

The innovation of this thesis relies on the combination of both quantitative and qualitative data; indeed, these two approaches were uses to validate and characterise the clusters created through the cluster analysis. Such analysis allowed to define categories of respondents willing to adopt Mobility as a Service for their daily mobility while, on the other hand, qualitative analysis allowed understanding what people think about Mobility as a Service and if it can represent a valid solution for their trips.
To this end, a tool from Service Design (Service Blueprint) was used during the Focus Groups with the respondents to let them design alternative mobility solutions for representative characters which were assigned to each group.

The comparison of both quantitative and qualitative data highlighted that:

- Cluster Analysis was partly confirmed: not all the clusters have been validated. This showed a gap between quantitative and qualitative analysis. Indeed, participants from Cluster 2 and 4 showed to be more interested in adopting more innovative transport solutions. However,

participants from Cluster 3 seem to be more reluctant, as emerged from the outcomes of the survey;

- participants from Cluster 3 were more sceptical about MaaS, while they though that more effort should be put into education in order to educate citizen how to travel more sustainably;
- participants (stakeholders) struggled to find a unique definition of Mobility as a Service, although most of them agreed that it should be a platform aimed to provide multimodal Real Time information and it should allow users to purchase a mobility package;
- where participants had to work on case studies (Personas), it was difficult to put Mobility as a Service in practice, and use MaaS as a tool to support their personas to have a more sustainable travel behaviour.

Moreover, in addition to the respondent's Focus Groups, final Focus Groups with the Local Authorities and Stakeholders was carried out to show them the outcomes of the survey and to gather their opinions about MaaS.
In detail, this stage of research showed that:

- stakeholders could not provide a unique definition of Mobility as a Service. Most of the participants agreed with the idea of a multimodal platform aimed to provide multimodal real-time information and to allow users to purchase tickets;
- the average prices for the most well evaluated packages were judged as not economically sustainable from all the transport operators;
- Piemonte Region and the City council of Torino were generally more enthusiast about MaaS compared with the Transport operators;
- transport operators observe that, since 35% of transport operators depend on ticketing, Mobility as a Service might be risky;
- the participants also pointed out that the costs that the transport operators cover to run the service are usually underestimated;
- transport operators said that a Loss Leader strategy could not work in rural municipalities; indeed, given such a little demand, it would be extremely challenging to drive a modal shift (from private cars to public transport) and make economy of scale;
- finally, all the participants agreed that more investments should be put into culture in order to educate people how to travel more sustainably.

Both respondents and stakeholder's Focus Groups highlighted the fact that there is still some confusion in terms of defining what MaaS is.

Therefore, updated information about user's habits is required to design a tailored MaaS. However, the outcomes of both the survey and the Focus Groups proved that there is not such a high rate of people who are willing to use MaaS.
In this respect, the Focus Groups of citizens highlighted that the participants are mainly interested in the improvement of the current modes of transport rather their integration. Therefore, the success of MaaS in terms of modal shift (from car to Public Transport) strongly depends on the quality of the supply of transport of each mode.
On the other hand, the Stakeholder's Focus Group highlighted that the main constraint for the development of MaaS in suburban and rural areas is related to the revenues.
It is impossible, under the current regulation, to provide mobility packages whose prices are lower than the prices of the subscriptions of each modes of transport.
Moreover, loss leader strategy would not work in these environments due to the limited numbers of users.

To conclude, the survey has been carried out to update the information about the mobility patterns of the population of the study area and better understanding preferences and attitudes of the respondents. In this respect, the outcomes of the survey have been shared with the Local Authorities.
Besides, even though a Cluster Analysis has been performed to identify the groups of respondents willing to travel using a new mobility paradigm; the prices for the mobility packages are not economically sustainable for the transport operators.
Therefore, even though Mobility as a Service is undoubtedly a fascinating concept which can be applied in some regions, in this case it clashes with the regulatory and economic landscapes which make MaaS impracticable.

Nevertheless, despite these limitations, this thesis can represent a contribution to the knowledge about the attitudes and expectations that people have about Mobility as a Service. Besides, this research can also be considered as a support in the definition of Mobility as a Service.

References

(2017, January 1). Tratto da Statista: https://www.statista.com/statistics/264687/countries-with-the-highest-population-growth-rate/

Aapaoja, A., & Eckhardt, J. (2017). Business models for MaaS. *1st international conference on Mobility as a Service*, (p. 1-16). Tampere.

Agenzia della Mobilità Piemontese. (2016, January 01). *Agenzia della Mobilità Piemontese*. Tratto il giorno September 15, 2017 da www.mtm.torino.it: http://mtm.torino.it/it/piani-progetti/progetti-a-scala-regionale/affidamento-servizi/Allegato-SFM-SFR_V5.pdf

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 179-211.

Anable, J. (2005). 'Complacent Car Addicts' or 'Aspiring Environmentalists'? Identifying travel behaviour segments using attitude theory. *Transport Policy*, 65-78.

Anderberg, M. (2014). *Cluster Analysis for Applications: Probability and Mathematical Statistics: A Series of Monographs and Textbooks.* Academic Press.

Anker Nielsen, O., Daly, A., & Frederiks, R. (2002). A Stochastic Route Choice Model for Car Travellers in the Copenhagen Region. *Networks and Spatial Economics*, 327-346.

Aquino, P., & Leite Fi, L. (2005). User Modeling with Personas. *Proceedings of the 2005 Latin American conference on Human-computer interaction*, (p. 277-282). Cuernavaca (Mexico).

ART, A. (2017). *Delibera n. 48 del 30 marzo 2017.* Rome: ART.

Balcombe, R. (2004). *The Demand for Public Transport: a Practical Guide.* Crowthorne, UK: TRL Report.

Balcombe, R., York , I., & Webster, D. (2003). *Factors influencing trip mode choice.* TRL.

Bejarano, J., Bose, K., Brannan, T., Thomas, A., Adragni, K., Neerchal, N., & Ostrouch, G. (2011). *Sampling within k-means algorithm to cluster large datasets.* . Oak Ridge National Laboratory (ORNL): Center for Computational Sciences.

Bitner, M., Ostrom, A., & Morgan, F. (2008). Service blueprinting: A practical technique for service innovation. *California Management Review*, 66-94.

Boch, H. H. (1985). On Some Significance Tests in Cluster Analysis. *Communication in Statistics*, 3: 1-27.

Buehler, R., Pucher, J., Gerike, R., & Götschi, T. (2016). Reducing car dependence in the heart of Europe: Lessons from Germany, Austria, and Switzerland. *Transport Reviews*, 1-25.

Bunton, D. (2002). Generic moves in PhD thesis introductions. In J. Flowerdew, *Academic discourse* (p. 57-75). London: Pearson Education Limited.

Camagni, R., Gibelli, M., & Rigamonti, P. (2002). Urban Mobility and Urban Form: The Social and Environmental Costs of Different Patterns of Urban Expansion. *Ecological Economics*, 196-216.

Camargo, P. (2019). *AequilibraE*. Tratto da http://aequilibrae.com

Carbon Brief. (2016, March 5). *Mapped: The global coal trade.* Tratto il giorno October 2018 da Carbon Brief - Clear on Climate: https://www.carbonbrief.org/mapped-the-global-coal-trade

Centre for Economics and Business Research. (2014, January 23). Tratto da https://cebr.com/reports/cost-of-raising-a-child-hits-227266-with-families-feeling-the-impact-of-benefit-cuts/

Chestera, M., Frasera, A., Matuteb, J., Flowera, C., & Pendyalac, R. (2015). Parking Infrastructure: A Constraint on or Opportunity for Urban Redevelopment? A Study of Los Angeles County Parking Supply and Growth. *Journal of the American Planning Association*.

Chick, D. (2017, October 17). What kind of collaboration does there need to be between operators, authorities and third-parties to ensure MaaS becomes a widespread reality? *Intelligent Transport*.

CIVITAS. (2016). *Mobility as a Service: A new transport model.* Tratto il giorno October 2018 da Civitas 2020: http://civitas.eu/content/civitas-insight- 18-mobility-service-new-transport-model

Commission of the European Communities. (2007). *Communication from the commission to the council and the European Parliament.* Brussels.

Costantini, F. (2017, Nov 08). *MaaS and GDPR: an overview.* Tratto il giorno Jan 04, 2018 da Cornell University Library: https://arxiv.org/abs/1711.02950

Curran, D. (2018, March 30). *Are you ready? Here is all the data Facebook and Google have on you.* Tratto da The Guardian: https://www.theguardian.com/commentisfree/2018/mar/28/all-the-data-facebook-google-has-on-you-privacy

Davis, K. (1955). The origin and growth of urbanization in the world. *American Journal of Sociology*, 429- 437.

Delft. (2015). *External and Infrastructure costs of HGVs in the EU28 in 2013.* Delft.

Dubes, R. C. (1987). How Many Clusters Are Best - An Experiment. *Pattern Recognition*, 20 (November): 645-63.

Duboz, A. (2017). *The effects of multimodal information systems on the modal behaviour.* Torino: Politecnico di Torino.

Duhigg, C. (2012). *The Power of Habit - why we do what we do in life and business.* Random House Trade Paperbacks.

Edwards, T., & Smith, S. (2008). Transport Problems Facing Large Cities. *NSW Parliamentary Library Briefing Paper*, 1-35.

EEA - European Environment Agency. (2006). *Greenhouse gas emission trends and projections in Europe 2006.* Copenhagen.

Esztergár-Kiss, D., Koppányi, Z., & Lovas, T. (2016). Mobility Mapping Based on a Survey from the City of Berlin. *Periodica Polytechnica Transportation Engineering*, 35-41.

European Commission. (2007). *Green Paper on the future Common European Asylum System.* Brussels.

European Commission. (2008). *Greening Transport: new Commission package to drive the market towards sustainability.* Brussels.

European Commission. (2015). *The Mid-Term Review of the EU Biodiversity Strategy to 2020. Report from the Commission to the European Parliament and the Council.* Brussell: European Commission.

European Environment Agency. (2015). *TERM 2015: Transport indicators tracking progress towards environmental targets in Europe.* Luxembourg: European Environment Agency.

European Parliament. (2003). *Directive 2003/30/EC.* Bruxelles.

European Parliament, & Council of the European Union. (2000). *Decision n°1753/2000 EC.* Bruxelles.

Eurostat. (2018, September 13). *Statistics on commuting patterns at regional level* . Tratto da Eurostat: https://ec.europa.eu/eurostat/statistics-explained/index.php/Statistics_on_commuting_patterns_at_regional_level

FAO - Food and Agriculture Organization of the Uni. (2018). *Crop Prospects and Food Situation.* FAO.

Ferguson, C. (2016). Managing and motivating sustainable travel behaviour change. In S. Biermann, D. Olaru, & V. Paul, *Planning boomtown and beyond* (p. 592-615). Crawley: UWA Publishing.

Ferrett , R. (2017, January 19). *How Rural Communities Can Meet Alternative Transportation Needs.* Tratto da WisContext: https://www.wiscontext.org/how-rural-communities-can-meet-alternative-transportation-needs

Friman, M. (2001). Frequency of negative critical incidents and satisfaction with public transport services. *Journal of Retailing and Consumer Services*, 95-104.

Fuse, T., Makimura, K., & Nakamura, T. (2010). Observation of travel behavior by IC card data and application to transportation planning. *A special joint symposium of ISPRS Technical Commission IV & AutoCarto in conjunction with ASPRS/CaGIS 2010 Fall Specialty Conference.* Orlando (Florida).

Gaborieau, J.-B. (2016). *Evaluation of the potential modal shift induced by the use of a real time multimodal navigator: psycho-social study of travel behaviour and attitudes.* Torino: Politecnico of Torino.

Giang, V. (2014, June 08). *Can Technology Really Change Your Habits?* Tratto da Fast Company: https://www.fastcompany.com/3033986/can-technology-really-change-your-habits

Giesecke, R., Surakka, T., & Hakonen, M. (2016). Conceptualising Mobility as a Service - A User Centric View on Key Issues of Mobility Services. *2016 Eleventh International Conference on Ecological Vehicles and Renewable Energies (EVER)*.

Gillis, J., & Harvey, H. (2018, April 25). *Cars Are Ruining Our Cities.* Tratto da The New York Times: https://www.nytimes.com/2018/04/25/opinion/cars-ruining-cities.html

Gollin , D., Jedwab, R., & Vollrath, D. (2016). Urbanization with and without industrialization. *Journal of Economic Growth*, 35-70.

Gree, P. E. (1978). *Analyzing Multivariate Data.* Hinsdale, (USA): Rinehart and Winston.

Greene, N. (2016, March 15). *How Much Land in Los Angeles Is Dedicated to Parking Spaces?* Tratto da Mental Foss: http://mentalfloss.com/article/77143/how-much-land-los-angeles-dedicated-parking-spaces

Groves, R., Fowler, F., Couper, M., Lepkowski, J., Singer, E., & Tourangeau, R. (2009). *Survey methodology. .* New Jersey: Wiley and Sons.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate Data Analysis.* Harlow: Pearson New Internation Edition.

Hartigan, J. A. (1985). Statistical Theory in Clustering. *Journal of Classification*, 2: 63-76.

Hayashi, Y., Doi, K., Yagishita, M., & Kuwata, M. (2004). Urban transport sustainability: asian trends, problems and policy practices. *European journal of transport and infrastructure research*, 27-45.

Heikkilä, S. (2014, April 28). Mobility as a Service – A Proposal for Action for the Public Administration. Espoo, Finland: Aalto University - School of Engineering.

Hensher, D. (2016). Future bus transport contracts under mobility as a service regime in. *International Conference on Competition and Ownership of Land*, (p. 1-9). Stockholm.

Hensher, D. (2017). Future bus transport contracts under a mobility as a service (MaaS) regime in the digital age: Are they likely to change? *Transportation Research Part A*, 86-96.

Hisham, S. (2009). Experimenting with the use of persona in a focus group discussion with older adults in Malaysia. *OZCHI '09 Proceedings of the 21st Annual Conference of the Australian Computer-Human Interaction Special Interest Group*, (p. 333-336). Melbourne - Australia.

Holmberg, P.-E., Collado, M., Sarasini, S., & Williande, M. (2015). *Mobility as a Service - MaaS, Describing the framework.* Tratto il giorno October 2018 da RISE: https://www.viktoria.se/publications/mobility-as-a-service-maas-describing-the-framework

Hoornweg, D., Freire, M., Lee, M., Yuen, B., & Bhada-Tata, B. (2011). *Cities and climate change - Responding to an urgent agenda.* World bank.

Indexmundi. (2018, January 1). Tratto da https://www.indexmundi.com/g/r.aspx?v=24

Jackson, S. (2000). *Overview of Transportation Impacts on Wildlife Movement and Populations.* Tratto da University of Massachusetts Amherst: https://ag.umass.edu/sites/ag.umass.edu/files/pdf-doc-ppt/tws_overview_ms.pdf

Jani-Pekka, J. (2016). *Economic Perspectives on Automated Demand Responsive Transportation and Shared Taxi Services.* Helsinki.

Jittrapirom , P., Marchau , V., & Meurs, H. (2017). DYNAMIC ADAPTIVE POLICYMAKING FOR IMPLEMENTING MOBILITY AS A SERVICE (MAAS). *European Transport Conference 2017*, (p. 1-23). Barcelona.

Jittrapirom, P., Marchau, V., & Meurs, H. (2017). Dynamic adaptive policymaking for implementing mobility as a service (MaaS). *European Transport Conference 2017*, (p. 1 - 23). NIjmegen.

Kaiser, F. G., & Wilson, M. (2000). Assessing People's General Ecological Behavior: A Cross-Cultural Measure. *Journal of Applied Social Psychology*, 952-978.

Kamargianni, M., & Matyas, M. (2017). The Business Ecosystem of Mobility-as-a-Service. *96th Transportation Research Board (TRB) Annual Meeting*, 3-13.

Kamargianni, M., Matyas, M., Li, W., & Schäfer, A. (2016). A critical review of new mobility services for urban transport. *Transportation Research Procedia*, 3294-3303.

Karlsson, I., Sochor, J., & Strömberg, H. (2016). Developing the 'Service' in Mobility as a Service: experiences from a field trial of an innovative travel brokerage. *Transportation Research Procedia*, 3265-3273.

Karlsson, M., Sochor, J., Aapaoja, A., Eckhardt, J., & König, D. (2018, October 3). *Deliverable 4: Impact Assessment of MaaS. MAASiFiE project funded by CEDR.* Tratto da http://www.vtt.fi/sites/maasifie/PublishingImages/results/CEDR_Mobility_MAASIFIE_Deliverable_4_Revised_Final.pdf

Kitzinger, J. (1995). Qualitative Research: Introducing Focus Group. *BMJ*, 299-302.

Kodinariya, T., & Makwana, P. (2013). Review on determining number of Cluster in K-Means Clustering. *International Journal of Advance Research in Computer Science and Management Studies* , 90-95.

Kolenbet, G. (2017). Demand Responsive Transport (DRT) - a solution for a 'first mile' commuter problem in seq? *IPWEA National Conference* , (p. 1-2). Perth.

Kwan, B. S. (2009). Reading in preparation for writing a PhD thesis: Case studies of experiences. *Journal of English for Academic Purposes*, pages 180-191.

Levinson , D., & Zhu, S. (2013). A portfolio theory of route choice. *Transportation Research Part C: Emerging Technologies*, 232-243.

Li , Y., Li , Q., & Shan, J. (2017). Discover Patterns and Mobility of Twitter Users—A Study of Four US College Cities. *International Journal of Geo-Information*, 1-17.

Li, Y., & Voege, T. (2017). Mobility as a Service (MaaS): Challenges of Implementation and Policy Required. *Journal of Transportation Technologies*, 95-106.

Lima, A., Stanojevic, R., Papagiannaki, D., & Rodrig, P. (2016). Understanding individual routing behaviour. *JOURNAL OF THE ROYAL SOCIETY INTERFACE*.

Luè, A., & Colorni, A. (2009). A software tool for commute carpooling: a case study on university students in Milan. *International Journal of Services Sciences*.

MaaS Alliance. (2017, September 4). *White Paper - Guidelines & Reccomendations to create the foundations for a thriving MaaS Ecosystem.* Tratto il giorno October 2018 da MaaS Alliance: https://maas-alliance.eu/wp-content/uploads/sites/7/2017/09/MaaS-WhitePaper_final_040917-2.pdf

MaaS Alliance. (2018, October 3). Tratto da MaaS Alliance: http://maas-alliance.eu/european-mobility-service-alliance/

Mageean, J., & Nelson, J. (2003). The evaluation of demand responsive transport services in Europe. *Journal of Transport Geography*, 255-270.

Malecki, A. (1978). Perceived and actual costs of operating cars. *Transportation*, 403-415.

Malthus, T. (1798). *n Essay on the Principle of Population, as it Affects the Future Improvement of Society.*

Milligan, G. (1980). An examination of the Effect of Six Types of Error Perturbation on Fifteen Clustering Algorithms. *Psychometrika*, 45 (September) 325-42.

Milman, O. (2015, December 2). *Earth has lost a third of arable land in past 40 years, scientists say.* Tratto da The Guardian: https://www.theguardian.com/environment/2015/dec/02/arable-land-soil-food-security-shortage

Mulley, C. (2017). Mobility as a Services (MaaS) – does it have critical mass? *Transport Reviews*, 247-251.

Nielsen, R. (2016). Growth of the World Population in the Past 12,000 Years and Its Link to the Economic Growth. *Journal of Economics Bibliography*, 2-12.

Nugo. (2019). Tratto il giorno March 2, 2019 da https://www.nugo.com/nugoweb/

OPTICITIES. (2014, November). *www.opticities.com*. Tratto il giorno July 2016 da OPTICITIES: www.opticities.com

Osterwalder , A., & Pigneur, Y. (2009). *Business Model Generation.* Amsterdam. Tratto da Business Model Generation: www.strategyzer.com

Pöllänen, J. (2017). *Is Whim the Netflix of mobility?* Tratto il giorno October 2018 da Helsinki Smart Region: https://www.helsinkismart.fi/portfolio-items/whim/

Pelletier, M., Trépanier, M., & Morency, C. (2011). Smart card data use in public transit: A literature review. *Transportation Research Part C*, 557-568.

Pero, M. (2003). *Habitat Fragmentation due to Transportation Infrastructure.* Tratto da http://www.cost.eu/COST_Actions/tud/341

Polis Network. (2017, September 04). *Mobility as a Service: Implications for Urban and Regional Transport.* Tratto da Polis network: https://www.polisnetwork.eu/uploads/Modules/PublicDocuments/polis-maas-discussion-paper-2017---final_.pdf

Pronello, C. (2018, October 9). *Come stanno cambiando i trasporti?* Tratto il giorno January 2019 da https://www.youtube.com/watch?v=BYMvvEdQ9MU

Pronello, C., & Camusso, C. (2011). Travellers' profiles definition using statistical multivariate analysis of attitudinal variables. *Journal of Transport Geography*, 1294-1308.

Pronello, C., Longhi, D., & Gaborieau, J.-B. (2018). Smart Card Data Mining to Analyze Mobility Patterns in Suburban Areas. *Sustainability*, 1-21.

Punj, G., & Stewart, D. (1983). Cluster analysis in marketing research: Review and suggestions for application. *Journal of marketing research*, 134-148.

Quesada, B., Devaraju, N., de Noblet-Ducoudré, N., & Arneth, A. (2017). Reduction of monsoon rainfall in response to past and future land use and land cover changes. *Geophysical Research Letters*.

Redman, L. (2012). Quality attributes of public transport that attract car users: A research review. *Transport Policy*, 119-127.

Reid, C. (2019, March 1). *Citymapper's Cheaper-Than-The-Operator Transit Deal For London Burns Trust.* Tratto il giorno March 22, 2019 da Forbes: https://www.forbes.com/sites/carltonreid/2019/03/01/citymappers-cheaper-than-the-operator-transit-deal-for-london-burns-trust/#3768b285e197

Ritchie, A., & Roser, M. (2018). *CO_2 and other Greenhouse Gas Emissions.* Tratto da Our world in data: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

RomaToday. (2016, September 19). *Il carpooling sbarca a Roma: i passaggi condivisi affiancano bus e metro „Il carpooling sbarca a Roma: passaggi condivisi al costo di una corsa in metro“ Potrebbe interessarti: http://www.romatoday.it/green/mobilita/moovit-carpooling-roma-passaggi-condiv.* Tratto da RomaToday: http://www.romatoday.it/green/mobilita/moovit-carpooling-roma-passaggi-condivisi.html

Sapiezynski , P., Stopczynski, A., Gatej, R., & Lehmann , S. (2015). Tracking Human Mobility Using WiFi Signals . *PLOS One*, 1-11.

Shostack, G. (1982). How to design a service. *European Journal of Marketing*, 49-63.

Silby, R., & Hone, J. (2002). Population growth rate and its determinants: An overview. *Philosophical Transactions of The Royal Society B Biological Sciences 357(1425)*, 1153-1170 .

Sims , R., Schaeffer, R., Creutzig, F., Cruz-Núñez, X., D'Agosto, M., Dimitriu, D., . . . Tiwari, G. (2014). Transport. In: Climate Change 2014: Miti. *Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Sipe, N., & Pojani, D. (2018, November 18). *For Mobility as a Service (MaaS) to solve our transport woes, some things need to change.* Tratto da The conversation: https://theconversation.com/for-mobility-as-a-service-maas-to-solve-our-transport-woes-some-things-need-to-change-105119

Sochor, J., Arby, H., Karlsson, M., & Sarasini, S. (2017). A topological approach to Mobility as a Service: A proposed tool for understanding requirements and effects, and for aiding the integration of societal goals. *ICoMaaS 2017 Proceedings*, 187-208.

Spratt, D., & Sutton, P. (2008). *Climate code red - The case for a sustainability emergency.* Fitzroy: Friends of the Earth. Tratto da http://www.global-greenhouse-warming.com/3-degrees.html

Sundararajan, A., & Dhar, V. (2007). Information Technologies in Business: A Blueprint for Education and Research. *Information Systems Research*, 125–141.

Surakka, T., & Haahtela, T. (2017, November 10). *Mobility as a Service as an example – needs of customers.* Tratto da https://mycourses.aalto.fi/pluginfile.php/488450/course/section/92313/E3121_2017_MaaS.pdf

Taipale, K., Le Blanc, D., & Fellini, C. (2012). Challenges and way forward in the urban sector. *Sustainable Development in the 21st century (SD21)*, 1-50.

The Data Team. (2018, February 28). *The hidden cost of congestion.* Tratto da The Economist: https://www.economist.com/graphic-detail/2018/02/28/the-hidden-cost-of-congestion

The Data World Bank. (2018, January 1). Tratto da https://data.worldbank.org/indicator/SP.POP.GROW

The European Parliament and of the Council. (2016). *REGULATION (EU) 2016/679 - General Data Protection Regulation.* Brussell.

Tuma, M., Scholz S.W., & Decker, R. (2009). The application of cluster analysis in marketing research: a literature analysis. *Business Quest Journal*.

United Nations. (2017). *International Migration Report 2017.* Tratto il giorno October 2018 da United Nations: http://www.un.org/en/development/desa/population/migration/publications/migrationreport/docs/MigrationReport2017_Highlights.pdf

United Nations. (2018). *Department of Economics and Social Affairs.* Tratto da United Nations: https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html

United States Environmental Protection Agency. (2016). *Greenhouse Gas Emissions*. Tratto da EPA: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#colorbox-hidden

United Unions. (2010). *Population Facts.* Tratto da United Unions: http://www.un.org/en/development/desa/population/publications/pdf/popfacts/popfacts_2010-5.pdf

Wholey, J., Hartry, H., & Newcomer, K. (2004). *Handbook of practical program evaluation.* San Francisco, CA: Wiley and Sons.

Willoughby, L. (2015, February 20). *European grain yield stagnation related to climate change, says Stanford scholar.* Tratto da Stanford news: https://news.stanford.edu/2015/02/20/wheat-yield-climate-022015/

Wray, S. (2018, May 10). *The "Spotify of transportation" – and getting aviation on the playlist*. Tratto il giorno October 2018 da Finn: https://www.wearefinn.com/topics/posts/the-spotify-of-transportation-and-getting-aviation-on-the-playlist/

Wreiner, T., Mårtensson, I., Arnell, O., Gonzalez, N., Holmlid, S., & Segelström, F. (2009). Exploring Service Blueprints for Multiple Actors: A Case Study of Car Parking Services. *Proceeding of first Nordic Conference on Service Design and Service Innovation*, 213-223.

Zavitsas, K., Kaparias, I., Bell, M., & Tomassini, M. (2010). *Transport problems in cities.* Tratto il giorno October 2018 da TRIMIS - Transport Research and Innovation Monitoring and Information System: http://www.transportresearch. info/sites/default/files/project/documents/20120402_173932_45 110_D 1.1

Zhang, W. (2015). *Economic Growth Theory Capital, Knowledge, and Economic Stuctures.* London: Routledge.