INSTITUTO
UNIVERSITÁRIO
DE LISBOA

The uptake of unmanned aerial vehicles in the urban environment

Tomás Lencastre Megre Ferreira

Master's in Management of Services and Technology

Supervisor:
PhD Sofia Kalakou, Assistant Professor at ISCTE
Department of Marketing, Operation and Management,
ISCTE

October, 2020

BUSINESS
SCHOOL

Department of Marketing, Strategy and Operations

The uptake of unmanned aerial vehicles in the urban environment

Tomás Lencastre Megre Ferreira

Master's in Management of Services and Technology

Supervisor:
PhD Sofia Kalakou, Assistant Professor at ISCTE
Department of Marketing, Operation and Management
ISCTE

October, 2020

[This page was intentionally left blank]

ACKNOWLEDGEMENTS

This thesis was written as the final Master's thesis of the Master's program in Management of Services and Technology at ISCTE business school. I would like to take this opportunity to thank everyone who helped me over this last year.

First and foremost, I would like to thank Professor Sophia Kalakou for all of her effort, patience, constant support and advice. It was a truly remarkable year, where I was constantly challenged by Professor Sophia to go further and to do better. It all started a year ago where we first met and shared our interest in mobility. From then on, I started to study this new field and by each day that it went by the more interesting it got.

In February 2020, we got the news that my paper was selected to be presented in the 2020 Conference on Sustainable Urban Mobility held in Greece. It was a great honour to have the opportunity of sharing my work and to see so many people interested in this new transport mode. All of this couldn't be achieved without the precious help of Professor Sophia, and for all that, I'm forever grateful for this opportunity.

Second, I would like to thank Joana, my fiancée, for her crucial role at this Master's course. She was always there to support me when I was down and to guide me for when I lost. Her example makes me want to be better and to excel in everything I do.

To my family, who were always present and always gave courage to keep up and helped me to get through this Master's course.

To my friends, who gave me the strength to go on and helped me to laugh and clear my mind whenever I needed it.

I would also like to thank my Master's colleagues who worked side by side with me in group works and studying for final exams. It was a true feeling of companionship where no one was left behind.

Last but not least, I would like to thank Duarte Prazeres for the help by sharing the survey and all of the 391 respondents who took their time to answer this survey and showed a strong interest in this topic.

[This page was intentionally left blank]

RESUMO

Os actuais sistemas de mobilidade do mundo são frequentemente ineficientes e insustentáveis, pelo que surge a necessidade de novos sistemas de forma a satisfazer as necessidades de mobilidade. Esta procura deu o impulso à indústria para investir em novas tecnologias, tais como sistemas autónomos que permitem a condução autónoma de veículos. Neste contexto, surgiu o conceito de Mobilidade Aérea Urbana (MAU), um termo utilizado para serviços de mobilidade aérea de curta distância, a pedido, automatizados, de passageiros ou de transporte de carga. Este estudo apresenta a fase de introdução do planeamento estratégico para a era da mobilidade aérea urbana centrada na aceitação e intenção de utilizar este novo meio de transporte por parte dos cidadãos. Um inquérito foi concebido para captar a percepção dos cidadãos e potenciais utilizadores sobre aspectos como segurança, bem-estar da sociedade (incluindo qualidade de vida, impactos sociais), hábitos de condução e de mobilidade, eventuais benefícios e qual o seu impacto na aceitação e na intenção de utilizar estes sistemas. A aceitação dos cidadãos e potenciais utilizadores (considerados como dois grupos diferentes) é também analisada em termos das suas potenciais utilizações (por exemplo, emergências de saúde, lazer). O inquérito foi distribuito em Portugal e foram recolhidas 391 respostas. Os dados recolhidos foram analisados através da análise de correlação, ANOVA e análises não paramétricas. Esta dissertação introduz um quadro de análise para a introdução de veículos aéreos. Este estudo revela quais são os principais factores que têm impacto nos cidadãos e que devem ser considerados pelos intervenientes.

Palavras-chave: Veículos Aéreos Autónomos, Mobilidade Aérea Urbana, Tecnologia, Mobilidade, Adopção, Aceitação.

[This page was intentionally left blank]

ABSTRACT

World's current mobility systems are often inefficient and unsustainable, therefore the need for new schemes to satisfy mobility needs appears. This quest has given the impetus to the industry to invest in new technologies such as autonomous systems enabling self-driving vehicles. In this context, the concept of Urban Air Mobility (UAM), a term used for short-distance, on-demand, highly automated, passenger or cargo-carrying air mobility services, has arisen. This thesis presents the introduction phase of strategic planning for the era of urban air mobility focusing on the user and citizen acceptance of the system required for its operation. A survey is designed to capture the perception of citizens and potential users on aspects such as safety, security, the well-being of the society (including issues of aesthetics, quality of life, social impacts), driving behaviour, mobility behaviour, expected benefits and their impact on the acceptance and the intention to use these systems. The acceptance of citizens and potential users (considered as two different groups) is also analysed in terms of its potential uses (e.g. health emergencies, leisure, connectivity to remote regions). The survey is applied to Portugal area and 391 responses were gathered. The collected data is analysed through correlation analysis, ANOVA and non-parametric analysis. The thesis introduces a framework of analysis for the introduction of Unmanned Aerial Vehicles. This study will reveal which are the main factors that have an impact on citizens' embracement and intention to use this new transport mode and that should be considered by stakeholders.

Keywords: Unmanned Aerial Vehicles, Urban Air Mobility, Adoption, Technology, Acceptance, Mobility.

[This page was intentionally left blank]

INDEX

[This page was intentionally left blank]

FIGURES INDEX

[This page was intentionally left blank]

TABLES INDEX

[This page was intentionally left blank]

ITEMS INDEX

GLOSSARY OF ACRONYMS

AV – Autonomous Vehicle

UAV – Unmanned Aerial Vehicle

PT – Public Transport

UAM – Urban Air Mobility

VTOL – Vertical Take-off and Landing Aircraft

ODM – On-demand mobility

MaaS – Mobility as a Service

R&D – Research and Development

KW – Kruskal-Wallis Non-parametric method

MD – Mean Difference

[This page was intentionally left blank]

1. INTRODUCTION

The population growth is today one of the major concerns that societies need to deal with. Currently, the earth is populated by 7 Billion people and that figure is expected to increase (Worldometers, 2019). According to the United Nations, the number of inhabitants will grow 10% until 2030 (reaching 8,9 Billion people) and 26% by 2050, making a total of 9,7 Billion people, more 2 Billion that our present record (United Nations, 2019).

This growth will affect various aspects of human life, one of them being urban transportation. Cities are becoming more and more crowded, aggravating the problem of urban mobility. In many cities, Public Transport (PT) is not a viable option as Dr Jean-Paul Rodrigue stated in his study (Rodrigue, 2017). Most of PT systems have a highly unstable demand during weekdays, with periods of peaks (rush hour) and troughs. On peak hours, the vehicles become crowed, creating discomfort among the passengers, and on low ridership periods, it becomes difficult for PT companies to cope with costs having a low income. Also, PT systems have a high infrastructure maintenance cost making it harder to maintain the service level and keep up with the demand.

By analysing this failure on PT systems, Tom Forth made the correlation between poor PT system and the UK's work productivity, where he made a comparison between non-capital cities of France and the UK. A bad supply of PT will have a direct impact on the user's work productivity (Forth, 2019).

Thus, most users choose to use their cars over PT (BTS, 2018), congesting the roads and increasing commuting times. Studies have shown that the average American citizen spends a total of 26.9 minutes per day in commute (Saldivia, 2015), and in India, the average commuter spends over 2 hours of his day on the road commuting to work or home (TomTom, 2019).

World's current way of mobility is insufficient and unsustainable, therefore the need for new ways of mobility is increasing. Noticing this need, multiple companies have started to develop new mobility services such as car-sharing (e.g. ZipCar, Car2Go) and ride-hailing services (i.e. Uber, Lyft) (Franckx & Mayeres, 2016). Companies' business based on the Sharing Economy began to thrive, creating innumerous opportunities including new business models such as Mobility as a Service (MaaS).

MaaS combines services from different modes of transportation to provide customised mobility services, all in one interface (Jittrapirom, Marchau, van der Heijden, & Meurs, 2018). Giving the user more flexibility by providing all the transportation means needed to commute.

This platform joins different transport modes and gives the possibility for the user to choose the ones he prefers and what model of payment does he wish to use, pay-as-you-go or mobility packages.

This quest for the next big step in mobility has made companies invest heavily in research and development (R&D) of new technologies. One technology that has seen great growth in the last years is the autonomous systems enabling self-driving vehicles. Multiple companies started to invest and later test this system in cars and began to study the application of such technologies on other modes of transport, such as the self-driving aircraft. Uber is one of the companies focused on developing this technology. In 2019, the ride-hailing service company invested $457 Million in R&D of autonomous vehicles indicating their vision of future urban mobility (Korosec, 2019).

Gradually other companies, institutions and policymakers started to analyse the possibilities of the urban mobility in the vertical dimension forming the concept of Urban Air Mobility (UAM) that expresses on-demand, highly automated (pilotless), passenger or cargo-carrying air transportation services (Wright, 2018). This concept relies on short-distance vertical take-off and landing aircraft (VTOL), therefore giving the flexibility needed to operate this aircraft.

There are three main uses of UAM: last-mile delivery, air metro and air taxi. Last-mile deliveries aim to transport goods from the distribution hub to the final delivery transportation. The Air Metro is an autonomously operated aircraft, that can accommodate 2 to 5 passengers at a time; it resembles PT services since it has fixed routes, schedules and stops. Air Taxi, much like the Air Metro aircraft, is autonomous and can carry multiple passengers, the difference relies on the fact that this transportation mode has no fixed route, no schedule and no predetermined stops, it works only on-demand and requires multiple possible stops so that the service can truly become door-to-door (Urban Air Mobility, 2018). Vertical take-off and landing aircraft (VTOL) can be the solution to mobility problems, providing a fast, clean, and ubiquitous alternative.

1.1. Thesis objective

As stated before, UAM is still an emerging sector and has yet to prove its profitability as a business plan. There are many obstacles for companies to overcome, such as regulation, public's perception, and high investment needs. Although UAM can provide benefits for their passengers it is still a very theoretical concept with a lot of risks. A thorough study must be done to identify those risks and minimize their probability.

This thesis objective is to contribute to this debate analysing the public's embracement and intention to use this transport mode. This thesis aims to answer the following questions:

1. Which factors affect the public embracement of UAVs?
2. Which factors affect the public's intention to use UAVs?
3. What purposes should UAVs be used for?

1.2. Thesis methodology

The methodology used to achieve the previous objectives will include the creation of an online survey to collect data from respondents and subsequent analysis through the use of the t-test, ANOVA analysis, non-parametric tests (e.g.: Kruskal Wallis test) and correlation analysis (i.e.: Pearson's correlation test).

1.3. Thesis structure

The current work is divided into five chapters, and it is structured as follows:

On the first chapter, the introduction to the theme is presented in three parts: the current state of the sector and presentation of the stakeholders, objective of this study and methodology applicable. The second chapter will present the literature used for the execution of this study. This review will serve as knowledge instruction to the readers to explain the current knowledge of AVs and UAVs, the main concerns regarding these technologies, the benefits of AVs and UAVs, and the public's intention to use this transport mode.

In the third chapter, the methodology used will be explored. It will go through by analysing the hypothesis constructed to perform this study and by reviewing each group of the survey.

The fourth chapter is dedicated to the results achieved by the analysis, mentioned before, of the data that was collected from the survey performed.

The fifth and final chapter includes the conclusion of this study and recommendations for future work to be done in this field.

[This page was intentionally left blank]

2. LITERATURE REVIEW

2.1. What are UAVs: specifications and possible uses

The Urban Air Mobility (UAM) concept aims to enable a world where people or goods can be transported in the urban environment in minutes rather than hours, always on demand. UAM can be realised in the form of air taxis and shared or owned vehicles, creating an on-demand flying service network. Currently, manufacturers are already on the prototype flying-test phase and are getting ready to reach market availability in 2023 (Holden & Goel, 2016). These unmanned aerial vehicles (UAV) will be VTOLs, an all-electric aircraft that has the capability to vertically take-off and land, therefore, does not require any runways (Lineberger, Hussain, Mehra, & Pankratz, 2018). According to Holden et al. (2016), UAM will add the third dimension, which increases the accessibility between suburbs and cities and, ultimately within urban areas (Holden & Goel, 2016). In resemblance to the automated vehicles (AV), VTOLs will be fuelled by electricity, thus, reducing emissions and generating lower noise emissions than a traditional helicopter (Lineberger et al., 2018). At the moment, the major manufacturers are Airbus with their model Vahana and CityAirbus; Boeing with Aurora (partnership made with Aurora flight sciences); and Volocopter with the VoloCity. These VTOLs are expected to have a range of 50Km and a top speed of 120Km/h.

Figure 2.1 - VoloCity UAV by Volocopter (Source: Volocopter)

In terms of the use of UAVs, there are some differences between Uber's and Volocopter's view. On Uber Whitepaper there is a belief that UAVs will be mainly useful for "mega-commuters", people who commute more than 150km on a daily basis (Holden & Goel, 2016). Uber believes that UAVs will be able to mitigate the commuter's "pain" by offering different transportation service. Although, there are some constraints on the technology level. The available battery technology allows manufacturers to have a range of 50 km and since this paper also suggests that there will be no time to recharge between trips it is a bit farfetched to believe that UAVs will be useful for the so-called "mega-commuters".

Volocopter, on the other hand, believes that UAVs will be used for the inner cities' mobility rather than for big commutes. According to Volocopter's white paper, there are many short-range commutes where Volocopter can be operated efficiently and economically with limited infrastructure (Boelens, 2019). These infrastructures can be located in key locations such as airports, shopping malls, business districts, train stations or hotels. Therefore, UAVs can be used for purposes other than commuting such as transporting passengers from a company to a hotel or from an airport to the hotel.

Volocopter aims to operate in megacities. Their study found that most of the megacities have an urban area in less than 30km from the geographic centre, meaning that with a range of 30-35km their eVTOL can serve various passengers. Figure 1 shows the population distribution in megacities. We can observe that in most of the examples the majority of the cities' inhabitants live in a 30 km radius from the city centre.

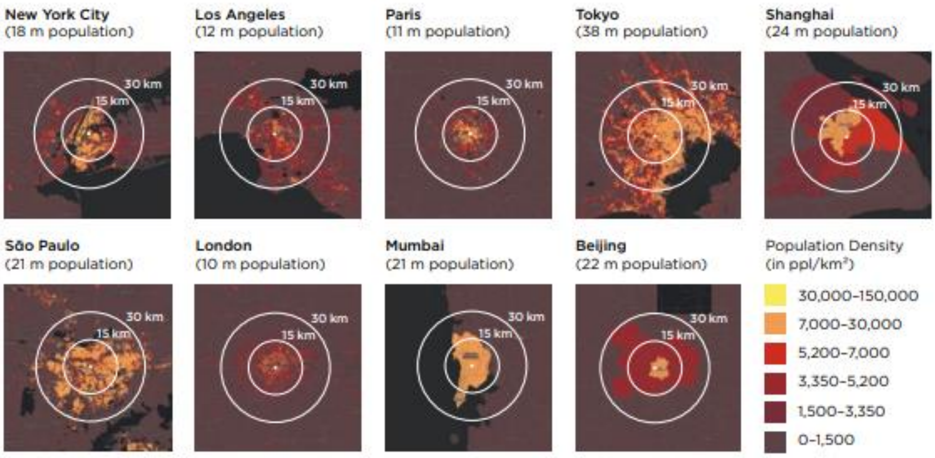


Figure 2.2 - Population density in megacities (source: Volocopter)

2.1.1. Noise

Noise can be one of the main public's concerns regarding air urban mobility. Uber believes that the noise level generated by the vehicle will be key for the acceptance of these vehicles into the community. Bearing this in mind, Uber developed some noise levels that they feel would be acceptable. Bellow, we can see the table with the desirable level for x meters of altitude.

Table 2.1 - Desirable noise levels (Source: Holden & Goel, 2016)

Altitude	Noise Level
150 Meters	62 dB
75 Meters	67 dB

To get an idea of the levels mentioned, 60dB is the equivalent to a normal conversation or office noise (IAC acoustic, 2018).

2.1.2. Battery range

Battery life is perhaps the biggest concern for the manufacturers. With the increase of electric cars there have been some developments on the battery technology allowing it to have a longer life but when designing an air taxi trade-off has to be made. Therefore, a battery with a longer range and life means a heavier VTOL, less efficient. According to the Volocopter study, 3 minutes is the amount of time their VTOL takes to take-off and landing. During that period, the

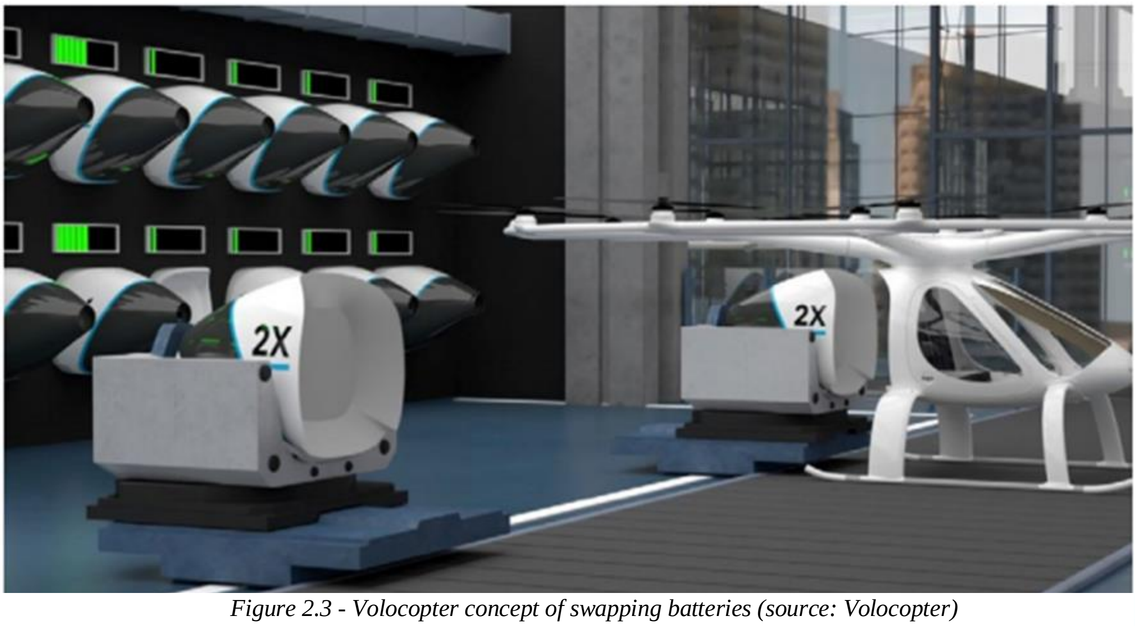


Figure 2.3 - Volocopter concept of swapping batteries (source: Volocopter)

expected energy consumption is equivalent to a fully charged battery on an electric car. Meaning that there are two options, build a VTOL with a large and heavy battery or create a smaller VTOL more efficient with a lower range.

Volocopter addressed this subject with a new approach, instead of grounding the aircraft in order for them to recharge, they created a system where the battery would be removed from the VTOL and a set to charge whilst another charged battery is plugged to the aircraft.

With this system, Volocopter can maximize battery life and minimize turnaround time. Thus, creating a more cost-efficient system. On Picture 2.3 we can see battery swapping system developed by Volocopter, and on Figure 2.1 we can see the influence of the battery on the total weight of the UAVs.

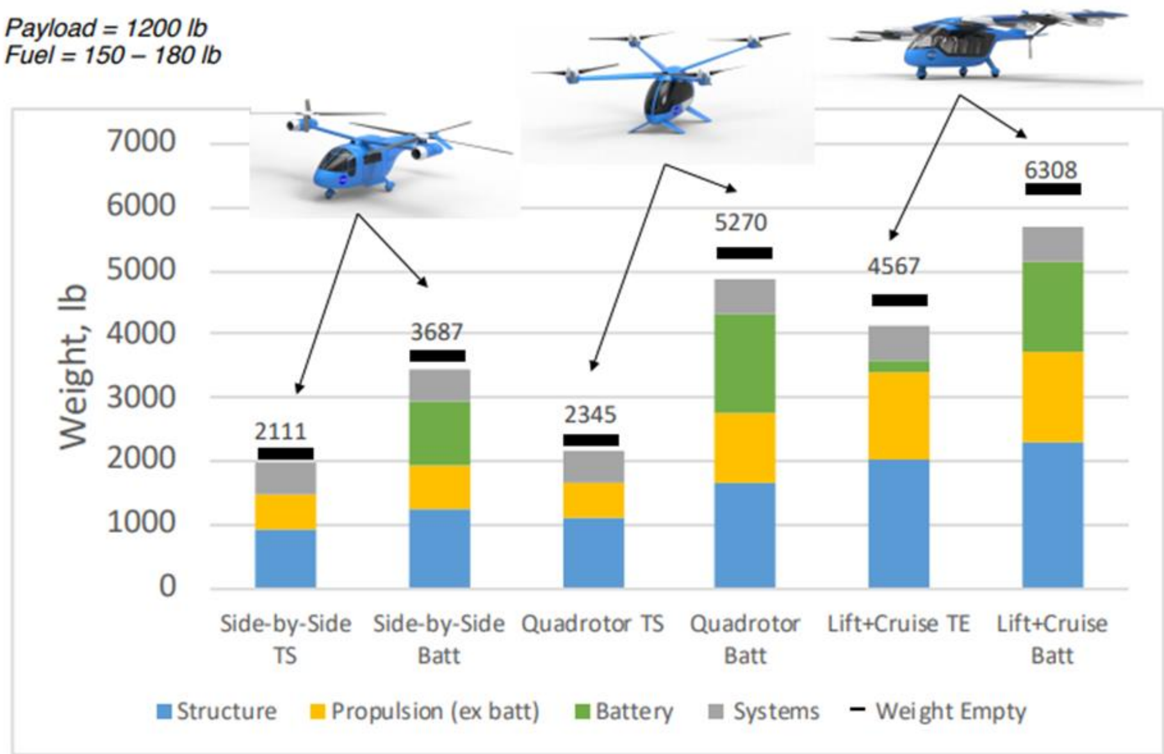


Figure 2.4 -The battery influence on the total weight (source: Nasa 2018)

2.1.3. Emissions

In 2018, Nasa performed an observational study from the exploration of current VTOLs designs where several characteristics from aircraft were discussed. For this study, Nasa considered various VTOLs with different capacities from 5 to 76 passengers. Then, Nasa estimated the CO_2 emissions for each aircraft and each energy source. As we can see on Picture 2.4, it is estimated that a VTOL (electric battery) with the capacity for 5 passengers will produce 27% fewer emissions than a 5-seat helicopter (after travelling 400 Nautical Miles) and if we consider a H_2 Fuel Cell the emissions can be 77% less (Johnson & Silva, 2019).

Although this study does not mention the emissions for 2 seat VTOLs, we can assume that it will be lower than the 5-seat aircraft.

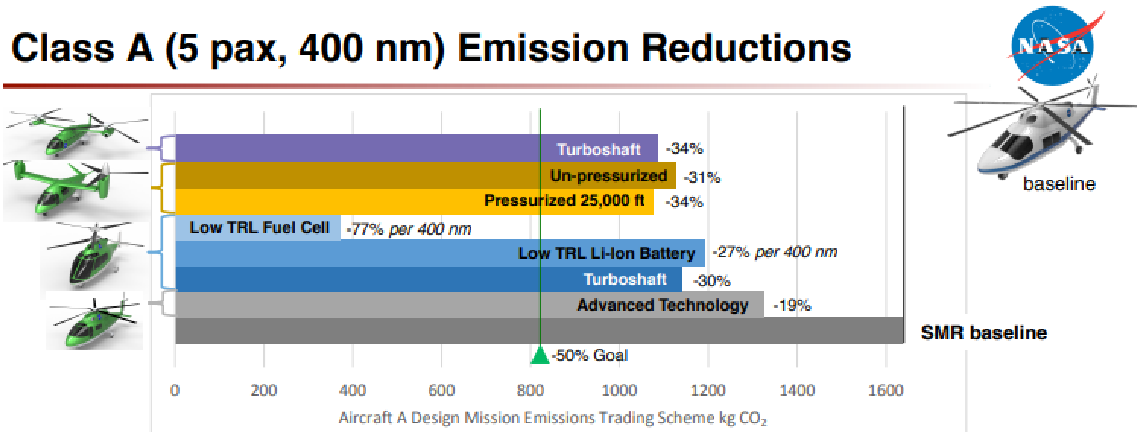


Figure 2.5 - UAVs emissions (Source: NASA)

2.1.4. Infrastructure requirements

This new mode of transportation has its requirements in terms of infrastructure, there is a need to have various pick-up/drop off to provide flexibility to the customer. This way, the customer has the possibility to start and end his flight at the best location possible for him.

There are two kinds of infrastructure needed for UAM network: vertistop and vertiports. Vertistops are single-vehicle landing locations where VTOLs can quickly drop-off and pick-up passengers. Vertiport, on the other hand, is a location where a VTOL would land and would have support facilities to charge the aircraft, fix some eventual problems that it may have, and, of course, pick-up and drop-off new passengers. Again, unlike vertistops, vertiports would have the capacity needed for more than one VTOL (Holden & Goel, 2016).

2.1.4.1. Uber air

Holden et al. (2016), studied with Nasa, all the possible infrastructures that Uber can use to develop their UAM service. According to the study, the best solution would be to use already placed infrastructures and modify them if needed to be used as a vertistop or a vertiport.

On Uber's white paper, NASA suggested different locations for vertistops and vertiports. For vertistops, NASA recommended unused helipads (frequently located on highly desirable downtown locations) and highway cloverleaves as they are extremely accessible, and the already present highway noise would cancel the aircraft noise. In terms of Vertiports, NASA proposed the use of floating barges (that would be perfect for coast cities like San Francisco as the price would be lower than building a vertiport close to the city) and, perhaps the best one, the top level of parking garages (Holden & Goel, 2016).

In light of 2018 Uber's Elevate Summit, six architecture and design firms released their vision for Uber's vertiports. On figure 4, we have the Uber hub developed by Humphreys & Partners. This was one of the top designs chosen by Uber. According to the firm who developed this project, the hub has the capacity of serving 900 passengers on each level per hour. Another good feature of the design is the location (Carey, 2018). Being on a highly accessible place, such as a freeway, the hub becomes more accessible giving. After landing the user has multiple solutions of mobility, such as public transport, request an Uber X or being picked up by someone.

Figure 2.6 - Uber Hub designed by Humphreys & Partners (Source: CN Traveler)

2.1.4.2. VoloPort by Volocopter

Volocopter GmbH is a German aircraft manufacturer based on drone technology and considers themselves to be pioneers in the development of electrical air taxis (eVTOLs). In 2011, Volocopter performed the first-ever manned flight of an all-electric multicopter (Volocopter, 2017).

Unlike any other manufacturer, Volocopter will also provide the UAM service. Airbus and Boeing are mainly focusing on the aircraft whilst Uber are focusing on the service design. Volocopter will release an App that allows users to call an air taxi, this way users can catch any Volocopter at any time at one of the VoloPorts (Boelens, 2019).

A VoloPort, designed by Volocopter, ideally will be placed on top of building in busy city centres to allow passenger proximity to their destination and turn into a great last-mile solution. VoloPort will work as a flowing system, first users land on the port and then are carried inside the hub, thus the landing site is immediately free for the next air taxi. After disembarking passengers, the VTOL is moved to an area where the battery will be changed automatically, then the aircraft can be stored or moved to the next flight.

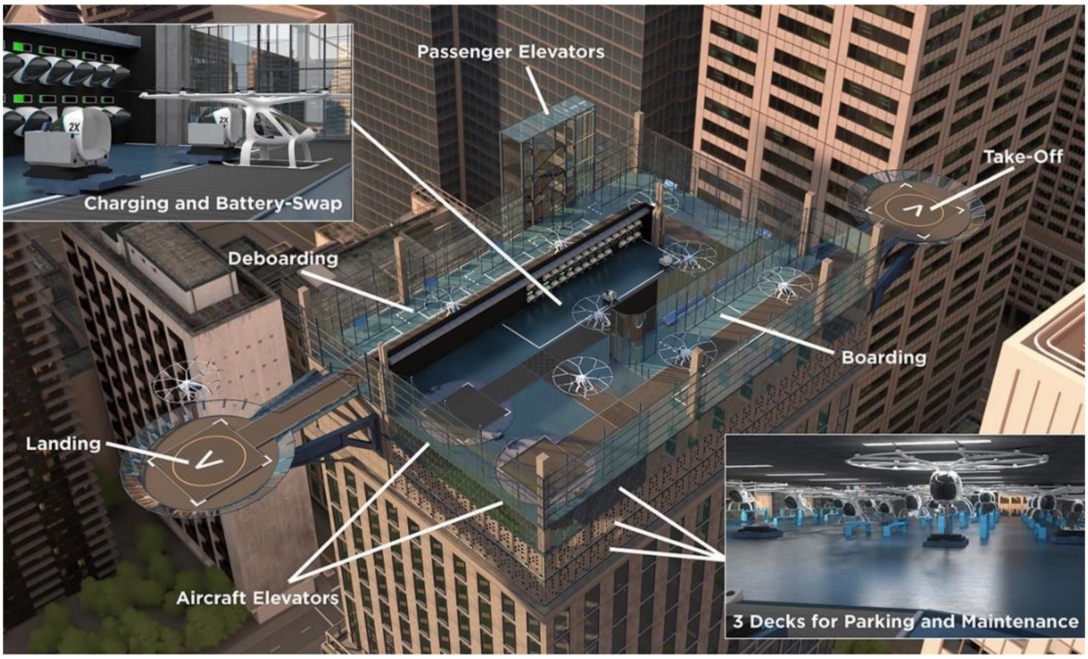


Figure 2.7 - VoloPort (Source: IEEE Spectrum)

2.2. Literature on UAVs

The availability of the technology generates opportunities for the study of the future of mobility especially in urban and suburban areas with the respective requirements in infrastructure and service operation. Al Haddad et al. (2020) performed a study to observe which factors affect the adoption and use of UAVs and found that safety plays a crucial role in early and late adoption. Other factors such as affinity with automation, data and ethical concerns were also found to have an impact on adoption (Al Haddad, Chaniotakis, Straubinger, Plötner, & Antoniou, 2020). These findings were coherent with a NASA study, where respondents reported that safety, costs and environmental aspects were determinants of adoption and the majority of respondents (over 70%) stated they would be comfortable with other people using air taxis services regardless of them using it or not (Urban Air Mobility, 2018).

Eker et al. (2020) found that women are more concerned with safety than men (e.g. safe interactions between UAVs) meaning that this safety concerns may prevent women from being early adopters (Eker, Fountas, Anastasopoulos, & Still, 2020). This finding corroborates with conclusions of Al Haddad et al. (2020) in which women expressed a lower interest in UAM, lower trust in automation, greater security, and safety concerns. Moreover, women had a higher desire of having extra safety measures such as an operator on the ground and in-vehicle safety cameras (Al Haddad et al., 2020). Income and education background can also be indicators of the likelihood of adopting this service. Castle et al. (2017) found that having a higher income and a greater degree of education would translate into a higher willingness to use UAM (Castle et al., 2017). Furthermore, there is evidence that young respondents are more likely early adopters which might be explained due to the largely unknown capabilities of UAVs (Eker et al., 2020). Additionally, it was suggested that informational campaigns should be designed and implemented to increase awareness (Eker et al., 2020).

Much like in Autonomous Vehicles, data privacy and ethical concerns can also have influential negative impacts on the early adoption of UAVs. Regulations should be created to establish standards for liability, security, and data privacy (Al Haddad et al., 2020). Furthermore, environmental concerns were also observed as crucial points in the adoption of UAM service. NASA observed that the environmental impact was the third-highest concern on their study with over 2,500 responses (Urban Air Mobility, 2018). Al Haddad stated that there is a need for policymaking regarding noise and visual impact. Regulating these areas could lead to higher public acceptance (Al Haddad et al., 2020).

NASA also studied what key actions that policymakers and constructors could undertake that would increase the public comfort with air taxis. The actions were related to safety, environmental concerns, legal issues and noise impact. The respondents showed a higher desire for actions such as proven lower accident rates than cars, successful human demonstrations of their safety and successful trials in other cities. The fourth most highlighted action was related to the environment, where respondents stated that they would feel more comfortable with air taxis if they are less harmful to the environment than regular cars. The least picked action was related to noise showing that respondents have a lack of concern with UAM noise (Urban Air Mobility, 2018).

2.3. Literature review on AVs

Although AVs and UAVs are not the same to the user's eyes, they share strong commonalities not only on the constituents' technology (Holden & Goel, 2016) but also on the challenges they face as a new way of transportation and the expected benefits. On the following chapter, I will go over autonomous vehicles, as UAVs challenges/benefits most likely will be the same as AVs.

Autonomous vehicles are every day becoming more of a reality, and with the rapid development of new technologies, it is expected to be available and on commonplace in the next decades. Begg et al. (2014) developed a survey targeting transportation experts in London, to understand their perception of whether and how soon the respondents would expect AVs to become a reality. In that survey, 26.4% of respondents stated that level 4 AVs - High Driving Automation (Documents et al., 2014) – will be on UK's public roads by 2030, and around 20% stated that level 5 AVs – Full Driving Automation (Documents et al., 2014) – would be on public roads by 2040 (Begg, 2014).

AVs can be a positive development concerning the traffic and the environmental crisis. However, Thomopoulos et al. (2015) stated that positive effects will only emerge if AVs are used in a shared way (Thomopoulos & Givoni, 2015).

Autonomous Taxi will work as on-demand mobility (ODM) service and will have a capacity of 5 passengers, but the user is not forced to share the AT if he or she does not desire to do so. As soon as the AT arrives at the destination the transaction is made, and the user continues his journey hassle-free and without needing to find a parking spot.

On the following subchapters, I will go over the benefits of AVs, the factor affecting the adoption AVs and some strategies that manufacturers and regulators can implement to increase the likelihood of adoption.

2.3.1. Potential benefits of AVs

Autonomous Vehicles are expected to have benefits that potentially can improve the users' life quality. AVs can: improve users' productivity - since they can use the travel time to work or take care of some errands; decrease the stress of driving – the passenger isn't required to operate the vehicle at any point; have a better fuel economy; reduce car crashes – increased safety – and lower insurance rates (Shabanpour, Golshani, Shamshiripour, & Mohammadian, 2018).

König and Neumayr (2017) stated that one of the major potential benefits of AVs would be the possibility to solve the mobility problems of the elderly, people with disabilities or even children (König & Neumayr, 2017). Begg (2014) when interviewing transports experts in the UK also found that this technology may enable higher independent mobility for the non-drivers whilst increasing road capacity and reducing traffic congestion (Begg, 2014).

AVs can offer last-mile solutions and fill the transportation needs in places with less frequently used routes. When compared to Public Transportation (PT), AVs offer more privacy, comfort and intimacy, seating availability would be guaranteed and walking time would be significantly reduced (Krueger, Rashidi, & Rose, 2016).

2.3.2. Factors affecting the adoption of AVs

AV's manufacturers will face many challenges before making AVs available to the market. Some of those challenges are technology constraints, missing regulation, infrastructure shortage and user behaviour.

According to Gkartzonikas & Gkritza (2019), who reviewed the stated preference and choice studies on AVs, nine areas that can potentially impact an individual's intention to ride an AV (Gkartzonikas & Gkritza, 2019). Those areas are the level of awareness of AVs; consumer innovativeness; safety; the trust of strangers; environmental concerns; relative advantage, compatibility, complexity; subjective norms; self-efficacy; driving-related seeking scale. These concepts will be analysed in the following points.

2.3.2.1. Safety

Safety is often seen as one of the most important concerns resulting from the emergence of AVs. In a survey performed by Casley et al. (2013), four out of five respondents ranked safety as the most important topic when asked about AVs (Casley, Jardim, & Quartulli, 2013). Safety concerns can negatively influence the consumers' perception towards AVs, making it difficult for them to adopt this technology.

Currently, recent events in the U.S. raised some doubts regarding the safety of AVs as self-driving test vehicles have been involved in various accidents. Uber’s AV alone was involved in 37 crashes in eighteen months (Shepardson, 2019). The most important and dangerous one was in March 2018 as the AV ran over a pedestrian killing her instantly. As a result of this accident, Uber suspended all tests until December to study this casualty. When talking about safety often another concern is brought to the debate, the liability in case of an accident occurs. Legal issues will be discussed later on.

2.3.2.2. Environmental concerns

With the rising of the environmental crisis, people have become more aware of the effects of their action. Haboucha et al (2017) attempted to measure the respondent’s concerns about the environment and see how it could affect their perception towards AVs. The results were that approximately six out of ten respondents stated that they would consider purchasing an AV if it were to emit fewer pollutants than conventional vehicles (Haboucha, Ishaq, & Shiftan, 2017).

2.3.2.3. Relative advantage, compatibility and complexity

Haboucha et al. (2017) inserted in their survey questions regarding the relative advantage of AVs, e.g. their potential to solve parking and mobility issues, and whether it is more fun to ride and AV than a conventional vehicle (Haboucha et al., 2017). The interviewers found that an increase in parking cost has the potential to encourage the use of AVs, but respondents who enjoy driving are less likely to adopt AVs. Howard and Dai (2014) also found that being able to multitask whilst on an AV is one of the most attractive features when riding an AV, along with safety and convenience (Howard & Dai, 2013).

2.3.2.4. Technology hacking and cybercrime

There are many barriers and concerns when autonomous vehicles are the subject. König and Neumayr (2017) concluded from their survey that the respondents have some concerns regarding AVs one of the major ones is the cybersecurity of the vehicles (König & Neumayr, 2017).

Respondents in this survey stated that AVs can lead to privacy issues caused by steady tracking and monitoring of the user's daily driving. Also, it was stated that users are afraid that the vehicle can be hacked. Schoettle et al. (2014) performed a survey where they found that one of the concerns that respondents have is that the hackers may be able to gain access to the car and divert its route (Schoettle & Sivak, 2014).

2.3.2.5. Legal and moral issues

Being that the driver has no control over the vehicle, respondents feel that the liability should be on the manufacturers or the regulators. AVs are programmed to make all sort of decisions during the travel time, they are also programmed to act one way when in the imminence of danger. In this situation the driver has power on the decision making, therefore studies show that respondents do not agree and are concerned that the with the possibility of drivers getting the liability of the accident (Schoettle & Sivak, 2014).

Liljamo et al. (2018) surveyed over 2,000 respondents to access their attitudes and concerns over AVs. According to their survey, the second biggest concern is moral issues (Liljamo, Liimatainen, & Pöllänen, 2018). Respondents showed that they are concerned that when driving in an AV, the vehicle will not work in dangerous situations according to their morals. In a survey performed by Howard and Dai (2014), the respondents stated that safety and liability concerns play a critical role in the adoption of AVs (Howard & Dai, 2013).

2.3.2.6. Strategies to increase users' perception and adoption

Some of the already mentioned surveys stated that AVs have some opportunities will improve the user's perception and time to adopt. Shabanpour et al. (2018) highlighted on their study that AVs adoption would likely increase if the liability in case of an accident is not on drivers. The authors also stated that creating exclusive lanes for AVs would enhance adoption of AVs

(Shabanpour et al., 2018). This way users would move faster and feel safer since there would be no conventional car.

Haboucha et al. (2017) stated that the increase on parking costs would have an impact on AV adoption and that for the users the actual price of AVs is not important, what is important is the relative price between AVs and regular vehicles (Haboucha et al., 2017).

2.4. Conclusion from Literature Review

After reading and analysing all the papers mentioned above, it is possible to acknowledge that there is a gap in terms of studying the public perception towards UAVs and UAM in terms of acceptance as a mode and also the intention to use. We can see this trend not only in UAVs but also in AVs. Manufacturers and companies are already preparing to launch this new transport mode but very few papers focused on the questions “Do people want this technology?”, “Is this a real public need?”. Not asking this question can lead to misleading conclusions on its utility to the public.

Thus, before making this technology available manufactures, companies and policymakers must better understand the public and assess their perceptions. I believe that this study is necessary because the intention to use is not the only indicator for the acceptance of this technology, there are many layers that need to be studied. For example, one can see themselves as a person who would not use UAVs but can see its benefits and be in favour of this new way of mobility or one can be totally against the civilians use of UAVs and believe that UAVs should only be used for state services for the public such as ambulances or police.

Following this line of thought, this Masters’ thesis aims not only to study the intention to use UAVs but also to, and perhaps more importantly, assess the public’s perception of UAM.

Table 2.2 - Summary of all papers (own authorship)

Reference	Title	Research Context	Sample	Research design	Data analysis methods
Al Haddad et al. 2020	Factors affecting the adoption and use of urban air mobility	Among Europe, USA, Latin America and Middle East	221 responses	Online Survey	Exploratory factor analysis; Multinomial logit model; Ordered logit model
Zeid, 2009	Measuring and Modelling Activity and Travel Well-Being	Among various countries, majority of respondents were from USA	594 responses	Online Survey	Factor analysis and latent choice models
Sanbonmatsu et al. 2018	Cognitive underpinnings of beliefs and confidence in beliefs about fully automated vehicles	USA	147 responses	Online Survey	Pearson correlation tests
Panagiotopoulos and Dimitrakopoulos 2018	An empirical investigation on consumers' intentions towards autonomous driving	Greece	483 responses	30-question online survey	TAM-extended research framework, Pearson correlation
Eker et al. 2020	An exploratory investigation of public perceptions towards key benefits and concerns from the future use of flying cars	Among Europe, USA, Latin America and Middle East	692 responses	Online Survey	Bivariate probit models
Brell, Philipsen, and Ziefle 2019	sCARy! Risk Perceptions in Autonomous Driving: The Influence of Experience on Perceived Benefits and Barriers	Germany	17 focus group participants, 516 responses	Focus group, online survey	Spearmen rank correlation analysis, semantic differentials
Shabanpour et al. 2018	Eliciting preferences for adoption of fully automated vehicles using best-worst analysis	Chicago metropolitan area, USA	1253 responses	Online Survey	Best-worst choice experiments, multinomial logit model
Fu, Rothfeld, and Antoniou 2019	Exploring preferences for transportation modes in an Urban Air Mobility environment: a Munich case study	Munich, Germany	248 responses	Online Survey	Stated preference study, multinomial logit

3. METHODOLOGY

This chapter describes the methodological approach of this research. In order to achieve the research objectives, a survey was created to be used as data collection. Section 3.1 will go over the conceptual model created to support the research hypothesis (section 3.3) and survey design (3.2.). Section 3.4 describes the data analysis methods used for the analysis of the data collected.

3.1. Conceptual model

UAM has various benefits for the cities that adopt this transport mode. However, it is important to ensure that the UAM does not decrease the quality of life by congesting the sky and increasing noise pollution. Therefore, having the public involved and co-creating becomes crucial for the adoption of UAM (Government Europa, 2019). The rate of adoption and acceptance is suggested that depends on the trust people have on technology and the tendency towards new technologies´ adoption, the perception of the people over the expected benefits and safety of UAVs, concerns over cybersecurity, people´s travel well-being, mobility and driving behaviour, their environmental concerns and their sociodemographic characteristics. Hence, a conceptual model was developed to research the impact of these aspects on the people´s embracement and intention to use UAVs (Figure 3.1).

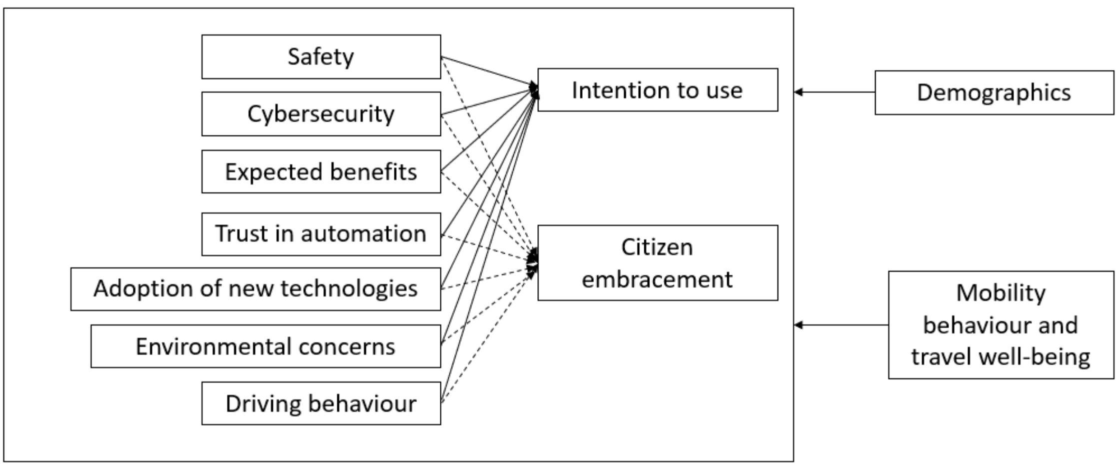


Figure 3.1 - Conceptual model (own authorship)

3.2. Survey design

As technology is rapidly evolving, the industry is developing prototypes of passenger aerial vehicles and some of them have already performed thousands of test flights (e.g. Airbus Vahana). With this rapid growth the need for research that assesses people's perception towards UAVs and their intention to use them arises. In this study, it is proposed that the integration of UAVs in the future transport systems is decomposed to two dimensions, the intention of citizens to use them and the embracement of this vehicle type from the society which indicates the voluntary inclusion of the mode in the transport system.

Therefore, to reach the research objectives, a survey was designed consisting of four parts, with a total of 49 questions. Before resealing the survey, tests were made with 30 respondents. This test had the objective of validating and improving the questions made based on suggestions from those 30 respondents. The survey particularly focused on the Portuguese region but it was also open for respondents from other regions, therefore, the survey was available in Portuguese (PT) and English (EN). The collected data had the form of categorical, continuous and ordinal variables and were assessed through the use of the Likert scale agreement statements (Likert, 1932), the scale chosen was the 7-point scale with options ranging from "strongly disagree" to "strongly agree" and with a midpoint "neither disagree nor agree".

The first part of the survey was composed of questions that reflected the trust of the respondents in automation and their attitude towards the adoption of new technologies. Some examples of the statements presented regarding the trust in automation are: "I believe that driver assistance systems are useful" "I am satisfied with the driver assistance systems I have used". After, respondents were also asked if they had, or know if any kin had, any interaction with an automated vehicle (e.g.: car, bus, tram, metro), if so, in the following question respondents were asked to state their agreement towards some examples of feelings that they might have felt (e.g.: "I felt..." comfortable, stressed, safe, anxious, scared).

The following section of this part was related to the adoption of new technologies. For this section, the Technology Adoption Life Cycle, also known as the Diffusion of Innovation, developed by E.M. Rogers, was used (Rogers, 1983). This theory defined that there are 5 different adoption categories, they are: the "innovators" – defined by people who want to be the first to try the innovation; the "early adopters" - are known to be the people who represent opinion leaders; the "early majority" – people that are rarely leaders but adopt new ideas before the average person; the "late majority" - people that are sceptical to change, and will only adopt an innovation after it has been tried by the majority; the “laggards” – people that are bound by tradition and very conservative. Tend to be very sceptical.

Bearing these definitions in mind, respondents were asked to answer the following questions “Regarding the adoption of a new technology, which adopter category represents you?”, “Regarding the adoption of a new technology, which adopter category represents you?” (in this question there were multiple examples given such as ride-hailing services, car-sharing services, among others).

Respondents were also asked to state their satisfaction towards these services, the scale presented was similar to the agreement scale mentioned above, ranging from “totally dissatisfied” to “totally satisfied”. At the end of this first part, respondents were asked if they know what an Unmanned Aerial Vehicle is.

At the second part, the participants were introduced to the UAVs and were presented some of the aircraft and service characteristics. This introduction helped the respondents to get more familiarized with the subject before expressing perceptions on it. Then the level of agreement to statements related to expected benefits, safety and cybersecurity of UAVs were measured. To assess the respondent´s view on expected benefits, their perception regarding UAVs impact on road traffic, mobility behaviour, safety, and independence on mobility (e.g. disabled people mobility) was captured.

Safety concerns were reflected through the measurement of the respondent´s agreement with situations that may occur such as flying under poor weather conditions or their fear of having a mid-air collision. The respondents were also asked to state if they would feel safer if the UAV service had some characteristics such as a pilot on the ground ready to take over the aircraft if needed, the possibility to speak with an operator at any time or security cameras inside the VTOL cabin.

The participants’ view on cybersecurity was assessed through the measurement of the degree of concern they had towards critical points of cybersecurity such as data privacy, user tracking, loss of privacy and loss of control.

The intention to use UAVs was measured using the Technology Adoption Life Cycle (from innovators to laggards) and the purpose of use was also reported. The embracement of this new transport mode as a citizen (not necessarily as a user) was also included; statements towards the level of comfort if UAVs are available in their city, the availability of UAVs to everyone and the possible purposes of use of UAVs were evaluated.

The next part of this survey consisted of questions about the respondents’ mobility (mode of transport, travel time, transfers) and driving behaviour (e.g. enjoying driving, driving after drinking, involvement in accidents) and environmental concerns. To finish the survey participants provided some socio-demographic information (e.g. age, gender, income, residence). The full survey can be visualized on Annex A. On Annex C, the survey questions can be found with the papers from which the questions were adapted from.

3.3. Presentation of hypotheses

In order to access the citizens' embracement and intention to use UAVs, the following hypotheses were elaborated to guide the research during various phases such as data validation, correlation and analysis. Therefore, hypotheses were created based on the previous literature mentioned. The hypotheses are as follows:

H1. Men intend to use UAVs earlier than women;
H2. Safety is perceived in a different way among the public embracement levels;
H3. Young people are willing to adopt UAVs earlier than the older;
H4. Familiarity with shared mobility services has an impact on adoption and embracement;
H5. Public embracement levels vary across adoption levels;
H6. Income levels don't vary across adoption levels;
H7. The expected benefits are differently perceived among the public embracement levels;
H8. Accident history vary across adoption levels;
H9. Cybersecurity is perceived in a different way across public embracement;
H10. People satisfied with ride-hailing services are willing to embrace this mode earlier.

3.4. Data analysis methods

The data analysis will be constituted by 3 parts, data sample presentation, Pearson's correlation and the variances analysis through the use of the t-test, ANOVA, Kruskal-Wallis method.

3.4.1. Pearson's Correlation

The Pearson's Correlation, also known as the Pearson product-moment correlation coefficient, is a statistical method of expression of the relationship between two variables. The method produces a coefficient *r* which is an index of a linear relationship, the slope of the best-fitting straight line for a bivariate (X, Y) distribution where the X and Y variables have each been standardized to the same variability (Cohen, 1988). This indicator may vary between -1 and 1.

Regarding the interpretation of the results, there is a general guideline which may vary by discipline. According to Cohen, an *r* between 0.1 and 0.3 is considered weak, 0.3 to 0.5 is moderate and 0.5 or higher is considered to be a strong correlation. All interpretations are equal for negative results. Negative correlations mean that the two variables are inversely proportional.

3.4.2. ANOVA

The ANOVA stands for Analysis of Variance and has as its objective to analyse the variances between the data groups. To do so, this method compares the means of two or more groups and then determines if they differ between them. The difference between the Hypothesis Test and the Analysis of Variance is that with the last method it is possible to analyse more than two samples. The One-Way ANOVA has one independent variable, in this research the Intention to use variable was used. However, to use the Analysis of Variance the data collected has to comply with the following assumptions:

1. The samples must be independent;
2. The samples must have a normal distribution;
3. The variances should be homogeneous.

The first assumption refers to samples that aren't related. To comply with the second assumption, one can test the sample's normal distribution by using the two most common tests Kolmogorov-Smirnov test and the Shapiro-Wilk test, or by using the Central Limit Theorem that states that when you have a large sample you can state that there is a normal distribution (Kwak & Kim, 2017). In this research, it can be assumed that there is a normal distribution if the independent factor has more than 30 answers per category. For the third assumption, a Levene test was performed to analyse the homogeneity of variances.

If the sample does not comply with three assumptions, the ANOVA method can be not be applied. For these cases, the non-parametric Kruskal-Wallis method shall be used.

3.4.3. Kruskal-Wallis non-parametric method (KW)

The Kruskal-Wallis method is a non-parametric method that can be used when the sample does not have a normal distribution. This method determines if there are any significant variances between one independent variable and other dependent variables. Much like the ANOVA method, some assumptions need to be validated:

1. The dependent variable must be measured at the ordinal or continuous level;
2. The independent variable must be composed by more than two categorical, independent groups;
3. There must be independence of observations;
4. Have to determine if the distribution of each group have the same variability.

This method was used to analyse the variances of the variables that didn't meet the requirements of the ANOVA method. Therefore, this method was used for the analysis of the variables that didn't have a significant *p* value on the test of homogeneity of variances on the Intention to use analysis and on the Public Embracement research, being that this sample does not have a normal distribution (AERD statistics, 2018).

3.4.4. Independent samples t-test

The independent samples t-test have equal means on some variable. For this test, the null hypothesis is that the two population means are equal. Before proceeding with the analysis, the data has to be validated in three assumptions: Independent observations – variables must be independent and identically distributed; Normality – the outcome variable must follow a normal distribution. This assumption can be discarded when the samples have a reasonable size (Central Limit Theorem).; Homogeneity – the outcome variable must have equal standard deviations in the two subpopulations

In this research, the independent samples t-test was used to analyse if there are variances between genders when considering the intention to use UAVs. Also, it was used to observe if people who had an accident as a driver have a higher likelihood of adopting UAVs.

4. RESULTS

A total of 391 valid random replies to the online survey were collected. The survey was created on Lime Survey and shared through WhatsApp, Facebook and E-mail. It was found that there is a reliable relationship between the measured dimensions and the measured aspects of intention and embracement (Cronbach's Alpha – see Annex D).

4.1. Research sample

Regarding the sample composition, it was observed that the sample is unevenly distributed. There was a predominance of the male gender. In terms of household, 40.9% stated that they have children, whereas the remaining sample has no children of their own (59.1%).

Regarding the age distribution, the majority of respondents are younger than 44 years old, with a cumulative percentage of 67.8%. The age group with the higher frequency was the 18 to 24 range. Bellow, we can find the tables with the frequency and percentage of each possible answer.

Table 4.1 - Gender distribution (own authorship)

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	168	43,0	43,0	43,0
	Male	223	57,0	57,0	100,0
	Total	391	100,0	100,0	

Table 4.2 - Age distribution (own authorship)

Age range

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18 to 24	118	30,2	30,2	30,2
	25 to 34	98	25,1	25,1	55,2
	35 to 44	49	12,5	12,5	67,8
	45 to 54	58	14,8	14,8	82,6
	55 to 64	63	16,1	16,1	98,7
	65 or older	5	1,3	1,3	100,0
	Total	391	100,0	100,0	

Concerning the income level, it was found that the majority of respondents have a maximum monthly income of 3000€, being that the 2000€-3000€ range was the one with higher frequency (See Table 4.3). Having into consideration that the average salary in Portugal in 2018 was 970,4€ (Pordata, 2018), it can be observed that the majority of respondents have a high salary when compared with the average.

Table 4.3 - Monthly income distribution (own authorship)

Distribution of Monthly Income

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Up to 500€	6	1,5	1,5	1,5
	500€ to less than 1000€	46	11,8	11,8	13,3
	1000€ to less than 2000€	87	22,3	22,3	35,5
	2000€ to less than 3000€	93	23,8	23,8	59,3
	3000€ to less than 4000€	52	13,3	13,3	72,6
	4000€ to less than 5000€	38	9,7	9,7	82,4
	6000€ to less than 7000€	17	4,3	4,3	86,7
	More than 7000€	10	2,6	2,6	89,3
	Prefer not to say	42	10,7	10,7	100,0
	Total	391	100,0	100,0	

As we can see in Table 4.4, the majority of respondents have either a Bachelors' degree or a Masters' degree. This data can explain why most of the survey's respondents have a much higher income level when we compare it with Portugal's average.

Table 4.4 - Educational background (own authorship)

Educational background

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary or secondary school	1	,3	,3	,3
	High school	30	7,7	7,7	7,9
	Apprenticeship with graduation	17	4,3	4,3	12,3
	Bachelors' degree	181	46,3	46,3	58,6
	Masters' degree	147	37,6	37,6	96,2
	PhD	14	3,6	3,6	99,7
	Prefer not to say	1	,3	,3	100,0
	Total	391	100,0	100,0	

Regarding the current employment situation, as expected, the majority of respondents are full time employed (working for others). Also, the sample collected had almost 20% full-time students and almost 9% of respondents are self-employed.

Table 4.5 - Employment situation (own authorship)

Current Employment Situation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Other	12	3,1	3,1	3,1
	Employed - Full time	206	52,7	52,7	55,8
	Retired	7	1,8	1,8	57,5
	Military or civil service	3	,8	,8	58,3
	Voluntary service	2	,5	,5	58,8
	Prefer not to say	5	1,3	1,3	60,1
	Employed - Part time (11 to less than 35hours/week)	15	3,8	3,8	63,9
	Self-employed	34	8,7	8,7	72,6
	Apprenticeship	12	3,1	3,1	75,7
	Pupil (including pre-school)	2	,5	,5	76,2
	Student (university or college)	76	19,4	19,4	95,7
	Currently unemployed	14	3,6	3,6	99,2
	Temporary leave (e.g. maternity leave, paternity leave)	1	,3	,3	99,5
	Housewife or househusband	2	,5	,5	100,0
	Total	391	100,0	100,0	

Regarding the type of residence area, the majority stated that they live in a city with less than 1 million inhabitants. Also, a large portion of the sample stated they live in what they consider to be a small town. The third most selected residence type was the city with over 1 million and 10 million inhabitants.

Table 4.6 - Residential area (own authorship)

Type of residence area

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Megacity	4	1,0	1,0	1,0
	City with over 1 million and less than 10 million	115	29,4	29,4	30,4
	City with less than 1 million habitants	131	33,5	33,5	63,9
	Small town	117	29,9	29,9	93,9
	Village	2	,5	,5	94,4
	Remote location	22	5,6	5,6	100,0
	Total	391	100,0	100,0	

Regarding the respondents' mobility, it was found that the majority have a commuting time between 15 to 30 minutes and also that the majority does not have a public transport monthly pass. It was asked if they had a driver's license, 369 stated that they do and of those, it was found that 301 have a private vehicle (bought or rental). Also, it was found that 253 respondents use their private vehicle to commute, 51 use public transports and 53 use public transports along with other transport modes.

Table 4.7 - Commuting time (own authorship)

Time spent commuting

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 15 minutes	118	30,2	30,2	30,2
	15-30 minutes	123	31,5	31,5	61,6
	30-45 minutes	77	19,7	19,7	81,3
	45-60 minutes	52	13,3	13,3	94,6
	Over 1 hour	21	5,4	5,4	100,0
	Total	391	100,0	100,0	

Table 4.8 - Public transport monthly pass (own authorship)

Public transport monthly pass

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	124	31,7	31,7	31,7
	No	267	68,3	68,3	100,0
	Total	391	100,0	100,0	

Table 4.9 - Driver's license (own authorship)

Driver's license

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	369	94,4	94,4	94,4
	No	22	5,6	5,6	100,0
	Total	391	100,0	100,0	

Table 4.10 - Private vehicle (own authorship)

Private Vehicle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	301	77,0	81,6	81,6
	No	68	17,4	18,4	100,0
	Total	369	94,4	100,0	
Missing	System	22	5,6		
Total		391	100,0		

When analysing the statistics of the trip purposes UAVs should be used for, it is found that the replies of the respondents vary significantly in the "strongly agree" level of the replies where it is seen that 37.9% believe they should be used for healthcare service, 5.9% for social activities, 6.1% for leisure, 5.9% for work and 19.2% to transfer goods to people. More than 46.3% of the respondents disagree (at any level) with the use of UAVs for work trips, 34.5% for leisure and 36.3% for social activities.

4.2. Pearson's correlation

In the following sections, I will go over the results of the Pearson's correlation analysis concerning Intention to use and Public Embracement.

4.2.1. Intention to use

Regarding the Intention to use, it was demonstrated that there is a positive correlation between the new technology embracement and the intention to use UAVs (.632). This means that a person with a higher embracement of new technologies has a higher probability of adopting UAVs. Furthermore, people with a higher embracement of ride-hailing services will be more likely to adopt UAVs (.508). The other mobility services also have an influence but a much weaker level.

On expected benefits, it was found that believing that UAVs will offer a safe and fast mean of transportation positively impacts the likelihood of adoption at a moderate level. Also, believing that moving with UAVs will be less stressful has a moderate positive impact on intention to use.

Regarding safety concerns, Pearson's correlation demonstrated that there is a moderate negative correlation between having safety concerns and intention to use (-.425). Thus, showing that a person with higher safety concerns is less likely to adopt UAVs. Cybersecurity concerns and fear of flying were found to have a weaker correlation with the intention to use UAVs.

Pearson's correlation showed that people who believe that UAVs are an acceptable transport mode are more likely to adopt (.353). However, noise and visual pollution were not found to have an impact on the likelihood of adoption.

When considering the feelings that people have towards UAVs, it was found that a person who feels safe and comfortable with UAVs has a higher probability of adopting UAVs as it was demonstrated by the Pearson's correlation that there is a moderate positive correlation regarding these feelings and the intention to use. On the hand, it was also found that feeling stressed and scared has a negative impact on adoption as you can see on the table below.

Table 4.11 - Pearson's correlation between feelings towards UAVs and Intention to use (own authorship)

Correlations

		UAVs make me feel stressed	UAVs make me feel safe	UAVs make me feel comfortable	UAVs make me feel scared
Intention to use	Pearson Correlation	-,323**	,392**	,449**	-,341**

Contrary to what would be expected, almost no correlations were found between the income level and intention to use (.093). Therefore, having a higher income level does not affect the likelihood of adoption. Furthermore, it was also found that age does not impact the intention to use either. It would be expected that younger people would have a higher intention to use UAVs, but Pearson's correlation shows us that there is a weak correlation between these two variables (.043).

No significant correlations were found when analysing Affinity to Automation, Cybersecurity, Safety, Mobility and driving behaviour and Environmental issues.

4.2.2. Public embracement

On Public embracement. Pearson's correlation demonstrated that who felt safe riding an autonomous vehicle are more likely to embrace UAVs. Contrary to intention to use, being familiar with ride-hailing services does not affect the embracement level, neither does the level of adoption when considering new technology.

The Pearson's correlation also demonstrated that the variables "UAVs will offer a safe and fast mean of transportation" and "UAVs will offer a less stressful mobility experience" have a positive impact on the embracement level. Thus, people who agree with this statement are more likely to have a higher embracement level.

Mid-air collisions were found to have a small negative correlation with the embracement level (-.208), meaning that this safety concern affects the embracement level. This analysis also revealed that having safety and cybersecurity concerns negatively impacts the embracement level (-.320 and -.261 respectively).

The Pearson's correlation demonstrated that a person who would use UAVs for any purpose (to commute, to go to leisure activities, social activities or healthcare services) is more likely to have a higher embracement level as it was shown that these four purposes have a moderate positive correlation.

The analysis determined that the variables "UAVs will increase the quality of life" and "UAVs will be beneficial for the society" have a strong positive correlation. Hence, a person who believes in these statements is more likely to have a higher embracement level towards UAVs. The variables "UAVs will improve transport accessibility for all citizens" and "Moving with UAVs will be as safe as with aeroplanes" have a moderate positive impact on the embracement level as we can observe on the table below.

Table 4.12 - Pearson's correlation on public embracement (own authorship)

Correlations

		UAVs will improve transport accessibility for all citizens	Moving with UAVs will be as safe as with aeroplanes	UAVs will increase the quality of life	UAVs will be beneficial for the society
UAVs are an acceptable means of transport	Pearson Correlation	,462**	,365**	,670**	,547**

Regarding the public concerns, it was found that the variable "I wouldn't feel comfortable living in a city that adopts UAVs" has a negative impact on the embracement level (-.478). Moreover, the variable "UAVs will be risky to the public" was also found to have a negative impact on embracement (-.415). Thus, a person who agrees with these statements is more likely of having a lower level of embracement.

Similar to intention to use, moderate positive correlations were found in the variables where the respondents were asked if they agree with some of the possible uses of UAVs. The variable with higher impact was the "UAVs should be used for commuting" (.404). Showing that a person that agrees more with this statement is more likely to have positive embracement level.

The feelings that people have towards UAVs were also found to have an impact on the embracement level. Felling safe or feeling comfortable have a strong correlation (.509 and .530), meaning that, as expected, a person who has these feelings is more likely to embrace UAVs. On the other hand, the analysis demonstrated that feeling scared, stressed or anxious negatively impacts the embrace level.

Regarding socio-demographics, as seen in the intention to use section, the Pearson's correlation revealed that there are no moderate or strong correlations regarding the income level or the respondents' age. Therefore, contrary to what could be expected, these variables have no impact on the embracement level.

4.3. Data analysis – Intention to use

In the following sections, the ANOVA and the Kruskal-Wallis analysis that were performed to analyse the variances between the Intention to Use question across the remaining groups are presented. As mentioned before, respondents were asked to state their likelihood of adoption of UAVs in the Technology life cycle adoption developed by Rogers. The scale was composed by five points, from Laggards to Innovators. Each point had a small explanation of each level in order to get a more realistic and accurate response from the respondents. Then, these responses were used as factors to perform the ANOVA and the Kruskal-Wallis analysis.

As mentioned before, it is necessary to perform the test of homogeneity of variances (Levene's test) of each variable of each question group. The Levene's test was used to determine which variables can be submitted to the ANOVA analysis. For variables that had *p* value higher than .05 were submitted to the mentioned analysis, for those variables who had a *p* value lower than .05 were submitted to the Kruskal-Wallis method (See Annex B).

The ANOVA null hypothesis is that the mean of the dependent variable is the same for all groups. Therefore, the variables have to have to show a significant *p* value not only on the ANOVA test but also on the Robust test of equality of means. All the results presented have a *p* value lower than 0.05, showing that these variables have significant differences. After presenting differences the Tuckey post-hoc test was performed to determine which groups have variances.

Likewise, the null hypothesis created for the KW method was that there are no differences between the variables. All variables that rejected the null hypothesis (*p* value lower than 0.05) were submitted to the Pairwise comparison, where difference can be observed and located.

In the following subsections, I will go through all groups and mention all variables that have a significant result and find where are the variances between the samples.

4.3.1. Affinity to automation

The first test performed was between the Affinity to Automation and the Intention to use. It was found that the variables presented to the ANOVA analysis didn't show variances and the other variables of this group did to meet the requirement of the ANOVA method. In the KW test summary, it was found that there are differences between both groups as the *p* value for the variable "When an automated technology gives me problems, I usually stop trusting it" is lower than 0.05 ($p = .006$).

On this variable, differences can be found between the respondents who stated themselves as Innovators from the Laggards ($p = .005$) and Late Majority ($p = .044$). The Innovators had a lower level of agreement towards the statement presented, meaning they have a higher comprehension of the technology problems and accept them. Whilst Laggards and Late majority respondents have a lower tolerance towards technological problems.

4.3.2. New Technologies embracement

The results from the ANOVA analysis indicated that two variables have statistically significant different means when considering the New Technology Embracement and Intention to use. The two variables are "Adoption of scooter services" and "Satisfaction with bicycle services". However, the Robust test only confirmed the ANOVA results for the variable "Adoption of scooter services". Therefore, only this variable can be analysed.

Table 4.13 - ANOVA Affinity to automation (own authorship)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Adoption of Scooter Services	Between Groups	71,727	4	17,932	6,954	,000
	Within Groups	995,409	386	2,579		
	Total	1067,136	390			

The Tuckey post hoc test demonstrated that Laggards have a significant difference with Early Adopters (MD = -.933) and Innovators (MD = -1.739), being that the higher difference was with Innovators. Late Majority (MD = -1.337) and Early Majority (MD = -.929) also demonstrated differences with Innovators. These results showed us that innovators had a higher embracement level than the rest of the categories.

Regarding the variables that didn’t meet the ANOVA requirements, it was found that all variables presented rejected the test’s null hypothesis, meaning that all of them have variances. I’ll go over each one in order to locate where is the variance.

The first variable was “Adoption of new technologies” (p = .000), in this variable, it was observed that those who stated to be Innovators in the adoption of new technologies also see themselves as possible innovators when considering UAVs. As on the other hand, respondents with a lower level of adoption on new technologies are likely to have the same behaviour when considering UAVs.

With the second variable “Adoption of Ride-Hailing services” (p = .000) a trend can start to be seen. As the first variable, the respondents that stated themselves as Innovators regarding the adoption of ride-hailing services most likely see themselves as Innovators when considering the adoption of UAVs. This trend can also be observed in the other variables regarding adoption of mobility services, such as car-sharing (p = .000), carpooling (p = .001), shared motorcycle (p = .014) and shared bicycle (p = .000).

4.3.3. Expected benefits

Regarding the expected benefits and intention to use, the ANOVA analysis showed that five variables have a significant p value.

Table 4.14 - Expected benefits ANOVA (own authorship)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
The use of UAVs will reduce road congestion	Between Groups	17,609	4	4,402	2,890	,022
	Within Groups	587,946	386	1,523		
	Total	605,555	390			
The use of UAVs will reduce accident on roads	Between Groups	30,881	4	7,720	4,372	,002
	Within Groups	681,661	386	1,766		
	Total	712,542	390			
The use of UAVs will make my travel time more productive	Between Groups	47,001	4	11,750	7,218	,000
	Within Groups	628,390	386	1,628		
	Total	675,391	390			
UAVs will offer a safe and fast mean of transportation	Between Groups	63,211	4	15,803	12,418	,000
	Within Groups	491,229	386	1,273		
	Total	554,440	390			
UAVs will increase the number of trips people will make	Between Groups	23,803	4	5,951	3,255	,012
	Within Groups	705,721	386	1,828		
	Total	729,524	390			

These same variables also had a significant *p* value in the Robust test, which means that in fact there are differences between these variables and intention to use.

In the variable “The use of UAVs will reduce road congestion” we can observe that Laggards have significant negative differences between Early Majority (MD = -.647) and

Innovators (MD = -.787). The differences are higher when comparing with innovators. However, the *p* value for the early majority is also very significant. From these results, one can conclude that Laggards believe less that UAVs can decrease roads' congestion when compared to Innovators and Early Majority respondents.

Regarding the variable "The use UAVs will reduce road accidents", the Tuckey HSD indicated that the differences are among Laggards and Late Majority when compared with Early Majority (MD = -.647 and -.529, respectively). Although Laggards and Late Majority have a significant difference with Innovators, the *p* values are not significant (p>.05) unlike in the Early Majority case.

The third variable, "The use of UAVs will make my travel time more productive", showed an interesting result. All adoption categories showed a significant difference between them and Laggards. This shows us that Laggards have a different opinion and that they believe less that UAVs can increase travel time productiveness.

Regarding the variable "UAVs will offer a safe and fast mean of transportation", Laggards and Late Majority respondents showed significant differences with the other three categories, but no significant differences between themselves. This means that these two groups struggle to believe that UAVs can be safe and fast transport mode.

Last but not least, in the fifth variable, the Tuckey HSD test showed differences between the Late Majority and Innovators. This shows that late majority respondents believe less that UAVs will increase the number of trips a person will make when compared to Innovators.

In conclusion and as it would be expected, Laggards and Late Majority respondents tend to believe less in the expected benefits when compared with the other categories. These results show manufactures, service provides and policy-makers the urge to address to these groups and to convert them into possible users.

Regarding the variables that didn't meet the ANOVA requirements, three rejected the null hypothesis, thus showing us that there are variances in the variables' sample. The three variables are "UAVs will significantly reduce travel time", "The use of UAVs will release more free space in the urban environment" and "UAVs will offer a less stressful mobility experience".

Table 4.15 - Variables with variances expected benefits (own authorship)

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	UAVs will significantly reduce travel time	Independent-Samples Kruskal-Wallis Test	,006	Reject the null hypothesis.
2	The use of UAVs will release more free space in the urban environment	Independent-Samples Kruskal-Wallis Test	,011	Reject the null hypothesis.
3	UAVs will offer a less stressful mobility experience	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.

In the variable “UAVs will significantly reduce travel time”, the respondents who see themselves as Laggards believe less in the statement presented when compared with Innovators (p = .016).

There is a general belief that with the use of UAVs the urban environment will have more free space for other facilities such as parks pedestrian zones. However, Laggards believe less that UAVs will have this consequence when compared with Innovators (p = .049). Regarding the statement “UAVs will offer a less stressful mobility experience”, Laggards (p = .000) and Late Majority (p = .001) were found to believe less that UAVs will have the presented benefit when compared with the remaining categories.

4.3.4. Safety

When analysing the Safety variables and intention to use, it is possible to verify that the ANOVA and the Robust test point out that the variable “I'm concerned that the first UAVs available will be unsafe due to technological issues of the vehicle” has differences in the distribution. However, the Tuckey HSD post hoc test revealed that there are no significant variances between groups.

Table 4.16 - Analysis of Variance on Safety group (own authorship)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
I'm concerned that the first UAVs available will be unsafe due to technological issues of the vehicle	Between Groups	21,747	4	5,437	3,366	,010
	Within Groups	623,465	386	1,615		
	Total	645,212	390			

Concerning the Kruskal-Wallis method, two of the three variables presented showed to have variances across the distribution of the samples by having rejected the null hypothesis. The first variable was the statement “I’m concerned about the UAVs’ performance under poor weather conditions”. Here we can observe that there is a general concern regarding the UAVs’ performance under poor weather conditions. However, there is a difference between the Early Majority and Late Majority (*p* = .042), showing the Early majority respondents believe less that UAVs will have problems when travelling under poor weather conditions.

The second variable was related to the fear of possible mid-air collisions with UAVs. As expected, we can observe that Laggards and Late majority respondents believe that UAVs will most likely have mid-air collisions whereas Early Adopters (*p* = .022) and Early Majority (*p* = .020) respondents tend to believe less in this statement. Perhaps these last two groups have the belief that there will be good air management software that will prevent these accidents.

Table 4.17 - Variables of Safety group with variances (own authorship)

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	“I’m concerned about the UAVs’ performance under poor weather conditions”	Independent-Samples Kruskal-Wallis Test	,045	Reject the null hypothesis.
2	“I’m concerned that the first UAVs will be unsafe due to possible vehicle collisions in the air above cities”	Independent-Samples Kruskal-Wallis Test	,001	Reject the null hypothesis.

4.3.5. Intention to use

In this analysis variables of the Intention to use group were compared with the adoption level question. All of the three variables presented showed significant p values in the ANOVA analysis and in the Robust test of equality of means. Those variables are “My cybersecurity concerns could prevent me from using UAVs”, “I would use UAVs for trips from/to work or college” and “I would use UAVs for trips to leisure activities” (see Table 4.18).

Regarding the first variable, significant differences were found in Late Majority respondents when compared with Early Majority (MD = .567) and Innovators (MD = 1.041) respondents. From these results, we can conclude that Late Majority respondents have higher cybersecurity concerns when compared with the two already mentioned categories.

The Tuckey test showed that the variable “UAVs should be used for trips from/to work or college” had differences regarding Laggards (MD = -1.208, -1.536, -1.769) and Late Majority

(MD = -.620, -.948, -1.181) when compared with the remaining groups. For this reason, we can state that Laggards and Late Majority respondents agree less that they would use UAVs for commuting.

Regarding the use of UAVs for travelling to leisure activities, Laggards show differences when compared with Early Majority (MD = -.972), Early Adopters (MD = -1.259) and Innovators (MD = -1.460). Late Majority also showed differences with Early Adopters (MD = -.724) and with Innovators (MD = -.925). Ergo, it is safe to state that Laggards and Late Majority also agree less that they would use UAVs for trips to leisure activities.

Table 4.18 - ANOVA on Intention to use (own authorship)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
My cybersecurity concerns could prevent me	Between Groups	45,427	4	11,357	4,221	,002
	Within Groups	1038,440	386	2,690		
	Total	1083,867	390			
UAVs should be used for trips from/to work or college	Between Groups	102,964	4	25,741	8,590	,000
	Within Groups	1156,668	386	2,997		
	Total	1259,632	390			
UAVs should be used for trips to leisure activities	Between Groups	64,481	4	16,120	8,581	,000
	Within Groups	725,151	386	1,879		
	Total	789,632	390			

In this analysis, the remaining questions of the Intention to use groups were also submitted to the Kruskal-Wallis analysis. Here it was found that all four variables tested rejected the null hypothesis.

Table 4.19 - KW analysis on Intention to use (own authorship)

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	My safety concerns could prevent me from using UAVs	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
2	My fear to fly could prevent me from using UAVs	Independent-Samples Kruskal-Wallis Test	,001	Reject the null hypothesis.
3	UAVs should be used for trips to social activities	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
4	UAVs should be used for Trips to healthcare services	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.

In the “My safety concerns could prevent me from using UAVs” variable we can observe that the answers given by the respondents were coherent with the adoption level that they revealed to be. The respondents with less likelihood of adoption (Laggards and Late Majority) are also the ones who have more concerns regarding safety (p = .000). Regarding the variable “My fear to fly could prevent me from using UAVs”, it was found that Early Adopters are less frightened by flying when compared with Laggards (p = .008) and Late Majority (p = .024). These two categories showed a higher level of agreement towards the statement presented. When analysing the statement “Would use UAVs for trips to social activities” it is possible to observe differences between the two lower adoption level categories and the other categories. These two categories agree less with the use of UAVs for transporting people to social activities.

Lastly, the variable “Would use UAVs for trips to healthcare services” showed differences between the two lower intention of adoption categories (Laggards and Late Majority) and the two higher intention to use UAVs (Early Adopters and Innovators). Although, Laggards and Late Majority respondents agree more with this purpose than the other purposes presented.

4.3.6. Public embracement

The ANOVA analysis and Robust test of the Public embracement group and Intention to use pointed many variables that have significant differences. Those variables are:

- “I’m concerned that UAVs will increase visual pollution”,
- “I’m concerned that UAVs will increase noise pollution”,
- “UAVs will be beneficial for society”,
- “Moving with UAVs will be as safe as moving with aeroplanes”,
- “UAVs should be used to transport people to/from their work or college”,
- “UAVs should be used for trips to leisure activities”,
- “UAVs should be used for trips to social activities”,
- “UAVs should be used to transport people to/from healthcare services”,
- “UAVs should be used to transport goods to people”,
- “UAVs make me feel stressed”,
- “UAVs make me feel safe”,
- “UAVs make me feel comfortable”
- “UAVs make me feel scared”.

Regarding visual and noise pollution, the differences found were identical. The differences in both variables were between Late Majority (MD visual = .742; MD noise = .966) and Early Adopters respondents. This result shows us that when compared to Late Majority, Early adopters believe less that UAVs will increase cities' visual and noise pollution.

In the variable "UAVs will be beneficial for society", it was found that Laggards and Late Majority have differences between all categories including them. From this result, we can conclude that Laggards believe less that UAVs will be beneficial for society when compared with the other four categories. Late majority respondents also believe less in the statement presented, although, they believe more than Laggards.

Regarding the variable "Moving with UAVs will be as safe as moving with aeroplanes", Laggards agree less with this statement when compared with Early Adopters (MD = -.947) and Innovators (MD = -.1442). Whereas Late Majority showed to have differences with Early Majority (MD = -.475), Early Adopters (MD = -.762) and Innovators (MD = -1.256).

Regarding the usage of UAVs for different purposes, it was found that Laggards and Late Majority believe less in the use of UAVs for commuting. Differences were found between Laggards and Early Majority (MD = -1.027), Early Adopters (MD = -1.323) and Innovators (MD = -1.810) and between Late Majority and Innovators (MD = -1.156). Also, Laggards and Late Majority were found to have differences between Early Adopters (MD = -.900) and Innovators (MD = -1.033) when considering using UAVs for trips to leisure activities. In relation to the use of UAVs for travelling to social activities, Laggards were found to have differences with all categories, whereas Late Majority was found to have differences with all but Early Majority. Laggards were also found to have differences between Early Majority and Innovators when considering the use of UAVs for transporting goods to people. In conclusion, it was found that in general Laggards and Late Majority respondents agree less in the use of UAVs for the previously mentioned purposes.

The last variables of the group of questions were related to feelings that UAVs can originate on people. Regarding the feeling of being stress when thinking of UAVs, Laggards and Late Majority showed to have differences with the remaining categories, thus showing that these two categories agree more with the statement presented. The same pattern can be observed in the variable "UAVs make me feel scared".

Concerning the variable "UAVs make me feel safe", as it would be expected Laggards and Late Majority have significant differences when compared with the other categories and even between them. This shows that Laggards disagree more with the statement whereas Late

Majority also disagree but at a lower level. The same can be observed in the variable “UAVs make me feel comfortable”.

Regarding the KW analysis, six out of the seven variables tested rejected the null hypothesis (see Table 4.20). Therefore, one can state that there are variances in the distribution of these variables.

The respondents were asked to state their agreement level towards the statement “UAVs are an acceptable means of transports”, here we can observe that Laggards and Late Majority respondents have a lower level of agreement when comparing with the three remaining categories. Regarding the statement “UAVs will increase the quality of life”, differences were found between Laggards and Late Majority when comparing with the other categories. Thus, showing us that Laggards and Late majority respondents believe less that by having UAVs a city can profit from it in terms of quality of life.

Table 4.20 - KW variances on Public Embracement variables (own authorship)

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	UAVs are an acceptable mean of transport	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
2	UAVs will increase the quality of life	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
3	UAVs will improve transport accessibility	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
5	I wouldn’t feel comfortable living in a city that adopts is the same across categories of G1.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
6	UAVs will be risky to the public	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
7	UAVs make me feel anxious	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.

In the “UAVs will improve transport accessibility” variable, it was found that Innovators agree more with the statement when compared with Laggards and Late Majority. Therefore, Innovators have a higher level of belief that through the use of UAVs, all citizens including elderly people, disabled people and even children can have higher mobility. Laggards were also found to have variances when compared with Early Majority and Early Adopters but with a lower level of significance.

The statement “I wouldn’t feel comfortable living in a city that adopts UAVs” was presented to the respondents, here I found that the respondents have the general belief that would feel comfortable living in a city with UAVs. However, Laggards and Late Majority believe less that they will feel comfortable when compared with Early Majority, Early Adopters and Innovators.

The fifth variable was the statement “UAVs will be risky to the public”, here it was found that Innovators, Early Adopters and Early Majority believe less when compared with Laggards and Late Majority.

Last but not least, in the variable “UAVs make me feel anxious” it was found that Early Majority and Early Adopters showed differences when comparing with Laggards and Late Majority. Therefore, Early Majority and Early Adopters respondents believe less that they feel anxious with UAVs.

4.3.7. Driving behaviour

The Driving behaviour groups were also analysed with the intention to use group. After performing the ANOVA analysis and the Robust test, one variable showed significant differences in the sample distribution. The variable presented a significant p value is “I feel safer driving myself rather than others driving me”. Here, we can observe a significant difference between the Late Majority and Early Adopters (MD = -.805). Thus, proving that Early Adopters agree more in the statement presented than Late Majority.

Regarding the Kruskal-Wallis analysis on the Driving behaviour group question, it was found that the variable “I don’t drive whenever I drink alcohol” rejected the null hypothesis. The differences discovered showed that the Early Majority respondents agree less with this statement when compared with Late Majority respondents (p = .004).

Another analysis made was to verify, through the independent samples t-test, if having an accident as a driver had an impact on the intention to use UAVs. The Levene’s test form equality of variances showed a p value higher than .05 (.159), therefore it was shown that the assumption of equal variances holds. The p value (2-tailed) demonstrated that there are differences in the means of the populations. Respondents who stated they had already an accident have a higher likelihood of adopting UAVs (mean difference .286), whereas respondents that didn’t had an accident are less likely to adopt UAVs right away. This result can be explained by the fact that people who didn't had an accident can be more risk-averse and/or with less experience in terms of mobility.

4.3.8. Sociodemographic

The first t-test performed was to observe if there were differences in the likelihood of adopting UAVs between the two genders. In the survey, the respondents had 3 choices to select when asked what their gender was (Female, Male and Prefer not to say). However, zero respondents choose the option "Prefer not to say". Therefore, the analysis was performed with the variables Male and Female.

The Levene's test for equality of variances returned a *p* value of .155, therefore we can assume that there is equality of variances. The 2-tailed *p* value showed us that there are the population means are, in fact, not equal (.000). This analysis demonstrated that Females are less likely to adopt UAVs (mean difference -.551), meaning that Females more conservative in terms of adopting when compared with the male gender (see Table 4.21). The majority of female respondents state themselves Late Majority, whereas the majority of males stated to be in Early Majority. Overall, we can assume that males have a higher tendency to adopt this new technology and that females are more risk-averse than males and have higher concerns regarding this transport mode.

Table 4.21 - Independent sample t-test gender (own authorship)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Intention to use	Equal variances assumed	2.030	0.155	-5.093	389	0.000	-0.55072	0.10812	-0.76330	-0.33813
	Equal variances not assumed			-5.209	383.102	0.000	-0.55072	0.10573	-0.75860	-0.34283

It was also studied if have children would have an impact on the likelihood of adoption. Here, it was also assumed that the variables have equal variances (Levene's test *p*=.319). The t-test for equality of means returned a *p* value (2-tailed) of .021, showing us that people who have children are more willing to adopt this transport mode when compared with people without children (mean difference .260).

4.4. Data analysis – Public embracement

As mentioned before, one of the requirements for the ANOVA analysis is to have a normal distribution, either by having a significant p value on Kolmogorov-Smirnov test (that analyses the distribution of a sample) or by having more than thirty answers in each option. Since the Public Embracement sample does not meet the requirements for the ANOVA analysis, the research proceeded with the KW non-parametric method to analyse the distribution of the sample. The variable used as factor in the KW analysis was “UAVs are an acceptable means of transport” where respondents could answer by using the 7-point Likert scale. The results obtained in this variable were: Strongly Disagree – 0.5%; Disagree – 1.8%; Somewhat Disagree – 2.8%; Neither Agree nor Disagree – 11%; Somewhat Agree – 22.8%; Agree – 46%; Strongly Agree – 15.1%.

4.4.1. Affinity to Automation

Regarding this question group, five out of nine variables rejected our null hypothesis. Thus, showing that there are variances between the samples’ distribution. In the variable “I believe that driver assistance systems are useful” (p = .001) we can observe that respondents who have a neutral response regarding the acceptance of UAVs tend to believe less in the usefulness of driver assistance systems when compared with Strongly Agree respondents (p = .000). Regarding the variable “I believe that driver assistance systems are reliable” (p = .005), the Strongly Agree respondents tend to agree more with the statement when compared with Agree respondents (p = .032).

The next three variables concerned the feeling that respondents had when using automated vehicles (e.g.: tram, bus, subway, car, etc.). Regarding feeling comfortable (p = .001) when riding these vehicles, differences can be found between Strongly agree when compared to Somewhat Disagree (p = .028), Neither Agree nor Disagree (p = .016), Somewhat Agree (p = .014) and Agree (p = .013). Therefore, we can conclude that Strongly Agree respondents agree more with the statement and felt more comfortable in this experience than the other category respondents.

In the variable “I felt safe” (p = .000), we can observe that Strongly Agree respondents agree more with this statement when compared with Neither Agree nor Disagree (p = .010). Although the third variable “I was scared” (p = .046) rejected the null hypothesis there were no significant differences in the pairwise comparison.

4.4.2. Expected benefits

Regarding Expected benefits, all the variables submitted to the KW rejected the test's null hypothesis as you can see in Table 4.23. Regarding the reduction of road congestion and road accidents as an effect of the usage of UAVs, it was found that Strongly Agree believe more in this expected benefit when compared with Somewhat Disagree (p = .003), Neither Agree nor Disagree (p = .038), Somewhat Agree (p = .000) and Agree (p = .047). It was also found that Agree respondents believe more in this benefit when compared with the neutral position (p = .038). Regarding the third and fourth variables, Somewhat Disagree, Neither Agree nor Disagree and Somewhat Agree were found to believe less in the increase of travel time productivity and in the reduction of travel time when compared with Agree and Strongly Agree.

Table 4.22 - KW analysis on Expected benefits (own authorship)

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The use of UAVs will reduce road congestion	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
2	The use of UAVs will reduce accident on roads	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
3	The use of UAVs will make my travel time more productive	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
4	UAVs will significantly reduce travel time	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
5	The use of UAVs will facilitate the connection of remote areas to bigger cities and multimodal nodes such as ports and airports	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
6	The use of UAVs will release more free space in the urban environment for other facilities such as parks and pedestrian zones	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
7	UAVs will produce lower CO2 emissions	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
8	UAVs will offer a safe and fast mean of transportation	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
9	UAVs will offer a less stressful mobility experience	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
10	UAVs will make it easier for people with reduced mobility to move	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
11	UAVs will make it easier ambulances and police to move fast to emergency cases	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
12	UAVs will increase the trips people will make	Independent-Samples Kruskal-Wallis Test	,024	Reject the null hypothesis.

Regarding the expected benefit that UAVs will facilitate the connection between remote areas and bigger cities and multimodal nodes such as ports and airports, it was found the Strongly Agree respondents believe more in this benefit when compared with Somewhat Disagree (p = .000), Neither Agree nor Disagree (p = .001), Somewhat Agree (p = .000) and Agree (p = .013).

Strongly Agree respondents were also found to agree more with the expected benefit, that the usage of UAVs will release more free space for other facilities when compared to the groups mentioned in the point above. Furthermore, in this variable, Agree respondents were also found to believe more in this benefit when compared with Somewhat Agree respondents.

Regarding the reduction of CO_2 emission by the usage of UAVs, we can observe that Somewhat Disagree and Neither Agree nor Disagree respondents on average believe less in this benefit when compared with Agree and Strongly Agree respondents

The variable "UAVs will offer a safe and fast mean of transportation" was found to have many variances between groups. Disagree and Somewhat Disagree respondents were found to agree less with the statement presented when compared with Agree and Strongly Agree respondents. Also, Neither Agree nor Disagree were found to believe less when compared with the three positive categories. Furthermore, we can also observe that Agree and Strongly Agree respondents believe more in this statement when compared with Somewhat Agree.

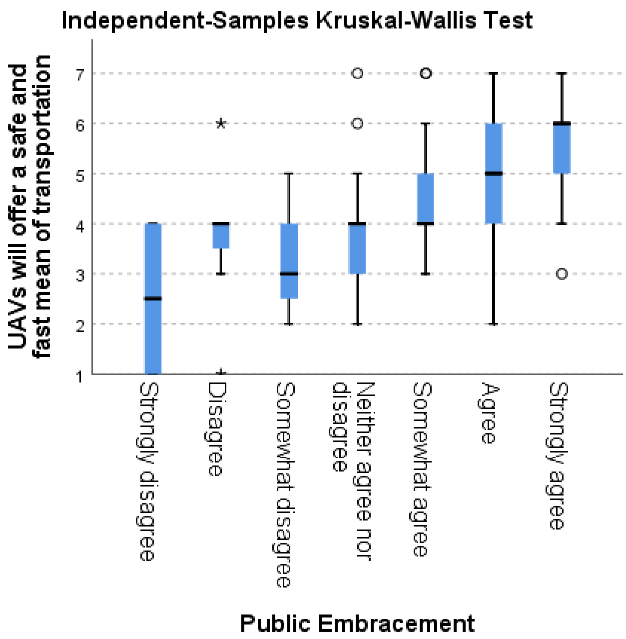


Figure 4.1 - "UAVs will offer a safe and fast mean of transportation" variations (own authorship)

Regarding the stressfulness of the UAV experience, Disagree, Somewhat Disagree, Neither Agree nor Disagree and Somewhat Agree respondents were found to believe less that the UAV experience will be a less stressful mobility experience when compared with Agree and Strongly Agree respondents.

One of the expected benefits of autonomous vehicles is that this new transport mode can increase the independence of people with reduced mobility. The beneficiaries can be people who are older and can't drive anymore, disabled or even children. Here it was found that the Strongly Agree and Agree respondents believe more in this benefit when compared with Neither Agree nor Disagree and Somewhat Agree.

Regarding the variable "UAVs will make it easier ambulances and police to move fast to emergency cases", through the KW analysis variances can be observed between groups. Somewhat Disagree, Neither Agree nor Disagree and Somewhat Agree respondents were found to believe less in this statement when compared with Strongly Agree respondents. Moreover, Agree respondents were found to have a higher belief in this statement when compared to Neither Agree nor Disagree respondents.

Although the last variable presented variances in the KW analysis, the Pairwise comparison did not show any significant differences between groups when considering the statement "UAVs will increase the trips people will make".

4.4.3. Safety

The next group to be submitted to the KW analysis was the Safety question group. From the seven variables presented two rejected the null hypothesis where it stated that the samples' distribution is the same across the categories of Public Embracement.

Although the first variable, "I'm concerned that the first UAVs available will be unsafe due to technological issues of the vehicle" (p = .040), rejected this null hypothesis it was found that the Pairwise comparison showed no significant variances between the categories.

However, in the second variable "I'm concerned that the first UAVs available will be unsafe due to possible vehicle collisions in the air above cities" (p = .001) variances were found between Strongly Agree and Somewhat Agree (p = .006). Strongly Agree respondents showed that they believe less in this statement when compared with the Somewhat Agree respondents.

4.4.4. Intention to use

Much like in Expected Benefits, the KW analysis showed that all seven variables rejected the null hypothesis. In the following paragraphs, each variable will be verified, and variances will be identified.

The first variable was “My safety concerns can prevent me from using UAVs”, here it was found that Strongly Agree and Agree respondents believe less that their safety concerns will be an obstacle when considering using UAVs when compared with Somewhat Disagree, Neither Agree nor Disagree and Somewhat Agree.

When considering the cybersecurity concerns as obstacles, we can observe that Disagree (p = .037), Neither Agree nor Disagree (p = .011) and Somewhat Agree (p = .004) believe more in this statement when compared with Strongly Agree respondents. Strongly Agree respondents were also found to believe less that their fear of flying will have an impact their decision of using UAVs when compared with Neither Agree nor Disagree (p = .020), Somewhat Agree (p = .001) and Agree respondents (p = .030).

Table 4.23 - KW on Intention to use (own authorship)

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	My safety concerns could prevent me from using UAVs	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
2	My cybersecurity concerns could prevent me from using UAVs	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
3	My fear to fly could prevent me from using UAVs	Independent-Samples Kruskal-Wallis Test	,001	Reject the null hypothesis.
4	I would use UAVs for trips from to work or college is	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
5	I would use UAVs for trips to leisure activities	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
6	I would use UAVs for trips to social activities	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
7	I would use UAVs for trips to healthcare services	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.

Respondents were also asked to state to which purpose they would see themselves using UAVs for. The first purpose was for commuting, here it was found that Disagree (p = .034), Somewhat Disagree (p = .004), Neither Agree nor Disagree (p = .000) and Somewhat Agree (p

= .000) respondents believe less in them using this transport mode for their commute when compared with Strongly Agree respondents. Here, it was also found that Neither Agree nor Disagree respondents agree less with the purpose when compared with Agree respondents (*p* = .037).

In the second purpose, trips to leisure activities, variances were found when considering Agree and Strongly Agree categories. These two categories were found to agree more with them using the UAVs for this purpose when compared with Disagree, Somewhat Disagree and Neither Agree nor Disagree respondents. The same results were found in the third purpose (trips to social activities), with two exceptions. The first exception is that Strongly Agree respondents were found to agree more in this statement when compared with Strongly Disagree Somewhat Agree respondents. The second was that Agree respondents were not found to have differences with Somewhat Disagree respondents.

The fourth and last usage was using UAVs to dislocate to healthcare services, here we found the exact same results as the variable “I would use UAVs for trips to social activities”.

4.4.5. Public embracement

On the KW analysis of this question group, it was found that all but two variables rejected the null hypothesis. The first variable was the statement “UAVs will increase the quality of life in the cities that offer this transport mode” (*p* = .000), Pairwise comparison results showed that Agree and Strongly agree respondents believe more in this statement when compared with the

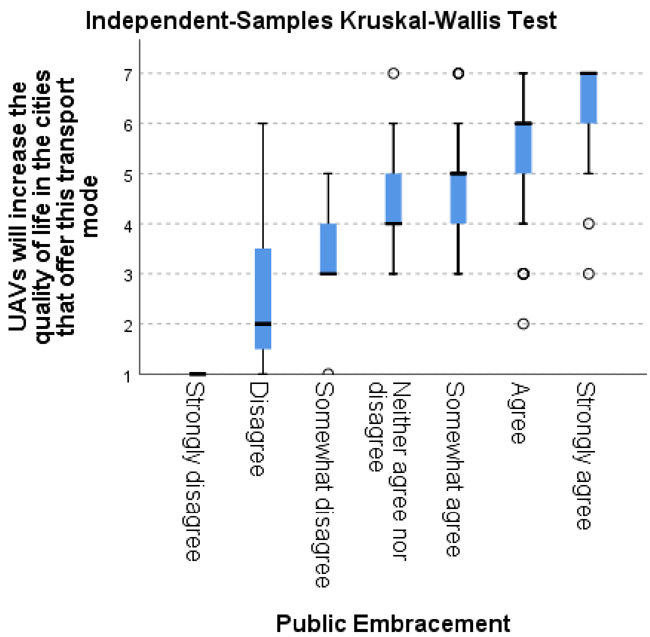


Figure 4.2 - UAVs impact on cities life quality variations (own authorship)

remaining categories. With the exception that Agree does not have variances when compared with Strongly Disagree respondents. Regarding the variable that stated that UAVs will improve all citizens transport accessibility (p = .000), all categories were found to agree less with this statement when compared with Strongly Agree. Furthermore, Somewhat Disagree, Neither Agree nor Disagree and Somewhat Agree were found to believe less when compared with Agree respondents.

The third variable to reject the null hypothesis was “I wouldn't feel comfortable living in a city that adopts this transport mode” (p = .000). As it would be expected, it was found that the categories with a lower embracement level agree more in this statement when compared with the two categories with higher embracement level (Agree and Strongly Agree).

Regarding the variable that addressed the possible increase of visual pollution (p = .022), it turned out that there are no significant variances, meaning that all categories have, more or less, the same level of agreement.

In the variable “UAVs will be beneficial for the society” (p = .000) the KW analysis determined that Disagree, Somewhat Disagree, Neither Agree nor Disagree and Somewhat Agree have a lower agreement level when compared with Agree and Strongly Agree respondents. Moreover, when compared, Strongly Agree respondents agree more than Agree respondents.

On the other hand, when analysing the variable “UAVs will be risky to the public” (p = .000) opposite results to the previous variable were found, as it would be expected.

The KW analysis on the variable “Moving with Air Vehicles will be as safe as with aeroplanes” (p = .000) revealed that Somewhat Agree and Neither Agree nor Disagree respondents agree less when compared with Agree and Strongly Agree respondents. Additionally, it was also found that Disagree and Somewhat Agree respondents have a lower agreement level when compared with Strongly Agree respondents.

The next section of this question group was related to the use of UAVs. Contrary to the previous group question, these questions did not ask for which purpose they would use UAVs for but rather for which purpose they think should be used. This was based on the premise that one person can think they would never use UAVs for their commute but be comfortable or agree with other people using for that purpose.

Regarding the use of UAVs for commuting (p = .000), the Disagree, Somewhat Disagree and Neither Agree nor Disagree respondents were found to agree less with this use when compared with Agree and Strongly Agree respondents. Furthermore, Somewhat Agree respondents also were found to believe less but only when compared with Strongly Agree. The same variances were found when considering the usage of UAVs for trips to leisure or social activities.

Regarding the usage of UAVs to transfer people from/to healthcare services (p = .000), the number of variations decreased. The KW determined that Neither Agree nor Disagree and Somewhat Agree respondents agree less with this usage. The decrease in variations can mean that there is a general agreement towards this use.

However, the number of variations observed increased when considering the variable "UAVs should be used to transfer goods to people" (p = .000). Here it was demonstrated that Disagree, Somewhat Disagree, Neither Agree nor Disagree and Somewhat Agree respondents have a lower agreement level when compared with Strongly Agree respondents.

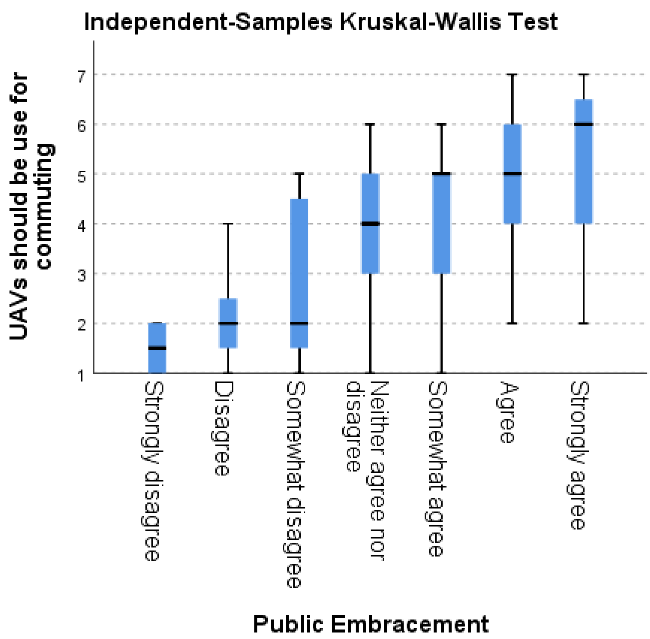


Figure 4.3 - "UAVs should be used for commuting" variations (own authorship)

Regarding the usage of UAVs from public institutions for emergency cases (p = .000) (e.g.: Police, ambulances, etc.), the analysis revealed that Neither Agree nor Disagree respondents agree less with this use when compared with Agree and Strongly Agree respondents. In addition, the Disagree, Somewhat Agree and Agree respondents were found to have a lower agreement level when compared with Strongly Agree.

The last section of this question group was related to the possible feelings that UAVs trigger in people. The first feeling was feeling stress due to UAVs (p = .000), here we can observe that

Strongly Agree respondents believe less in this statement when compared the remaining categories. Moreover, Agree respondents were also found to believe less when compared with Neither Agree nor Disagree and Somewhat Disagree. As it would be expected, when considering the statement “UAVs make me feel safe” (*p* = .000) the results invert. Thus, Agree and Strongly Agree respondents became the ones who agree when compared with the remaining categories.

Regarding the variable “UAVs make me feel anxious” (*p* = .000), the analysis determined that Strongly Agree respondents agree less with them feeling anxious when compared with Neither Agree nor Disagree, Somewhat Agree and Agree respondents. This last category was also found to have differences when compared with Neither Agree nor Disagree and Somewhat Agree.

The KW analysis also found that the Strongly Disagree, Disagree, Somewhat Disagree and Neither Agree nor Disagree respondents believe less that they feel comfortable (*p* = .000) when considering UAVs when compared with Agree and Strongly Agree respondents.

Lastly, Strongly Agree and Agree respondents were found to comply with the statement “UAVs make me feel scared” (*p* = .000) when compared with the remaining categories.

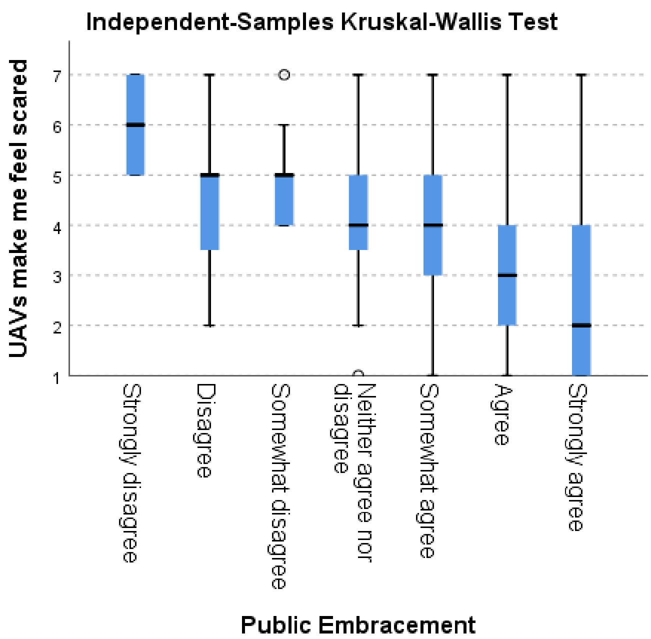


Figure 4.4 - "UAVs make me feel scared" variations (own authorship)

4.4.6. Environmental concerns

The next group to have variables with variation was the Environmental concerns group. Here the respondents were asked to set their level of agreement towards statements regarding this topic.

The variables that presented variances was “I'm capable of changing my behaviour based on environmental concerns” (p = .014). Here, the analysis demonstrated that Neither Agree nor Disagree believe less in this statement when compared with Strongly Agree (p = .018). Thus, showing us that Strongly Agree respondents believe more that they can change their habits if they are proven to be harmful to the environment.

4.4.7. Driving behaviour

In this analysis, the effect of having had an accident as a driver on Public embracement was also studied. Similar to before, this effect was studied through the independent samples t-test. As a consequence of the Levene’s test p value (.550) equal variances were assumed. However, the independent samples t-test returned a 2-tailed p value higher than .05, thus, this test failed to reject our null hypothesis.

Table 4.24 - Accident as a driver T-test (own authorship)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Public embracement	Equal variances assumed	0.358	0.550	1.923	367	0.055	0.226	0.117	-0.005	0.456
	Equal variances not assumed			1.923	357.986	0.055	0.226	0.117	-0.005	0.456

4.4.8. Sociodemographic

Similar to the analysis of Intention to use, an independent samples t-test was performed between gender and Public embracement. Equal variances were assumed since the p value of the Levene’s test was higher than .05 (.918). The 2-tailed p value (.025) determined that, similar to before, Males have a higher embracement level towards UAVs than Females.

Table 4.25 - Public embracement t-test on gender (own authorship)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Public embracement	Equal variances assumed	0.011	0.918	-2.255	389	0.025	-0.257	0.114	-0.482	-0.033
	Equal variances not assumed			-2.278	372.125	0.023	-0.257	0.113	-0.479	-0.035

Regarding the effect of having children in the embracement, the Levene's test *p* value revealed that equal variances cannot be assumed (.033). The 2-tailed *p* value revealed that people the null hypothesis is rejected, thus showing that the population mean is not equal. Here we can observe that respondents who have children are more likely to have a higher embracement level when compared with respondents who don't have children (MD = .302).

Table 4.26 - T-test on having children (own authorship)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Public embracement	Equal variances assumed	4.559	0.033	2.633	389	0.009	0.302	0.115	0.076	0.527
	Equal variances not assumed			2.705	371.047	0.007	0.302	0.112	0.082	0.521

[This page was intentionally left blank]

5. CONCLUSION

This thesis objective is to understand the people’s embracement and intention to use UAVs by performing a survey in which various UAVs related topics were addressed. These topics were related to safety and cybersecurity concerns, expected benefits, mobility and driving behaviour, among others. In the following subsections, I will cover the questions that I asked in the Thesis Objective section (see subchapter 1.2), the hypothesis validation and future work.

5.1. Thesis objectives review

5.1.1. “Which factors affect the public embracement of UAVs?”

Affinity to automation was found to affect the public embracement, here we can observe that respondents who believe more, when compared to other categories, in the usefulness and reliability of driver assistance are more likely to have a higher embracement of UAVs. Furthermore, it was also found that having past experiences with automated vehicles also have a positive impact on embracement.

Regarding the expected benefits of UAVs, as it would be expected, the respondents who demonstrated lower embracement levels have lower beliefs regarding the benefits of UAVs. On the other hand, the respondents who indicated to have a higher embracement believe more in the majority of benefits when compared with other categories. These results demonstrated that there is a need for the stakeholders to invest in the public information of the possible benefits, in order to convert the respondents who have doubts regarding UAVs. 11% of respondents answered “Neither Agree nor Disagree” when considering the acceptance of UAVs, these respondents showed some differences with their belief on the expected benefits presented when compared with Agree and Strongly Agree respondents. This category should be targeted by stakeholders since they have a neutral position.

In the safety question group, it was observed that all groups expressed concerns regarding UAVs’ safety aspects. This means all groups have the same belief, with the exception that Somewhat Agree respondents are more afraid of mid-air collisions when compared with Strongly Agree.

Moreover, cybersecurity was also found to be a concern to the respondents. Here, no differences were found between categories, meaning that respondents have the same level of concerns regardless of the level of embracement. In the intention to use group, the research showed that safety, cybersecurity and being afraid of flying are the main obstacles to a higher level of embracement from the lower categories. Here, as mentioned, it was found that categories with lower embracement levels tend to agree more with these concerns when compared with higher embracement level categories.

The public embracement section, the analysis demonstrated that the categories with lower embracement levels showed coherence throughout the questions of these groups. When they were presented with a possible negative aspect of UAVs, they showed higher levels of agreement, also, the opposite was demonstrated when considering a positive aspect. This result shows that there is a difficulty from the lower level of embracement to consider some positive outcome of UAVs such as increasing the citizens' transport accessibility. On the other hand, categories with a higher level of embracement showed to be comfortable with the idea of having UAVs in their city and believe more that they are beneficial to society. Regarding the increase of visual and noise pollution, on average, all categories showed some concerns with this aspect, being that the most selected answer was "Somewhat Agree".

It was also demonstrated that respondents with higher embracement levels are more willing to change their behaviours with the objective of being more environmentally friendly. Thus, showing us that having higher environmental awareness can lead to higher embracement levels.

Through the independent samples t-test, it was demonstrated that people with prior accident history as drivers have, on average, a higher embracement level than people with no accidents. Furthermore, this analysis also showed that males and people with children have a higher level of agreement when compared with females and people with no children.

In sum, the main obstacles to the public embracement of UAVs are safety and cybersecurity concerns, lack of knowledge of possible benefits. As said before, policymakers, manufacturers and service providers should tackle these obstacles in other to achieve a higher public embracement. Although, it must be noted that the majority of respondents located themselves between Somewhat Agree and Agree.

5.1.2. "Which factors affect the public's intention to use UAVs?"

Through the analysis made, it was found that there are various factors that have either positive or negative impacts on the adoption of UAVs. In the affinity to automation group, it was observed that respondents who showed higher trust in automated technologies are more likely to have a higher intention to use when compared to people who do not have such level of trust.

Furthermore, in the new technologies' embracement group, it was demonstrated that having familiarity with mobility-related services can lead to higher adoption level.

As seen before, the categories that are less willing to adopt UAVs believe less in the benefits presented to them, meaning that, as on public embracement, stakeholders must create a strategy to inform and to prove to the public that UAVs can, in fact, provide these benefits.

Safety was found to be a factor that has a negative impact on the intention to use. We can observe that the categories with lower adoption levels have higher concerns with the operation of UAVs when compared with the remaining groups. These concerns are regarding the aircraft safety under poor conditions, possible technological issues and mid-air collisions.

The analysis of the intention to use group showed us that safety, cybersecurity and being afraid of flying constitute the mains obstacles for the categories with lower intention to use UAVs.

An eventual increase in noise and visual pollution can also be seen as an obstacle to the willingness to adopt. Furthermore, respondents that have accident history as a driver and that prefer to drive over others are more willing to adopt when compared with other respondents.

In resemblance to public embracement, the results demonstrated that males and people with children are more willing to adopt UAVs.

5.1.3. "What purposes should UAVs be used for?"

In this survey, the respondents were asked two questions regarding the use of UAVs. The first question was in the intention to use group, here I asked for what purpose they would use UAVs for. Commuting was found to be the least consensual purpose, where opinions dispersed into all possible answers. 38.9% of respondents disagree at any level with the possibility of them using UAVs to travel to/from work or college, 16.9% had a neutral position and 44.2% agreed with this use at any level. However, the other purposes presented achieved a much higher validation, in all of them, the majority of respondents stated that they agree with the possibility of them using UAVs to go to leisure or social activities and to dislocate themselves to healthcare services.

The second question was in the public embracement group, here the respondents were asked to state for what purposes they believe that UAVs should be used for. The premise for this question was based on the fact that one person could never use UAVs to commute but agree that it is a valid purpose.

Regarding the use of UAVs for commuting, the majority of respondents agrees at any level (53.8%) with this use although there is a big portion of respondents who disagree or have a neutral position (46.3%). Thus, proving that this purpose is validated by respondents. The usage of UAVs for travelling to/from leisure or social activities was also validated as the majority of respondents stated they agreed with this use at any level (65.5% and 63.7% respectively).

Using UAVs to transport people from/to healthcare services was validated with a great expression, 78.8% of respondents stated that they “Agree” or “Strongly Agree” with this purpose. Furthermore, a greater expression was seen when considering the use of UAVs as instruments, such as ambulances or police squads, to respond to emergency cases. Here it was found that 85.7% of respondents “Agree” or “Strongly Agree” with this use.

However, contrary to what would be expected, using UAVs to transfer goods to people was validated with a much lower expression that the two previous usages, this means that respondents have some doubts regarding this purpose.

In conclusion, all purposes suggested were validated. However, some of the purposes have a large portion of respondents that have a negative or neutral position, thus proving the need for UAVs stakeholders to tackle these issues.

5.2. Hypothesis Testing

In the methodology section, ten hypotheses were created to be validated in the data analysis. Throughout the analysis, it was demonstrated that six out of all hypotheses were validated by the results achieved. The t-test proved that Men are more willing to adopt UAVs earlier than Women and that accident history varies through the adoption categories. Having familiarity with shared mobility services were found to have an impact on adoption, however, the same behaviour was not observed in the public embracement. Therefore, the fourth hypothesis was not validated. Public embracement was found to vary across the adoption categories, respondents with a lower level of adoption were also seen to have a lower level of embracement towards UAVs.

Income, contrary to what would be expected based on previous studies, does not have an impact on the respondents’ willingness to adopt UAVs earlier. Therefore, H6 was validated. As observed before, the expected benefits were perceived in a different manner by respondents who have a lower intention to use when compared with respondents with a higher willingness to adopt UAVs.

Cybersecurity, however, was not found to vary across the public embracement categories. Thus, showing us, that this topic is a concern for all respondents regardless of their level of embracement.

Satisfaction with ride-hailing services was not found to have an impact on the respondents' level of embracement. The KW analysis demonstrated that no variances were found across the distribution of public embracement when considering the respondents' satisfaction towards ride-hailing services.

Table 5.1 - Hypotheses testing (own authorship)

Hypotheses	Testing
H1. Men intend to use UAVs earlier than women;	Validated
H2. Safety is perceived in a different way among the public embracement levels;	Validated
H3. Young people are willing to adopt UAVs earlier than the older;	Not validated
H4. Familiarity with shared mobility services has an impact on adoption and embracement;	Not validated
H5. Public embracement levels vary across adoption levels;	Validated
H6. Income levels don't vary across adoption levels;	Validated
H7. The expected benefits are differently perceived among the public embracement levels;	Validated
H8. Accident history vary across adoption levels;	Validated
H9. Cybersecurity is perceived in a different way across public embracement;	Not validated
H10. People satisfied with ride-hailing services are willing to embrace this mode earlier.	Not validated

5.3. Suggestions and future work

There is a need for a new, safer, faster, and greener solution of transportation. UAVs can be a new opportunity in urban mobility. This study presented the dimensions to be studied in the process of the introduction of UAVs in mobility systems in a way that they can serve citizens and potential users. Public's embracement and intention to use UAVs are both important for the successful planning and implementation of the new service in the third dimension of urban space. A survey was conducted in Lisbon area to collect data on citizen´s perceptions over aspects related to the introduction of UAVs in the transport system of a city. With the analysis of the 391 replies, it was found that the major obstacle to the embracement and intention to use UAVs is the lack of previous knowledge. The analysis showed variances between the respondents' beliefs regarding the possible benefits of UAVs, this means that with some investment in communication by stakeholders could translate into higher levels of adoption and embracement. Safety and cybersecurity are, as expected, the major concerns regarding this new mean of transportation. Stakeholders could also create initiatives where they would explain the projected safety and cybersecurity protocols in order to ease the publics' perception towards UAVs.

Regarding the use of UAVs, as seen before, some of the possible uses achieved a higher level of acceptance than others (e.g.: using for emergency cases versus using for commuting). Therefore, stakeholders should first begin to operate UAVs for those purposes. Then, after proving that UAVs are safe to be in cities, other purposes could be offered to the public. I believe that with this strategy the impact to the public eyes would be lower, allowing the citizens to get used to this new transport mode before considering using it for their mobility needs.

Therefore, initiatives such as the Urban Air Mobility from the European Innovation Partnerships on Smart Cities and Communities (EIP-SCC), supported by the European Commission, are needed. This initiative was created in 2018 and aims to contribute to the creation of a market for UAM that brings together cities and regions with companies, allows innovative urban mobility solutions to be showcased, and supports, where possible their replication at scale (European Commission, 2018).

These initiatives can pave the way to a more direct approach to the possible user. Companies, by creating partnerships with cities councils and regulators, can create synergies and develop a better strategy to implement this new transport mode. This thesis not only revealed the impact of UAVs on citizen perception but also revealed the main concerns and obstacles. Cities councils, manufactures and regulators should build initiatives like the one mentioned before with the goal of creating a strategy based on the factors mentioned in this study.

Future work will go through the development of discrete choice models that will model the intention to use and public embracement levels in order to predict the shares of people belonging to each category and identify the characteristics of the choices.

6. REFERENCES

6.1. Websites

Worldometers (2019). Retrieved 26 September 2019, from https://www.worldometers.info/world-population/

Rodrigue, J. (2017). *Urban Transport Challenges*. Retrieved 26 September 2019, from https://transportgeography.org/?page_id=4621

Bureau of Transportation Statistics (BTS) (2018). *Principal Means of Transportation to Work*. Retrieved 26 September 2019, from https://www.bts.gov/content/principal-means-transportation-work

Forth T. (2019). *"Birmingham isn't a big city at peak times": How poor public transport explains the UK's productivity puzzle*. Retrieved 28 September 2019, from https://www.citymetric.com/transport/birmingham-isn-t-big-city-peak-times-how-poor-public-transport-explains-uk-s-productivity

Saldivia G. (2018). *Stuck in Traffic? You're Not Alone. New Data Show American Commute Times Are Longer.* Retrieved 30 September 2019, from https://www.npr.org/2018/09/20/650061560/stuck-in-traffic-youre-not-alone-new-data-show-american-commute-times-are-longer

TomTom (2018). *TomTom Traffic Index.* Retrieved 3 October 2019, from https://www.tomtom.com/en_gb/traffic-index/ranking

Korosec K. (2019*). Uber spent $457 million on self-driving and flying car R&D last year*. Retrieved 3 October 2019, from https://techcrunch.com/2019/04/11/uber-spent-457-million-on-self-driving-and-flying-car-rd-last-year/

Wright K (2018). *Urban Air Mobility Adds a New Dimension to Travel*. Retrieved 4 October 2019, from https://www.mitre.org/publications/project-stories/urban-air-mobility-adds-a-new-dimension-to-travel

IAC acoustics (2018), *Comparative Examples of Noise Levels*. Retrieved 26 October 2020, from https://www.iacacoustics.com/blog-full/comparative-examples-of-noise-levels.html

Shepardson, D. (2019). *In review of fatal Arizona crash, U.S. agency says Uber software had flaws*. Retrieved from 12 November 2019, from https://www.reuters.com/article/us-uber-crash/uber-test-vehicles-involved-in-37-crashes-before-fatal-self-driving-incident-idUSKBN1XF2HA

Pordata (2018). *Salário médio mensal dos trabalhadores por conta de outrem: remuneração base e ganho*. Retrieved 16 October 2020, from https://www.pordata.pt/Portugal/Sal%c3%a1rio+m%c3%a9dio+mensal+dos+trabalhadores+por+conta+de+outrem+remunera%c3%a7%c3%a3o+base+e+ganho-857-6932

AERD statistics (2018). *Kruskal-Wallis H Test using SPSS Statistics*. Retrieved 16 October 2020, from https://statistics.laerd.com/spss-tutorials/kruskal-wallis-h-test-using-spss-statistics.php

Government Europa (2019). *Saving the planet*. Government Europa Quarterly 28. Retrieved 18 May 2020, from https://www.governmenteuropa.eu/government-europa-quarterly-28/91844/

European Commission (2018), *Commission welcomes European cities joining the Urban Air Mobility initiative*, Mobility and Transport. Retrieved 30 October 2020, from https://ec.europa.eu/transport/media/news/news/2018-05-30-commission-welcomes-european-cities-joining-urban-air-mobility-initiative_en#:~:text=The%20Urban%20Air%20Mobility%20(UAM)%20Initiative%20aims%20to%20contribute%20to,possible%20their%20replication%20at%20scale.

6.2. Scientific papers

Al Haddad, C., Chaniotakis, E., Straubinger, A., Plötner, K., & Antoniou, C. (2020). Factors affecting the adoption and use of urban air mobility. *Transportation Research Part A: Policy and Practice*. https://doi.org/10.1016/j.tra.2019.12.020

Begg, D. (2014). *Vision for London : a 2050 Vision for London :* Retrieved from https://www.transporttimes.co.uk/Admin/uploads/64165-transport-times_a-2050-vision-for-london_aw-web-ready.pdf

Boelens, J.-H. (2019). *Pioneering the Urban Air Taxi*. 1–28. Retrieved from https://press.volocopter.com/images/pdf/Volocopter-WhitePaper-1-0.pdf

Brell, T., Philipsen, R., & Ziefle, M. (2019). sCARy! Risk Perceptions in Autonomous Driving: The Influence of Experience on Perceived Benefits and Barriers. *Risk Analysis*. https://doi.org/10.1111/risa.13190

Casley, S. V., Jardim, A. ., & Quartulli, A. M. (2013). A Study of Public Acceptance of Autonomous Cars. *Wpi*, 1–146. https://doi.org/10.1016/j.ympev.2009.08.027

Castle, J., Fornaro, C., Genovesi, D., Lin, E., Strauss, D. E., Waldewitz, T., & Edridge, D. (2017). Flying solo – how far are we down the path towards pilotless planes? *UBS Global Research*, (August), 53. Retrieved from https://neo.ubs.com/shared/d1ssGmLAVeEB/

Cohen, J. (1988). Statistical Power Analysis for the Behavioural Science (2nd Edition). In

Statistical Power Anaylsis for the Behavioral Sciences.

Documents, A., Caps, R., Necks, F., Nomenclature, R., Duty, H., Test, V., & Tests, D. (2014). *Surface Vehicle*. 1–2.

Eker, U., Fountas, G., Anastasopoulos, P. C., & Still, S. E. (2020). An exploratory investigation of public perceptions towards key benefits and concerns from the future use of flying cars. *Travel Behaviour and Society*. https://doi.org/10.1016/j.tbs.2019.07.003

Franckx, L., & Mayeres, I. (2016). Future trends in mobility: the rise of the sharing economy and automated transport. *Mind Sets*, (3). https://doi.org/10.13140/RG.2.2.34864.46083

Fu, M., Rothfeld, R., & Antoniou, C. (2019). Exploring Preferences for Transportation Modes in an Urban Air Mobility Environment: Munich Case Study. *Transportation Research Record*. https://doi.org/10.1177/0361198119843858

Gkartzonikas, C., & Gkritza, K. (2019). What have we learned? A review of stated preference and choice studies on autonomous vehicles. *Transportation Research Part C: Emerging Technologies*, *98*(March 2018), 323–337. https://doi.org/10.1016/j.trc.2018.12.003

Haboucha, C. J., Ishaq, R., & Shiftan, Y. (2017). User preferences regarding autonomous vehicles. *Transportation Research Part C: Emerging Technologies*, *78*, 37–49. https://doi.org/10.1016/j.trc.2017.01.010

Holden, J., & Goel, N. (2016). *Fast-Forwarding to a Future of On-Demand Urban Air Transportation*. 1–98. Retrieved from https://www.uber.com/elevate.pdf

Howard, D., & Dai, D. (2013). Public Perceptions of Self-driving Cars. *93rd Annual Meeting of the Transportation Research Board*, *2014*, 21. Retrieved from https://www.ocf.berkeley.edu/~djhoward/reports/Report - Public Perceptions of Self Driving Cars.pdf

Jittrapirom, P., Marchau, V., van der Heijden, R., & Meurs, H. (2018). Future implementation of mobility as a service (MaaS): Results of an international Delphi study. *Travel Behaviour and Society*, (November), 1–14. https://doi.org/10.1016/j.tbs.2018.12.004

Johnson, W., & Silva, C. (2019). Observations from exploration of VTOL urban air mobility designs. *The Vertical Flight Society - Forum 75: The Future of Vertical Flight - Proceedings of the 75th Annual Forum and Technology Display, Special Sessions*, (October).

König, M., & Neumayr, L. (2017). Users' resistance towards radical innovations: The case of the self-driving car. *Transportation Research Part F: Traffic Psychology and Behaviour*, *44*, 42–52. https://doi.org/10.1016/j.trf.2016.10.013

Krueger, R., Rashidi, T. H., & Rose, J. M. (2016). Preferences for shared autonomous vehicles. *Transportation Research Part C: Emerging Technologies*, *69*, 343–355. https://doi.org/10.1016/j.trc.2016.06.015

Kwak, S. G., & Kim, J. H. (2017). Central limit theorem: The cornerstone of modern statistics. *Korean Journal of Anesthesiology*. https://doi.org/10.4097/kjae.2017.70.2.144

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*.

Liljamo, T., Liimatainen, H., & Pöllänen, M. (2018). Attitudes and concerns on automated vehicles. *Transportation Research Part F: Traffic Psychology and Behaviour*, *59*(2018), 24–44. https://doi.org/10.1016/j.trf.2018.08.010

Lineberger, R., Hussain, A., Mehra, S., & Pankratz, D. (2018). *Passenger drones and flying cars*. Retrieved from https://www2.deloitte.com/content/dam/insights/us/articles/4339_Elevating-the-future-of-mobility/DI_Elevating-the-future-of-mobility.pdf

Panagiotopoulos, I., & Dimitrakopoulos, G. (2018). An empirical investigation on consumers' intentions towards autonomous driving. *Transportation Research Part C: Emerging Technologies*. https://doi.org/10.1016/j.trc.2018.08.013

Rogers, E. M. (1983). DIFFUSION OF INNOVATIONS Third Edition. *Journal of Continuing Education in the Health Professions*.

Sanbonmatsu, D. M., Strayer, D. L., Yu, Z., Biondi, F., & Cooper, J. M. (2018). Cognitive underpinnings of beliefs and confidence in beliefs about fully automated vehicles. *Transportation Research Part F: Traffic Psychology and Behaviour*. https://doi.org/10.1016/j.trf.2018.02.029

Schoettle, B., & Sivak, M. (2014). Public Opinion about Self-Driving Vehicles in China, India, Japan, the U.S., the U.K., and Australia. In *Transportation Research Institute*.

Shabanpour, R., Golshani, N., Shamshiripour, A., & Mohammadian, A. (Kouros). (2018). Eliciting preferences for adoption of fully automated vehicles using best-worst analysis. *Transportation Research Part C: Emerging Technologies*, *93*(June), 463–478. https://doi.org/10.1016/j.trc.2018.06.014

Thomopoulos, N., & Givoni, M. (2015). The autonomous car—a blessing or a curse for the future of low carbon mobility? An exploration of likely vs. desirable outcomes. *European Journal of Futures Research*, *3*(1). https://doi.org/10.1007/s40309-015-0071-z

United Nations. (2019). World Population Prospects 2019: Highlights. *Department of Economic and Social Affairs.*, ((ST/ESA/SER.A/423)), 1–46. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12283219

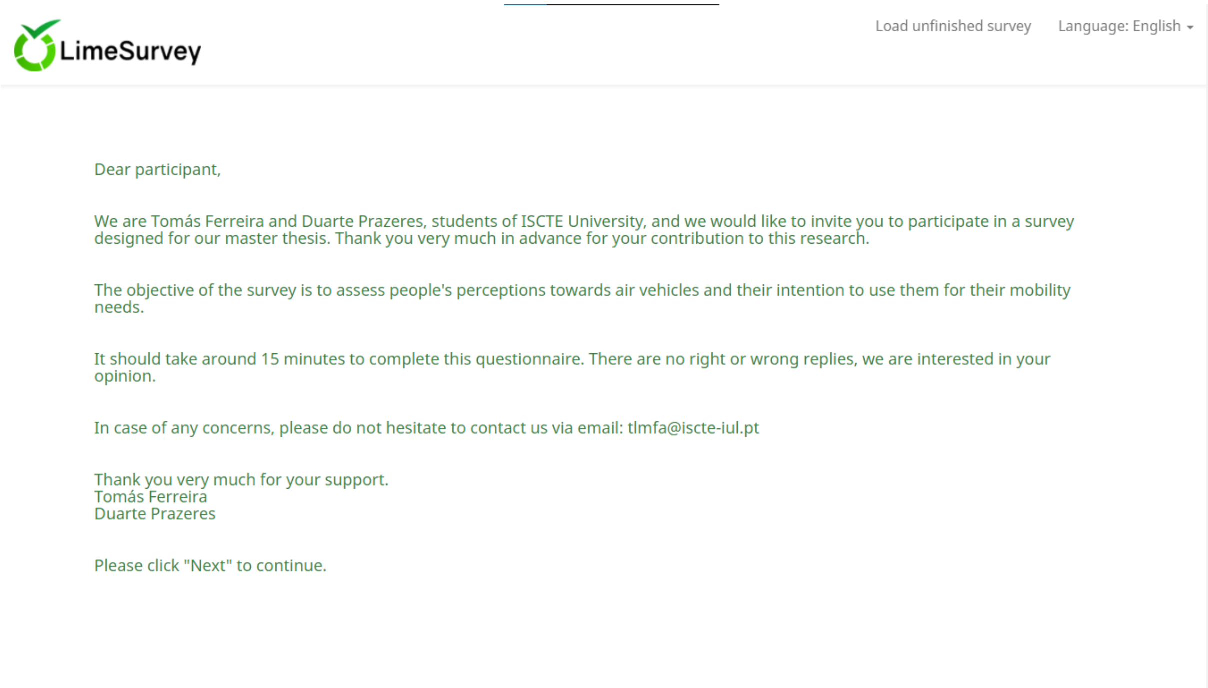
Urban Air Mobility, N. (2018). *Uam-Market-Study-Executive-Summary-Pr.Pdf*. (November). Retrieved from https://www.nasa.gov/sites/default/files/atoms/files/uam-market-study-executive-summary-pr.pdf

Zeid, M. A. (2009). Measuring and Modeling Activity and Travel Well-Being. *Environmental Engineering*.

[This page was intentionally left blank]

7. ANNEXES

ANNEX A – ONLINE SURVEY



LimeSurvey

Load unfinished survey   Language: English

Dear participant,

We are Tomás Ferreira and Duarte Prazeres, students of ISCTE University, and we would like to invite you to participate in a survey designed for our master thesis. Thank you very much in advance for your contribution to this research.

The objective of the survey is to assess people's perceptions towards air vehicles and their intention to use them for their mobility needs.

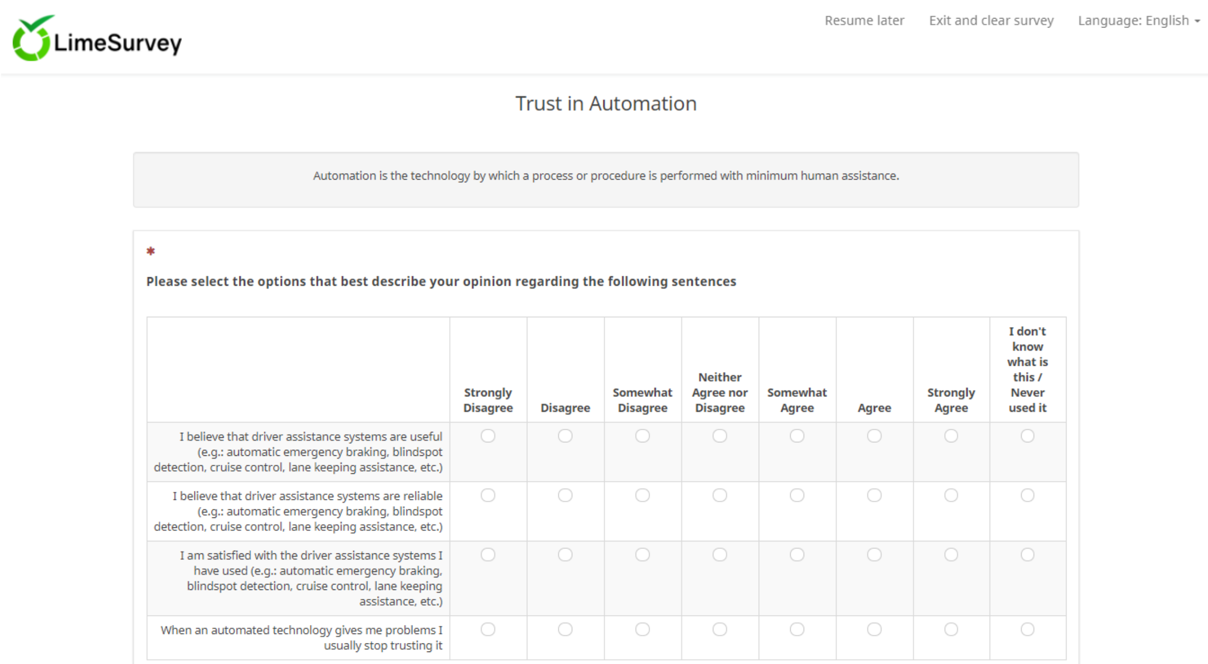
It should take around 15 minutes to complete this questionnaire. There are no right or wrong replies, we are interested in your opinion.

In case of any concerns, please do not hesitate to contact us via email: tlmfa@iscte-iul.pt

Thank you very much for your support.
Tomás Ferreira
Duarte Prazeres

Please click "Next" to continue.

Item 7.1 - Survey Introduction (own authorship)



LimeSurvey

Resume later   Exit and clear survey   Language: English

Trust in Automation

Automation is the technology by which a process or procedure is performed with minimum human assistance.

*

Please select the options that best describe your opinion regarding the following sentences

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	I don't know what is this / Never used it
I believe that driver assistance systems are useful (e.g.: automatic emergency braking, blindspot detection, cruise control, lane keeping assistance, etc.)	○	○	○	○	○	○	○	○
I believe that driver assistance systems are reliable (e.g.: automatic emergency braking, blindspot detection, cruise control, lane keeping assistance, etc.)	○	○	○	○	○	○	○	○
I am satisfied with the driver assistance systems I have used (e.g.: automatic emergency braking, blindspot detection, cruise control, lane keeping assistance, etc.)	○	○	○	○	○	○	○	○
When an automated technology gives me problems I usually stop trusting it	○	○	○	○	○	○	○	○

Item 7.2 - Trust in Automation Part 1 (own authorship)

LimeSurvey

Resume later   Exit and clear survey   Language: English

*

Have you ever used a driverless vehicle? (e.g. car, bus, tram, metro)

Choose one of the following answers

- (●) Yes
- ( ) No
- ( ) I don't what this is

*

Please select the options that best describe your experience regarding the following sentences

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
I felt comfortable	○	○	○	○	○	○	○
I was stressed	○	○	○	○	○	○	○
I felt safe	○	○	○	○	○	○	○
I felt anxious	○	○	○	○	○	○	○
I was scared	○	○	○	○	○	○	○

Item 7.3 - Trust in Automation Part 2 (own authorship)

LimeSurvey

Resume later   Exit and clear survey   Language: English

8%

Adoption of a new technology

*

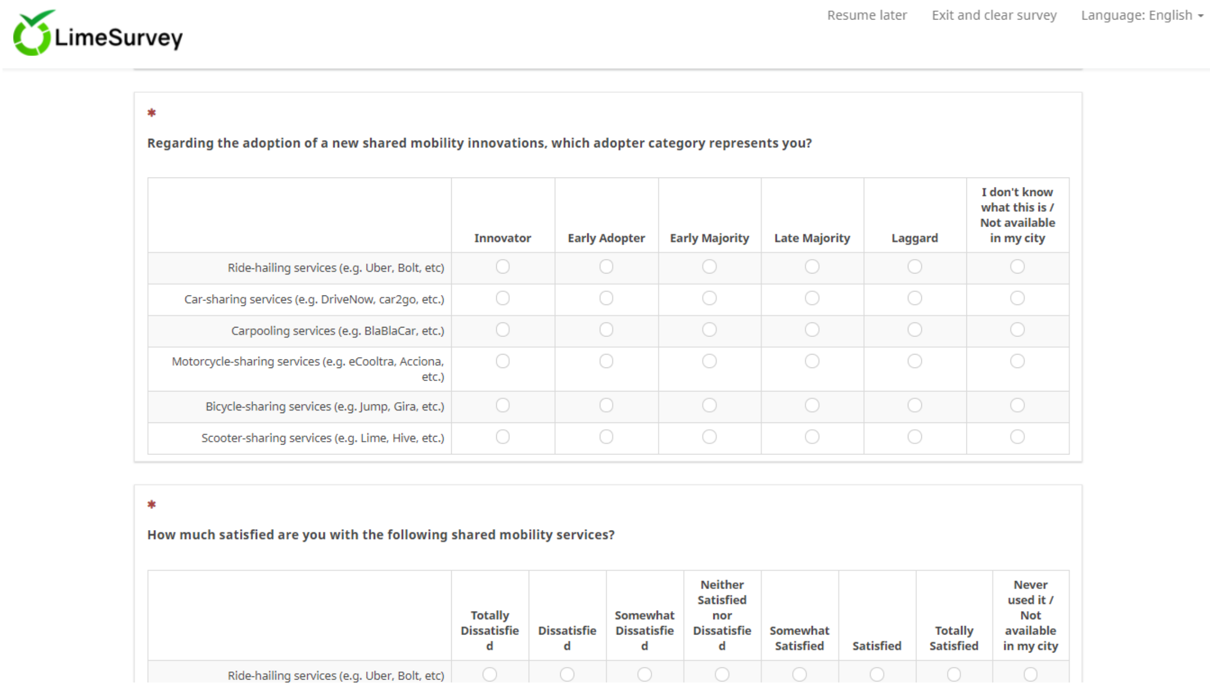
Regarding the adoption of a new technology, which adopter category represents you?

Choose one of the following answers

- ( ) Innovator - These are people who want to be the first to try the innovation. They are venturesome and interested in new ideas. These people are very willing to take risks, and are often the first to develop new ideas
- ( ) Early Adopter - These are people who represent opinion leaders. They enjoy leadership roles, and embrace change opportunities. They are already aware of the need to change and so are very comfortable adopting new ideas
- ( ) Early Majority - These people are rarely leaders, but they do adopt new ideas before the average person. That said, they typically need to see evidence that the innovation works before they are willing to adopt it.
- ( ) Late Majority - These people are skeptical of change, and will only adopt an innovation after it has been tried by the majority
- ( ) Laggard - These people are bound by tradition and very conservative. They are very skeptical of change.

*

Item 7.4 - Adoption of New Technologies Part 1 (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

*

Regarding the adoption of a new shared mobility innovations, which adopter category represents you?

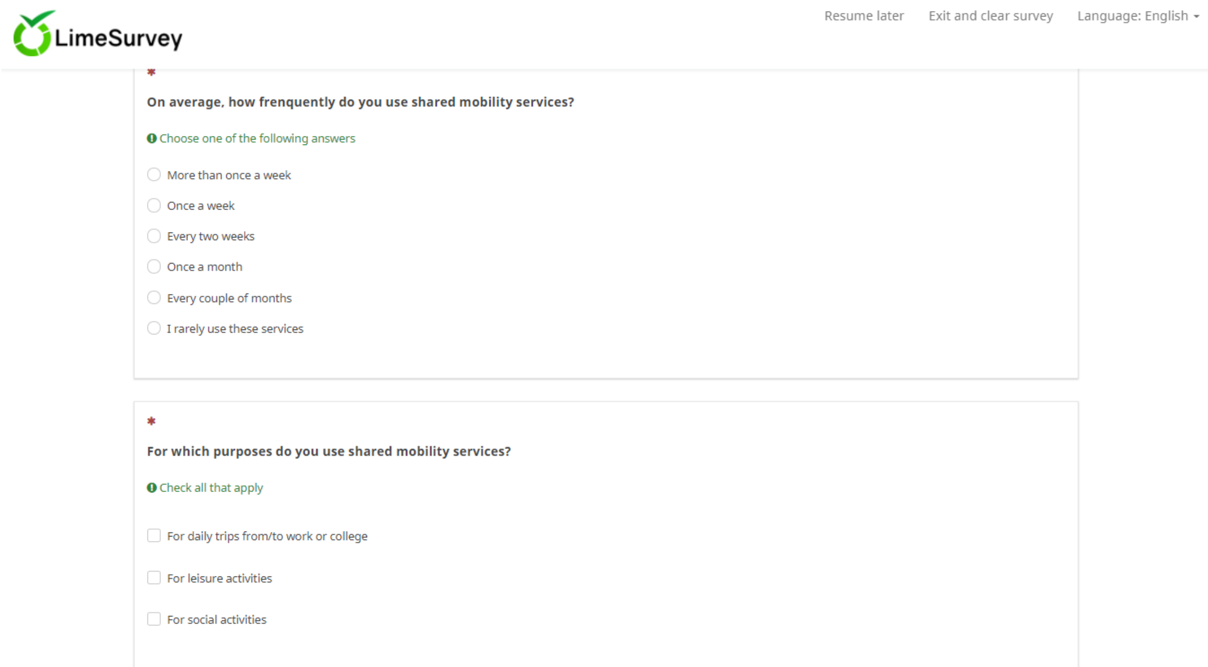
	Innovator	Early Adopter	Early Majority	Late Majority	Laggard	I don't know what this is / Not available in my city
Ride-hailing services (e.g. Uber, Bolt, etc)	○	○	○	○	○	○
Car-sharing services (e.g. DriveNow, car2go, etc.)	○	○	○	○	○	○
Carpooling services (e.g. BlaBlaCar, etc.)	○	○	○	○	○	○
Motorcycle-sharing services (e.g. eCooltra, Acciona, etc.)	○	○	○	○	○	○
Bicycle-sharing services (e.g. Jump, Gira, etc.)	○	○	○	○	○	○
Scooter-sharing services (e.g. Lime, Hive, etc.)	○	○	○	○	○	○

*

How much satisfied are you with the following shared mobility services?

	Totally Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neither Satisfied nor Dissatisfied	Somewhat Satisfied	Satisfied	Totally Satisfied	Never used it / Not available in my city
Ride-hailing services (e.g. Uber, Bolt, etc)	○	○	○	○	○	○	○	○

Item 7.5 - Adoption of New Technologies Part 2 (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

*

On average, how frenquently do you use shared mobility services?

Choose one of the following answers

- ○ More than once a week
- ○ Once a week
- ○ Every two weeks
- ○ Once a month
- ○ Every couple of months
- ○ I rarely use these services

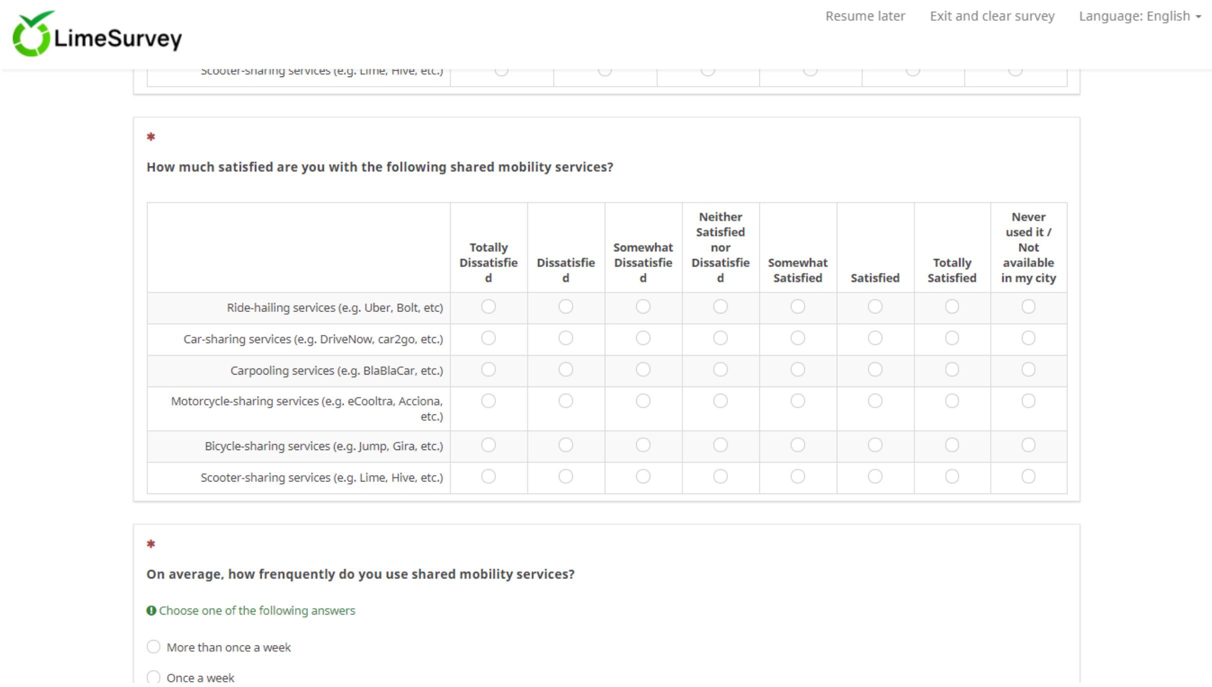
*

For which purposes do you use shared mobility services?

Check all that apply

- ☐ For daily trips from/to work or college
- ☐ For leisure activities
- ☐ For social activities

Item 7.6 - Adoption of New Technologies Part 3 (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

Scooter-sharing services (e.g. Lime, Hive, etc.)

*

How much satisfied are you with the following shared mobility services?

	Totally Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neither Satisfied nor Dissatisfied	Somewhat Satisfied	Satisfied	Totally Satisfied	Never used it / Not available in my city
Ride-hailing services (e.g. Uber, Bolt, etc)								
Car-sharing services (e.g. DriveNow, car2go, etc.)								
Carpooling services (e.g. BlaBlaCar, etc.)								
Motorcycle-sharing services (e.g. eCooltra, Acciona, etc.)								
Bicycle-sharing services (e.g. Jump, Gira, etc.)								
Scooter-sharing services (e.g. Lime, Hive, etc.)								

*

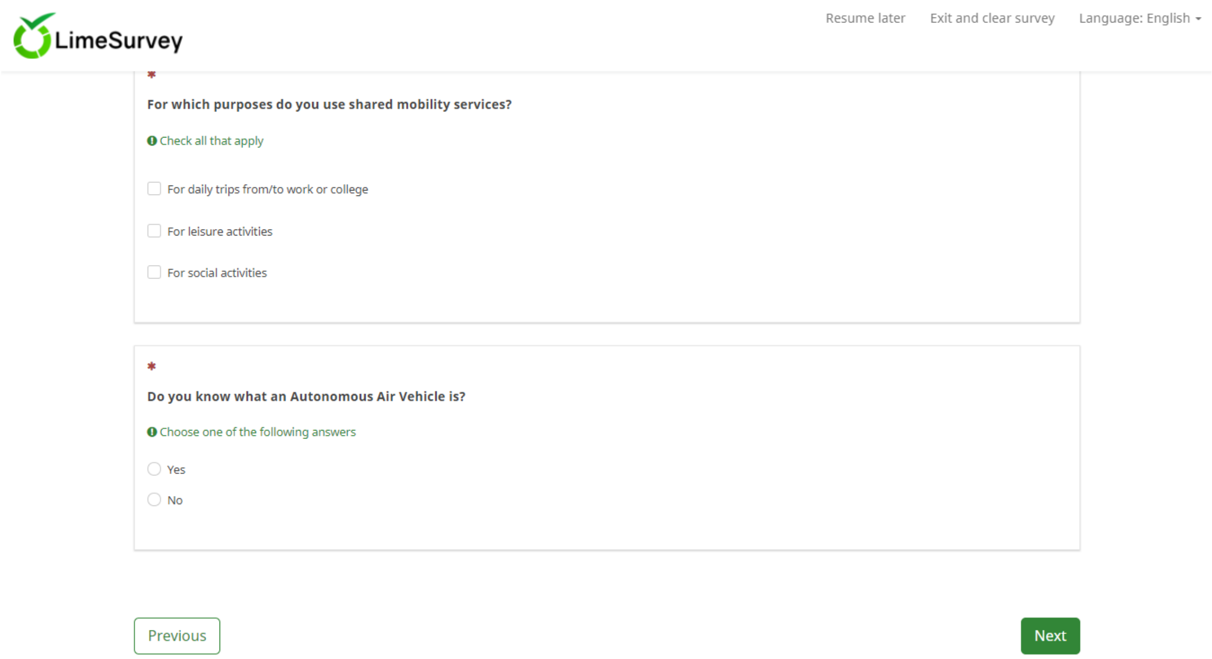
On average, how frenquently do you use shared mobility services?

Choose one of the following answers

More than once a week

Once a week

Item 7.7 - Adoption of New Technologies Part 4 (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

*

For which purposes do you use shared mobility services?

Check all that apply

For daily trips from/to work or college

For leisure activities

For social activities

*

Do you know what an Autonomous Air Vehicle is?

Choose one of the following answers

Yes

No

Previous Next

Item 7.8 - Adoption of New Technologies Part 5 (own authorship)

LimeSurvey

Resume later · Exit and clear survey · Language: English

Let me introduce you to a new transport mode: Autonomous Air Vehicles. These vehicles will fly above the cities. Bellow you can find a short description of this new air mobility concept.

(Source: Airbus)

Moving with Air Vehicles means that:

You reserve your Air Vehicle via smartphone app

You can use it whenever you require the service

You can pick-up a vehicle and drop-off from/to a nearby location

You travel at a speed that is 3 times higher than the speed of conventional road cars

You can have the entire Air Vehicle for yourself or for your travel group (max. 4 passengers)

No pilot is needed, the Air Vehicle is autonomous

The Air Vehicle is fully electric and has a range of 50 kilometers

Item 7.9 - Introduction to UAVs (own authorship)

LimeSurvey

Resume later · Exit and clear survey · Language: English

25%

Expected Benefits

*

Based on this information, please select how much you agree with the following statements that express the expected benefits of introducing this new transport mode in mobility systems

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
The use of Air Vehicles will reduce road congestion	○	○	○	○	○	○	○
The use of Air Vehicles will reduce accident on roads	○	○	○	○	○	○	○
The use of Air Vehicles will make my travel time more productive	○	○	○	○	○	○	○
Air Vehicles will significantly reduce travel time	○	○	○	○	○	○	○
The use of Air Vehicles will facilitate the connection of remote areas to bigger cities and multimodal nodes such as ports and airports.	○	○	○	○	○	○	○
The use of Air Vehicles will release more free space in the urban environment for other facilities such as	○	○	○	○	○	○	○

Item 7.10 - Expected Benefits Part 1 (own authorship)

LimeSurvey

Resume later Exit and clear survey Language: English

The use of Air Vehicles will reduce accident on roads							
The use of Air Vehicles will make my travel time more productive							
Air Vehicles will significantly reduce travel time							
The use of Air Vehicles will facilitate the connection of remote areas to bigger cities and multimodal nodes such as ports and airports.							
The use of Air Vehicles will release more free space in the urban environment for other facilities such as parks and pedestrian zones.							
Air vehicles will produce lower CO2 emissions							
Air vehicles will offer a safe and fast mean of transportation							
Air vehicles will offer a less stressful mobility experience							
Air vehicles will make it easier for people with reduced mobility to move (e.g. elderly, children, disabled people).							
Air vehicles will make it easier ambulances and police to move fast to emergency cases							
Air vehicles will increase the trips people will make							

Previous Next

Item 7.11 - Expected Benefits Part 2 (own authorship)

LimeSurvey

Resume later Exit and clear survey Language: English

Cyber security

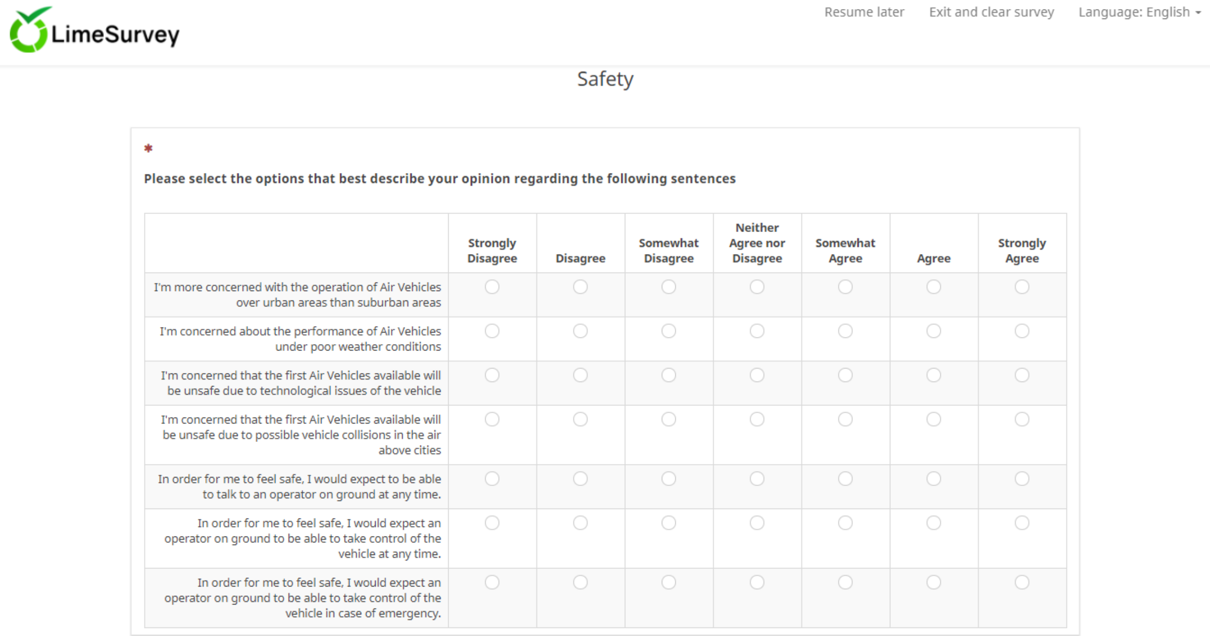
Cybersecurity is the practice of protecting systems, networks, and programs from digital attacks.

*

Please select the options that best describe your opinion regarding the following sentences

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
I make sure that my data are kept private whenever I use the internet							
I'm concerned that my data is kept resilient to common cyber security threats whenever I use internet							
I'm concerned that others can keep track of my location							
I am concerned that Air Vehicles will use my personal information for other purposes without my authorization							
I am concerned that Air Vehicles will share my personal information with other entities without my authorization							
I'm concerned that someone can take control of the Air Vehicle and cause a terrorist attack							

Item 7.12 - Cybersecurity (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

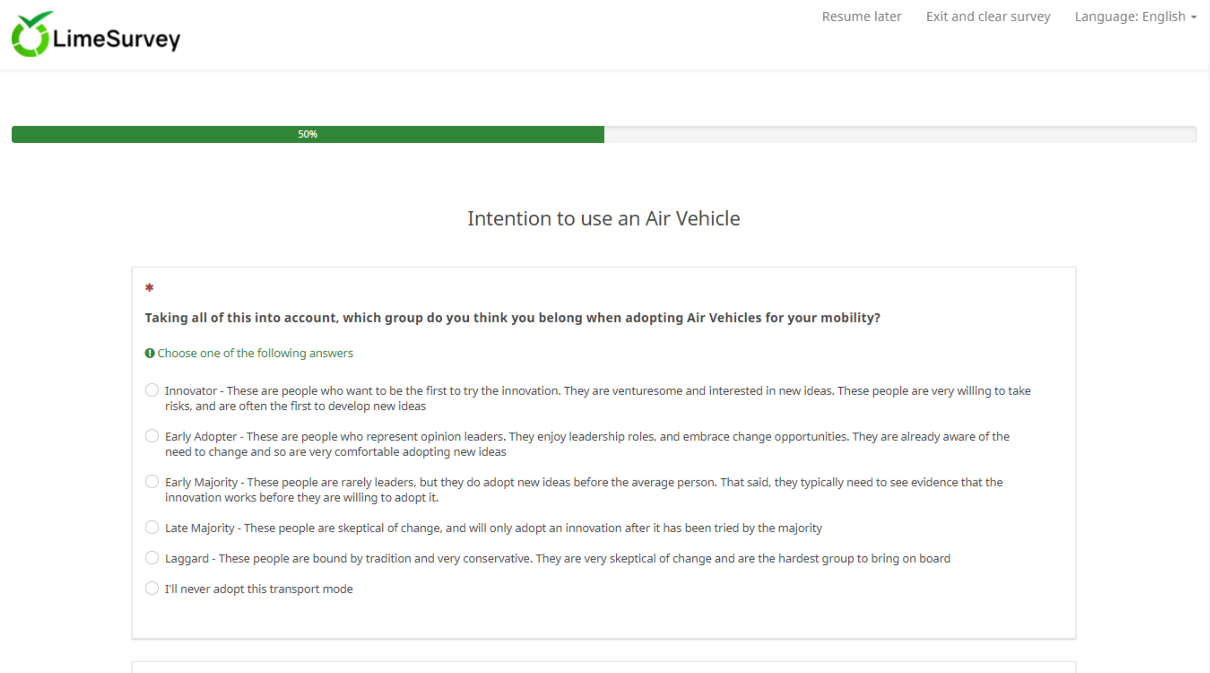
Safety

*

Please select the options that best describe your opinion regarding the following sentences

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
I'm more concerned with the operation of Air Vehicles over urban areas than suburban areas	○	○	○	○	○	○	○
I'm concerned about the performance of Air Vehicles under poor weather conditions	○	○	○	○	○	○	○
I'm concerned that the first Air Vehicles available will be unsafe due to technological issues of the vehicle	○	○	○	○	○	○	○
I'm concerned that the first Air Vehicles available will be unsafe due to possible vehicle collisions in the air above cities	○	○	○	○	○	○	○
In order for me to feel safe, I would expect to be able to talk to an operator on ground at any time.	○	○	○	○	○	○	○
In order for me to feel safe, I would expect an operator on ground to be able to take control of the vehicle at any time.	○	○	○	○	○	○	○
In order for me to feel safe, I would expect an operator on ground to be able to take control of the vehicle in case of emergency.	○	○	○	○	○	○	○

Item 7.13 - Safety (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

50%

Intention to use an Air Vehicle

*

Taking all of this into account, which group do you think you belong when adopting Air Vehicles for your mobility?

Choose one of the following answers

○ Innovator - These are people who want to be the first to try the innovation. They are venturesome and interested in new ideas. These people are very willing to take risks, and are often the first to develop new ideas

○ Early Adopter - These are people who represent opinion leaders. They enjoy leadership roles, and embrace change opportunities. They are already aware of the need to change and so are very comfortable adopting new ideas

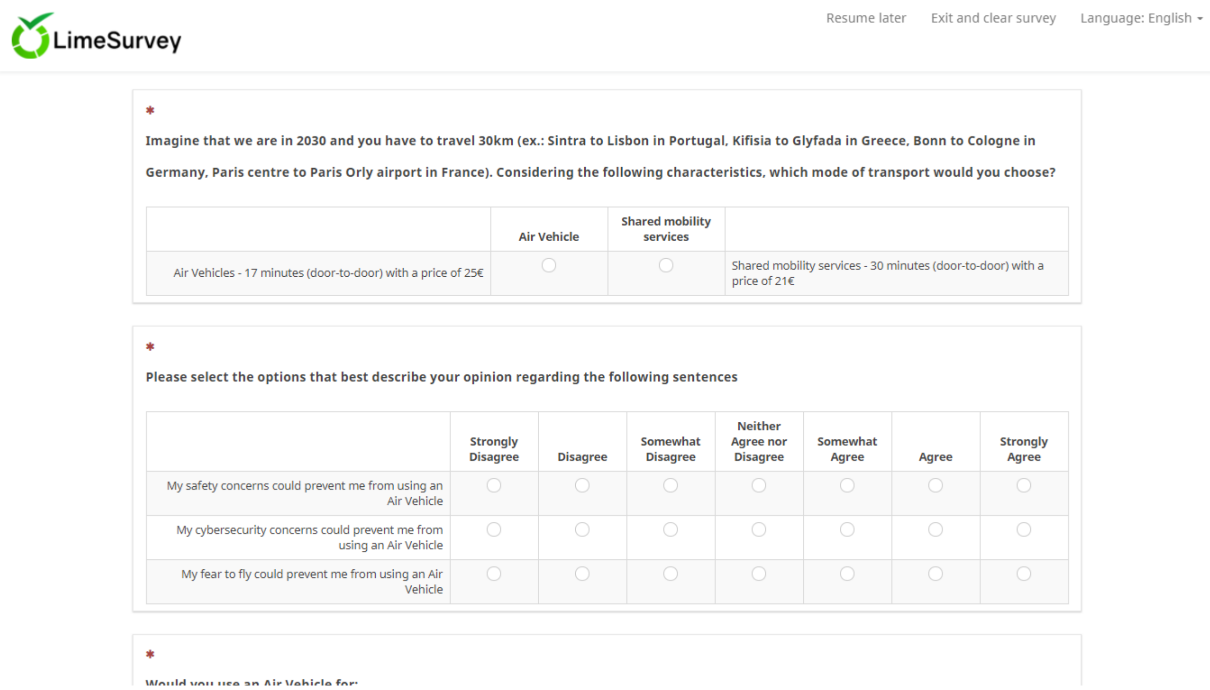
○ Early Majority - These people are rarely leaders, but they do adopt new ideas before the average person. That said, they typically need to see evidence that the innovation works before they are willing to adopt it.

○ Late Majority - These people are skeptical of change, and will only adopt an innovation after it has been tried by the majority

○ Laggard - These people are bound by tradition and very conservative. They are very skeptical of change and are the hardest group to bring on board

○ I'll never adopt this transport mode

Item 7.14 - Intention to use Part 1 (own authorship)



LimeSurvey

Resume later | Exit and clear survey | Language: English

*

Imagine that we are in 2030 and you have to travel 30km (ex.: Sintra to Lisbon in Portugal, Kifisia to Glyfada in Greece, Bonn to Cologne in Germany, Paris centre to Paris Orly airport in France). Considering the following characteristics, which mode of transport would you choose?

	Air Vehicle	Shared mobility services	
Air Vehicles - 17 minutes (door-to-door) with a price of 25€	○	○	Shared mobility services - 30 minutes (door-to-door) with a price of 21€

*

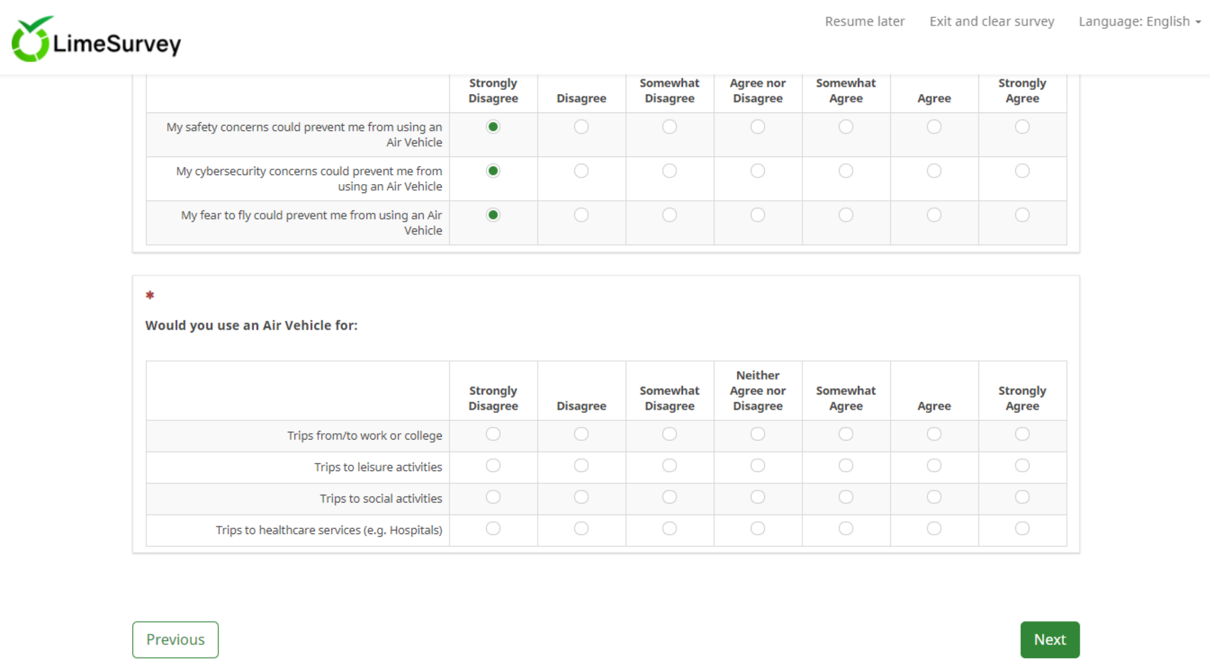
Please select the options that best describe your opinion regarding the following sentences

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
My safety concerns could prevent me from using an Air Vehicle	○	○	○	○	○	○	○
My cybersecurity concerns could prevent me from using an Air Vehicle	○	○	○	○	○	○	○
My fear to fly could prevent me from using an Air Vehicle	○	○	○	○	○	○	○

*

Would you use an Air Vehicle for:

Item 7.16 - Intention to use Part 2 (own authorship)



LimeSurvey

Resume later | Exit and clear survey | Language: English

	Strongly Disagree	Disagree	Somewhat Disagree	Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
My safety concerns could prevent me from using an Air Vehicle	●	○	○	○	○	○	○
My cybersecurity concerns could prevent me from using an Air Vehicle	●	○	○	○	○	○	○
My fear to fly could prevent me from using an Air Vehicle	●	○	○	○	○	○	○

*

Would you use an Air Vehicle for:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Trips from/to work or college	○	○	○	○	○	○	○
Trips to leisure activities	○	○	○	○	○	○	○
Trips to social activities	○	○	○	○	○	○	○
Trips to healthcare services (e.g. Hospitals)	○	○	○	○	○	○	○

Previous | Next

Item 7.15 - Intention to use Part 3 (own authorship)

LimeSurvey

Resume later   Exit and clear survey   Language: English

Public embracement

As a citizen (not necessarily as an user) please choose the answer that suits best your acceptance towards this new mean of transportation

*

As a citizen (not necessarily a user) please choose the answer that suits best your acceptance towards this new mean of transportation:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Air Vehicles are an acceptable means of transport	○	○	○	○	○	○	○
Air Vehicles will increase the quality of life in the cities that offer this transport mode	○	○	○	○	○	○	○
Air Vehicles will improve transport accessibility for all citizens	○	○	○	○	○	○	○
I am concerned that the Air Vehicles will become a transport mode only for the rich	○	○	○	○	○	○	○
I wouldn't feel comfortable living in a city that adopts this transport mode	○	○	○	○	○	○	○
I am concerned that Air Vehicles will increase visual pollution	○	○	○	○	○	○	○
I am concerned that Air Vehicles will increase noise pollution	○	○	○	○	○	○	○
Air Vehicles will be beneficial for the society	○	○	○	○	○	○	○

Item 7.17 - Public Embracement Part 1 (own authorship)

LimeSurvey

Resume later   Exit and clear survey   Language: English

Air Vehicles will be beneficial for the society	○	○	○	○	○	○	○
Air Vehicles will be risky to the public	○	○	○	○	○	○	○
Moving with Air Vehicles will be as safe as with airplanes	○	○	○	○	○	○	○

*

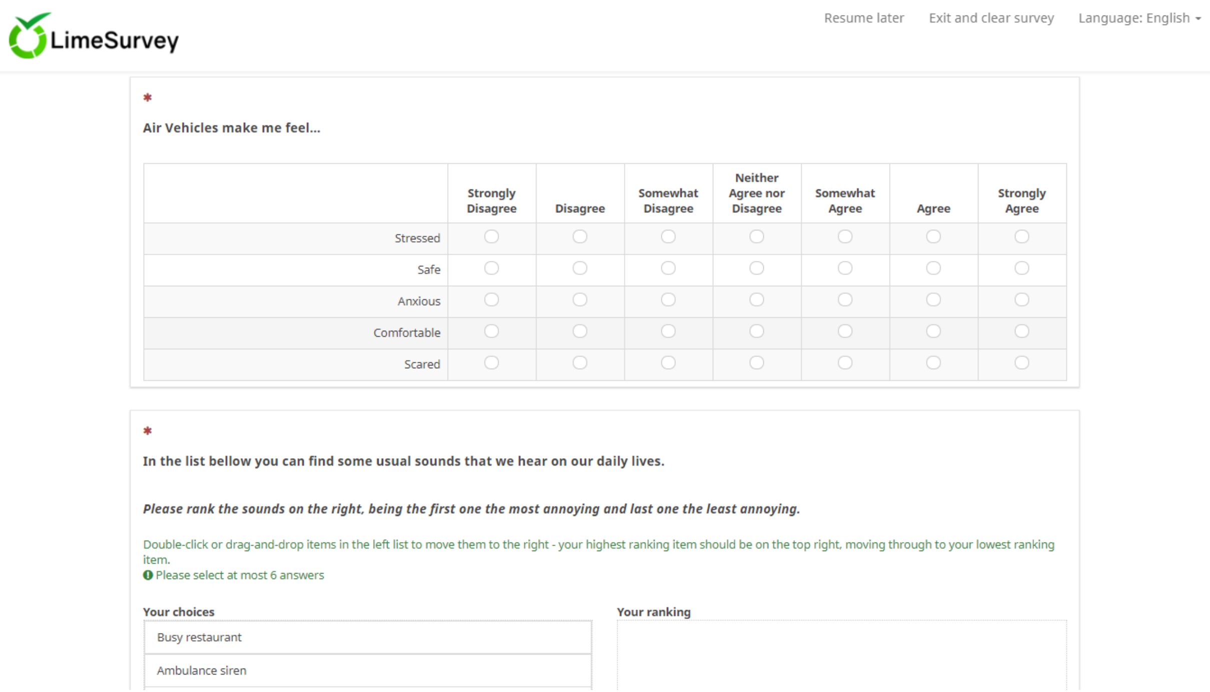
Air Vehicles should be use to:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Transfer people from/to work or school	○	○	○	○	○	○	○
Transfer people for leisure	○	○	○	○	○	○	○
Transfer people for social activities	○	○	○	○	○	○	○
Transfer people from/to healthcare services (e.g. Hospitals)	○	○	○	○	○	○	○
Transfer goods to people	○	○	○	○	○	○	○
Respond to emergency cases (e.g ambulances, police units, etc.)	○	○	○	○	○	○	○

*

Air Vehicles make me feel...

Item 7.18 - Public Embracement Part 2 (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

*

Air Vehicles make me feel...

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Stressed	○	○	○	○	○	○	○
Safe	○	○	○	○	○	○	○
Anxious	○	○	○	○	○	○	○
Comfortable	○	○	○	○	○	○	○
Scared	○	○	○	○	○	○	○

*

In the list bellow you can find some usual sounds that we hear on our daily lives.

Please rank the sounds on the right, being the first one the most annoying and last one the least annoying.

Double-click or drag-and-drop items in the left list to move them to the right - your highest ranking item should be on the top right, moving through to your lowest ranking item.

Please select at most 6 answers

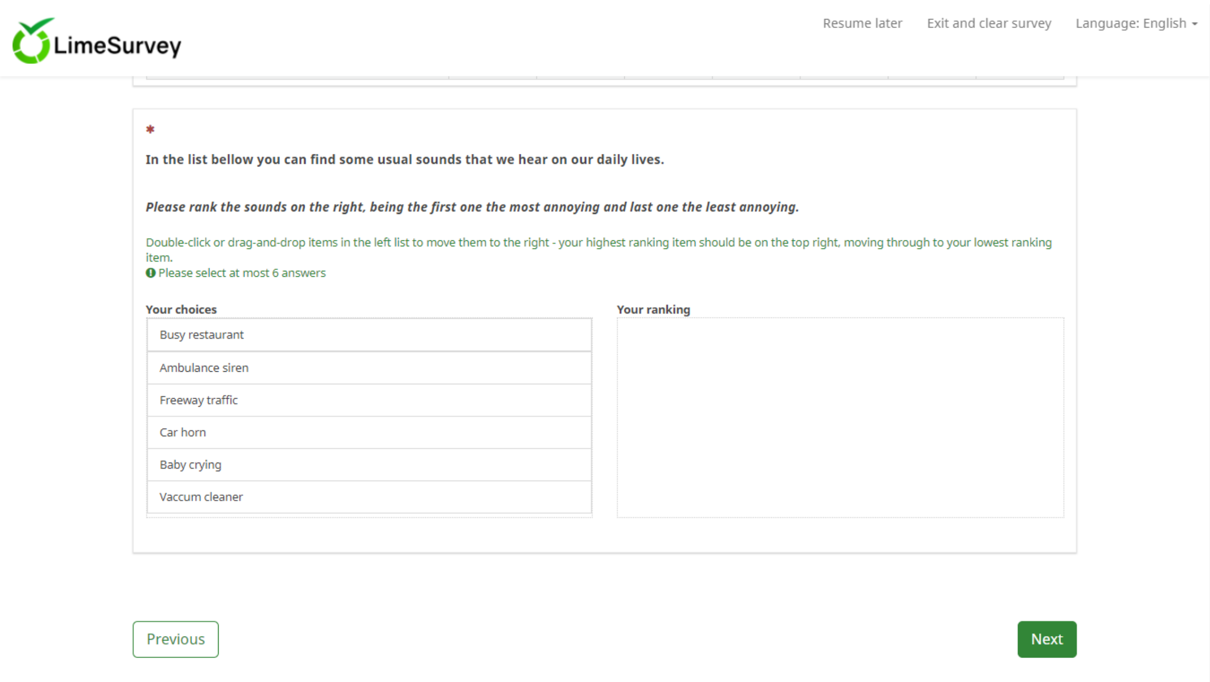
Your choices

Busy restaurant

Ambulance siren

Your ranking

Item 7.19 - Public Embracement Part 3 (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

*

In the list bellow you can find some usual sounds that we hear on our daily lives.

Please rank the sounds on the right, being the first one the most annoying and last one the least annoying.

Double-click or drag-and-drop items in the left list to move them to the right - your highest ranking item should be on the top right, moving through to your lowest ranking item.

Please select at most 6 answers

Your choices

Busy restaurant

Ambulance siren

Freeway traffic

Car horn

Baby crying

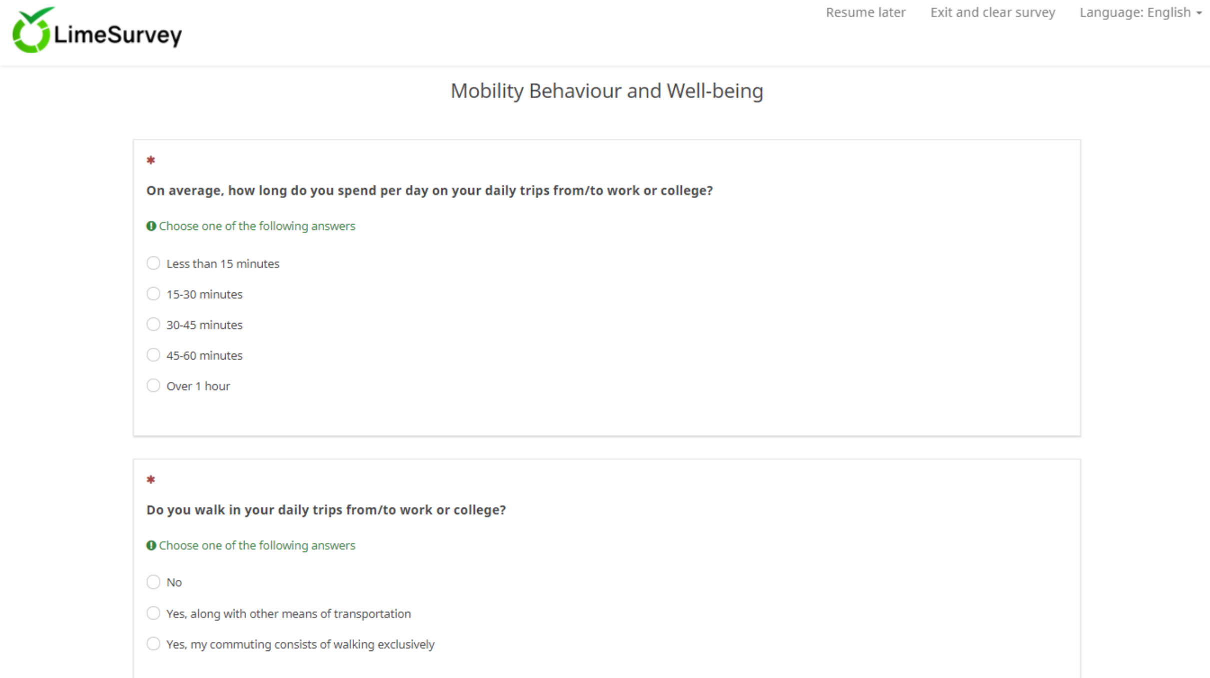
Vaccum cleaner

Your ranking

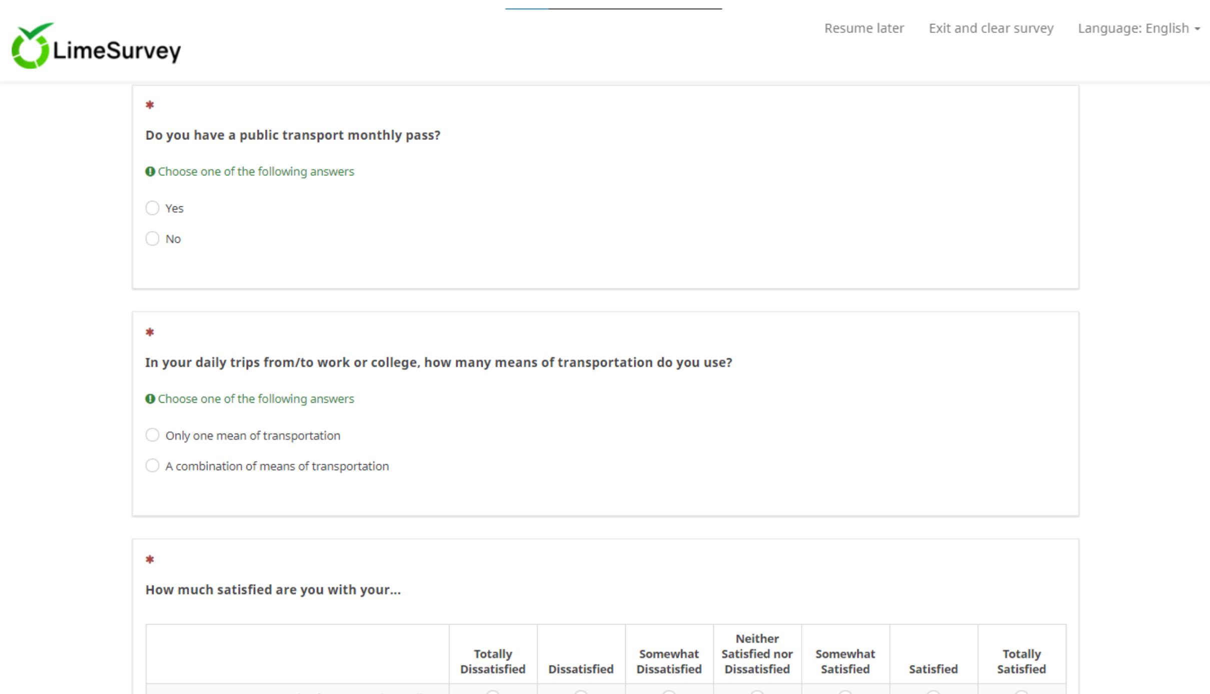
Previous

Next

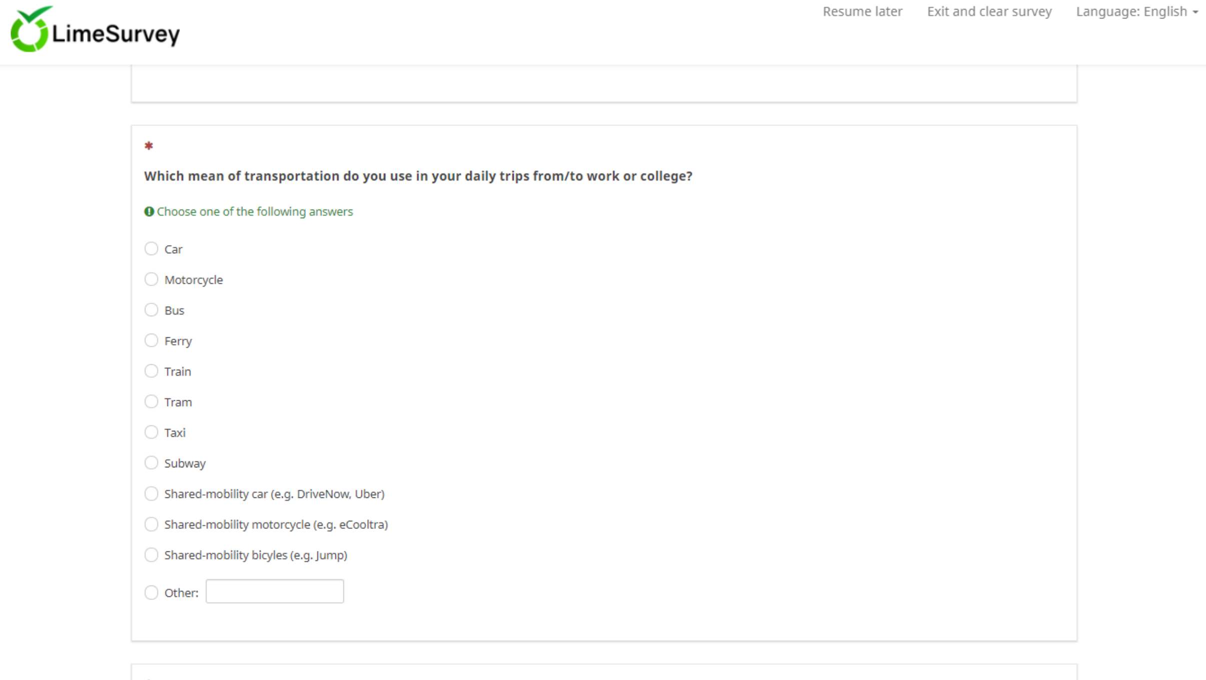
Item 7.20 - Public Embracement Part 4 (own authorship)



Item 7.21 - Mobility Behaviour Part 1 (own authorship)



Item 7.22 - Mobility Behaviour Part 2 (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

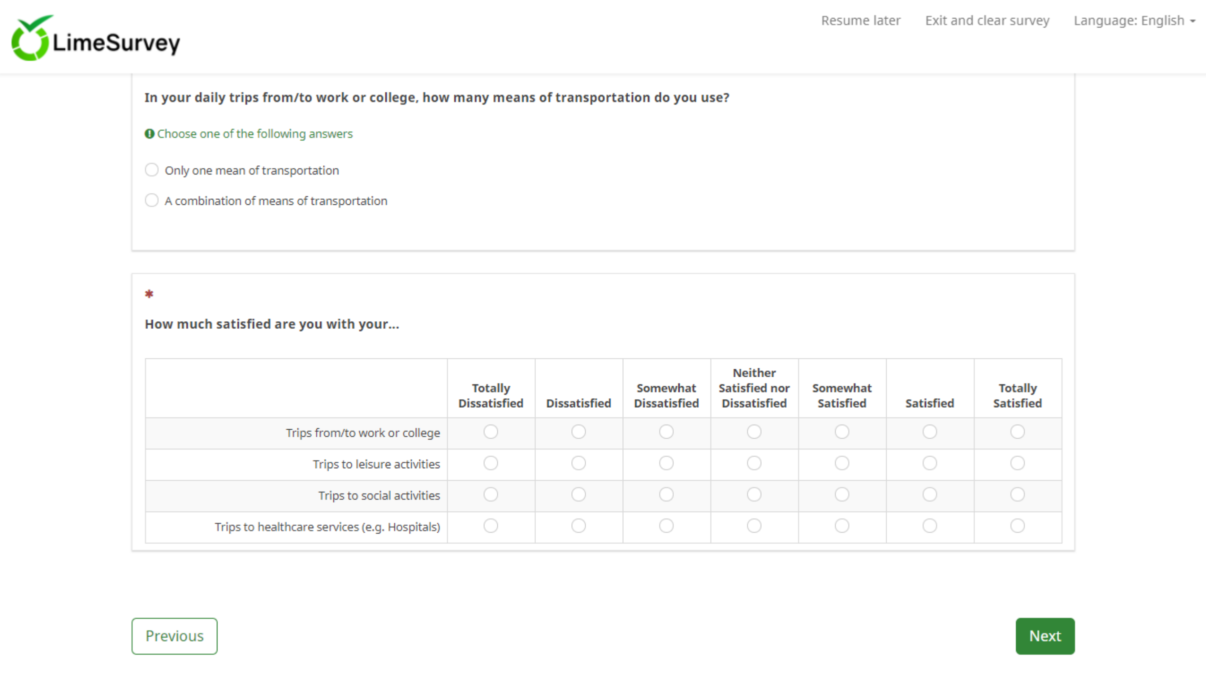
*

Which mean of transportation do you use in your daily trips from/to work or college?

Choose one of the following answers

- Car
- Motorcycle
- Bus
- Ferry
- Train
- Tram
- Taxi
- Subway
- Shared-mobility car (e.g. DriveNow, Uber)
- Shared-mobility motorcycle (e.g. eCooltra)
- Shared-mobility bicyles (e.g. Jump)
- Other:

Item 7.23 - Mobility Behaviour Part 3 (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

In your daily trips from/to work or college, how many means of transportation do you use?

Choose one of the following answers

- Only one mean of transportation
- A combination of means of transportation

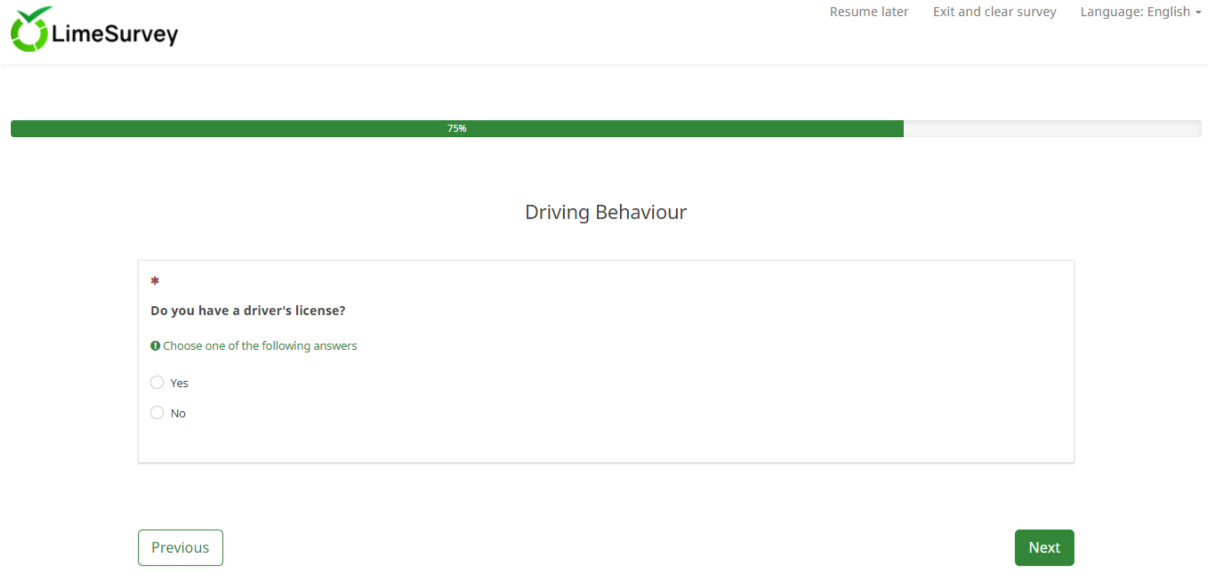
*

How much satisfied are you with your...

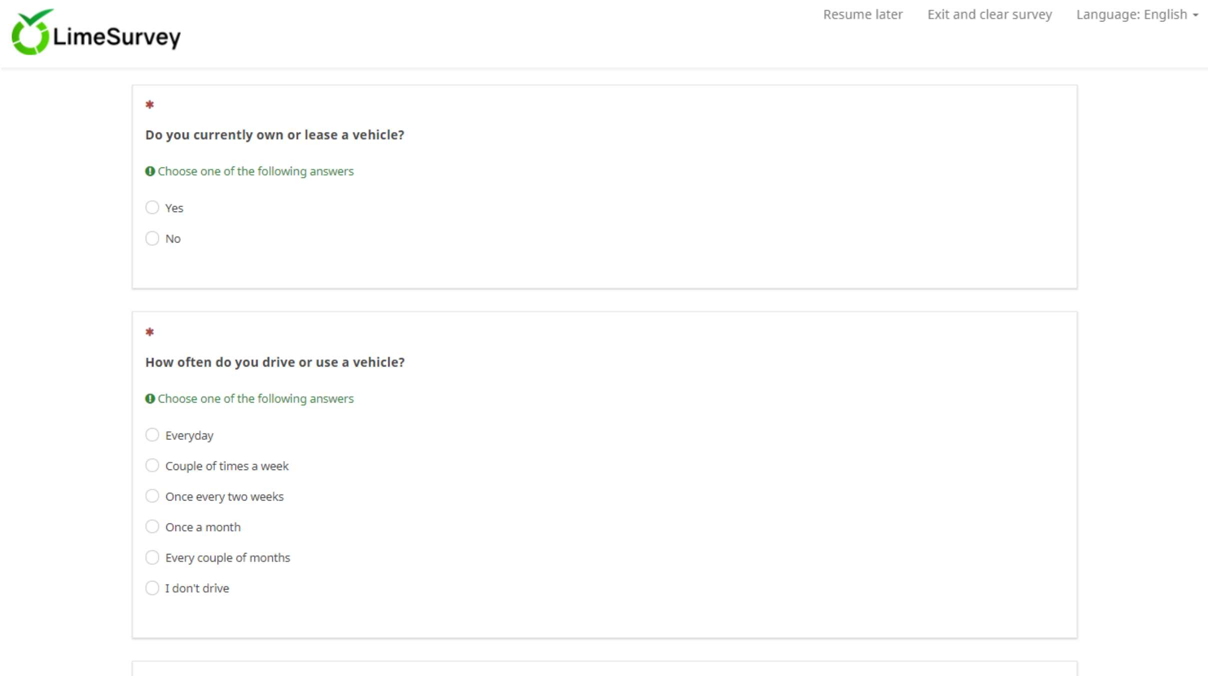
	Totally Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neither Satisfied nor Dissatisfied	Somewhat Satisfied	Satisfied	Totally Satisfied
Trips from/to work or college							
Trips to leisure activities							
Trips to social activities							
Trips to healthcare services (e.g. Hospitals)							

Previous Next

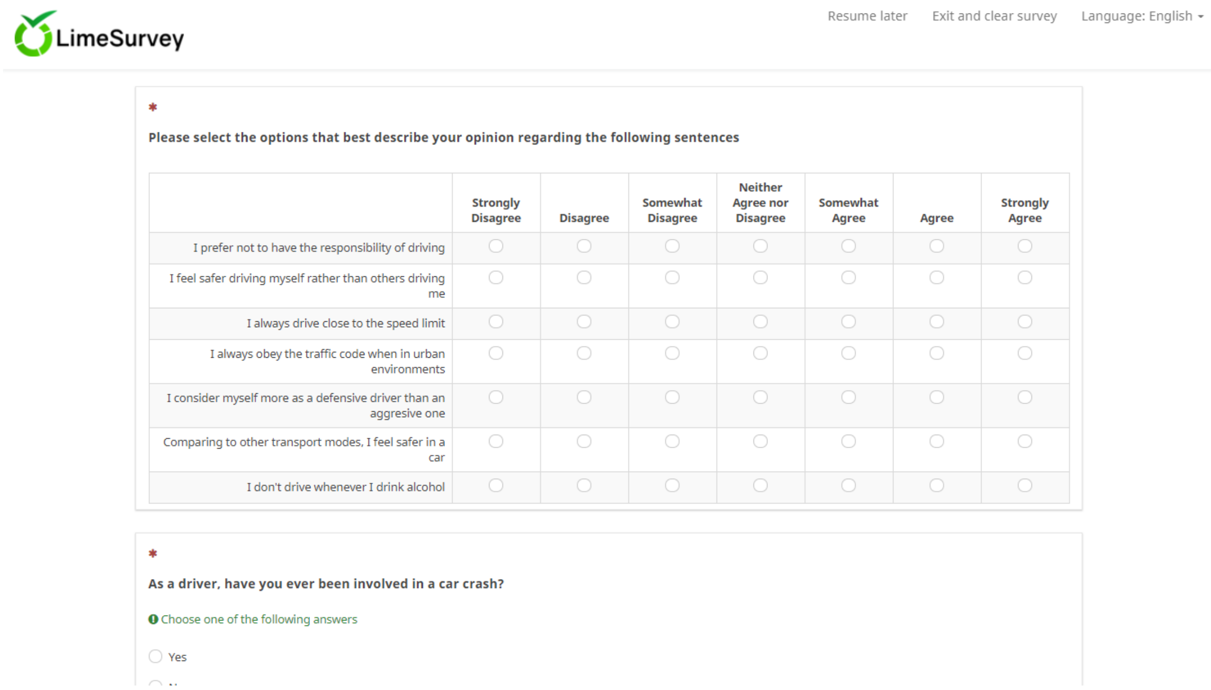
Item 7.24 - Mobility Behaviour Part 4 (own authorship)



Item 7.25 - Driving Behaviour Part 1 (own authorship)



Item 7.26 - Driving Behaviour Part 2 (own authorship)



LimeSurvey

Resume later | Exit and clear survey | Language: English

*

Please select the options that best describe your opinion regarding the following sentences

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
I prefer not to have the responsibility of driving	○	○	○	○	○	○	○
I feel safer driving myself rather than others driving me	○	○	○	○	○	○	○
I always drive close to the speed limit	○	○	○	○	○	○	○
I always obey the traffic code when in urban environments	○	○	○	○	○	○	○
I consider myself more as a defensive driver than an aggresive one	○	○	○	○	○	○	○
Comparing to other transport modes, I feel safer in a car	○	○	○	○	○	○	○
I don't drive whenever I drink alcohol	○	○	○	○	○	○	○

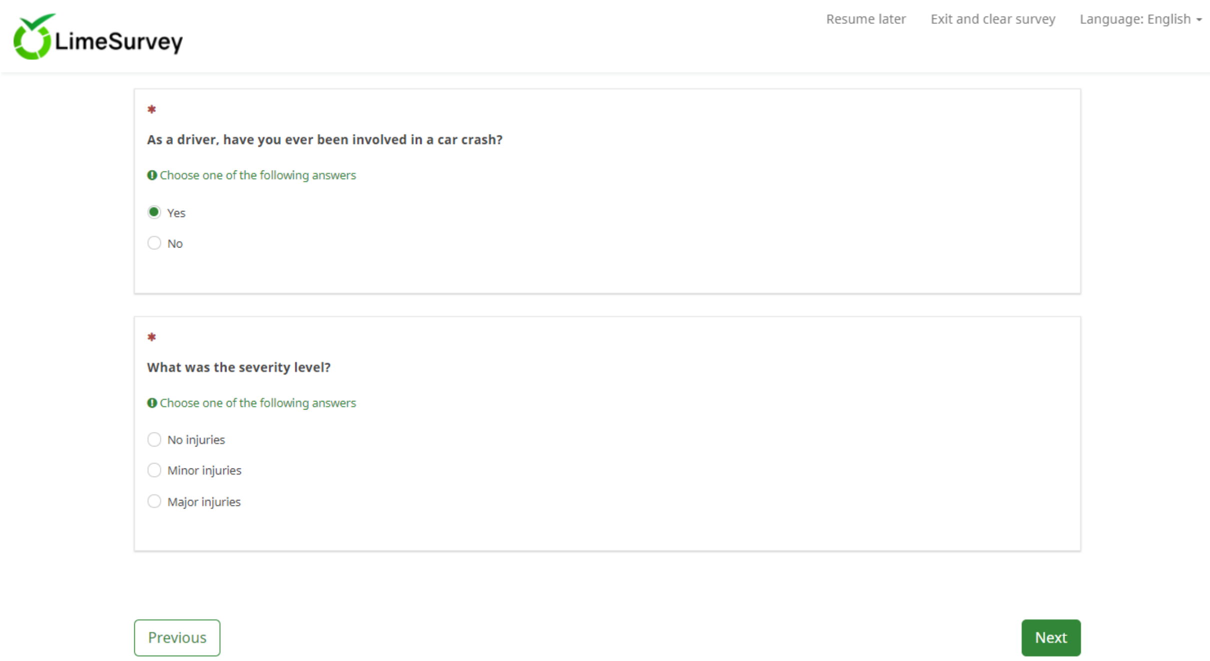
*

As a driver, have you ever been involved in a car crash?

Choose one of the following answers

○ Yes

Item 7.28 - Driving Behaviour Part 3 (own authorship)



LimeSurvey

Resume later | Exit and clear survey | Language: English

*

As a driver, have you ever been involved in a car crash?

Choose one of the following answers

● Yes

○ No

*

What was the severity level?

Choose one of the following answers

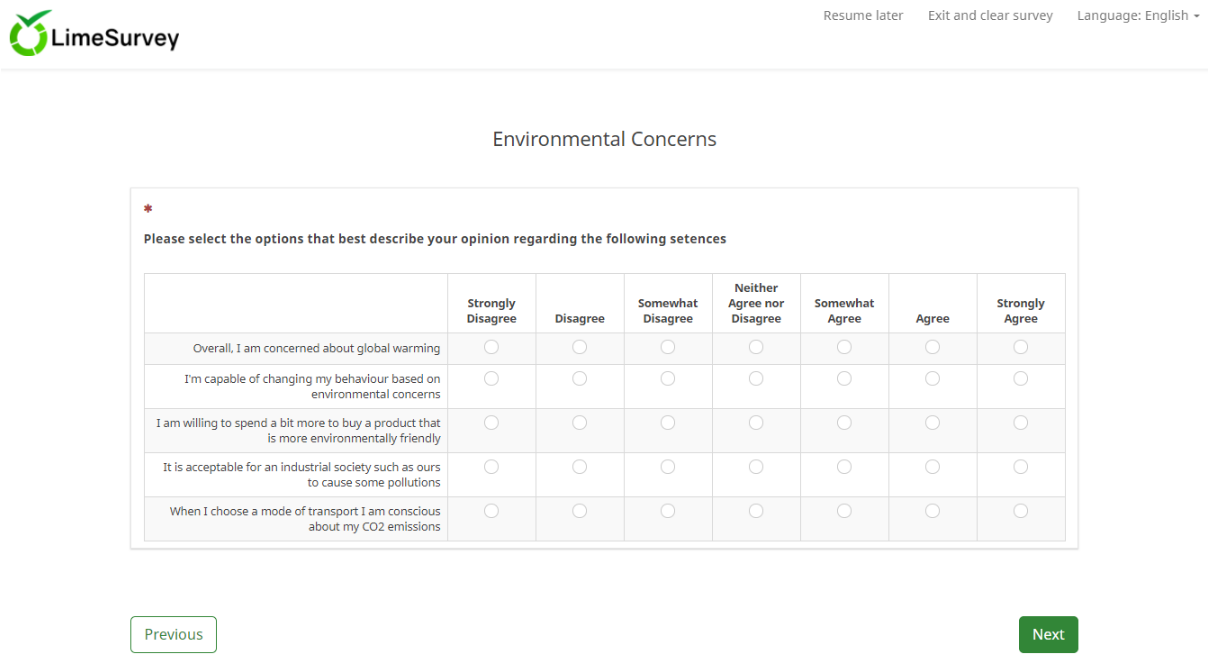
○ No injuries

○ Minor injuries

○ Major injuries

Previous | Next

Item 7.27 - Driving Behaviour Part 4 (own authorship)


LimeSurvey

Resume later Exit and clear survey Language: English

Environmental Concerns

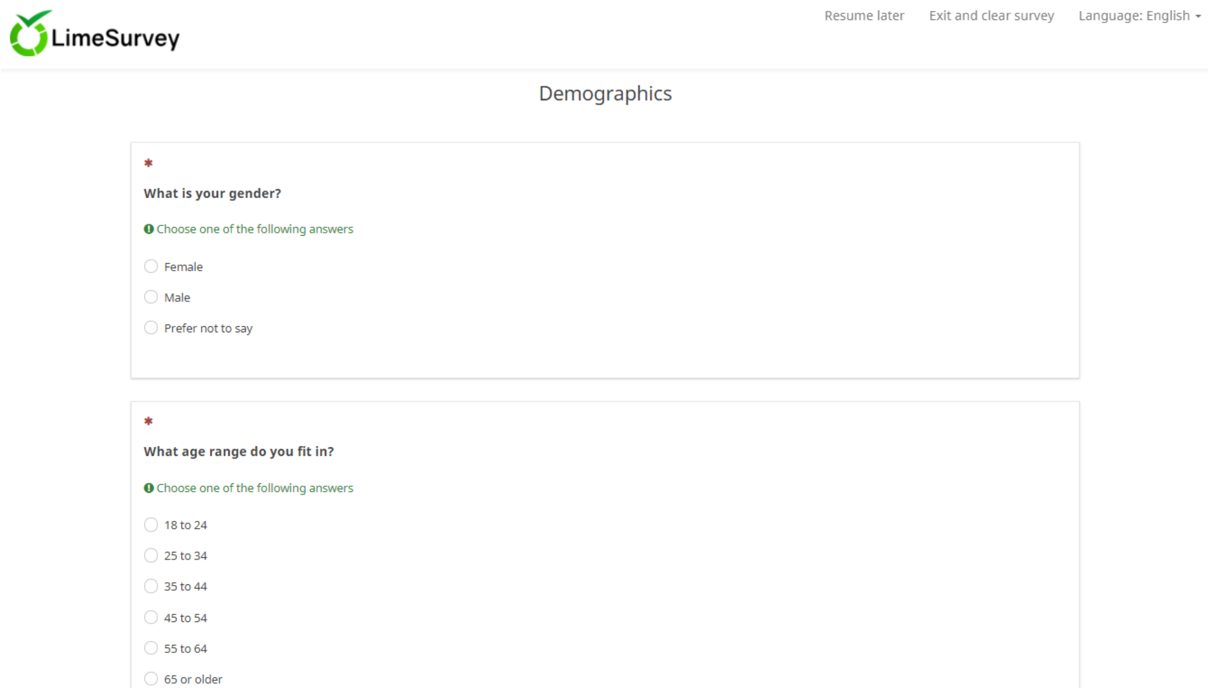
*

Please select the options that best describe your opinion regarding the following setences

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Overall, I am concerned about global warming	○	○	○	○	○	○	○
I'm capable of changing my behaviour based on environmental concerns	○	○	○	○	○	○	○
I am willing to spend a bit more to buy a product that is more environmentally friendly	○	○	○	○	○	○	○
It is acceptable for an industrial society such as ours to cause some pollutions	○	○	○	○	○	○	○
When I choose a mode of transport I am conscious about my CO2 emissions	○	○	○	○	○	○	○

Previous Next

Item 7.29 - Environmental Concerns (own authorship)


LimeSurvey

Resume later Exit and clear survey Language: English

Demographics

*

What is your gender?

Choose one of the following answers

○ Female
○ Male
○ Prefer not to say

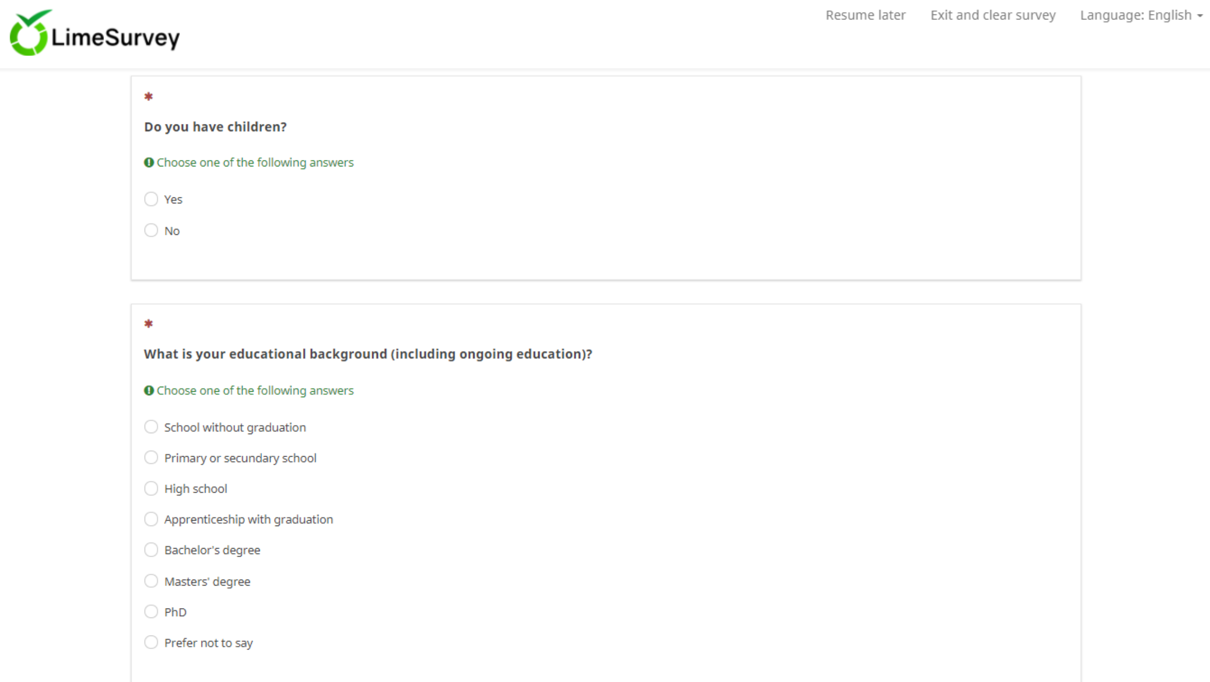
*

What age range do you fit in?

Choose one of the following answers

○ 18 to 24
○ 25 to 34
○ 35 to 44
○ 45 to 54
○ 55 to 64
○ 65 or older

Item 7.30 – Socio-demographics Part 1 (own authorship)


LimeSurvey

Resume later Exit and clear survey Language: English

*

Do you have children?

Choose one of the following answers

- Yes
- No

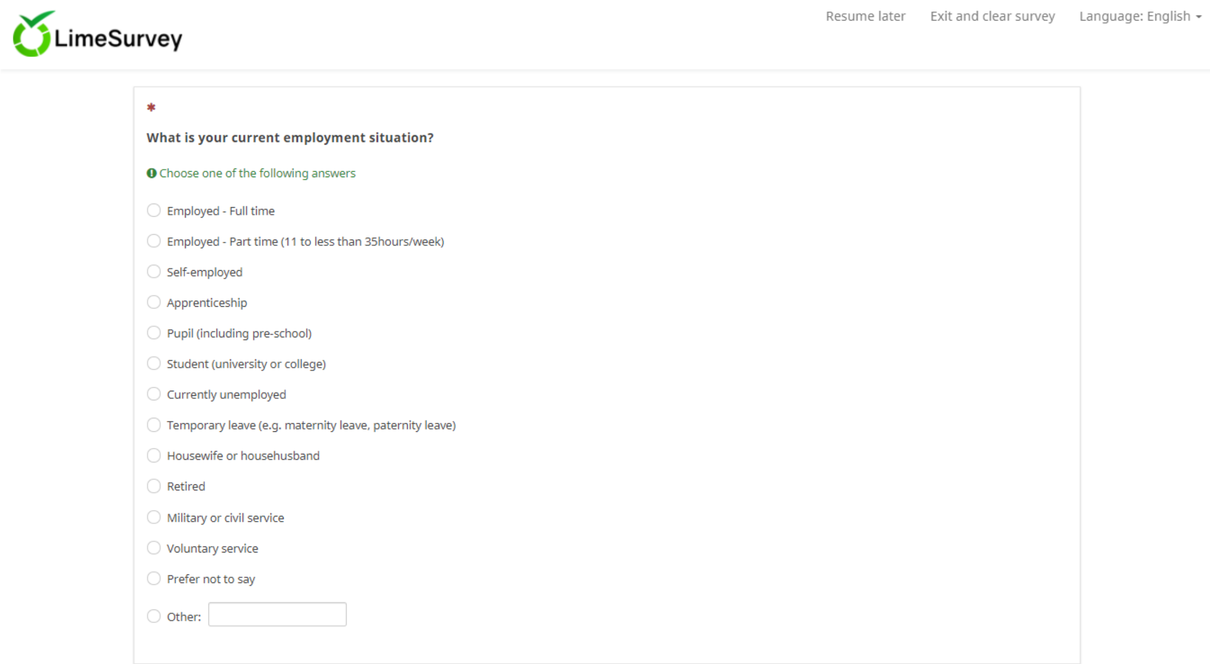
*

What is your educational background (including ongoing education)?

Choose one of the following answers

- School without graduation
- Primary or secundary school
- High school
- Apprenticeship with graduation
- Bachelor's degree
- Masters' degree
- PhD
- Prefer not to say

Item 7.32 - Socio-demographics Part 2 (own authorship)


LimeSurvey

Resume later Exit and clear survey Language: English

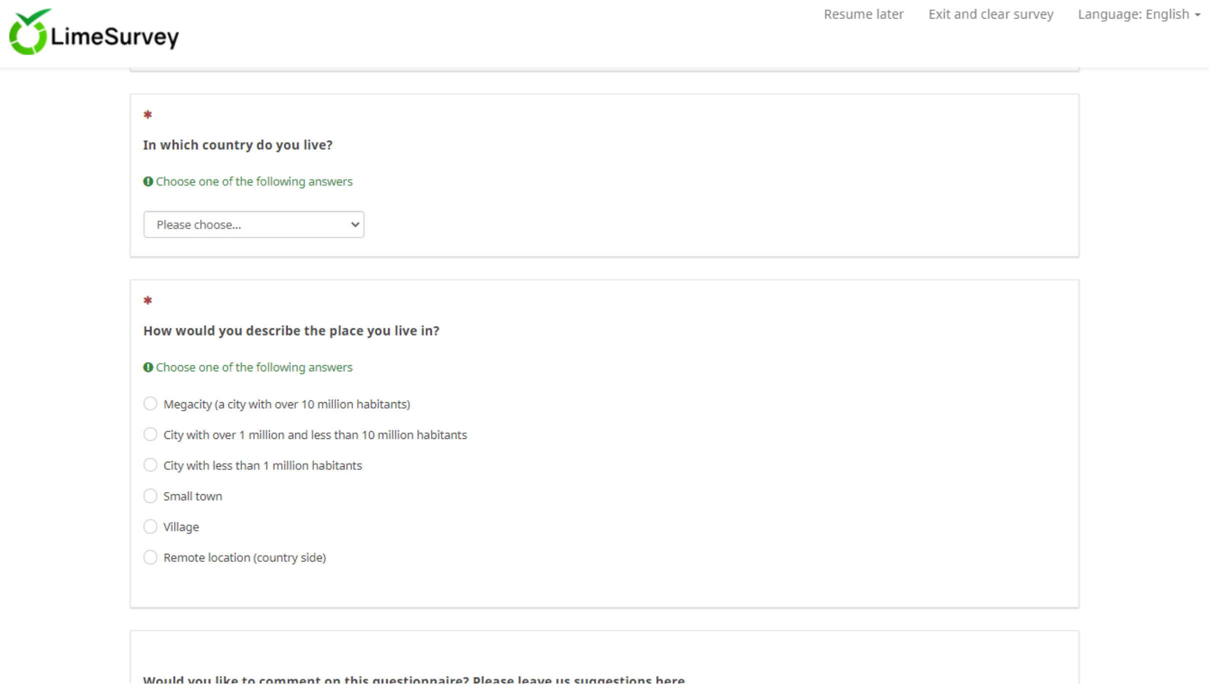
*

What is your current employment situation?

Choose one of the following answers

- Employed - Full time
- Employed - Part time (11 to less than 35hours/week)
- Self-employed
- Apprenticeship
- Pupil (including pre-school)
- Student (university or college)
- Currently unemployed
- Temporary leave (e.g. maternity leave, paternity leave)
- Housewife or househusband
- Retired
- Military or civil service
- Voluntary service
- Prefer not to say
- Other:

Item 7.31 - Socio-demographics Part 3 (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

*

In which country do you live?

Choose one of the following answers

Please choose...

*

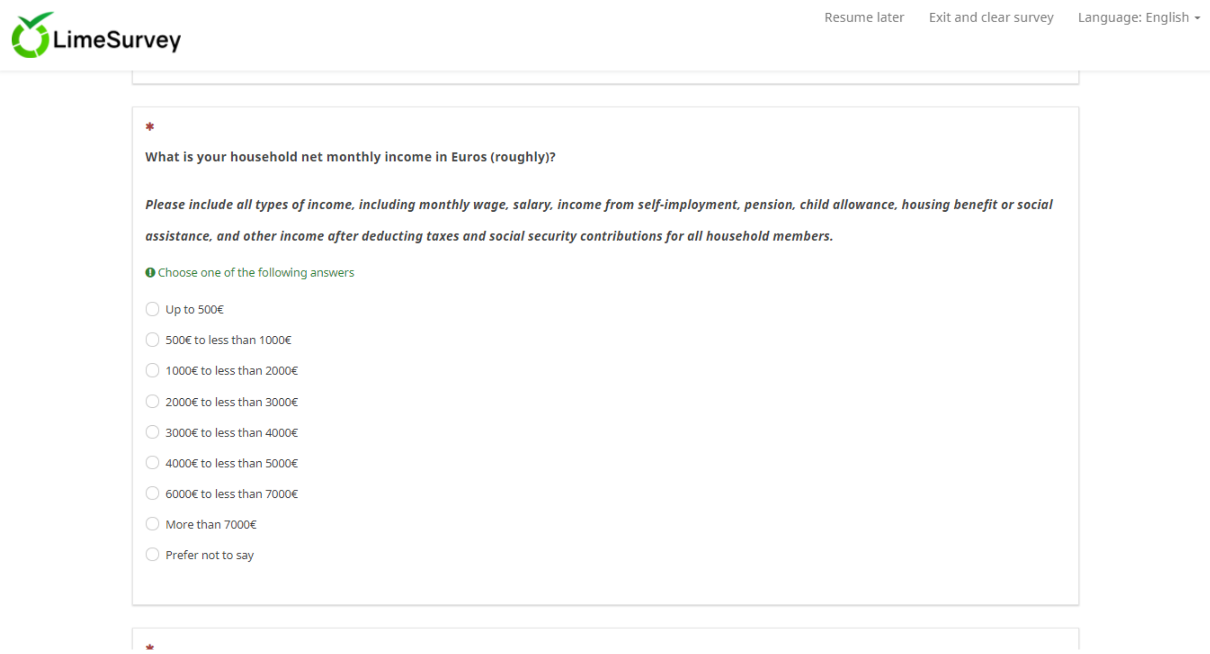
How would you describe the place you live in?

Choose one of the following answers

- Megacity (a city with over 10 million habitants)
- City with over 1 million and less than 10 million habitants
- City with less than 1 million habitants
- Small town
- Village
- Remote location (country side)

Would you like to comment on this questionnaire? Please leave us suggestions here

Item 7.33 - Socio-demographics Part 4 (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

*

What is your household net monthly income in Euros (roughly)?

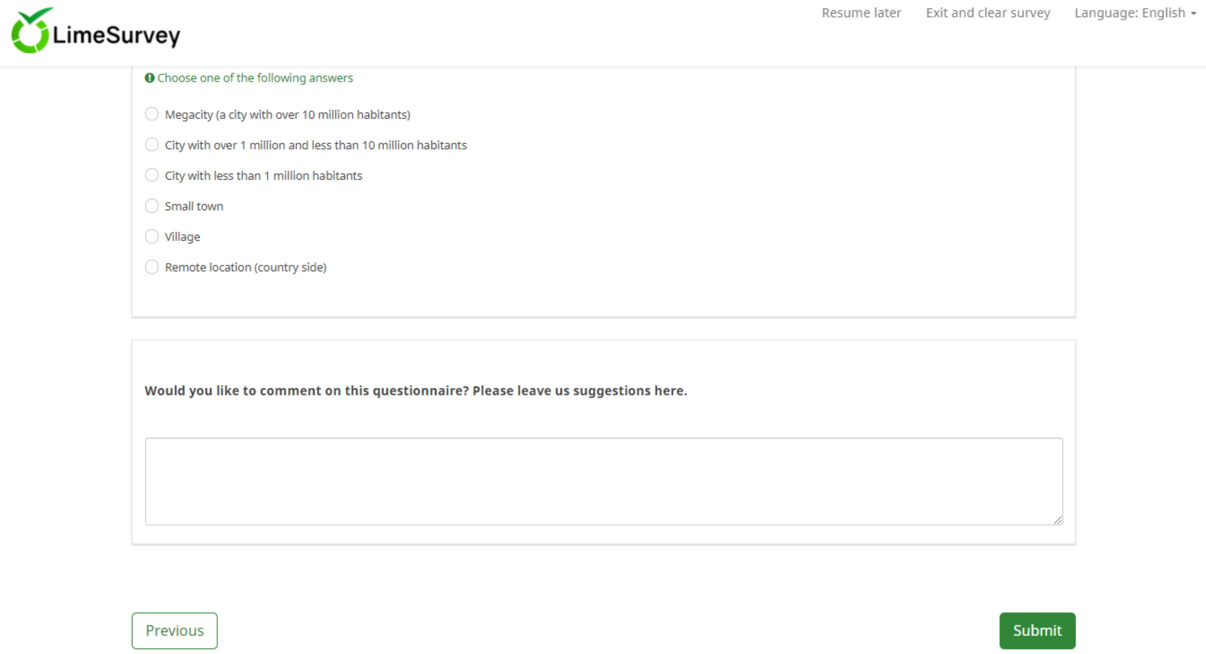
Please include all types of income, including monthly wage, salary, income from self-implyment, pension, child allowance, housing benefit or social assistance, and other income after deducting taxes and social security contributions for all household members.

Choose one of the following answers

- Up to 500€
- 500€ to less than 1000€
- 1000€ to less than 2000€
- 2000€ to less than 3000€
- 3000€ to less than 4000€
- 4000€ to less than 5000€
- 6000€ to less than 7000€
- More than 7000€
- Prefer not to say

*

Item 7.34 - Socio-demographics Part 5 (own authorship)



LimeSurvey

Resume later Exit and clear survey Language: English

Choose one of the following answers

- Megacity (a city with over 10 million habitants)
- City with over 1 million and less than 10 million habitants
- City with less than 1 million habitants
- Small town
- Village
- Remote location (country side)

Would you like to comment on this questionnaire? Please leave us suggestions here.

Previous

Submit

Item 7.35 - Socio-demographics Part 6 (own authorship)

ANNEX B – LEVENE'S TEST OF HOMOGENEITY OF VARIANCES

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.	Analysis
I believe that driver assistance systems are useful	Based on Mean	4.889	4	386	0.001	KW
I believe that driver assistance systems are reliable	Based on Mean	1.291	4	386	0.273	ANOVA
I am satisfied with the driver assistance systems I have used	Based on Mean	3.394	4	386	0.010	KW
When an automated technology gives me problems, I usually stop trusting it	Based on Mean	5.164	4	386	0.000	KW
I felt comfortable	Based on Mean	0.430	4	106	0.787	ANOVA
I was stressed	Based on Mean	1.402	4	106	0.238	ANOVA
I felt safe	Based on Mean	0.670	4	106	0.614	ANOVA
I felt anxious	Based on Mean	4.582	4	106	0.002	KW
I was scared	Based on Mean	0.870	4	106	0.485	ANOVA
Adoption of a New technology	Based on Mean	5.884	4	386	0.000	KW
Adoption of Ride-hailing services	Based on Mean	2.871	4	386	0.023	KW
Adoption of Car-sharing services	Based on Mean	5.163	4	386	0.000	KW
Adoption of Carpooling services	Based on Mean	3.135	4	386	0.015	KW
Adoption of Motorcycle-sharing services	Based on Mean	8.342	4	386	0.000	KW
Adoption of Bicycle-sharing services	Based on Mean	3.395	4	386	0.010	KW
Adoption of Scooter-sharing services	Based on Mean	1.669	4	386	0.156	ANOVA
Satisfied with Car sharing services	Based on Mean	0.500	4	386	0.736	ANOVA
Satisfied with Carpooling services	Based on Mean	1.555	4	386	0.186	ANOVA
Satisfied with Motorcycle sharing services	Based on Mean	16.885	4	386	0.000	KW
Satisfied with Bicycle sharing services	Based on Mean	0.209	4	386	0.934	ANOVA
Satisfied with Scooter sharing services	Based on Mean	2.209	4	386	0.067	ANOVA
The use of UAVs will reduce road congestion	Based on Mean	0.922	4	386	0.451	ANOVA
The use of UAVs will reduce accident on roads	Based on Mean	0.678	4	386	0.608	ANOVA
The use of UAVs will make my travel time more productive	Based on Mean	1.676	4	386	0.155	ANOVA
UAVs will significantly reduce travel time	Based on Mean	6.118	4	386	0.000	KW
The use of UAVs will facilitate the connection of remote areas to bigger cities and multimodal nodes such as ports and airports.	Based on Mean	0.888	4	386	0.471	ANOVA

The use of UAVs will release more free space in the urban environment for other facilities such as parks and pedestrian zones.	Based on Mean	2.979	4	386	0.019	KW
UAVs will produce lower CO2 emissions	Based on Mean	0.628	4	386	0.643	ANOVA
UAVs will offer a safe and fast mean of transportation	Based on Mean	0.077	4	386	0.989	ANOVA
UAVs will offer a less stressful mobility experience	Based on Mean	2.426	4	386	0.048	KW
UAVs will make it easier for people with reduced mobility to move	Based on Mean	1.435	4	386	0.222	ANOVA
UAVs will make it easier ambulances and police to move fast to emergency cases	Based on Mean	4.404	4	386	0.002	KW
UAVs will increase the trips people will make	Based on Mean	1.196	4	386	0.312	ANOVA
I make sure that my data are kept private whenever I use the internet	Based on Mean	2.271	4	386	0.061	ANOVA
I'm concerned that my data is kept resilient to common cyber security threats whenever I use internet	Based on Mean	3.690	4	386	0.006	KW
I'm concerned that others can keep track of my location	Based on Mean	2.776	4	386	0.027	KW
I am concerned that UAVs will use my personal information for other purposes without my authorization	Based on Mean	2.253	4	386	0.063	ANOVA
I am concerned that UAVs will share my personal information with other entities without my authorization	Based on Mean	1.498	4	386	0.202	ANOVA
I'm concerned that someone can take control of the Air Vehicle and cause a terrorist attack	Based on Mean	1.935	4	386	0.104	ANOVA
I'm more concerned with the operation of UAVs over urban areas than suburban areas	Based on Mean	0.565	4	386	0.688	ANOVA
I'm concerned about the performance of UAVs under poor weather conditions	Based on Mean	3.629	4	386	0.006	KW
I'm concerned that the first UAVs available will be unsafe due to technological issues of the vehicle	Based on Mean	1.179	4	386	0.320	ANOVA
I'm concerned that the first UAVs available will be unsafe due to possible vehicle collisions in the air above cities	Based on Mean	2.580	4	386	0.037	KW
In order for me to feel safe, I would expect to be able to talk to an operator on ground at any time	Based on Mean	2.832	4	386	0.024	KW
In order for me to feel safe, I would expect an operator on ground to be able to take control of the vehicle at any time	Based on Mean	0.932	4	386	0.445	ANOVA
In order for me to feel safe, I would expect an operator on ground to be able to take control of the vehicle in case of emergency.	Based on Mean	1.573	4	386	0.181	ANOVA
My safety concerns could prevent me from using an Air Vehicle	Based on Mean	10.221	4	386	0.000	KW
My cybersecurity concerns could prevent me from using an Air Vehicle	Based on Mean	0.824	4	386	0.510	ANOVA
My fear to fly could prevent me from using an Air Vehicle	Based on Mean	6.459	4	386	0.000	KW
Trips from to work or college	Based on Mean	0.018	4	386	0.999	ANOVA
Trips to leisure activities	Based on Mean	0.795	4	386	0.529	ANOVA

Trips to social activities	Based on Mean	2.880	4	386	0.023	KW
Trips to healthcare services	Based on Mean	4.960	4	386	0.001	KW
UAVs are an acceptable means of transport	Based on Mean	17.404	4	386	0.000	KW
UAVs will increase the quality of life in the cities that offer this transport mode	Based on Mean	4.441	4	386	0.002	KW
UAVs will improve transport accessibility for all citizens	Based on Mean	3.226	4	386	0.013	KW
I am concerned that the UAVs will become a transport mode only for the rich	Based on Mean	2.943	4	386	0.020	KW
I wouldn't feel comfortable living in a city that adopts this transport mode	Based on Mean	2.901	4	386	0.022	KW
I am concerned that UAVs will increase visual pollution	Based on Mean	2.397	4	386	0.050	ANOVA
I am concerned that UAVs will increase noise pollution	Based on Mean	2.343	4	386	0.054	ANOVA
UAVs will be beneficial for the society	Based on Mean	1.329	4	386	0.259	ANOVA
UAVs will be risky to the public	Based on Mean	11.084	4	386	0.000	KW
Moving with UAVs will be as safe as with aeroplanes	Based on Mean	0.144	4	386	0.966	ANOVA
Transfer people from to work or school	Based on Mean	0.690	4	386	0.599	ANOVA
Transfer people for leisure	Based on Mean	1.778	4	386	0.132	ANOVA
Transfer people for social activities	Based on Mean	1.666	4	386	0.157	ANOVA
Transfer people from to healthcare services	Based on Mean	1.186	4	386	0.316	ANOVA
Transfer goods to people	Based on Mean	1.537	4	386	0.191	ANOVA
Respond to emergency cases	Based on Mean	0.348	4	386	0.845	ANOVA
UAVs make me feel stressed	Based on Mean	0.813	4	386	0.518	ANOVA
UAVs make me feel safe	Based on Mean	1.947	4	386	0.102	ANOVA
UAVs make me feel anxious	Based on Mean	3.752	4	386	0.005	KW
UAVs make me feel comfortable	Based on Mean	1.694	4	386	0.151	ANOVA
UAVs make me feel scared	Based on Mean	1.409	4	386	0.230	ANOVA
Satisfaction with your Trips from to work	Based on Mean	1.224	4	386	0.300	ANOVA
Satisfaction with your Trips to leisure activities	Based on Mean	1.053	4	386	0.380	ANOVA
Satisfaction with your Trips to social activities	Based on Mean	2.175	4	386	0.071	ANOVA
Satisfaction with your Trips to health care services	Based on Mean	2.307	4	386	0.058	ANOVA
I prefer not to have the responsibility of driving	Based on Mean	4.887	4	364	0.001	KW
I feel safer driving myself rather than others driving me	Based on Mean	1.961	4	364	0.100	ANOVA
I always drive close to the speed limit	Based on Mean	0.473	4	364	0.755	ANOVA
I always obey the traffic code when in urban environments	Based on Mean	0.752	4	364	0.557	ANOVA

I consider myself more as a defensive driver rather than an aggressive one	Based on Mean	1.354	4	364	0.250	ANOVA
Comparing to other transport modes, I feel safer in a car	Based on Mean	2.222	4	364	0.066	ANOVA
I don't drive whenever I drink alcohol	Based on Mean	2.965	4	364	0.020	KW
Overall, I am concerned about global warming	Based on Mean	1.602	4	386	0.173	ANOVA
I'm capable of changing my behaviour based on environmental concerns	Based on Mean	3.867	4	386	0.004	KW
I am willing to spend a bit more to buy a product that is more environmentally friendly	Based on Mean	3.661	4	386	0.006	KW
It is acceptable for an industrial society such as ours to cause some pollutions	Based on Mean	3.506	4	386	0.008	KW
When I choose a mode of transport, I am conscious about my CO2 emissions	Based on Mean	1.838	4	386	0.121	ANOVA

Item 7.36 - Levene's test of homogeneity of variances (own authorship)

ANNEX C – SURVEY QUESTIONS WITH SOURCES

Group	Question	Adapted from
Trust in Automation	I believe that driver assistance systems are useful (e.g.: automatic emergency braking, blindspot detection, cruise control, lane keeping assistance, etc.)	Al Haddad et al, 2019
	I believe that driver assistance systems are reliable (e.g.: automatic emergency braking, blindspot detection, cruise control, lane keeping assistance, etc.)	Al Haddad et al, 2019
	I am satisfied with the driver assistance systems I have used (e.g.: automatic emergency braking, blindspot detection, cruise control, lane keeping assistance, etc.)	Zeid, 2009
	When an automated technology gives me problems I usually stop trusting it	Al Haddad et al, 2019
	Have you ever used a driverless vehicle? (e.g. car, bus, tram, metro)	Sanbonmatsu et al, 2018
	(IF YES) Please select the options that best describe your experience regarding the following sentences	
	Do know you someone who used a driverless vehicle?	
Adoption of a new technology	Regarding the adoption of a new technology, which adopter category represents you?	Panagiotopoulos et al, 2018
	Regarding the adoption of a new shared mobility innovations, which adopter category represents you?	Panagiotopoulos et al, 2018
	How much satisfied are you with the following shared mobility services?	Zeid, 2009
	On average, how frequently do you use shared mobility services?	Al Haddad et al, 2019
	For which purposes do you use shared mobility services?	
	Do you know what an Autonomous Air Vehicle is?	
UAVs introduction		
Expected benefits	The use of Air Vehicles will reduce road congestion	Shabanpour et al, 2018
	The use of Air Vehicles will reduce accident on roads	Shabanpour et al, 2018
	The use of Air Vehicles will make my travel time more productive	
	Air Vehicles will significantly reduce travel time	Eker et al, 2019
	The use of Air Vehicles will facilitate the connection of remote areas to bigger cities and multimodal nodes such as ports and airports.	
	The use of Air Vehicles will release more free space in the urban environment for other facilities such as parks and pedestrian zones.	
	Air vehicles will produce lower CO_2 emissions	Eker et al, 2019
	Air vehicles will offer a safe and fast mean of transportation	Shabanpour et al, 2018
	Air vehicles will offer a less stressful mobility experience	
	Air vehicles will make it easier for people with reduced mobility to move (e.g. elderly, children, disabled people)	Shabanpour et al, 2018

	Air vehicles will make it easier ambulances and police to move fast to emergency cases	
	Air vehicles will increase the trips people will make	
Cybersecurity	I make sure that my data are kept private whenever I use the internet	Panagiotopoulos et al, 2018
	I'm concerned that my data is kept resilient to common cyber security threats whenever I use internet	Panagiotopoulos et al, 2018
	I'm concerned that others can keep track of my location	Brell, 2018
	I am concerned that Air Vehicles will use my personal information for other purposes without my authorization	Brell, 2018
	I am concerned that Air Vehicles will share my personal information with other entities without my authorization	Brell, 2018
	I'm concerned that someone can take control of the Air Vehicle and cause a terrorist attack	
Safety	I'm more concerned with the operation of Air Vehicles over urban areas than suburban areas	Eker et al, 2019
	I'm concerned about the performance of Air Vehicles under poor weather conditions	Eker et al, 2019
	I'm concerned that the first Air Vehicles available will be unsafe due to technological issues of the vehicle	Sanbonmatsu et al, 2018
	I'm concerned that the first Air Vehicles available will be unsafe due to possible vehicle collisions in the air above cities	Sanbonmatsu et al, 2018
	In order for me to feel safe, I would expect to be able to talk to an operator on ground at any time	Al Haddad et al, 2019
	In order for me to feel safe, I would expect an operator on ground to be able to take control of the vehicle at any time	Al Haddad et al, 2019
	In order for me to feel safe, I would expect an operator on ground to be able to take control of the vehicle in case of emergency	Al Haddad et al, 2019
Intention to use UAVs	Taking all of this into account, which group do you think you belong when adopting Air Vehicles for your mobility?	Panagiotopoulos et al, 2018
	Imagine that we are in 2030 and you have to travel 30km (ex.: Sintra to Lisbon in Portugal, Kifisia to Glyfada in Greece, Bonn to Cologne in Germany, Paris centre to Paris Orly airport in France). Considering the following characteristics, which mode of transport would you choose?	Fu, 2019
	My safety concerns could prevent me from using an Air Vehicle	
	My cybersecurity concerns could prevent me from using an Air Vehicle	
	My fear to fly could prevent me from using an Air Vehicle	
	Would you use an Air Vehicle for Trips from/to work or college	
	Would you use an Air Vehicle for: Trips to leisure activities	
	Would you use an Air Vehicle for: Trips to social activities	

	Would you use an Air Vehicle for: Trips to healthcare services (e.g. Hospitals)	
Public embracement	Air Vehicles are an acceptable means of transport	
	Air Vehicles will increase the quality of life in the cities that offer this transport mode	
	Air Vehicles will improve transport accessibility for all citizens	
	I am concerned that the Air Vehicles will become a transport mode only for the rich	Eker et al, 2019
	I wouldn't feel comfortable living in a city that adopts this transport mode	
	I am concerned that Air Vehicles will increase visual pollution	Al Haddad et al, 2019
	I am concerned that Air Vehicles will increase noise pollution	Al Haddad et al, 2019
	Air Vehicles will be beneficial for the society	
	Air Vehicles will be risky to the public	
	Moving with Air Vehicles will be as safe as with aeroplanes	
	Air Vehicles should be used to: Transfer people from/to work or school	
	Air Vehicles should be used to: Transfer people for leisure	
	Air Vehicles should be used to: Transfer people for social activities	
	Air Vehicles should be used to: Transfer people from/to healthcare services (e.g. Hospital)	
	Air Vehicles should be used to: Transfer goods to people	
	Air Vehicles should be used to: Respond to emergency cases (e.g ambulances, police units, etc.)	
	Air Vehicles make me feel… Stressed	Zeid, 2009
	Air Vehicles make me feel… Safe	Zeid, 2009
	Air Vehicles make me feel… Anxious	Zeid, 2009
	Air Vehicles make me feel… Comfortable	Zeid, 2009
	Air Vehicles make me feel… Scared	Zeid, 2009
	In the list bellow you can find some usual sounds that we hear on our daily lives.	Zeid, 2009
Mobility Behaviour and Well-being	On average, how long do you spend per day on your daily trips from/to work or college?	
	Do you walk in your daily trips from/to work or college?	
	Do you have a public transport monthly pass?	
	In your daily trips from/to work or college, how many means of transportation do you use?	
	How much satisfied are you with your… Trips from/to work or college	Zeid, 2009
	How much satisfied are you with your… Trips to leisure activities	Zeid, 2009
	How much satisfied are you with your… Trips to social activities	Zeid, 2009
	How much satisfied are you with your… Trips to healthcare services (e.g. Hospitals)	Zeid, 2009

Driving Behaviour	Do you have a driver's license?	
	Do you currently own or lease a vehicle?	
	How often do you drive or use a vehicle?	
	Do you have free parking near your home?	
	Do you have free parking at your work/college?	
	I prefer not to have the responsibility of driving	
	I feel safer driving myself rather than others driving me	Panagiotopoulos et al, 2018
	I always drive close to the speed limit	Eker et al, 2019
	I always obey the traffic code when in urban environments	Eker et al, 2019
	I consider myself more as a defensive driver than an aggresive one	Eker et al, 2019
	Comparing to other transport modes, I feel safer in a car	
	I don't drive whenever I drink alcohol	Eker et al, 2019
	As a driver, have you ever been involved in a car crash?	Eker et al, 2019
	What was the severity level?	Eker et al, 2019
Environmental Concerns	Overall, I am concerned about global warming	Al Haddad et al, 2019
	I'm capable of changing my behaviour based on environmental concerns	Al Haddad et al, 2019
	I am willing to spend a bit more to buy a product that is more environmentally friendly	Al Haddad et al, 2019
	It is acceptable for an industrial society such as ours to cause some pollutions	Fu, 2019
	When I choose a mode of transport, I am conscious about my CO2 emissions	
Demographics	What is your gender?	
	What age range do you fit in?	
	Do you have children?	
	What is your educational background (including ongoing education)?	
	What is your household net monthly income in Euros (roughly)?	
	What is your current employment situation?	
	In which country do you live?	
	How would you describe the place you live in?	
	Would you like to comment on this questionnaire? Please leave us suggestions here.	

Item 7.37 - Survey questions with sources (own authorship)

ANNEX D – CRONBACH'S ALPHA

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.561	0.589	3

Item 7.38 - Cronbach's Alpha on Affinity to Automation (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.796	0.801	3

Item 7.39 – Cronbach's Alpha city-related expected benefits (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.784	0.788	2

Item 7.40 - Cronbach's Alpha on mobility-related expected benefits (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.841	0.838	3

Item 7.41 - Cronbach's Alpha on cybersecurity concerns related to personal information (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.769	0.769	3

Item 7.42 - Cronbach's Alpha on cybersecurity concerns related to personal data (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.692	0.702	3

Item 7.43 - Cronbach's Alpha on UAVs safety

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.758	0.766	3

Item 7.44 - Cronbach's Alpha on-ground safety (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.757	0.765	4

Item 7.45 - Cronbach's Alpha on possible UAVs usage (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.651	0.663	3

Item 7.46 - Cronbach's Alpha on UAVs obstacle (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.832	0.842	4

Item 7.47 - Cronbach's Alpha on positive embracement (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.747	0.748	4

Item 7.48 - Cronbach's Alpha on negative embracement (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.837	0.839	4

Item 7.49 - Cronbach's Alpha on UAVs possible purpose (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.185	0.055	5

Item 7.50 - Cronbach's Alpha on possible feelings towards UAVs (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.760	0.781	4

Item 7.51 - Cronbach's Alpha on mobility satisfaction

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.257	0.288	3

Item 7.52 - Cronbach's Alpha on own driving (own authorship)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.755	0.784	4

Item 7.53 - Cronbach's Alpha on environment concerns