applied sciences

MDPI

Article

Exploring the Evolution of Autonomous Vehicle Acceptance through Hands-On Demonstrations

Rodrigo Encinar [1], Ángel Madridano [2], Miguel Ángel de Miguel [2], Martín Palos [3], Fernando García [3,*] and John Bolte [4]

[1] CESVIMAP, 05004 Ávila, Spain; 100404542@alumnos.uc3m.es
[2] Department of Signal Theory, Telematics, and Computer Science, Rey Juan Carlos University (URJC), 28942 Fuenlabrada, Spain; angel.madridano@urjc.es (Á.M.); miguelangel.demiguel@urjc.es (M.Á.d.M.)
[3] Department of Systems Engineering and Automation, Universidad Carlos III de Madrid (UC3M) , 28911 Leganes, Spain; mpalos@ing.uc3m.es
[4] Research Group Smart Sensor Systems, The Hague University of Applied Sciences, 2628 AL Delft, The Netherlands; j.f.b.bolte@hhs.nl
* Correspondence: fegarcia@ing.uc3m.es

Abstract: This article delves into the acceptance of autonomous driving within society and its implications for the automotive insurance sector. The research encompasses two different studies conducted with meticulous analysis. The first study involves over 600 participants involved with the automotive industry who have not yet had the opportunity to experience autonomous driving technology. It primarily centers on the adaptation of insurance products to align with the imminent implementation of this technology. The second study is directed at individuals who have had the opportunity to test an autonomous driving platform first-hand. Specifically, it examines users' experiences after conducting test drives on public roads using an autonomous research platform jointly developed by MAPFRE, Universidad Carlos III de Madrid, and Universidad Politécnica de Madrid. The study conducted demonstrates that the user acceptance of autonomous driving technology significantly increases after firsthand experience with a real autonomous car. This finding underscores the importance of bringing autonomous driving technology closer to end-users in order to improve societal perception. Furthermore, the results provide valuable insights for industry stakeholders seeking to navigate the market as autonomous driving technology slowly becomes an integral part of commercial vehicles. The findings reveal that a substantial majority (96% of the surveyed individuals) believe that autonomous vehicles will still require insurance. Additionally, 90% of respondents express the opinion that policies for autonomous vehicles should be as affordable or even cheaper than those for traditional vehicles. This suggests that people may not be fully aware of the significant costs associated with the systems enabling autonomous driving when considering their insurance needs, which puts the spotlight back on the importance of bringing this technology closer to the general public.

Keywords: autonomous driving; self driving; automotive insurance; user acceptance; real-world applications

Citation: Encinar, R.; Madridano, Á.; de Miguel, M.Á.; Palos, M.; García, F.; Bolte, J. Exploring the Evolution of Autonomous Vehicle Acceptance through Hands-On Demonstrations. *Appl. Sci.* **2023**, *13*, 12822. https://doi.org/10.3390/app132312822

Academic Editor: Luís Picado Santos

Received: 26 October 2023
Revised: 21 November 2023
Accepted: 27 November 2023
Published: 29 November 2023

1. Introduction

The emergence of commercial vehicles equipped with autonomous driving systems will be directly linked to a reduction in human intervention in this task. This evolution is expected to ultimately lead to complete human non-involvement in vehicles that achieve level 5 automation according to the SAE levels established by the automotive industry [1]. The reduction in driver involvement and responsibility is poised to reshape the driving landscape. Altering a task as ubiquitous and routine as driving may elicit resistance from individuals comfortable with traditional manual control. Hence, it is imperative, firstly, to allow individuals the opportunity to test these emerging technologies using prototypes

and research platforms. This aims to ensure both the safety and user comfort of such systems. Secondly, it is crucial to investigate firsthand how the testing of this technology impacts its acceptance within the general population. This involves contrasting the perspectives of those who have experienced autonomous vehicles with those individuals in the automotive sector who, despite their expertise, may not have firsthand experience with autonomous driving.

In addition, the diminishing role of drivers will undoubtedly lead to a shift in responsibilities in the event of an accident, which will cause significant disruption in the insurance industry as these developments will lead to changes in ownership patterns, vehicle usage, and associated risks [2].

In Spain, this reassignment of responsibilities will be accompanied by revisions of the existing legislation regulating the use of motor vehicles. These modifications will impact the Law on Civil Liability and Insurance in Motor Vehicle Traffic, which currently establishes the driver's liability in the event of an accident based on the risks associated with their vehicle's operation. Furthermore, the law attributes to the driver the responsibility for any material and/or personal damages caused by their actions [3]. Until now, not only have lower levels of automation required significant driver involvement, but data compiled by the European Commission credits human error to be a contributing factor in approximately 90% of all accidents [4,5]. This reality has led both the automotive industry and government institutions to perceive autonomous driving as a paradigm shift in mobility and human–vehicle interactions [6]. As a result, not only is research in this field progressing rapidly but European legislation is also actively working in this direction. Since July 2022, several Advanced Driver Assistance Systems (ADAS) have become mandatory for new vehicle homologations [7]. Moreover, as of July 2024, systems such as ISA (Intelligent Speed Adaptation), LKS (the Lane-Keeping System), and AEB (Autonomous Emergency Braking) will become mandatory for all newly registered vehicles [8,9]. These systems involve the vehicle's electronics assuming control to modify its trajectory or speed. Consequently, all vehicles sold from 2024 onward will be elevated to level 2 automation on the SAE scale.

The introduction of these systems as a preliminary step towards autonomous driving already represents a leap forward in the realm of mobility. Their complete integration is anticipated to lead to a reduction in accidents, the alleviation of traffic congestion, and optimized fuel consumption through more efficient operations, as highlighted in studies like [10,11].

While the growing integration of ADAS in commercial vehicles suggests a positive societal response, it is essential to acknowledge potential challenges. The transition to driverless systems may be perceived as a threat by specific segments of the population linked to driving professions, including cab drivers, truck drivers, and bus service operators. Thus, a comprehensive analysis of the societal impact of these technologies is imperative, aiming to address concerns and dispel negative perceptions. This effort is crucial for fostering understanding that these advancements are tools to enhance road safety, reduce accidents, and mitigate the environmental consequences of terrestrial mobility.

The advancement of ADAS will usher in an era in which highly automated vehicles (SAE levels 4 and 5) coexist on the roads with vehicles driven entirely by humans, featuring minimal automation levels (SAE level 2 or lower). This coexistence will be a reality until autonomous or highly automated vehicles dominate the societal automotive fleet.

This coexistence poses several challenges that require attention and analysis from the scientific community. In this regard, research such as [12] focuses on these aspects, examining the need for the coordination and optimization of road resources, particularly at intersections, aiming to provide solutions for this emerging era. The study concludes that current coordination policies considering the limitations of human drivers are essential. It proposes auction mechanisms to regulate mobility, ensure equity in resource access, and facilitate the effective coexistence of both vehicle types.

Aligned with this coexistence analysis is [13], where the authors explore how the presence of highly automated vehicles alongside human-driven vehicles on roads may

impact traffic performance, travel demand, and transportation decisions. This study offers relevant insights for transportation planning and decision-making. The research concludes that the coexistence's impact on traffic and societal mobility will be significant. The introduction of highly automated vehicles may increase public attraction to this sector, reducing barriers for people to drive, leading to a shift toward increased private vehicle usage, thereby raising travel distance and time. This could result in a general increase in traffic and a deterioration of the transportation system. Despite these challenges, the study suggests a thorough analysis of the coexistence of both vehicle types is imperative, and the advent of these technologies will enhance society's daily life. It emphasizes the need to disseminate knowledge among the public to enable informed positions in favor of or against this technology.

Therefore, efforts should be directed towards demonstrating the technology to the public, emphasizing its potential to improve daily life without endangering employment. Despite significant reductions in human intervention, the role of the driver remains indispensable, akin to other modes of transportation like high-speed trains or airplanes. To achieve this, it becomes paramount to identify, address, and resolve challenges involving stakeholders and users in this evolving landscape.

Given the legislative challenges in performing real autonomous driving demonstrations on the road, it is crucial for society to also have access to other types of autonomous mobile systems that, while not navigating on roads, can interact with the population and bring this technology closer to users. Therefore, the introduction of autonomous vehicles responsible for last-mile deliveries also contributes to the overarching goal of familiarizing users with this technology [14,15]. This not only aids in positively influencing the acceptance of these systems but also ensures that a larger number of individuals can experience the workings of this technology.

In light of this, CESVIMAP, the R&D center of the Spanish insurance company MAPFRE, in collaboration with the Polytechnic University of Madrid and the Carlos III University of Madrid, has developed a level 4 test vehicle named Autonomous Testing pLAtform for insurance reSearch (ATLAS, Figure 1). This platform facilitates the testing of sensors, methods, and algorithms associated with autonomous driving. Concurrently, CESVIMAP conducts social surveys and experiments to understand user acceptance of this technology. After several years of development, a series of demonstrations were conducted in urban settings throughout 2022, wherein the ATLAS vehicle autonomously transported passengers. These demonstrations were complemented by extensive acceptance surveys among both users who experienced the vehicle, and the general public.

In this paper, a comprehensive analysis of the data collected in these surveys is presented, with a particular emphasis on the social perspective. This analysis offers valuable insights into the current knowledge, opinions, and sentiments of individuals concerning this technology, even among those directly related to the automotive sector.

This study strives to encourage the acceptance of autonomous driving technologies through hands-on demonstrations, with the premise that drivers will be more inclined to embrace these technologies once their efficiency and safety have been demonstrated. By conducting demonstrations in which the target audience experiences rides on public roads in autonomous vehicles, we draw conclusions on how these events influence the social perspective on this technology. Furthermore, this paper gathers and analyzes people's opinions on whether future cars should be insured and how this insurance should be configured. The objective of this analysis is to assist insurers in anticipating and adapting to this new mobility paradigm.

The paper is structured as follows: Section 2 analyzes the current state of the art, focusing on the study of autonomous vehicle and last-mile delivery robot acceptance and on recent works that primarily examine the impact of this technology on legislation and, consequently, on insurance. Section 3 introduces the autonomous vehicle use case employed for this study and describes the methodology used to conduct the surveys. Next, Section 4 presents the results and discussion of the two user acceptance surveys conducted.

This section explores the differences in opinions and sentiments between the two distinct user groups while studying how hands-on demonstrations can influence these attitudes and perspectives. Finally, Section 5 provides the conclusions of the study.

Figure 1. ATLAS Platform.

2. State of the Art

The significant increase in embedded technology in vehicles to achieve higher SAE levels (Level 3/Level 4) [1] has led to the emergence of research and scientific trends aimed at analyzing the impact of this technology on society, along with all economic, industrial, and productive sectors surrounding the automotive industry. For this reason, the state of the art has been reviewed from three different perspectives: the acceptance of autonomous vehicles, their use as last-mile transportation, and their influence on insurance.

2.1. Autonomous Driving Acceptance

On one hand, there is the analysis of how humans will interact with autonomous driving technology and the quest to find ways to design systems that optimize this interaction. Therefore, in the field of human factors, researchers are focusing on understanding and enhancing the relationship between humans and autonomous vehicles to improve safety; efficiency; and, of course, the acceptance of this emerging technology.

There are several works in the literature that analyze the acceptance of autonomous vehicles as well as the lines of research that need to be promoted for their future implementation. Such is the case of [16], where the authors discuss the areas where further research is needed to improve the acceptance of autonomous vehicles. They also emphasize the need for collaboration between researchers, policymakers, and other stakeholders to ensure that automated driving technology is safe, effective, and accepted by the public. On the other hand, in [17] an attempt is made to find the key aspects that will generate greater confidence in autonomous vehicles regarding users. In [18], the authors review key studies on Human–Computer Interaction (HCI) to try to establish the cost (safety, security, and comfort versus dangerous unintended consequences) of autonomous vehicles, a fundamental aspect in the acceptance of autonomous vehicles.

In the study presented in [19], the research focused on on analyzing studies and surveys related to the public acceptance and perception of autonomous vehicles. Surveys and studies conducted in different countries conclude that public acceptance of this technology is influenced by various factors, encompassing safety, responsibility, regulations, and even

user experience with the technology—so much so that, in the results section, it is noted that approximately 73% of individuals with prior experience with autonomous systems would prefer their use in travel, compared to 55% of respondents without any experience with autonomous vehicles. This suggests that demonstrations with research platforms, such as the one presented in our work, can be useful for gathering more data and, above all, enhancing influence on public acceptance.

While several papers such as those mentioned above have studied acceptance from a theoretical point of view, only a few have conducted actual tests with an autonomous vehicle platform, and most of them use simulators due to the simplicity of performing a large number of tests and obtaining a large number of data in contrast to a real platform, which is much more difficult to set up. However, field and simulated experiments are not equivalent. There are several differences between the two types of experiments, including safety critical events, driving style, duration for each drive, and trust rating assessment. Additionally, field experiments usually involve driving in real traffic, while the simulator experiment creates controlled experimental conditions [20].

Among the works with real experiments is [21], whose research aimed to investigate the influences of direct experience with autonomous vehicles on acceptance and its psychological determinants. A field experiment was conducted with some participants who directly experienced riding in a Level 5 AV. The study found that direct experience increased trust, perceived usefulness, and perceived ease of use but did not significantly affect behavioral intention to use autonomous vehicles. The study also highlighted the importance of increasing technical reliability, addressing safety concerns, and enhancing public trust in promoting AV acceptance. However, the study is limited to acceptance and does not consider underlying aspects such as the insurance of this type of vehicle or its use as last-mile transport.

2.2. Last-Mile Delivery Robots Acceptance

The study on the acceptance of autonomous vehicles has laid the groundwork for understanding public attitudes and preferences towards autonomous driving. In this context, there is a growing interest in exploring the acceptance of autonomous robots for last-mile deliveries. Previous work has addressed in detail the public's disposition towards autonomy in mobility contexts, and now this focus is expanding to the sphere of logistics and distribution. By examining the acceptance of autonomous robots for last-mile deliveries, we seek to discern how familiarity with autonomy, trust in the technology, and prior experiences influence users' willingness to adopt and use these systems. This extension of the research provides a more holistic understanding of autonomy acceptance, establishing connections between predisposition toward autonomous vehicles and willingness to accept similar innovations in the delivery domain, thus contributing to a more comprehensive approach to the development and adoption of autonomous mobility technologies such as autonomous vehicles.

Therefore, studies such as the one reported in [14] conclude, thanks to a survey of approximately 501 participants, that aspects such as the expectation of performance, price, or ease of use of these systems are factors that influence people's sensitivity to using these products. Along with this, and in view of the work we present in this document, the study collected by [14] establishes that the interaction with these devices and the ability to acquire skills in the use of autonomous systems are also determining factors in the acceptance of this technology. Facilitating iteration and raising awareness of these systems are therefore part of the aspects that autonomous last-mile delivery systems seek to address in order to improve the acceptance of autonomous vehicles in general.

In line with this work, the authors of [22] emphasize the importance of analyzing user behaviors and preferences in interacting with and testing autonomous delivery system technology. The goal is to assess the degree of acceptance of the technology and, through these interactions, to identify more concisely the factors influencing the acceptance of

both autonomous and environmentally neutral vehicles. The ultimate aim is to develop strategies to enhance their adoption by society.

2.3. Auto Insurance and Regulation

So far, this section has explored the human side of autonomous vehicle acceptance and has examined papers analyzing how the implementation of this technology in last-mile delivery tasks can enhance user interaction and familiarity with these systems. However, as we move towards widespread adoption, it is crucial to consider the role of regulation and the auto insurance industry in this evolving landscape. The implementation of autonomous vehicles in the delivery sector poses regulatory challenges ranging from safety issues to traffic regulations. Likewise, the insurance industry faces the need to adapt its models to address new liabilities and risks associated with autonomous commercial vehicles. Addressing these issues in a comprehensive and collaborative manner will be essential to establishing a robust regulatory framework and insurance system that supports the successful transition to an environment where autonomous vehicles play a central role in society's mobility.

The irruption of autonomous vehicles poses regulatory and insurance challenges that must be addressed with care and that are already being studied by the scientific community. Thus, in [23], the importance of establishing clear rules is highlighted, proposing approaches such as mandatory insurance under strict liability. This work underlines the need for collaboration between legislators and technicians. Meanwhile, ref. [24] focuses on the specific situation in California, analyzing the potential impact on the insurance industry and the associated regulatory challenges.

Exploring solutions, "Splitting the Bill" [25] proposes the creation of a national insurance fund for accidents involving autonomous vehicles, addressing legal and insurance challenges. In turn, ref. [26] highlights the necessary adaptation of existing insurance models and the importance of consistent federal regulation to address evolving liability.

In a market context, ref. [27] projects significant changes in the UK motor insurance industry due to the advent of autonomous vehicles. It highlights the need to transform the insurance value chain and the continued importance of studying the impact of this technology on the market.

Simultaneously, user acceptance is critical. Ref. [28] explores Chinese users' concerns and expectations regarding insurance for autonomous vehicles, emphasizing the importance of understanding user opinions to ensure overall approval. Complementing this aspect, ref. [29] points out the need to consider user perception when analyzing obstacles to the acceptance of autonomous vehicles in the insurance sector.

Furthermore, in consonance with the dichotomy of driving, it is crucial to recognize that transportation, including driving, is evolving towards a novel paradigm: mobility. This notion of mobility encompasses a wide range of possibilities and poses challenges for insurers because the conventional business model of insuring individual vehicles is transitioning towards fleet insurance. This transition is driven by the proliferation of vehicle rental; ride-sharing; and, notably, autonomous mobility, which introduces an additional layer of complexity. Given the multitude of sensors required, the substantial cost of these vehicles, and operational optimization, the ownership of autonomous vehicles will predominantly remain out of reach for individual users.

Therefore, after conducting this in-depth analysis, it is evident that autonomous vehicle technology presents significant challenges that must be addressed to ensure a safe and effective transition towards a future of autonomous and intelligent mobility. These challenges include the need to adapt traditional insurance models, determine liability in the event of an accident, and establish appropriate coverage thresholds.

Furthermore, it has been underlined that the impact of these technologies and their introduction into society must be further studied. This is crucial as it requires a transition and adaptation period in which a wide range of vehicles equipped with different technologies, with varying levels of SAE automation, coexist. Additionally, the pressing need for

autonomous driving to have a positive impact on people cannot be overlooked, for which generating a high acceptance level towards this technology is a top priority.

Consequently, it is imperative to persist in the collection and analysis of data regarding individuals' perspectives on this new mobility paradigm. By leveraging these insights, we can obtain meaningful conclusions that will guide the roadmap for the safe, progressive, and positive integration of autonomous driving into our society.

3. Methodology

The conclusions obtained from the review of the state of the art in Section 2 endorse the need to further study the degree of acceptance of autonomous vehicles by end users. Additionally, during the review of relevant studies and bibliography, a research gap was identified. As mentioned in the previous section, most autonomous vehicle acceptance studies approach acceptance from a theoretical standpoint or utilizes simulators to study the evolution of opinions among testers and survey respondents. Consequently, the incorporation of real autonomous driving hands-on demonstrations in acceptance surveys is very rare. Therefore, the study of how road tests with a real vehicle influence the acceptance of autonomous vehicles remains a relatively understudied field but a highly interesting one, as it can be used to design different strategies to accelerate the acceptance of autonomous vehicles.

Consequently, CESVIMAP has embarked on the participation in several projects, from the ATLAS research platform for the evaluation of autonomous vehicles' sensors and software [30], to its participation in the development of autonomous bus-type vehicles for tourist routes in cities [31], or the pilot testing of a food delivery company that uses small autonomous robots.

Hence, leveraging these projects and in order to research the relevance of the aforementioned concerns from the user's perspective, a set of studies was designed to understand how acceptance evolves from future users (inexperienced users) to current users (users who have recently interacted with an autonomous vehicle). To this end, as collected in Sections 3.1 and 3.2, two different surveys were designed and conducted, on people who have never experienced riding in an autonomous vehicle and on people who have tested ATLAS on public roads. This was accomplished by taking advantage of the fact that this is the first time in Spain that an event is being held where it is possible to test an autonomous vehicle on the streets in a real manner. This marks a significant advance and has enabled the execution of this study with real users of autonomous driving, making it the first of its kind in Spain.

Section 3.1 details the methodology used to perform the studies and analysis related to future users, i.e., people who at the time of the survey have not had the opportunity to interact with the ATLAS platform nor with autonomous driving systems but who are knowledgeable on the subject because they are professionally related to the automotive world. Likewise, in Section 3.2 the methodology followed to carry out the study among those users who have interacted with the vehicle is described. For this reason, this section of the article provides details on the scenario where the vehicle demonstrations in which the respondents participated were held.

3.1. Study on Future Users

The first segment of the presented work focuses on the study of the degree of acceptance of autonomous vehicle technology among future users, i.e., people who have not yet been able to experience autonomous driving but who have some expertise in the automotive field. This part of the research involved conducting a survey titled "How much do you know about the autonomous car?" and the subsequent analysis of the data (the structure of which is shown in Table A1). The question set was designed based on the in-depth analysis of the state of the art under the guidance of in-house psychology experts in user acceptance, based on the research premises introduced in this paper.

This study focused on the social perspective of autonomous mobility to assess its acceptance in society. In order to obtain a large number of data, MAPFRE launched the survey on its intranet and also published it through the ASEPA (Spanish Association of Automotive Professionals) newsletter in 2022. In this way, the survey was directed to a common target audience of more than 10,000 users with knowledge in the sector. The idea was that, by analyzing all the gathered data, it would be possible to further understand people's fears and risks regarding this technology, as well as to define lines of action in the automotive insurance sector.

With the intention of having a detailed and widely scalable study of autonomous mobility technologies, the survey also includes a section dedicated to the use of autonomous mobile systems for last-mile package and product delivery. These systems are already a reality, and an increasing number of researchers and companies are dedicating part of their efforts towards introducing autonomous systems into society, mainly ground-based ones, which are responsible for delivering packages to users directly to their homes [32–34]. This technological breakthrough is closely related to autonomous vehicles and the human interaction with these systems, so this section has been included to assess the level of acceptance of this particular application of autonomous and intelligent mobility systems.

Table A1 gathers the set of questions included in the survey conducted to assess the level of acceptance of these technologies among people who have never interacted with an autonomous vehicle. As can be seen, the survey includes some initial questions that provide demographic data about respondents and establish filters in terms of driving experience (questions 1 through 5). This is followed by a second set of questions (6 to 10), aimed at gathering data on respondents' interest in and knowledge of the automotive sector. The next set of questions focuses on people's knowledge and opinions toward autonomous driving technology (questions 11 through 19). Finally, a series of questions centered on the acceptance of autonomous mobile systems for home parcel delivery (questions 20 to 23) are asked. A large number of questions, almost 70%, are dichotomous (yes or no), while the rest are divided into numerical questions (for age and gender) and closed questions where the respondent has to choose a single value among several given options (questions 5, 6, 11, 18, and 23). Following this methodology, the data collection on future users of autonomous vehicles was carried out for further analysis in Section 4.

3.2. Study on Current Users

This subsection is focused on the methodology used to conduct the acceptance study of this technology in current users of autonomous vehicles, i.e., it focuses on the data collected through surveys of people who have had the opportunity of testing and interacting with an autonomous vehicle. With the intention of conducting these surveys (whose content is shown in Table A2), two public demonstrations of the ATLAS autonomous vehicle were held. At these events, attendees were invited to ride in the vehicle and complete a circuit on public roads while the platform drove autonomously. Once the tour was completed, users were asked to answer the proposed survey.

At this point, it is important to be familiar with ATLAS. The ATLAS platform is a SAE Level 4 autonomous vehicle built from a Mitsubishi i-Miev commercial vehicle. This research platform is currently used to install and test different hardware and software components that allow the collaborating institutions (CESVIMAP, Universidad Carlos III de Madrid and Universidad Politécnica de Madrid) to obtain first-hand knowledge about the on-board technology of autonomous vehicles and what their most common problems, failures, and drawbacks are.

This collaborative project was born in 2018, and the architecture of the platform has already been published in a paper in 2020: "A Research Platform for Autonomous Vehicles Technologies Research in the Insurance Sector" [30]. During these years of research, all the developments and implementations performed have made it possible to learn a vast number of lessons that allow the insurer to identify the technological limits of the various

on-board sensors and components and to determine the margins of liability in the event of a claim.

As mentioned above, throughout 2022 two different demonstrations were conducted in urban environments, one in the city of Ávila (Spain) and the other in Leganés (Madrid). In these demonstrations, the capabilities of this platform were shown, and both events were attended by numerous media figures, political personalities, and representatives of Spanish research centers. In both cases, the exhibition itinerary consisted of an avenue with two roundabouts, see Figure 2, which had been previously mapped using a camera, a LiDAR (Light Detection and Ranging), and a GPS (Global Positioning System) + IMU (Inertial Measurement Unit).

Figure 2. Ávila demonstration area.

The hardware–software architecture developed and installed in ATLAS allows the vehicle to complete these routes autonomously. Thus, the vehicle is able, based on a visual lane-tracking system, to drive autonomously in the avenues. On the other hand, for the roundabout areas, including their entrance and exit, the vehicle uses a navigation system based on GPS positioning to drive autonomously. In addition, both routes include a crosswalk area where the vehicle detects the presence of obstacles and acts accordingly, and a mandatory stop zone for occupants pick-up.

In the aforementioned demonstrations, volunteer passengers were given the opportunity to ride in the vehicle while it drove autonomously along the predefined itinerary. Subsequently, passengers were asked to complete a user acceptance survey that included a series of questions about the experience of riding in ATLAS and about their opinion on autonomous vehicles, which are collected in Table A2. Again ,this set of questions was crafted under the guidance of experts in user acceptance, based on the findings made during the literature review.

4. Results and Discussion

This section collects and analyzes the data generated from the two survey-based studies presented in the previous section. Again, as in Section 3, the results are structured according to the type of study conducted. First, Section 4.1 analyzes the results obtained from the acceptance surveys conducted with current users of autonomous driving technologies, i.e., those people who were able to interact with ATLAS during public demonstrations. Secondly, Section 4.2 studies in detail the results obtained from the surveys conducted among potential future users, i.e., those people who did not take part in the demonstrations but whose professional profile is linked to the automotive and insurance sectors. Since

the survey for future users includes sets of questions with different themes, it has been decided to split the analysis into different sections accordingly when examining the results. These themes are: autonomous last-mile delivery systems (Section 4.2.1), autonomous human–vehicle coexistence (Section 4.2.2) and, finally, vehicle insurance expectations in relation to autonomous mobility technology (Section 4.2.3).

4.1. Current Users Survey Results

This subsection analyzes the survey results of those passengers who agreed to interact and complete the pre-established route aboard the ATLAS autonomous vehicle for a distance ranging from 1 to 3 Kms in an urban environment. As described in Section 3, the path included roundabouts and crosswalks where different people were waiting to cross. Passengers were seated in the passenger and rear seats and were accompanied by a professional driver (in case any intervention was required) and a technician who provided information on the operation and performance of the vehicle.

During these demonstrations, a total of 27 people participated in the survey. If we analyze the demographic aspects of the survey, it should be noted that of the total number of respondents, 14 were men and 12 were women, plus one person who preferred not to indicate their gender. Furthermore, the age of the respondents was evenly distributed between 18 and 65 years. Detailed information on this survey can be found in [35].

Among the main findings of this survey is that most participants believed they had limited knowledge concerning autonomous driving. This was not the case when the study focused on knowledge about the automotive sector; by observing Figure 3, it can be concluded that the percentage of people with medium or superior knowledge on the sector (approximately 82%) is higher than the percentage of those who had medium or superior knowledge regarding autonomous driving (approximately 63%).

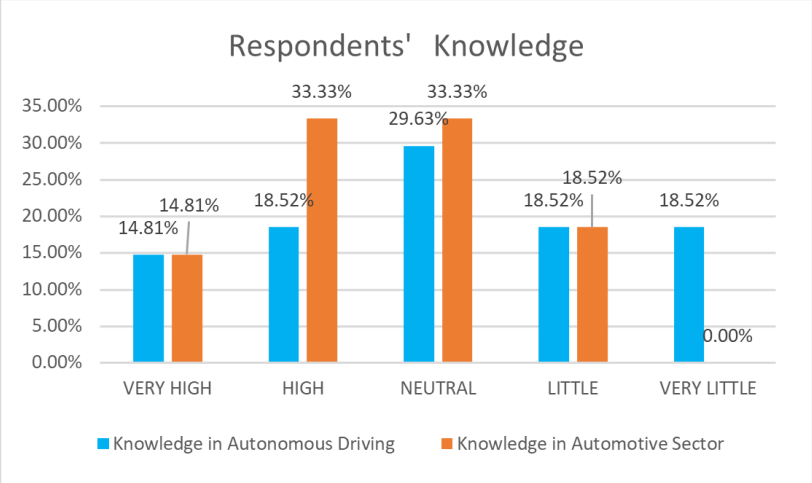

Figure 3. Current users' knowledge on autonomous driving and automotive sector.

Focusing on the analysis of the results on autonomous vehicles and on the acceptance of this technology from the point of view of people who have been able to test this type of vehicle, the most relevant conclusions are centered on two responses, as shown in Figure 4:

- First, as shown in the diagram on the right, regarding the question regarding the possibility of using the autonomous vehicle daily if they had access to it, 81.48% of respondents answered that they would use it. This suggests a willingness to adopt this technology and a high predisposition of people to use these vehicles and to get involved in their implementation.
- Despite this positive feedback, the study also demonstrates the need to bring this technology closer to people through demonstrations such as the ones presented in this work, given that nearly 78% of respondents stated that, although they would use the vehicle, they would be somewhat concerned about doing so.

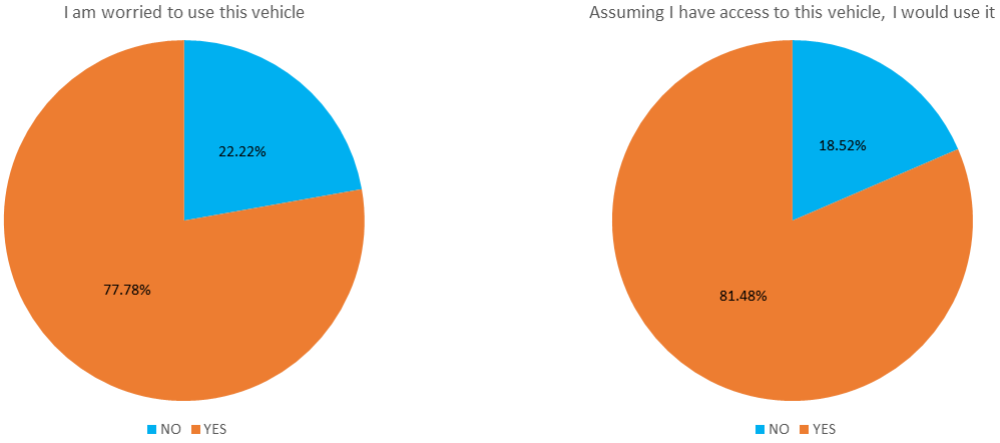

Figure 4. Current users' feelings towards autonomous driving.

4.2. Future Users Survey Results

In this section, the analysis of results focuses on the 22-question survey conducted among a total of 629 people considered as potential and future users of autonomous driving as they are professionally linked to the automotive sector.

Among the survey's main demographics, 68% of respondents are men, while 32% are women, all between the ages of 20 and 65 and with an average age of 49 years. In terms of driving experience, the survey shows that 94.3% of participants have their own vehicle and at least 34% admit to having had an accident in the last 10 years.

If we focus the analysis on the knowledge regarding the automotive world and the advancements being made in the sector, we observe aspects such as that 83% of those surveyed are familiar with ADAS systems, but only 37% are certain that their vehicle is equipped with ADAS and, of these, up to 14%, of which the majority are men, consider themselves dissatisfied with the performance of these systems. This last percentage is noteworthy because it means that there is a certain number of respondents who, having some experience in the sector, consider that the ADAS technology already installed in commercial vehicles should be improved. This illustrates the importance of these studies in identifying these complaints and encouraging the industry to continue research and development in this field.

Continuing with the analysis of future users' survey answers, in relation to knowledge about autonomous driving, the first element to highlight is a striking gender gap between the number of men and women who claim to know about the technology and the level of knowledge they have about it. If we look at Figure 5, we can see how in the case of women, 87% recognize that their knowledge about this technology is basic (55%) or null (32%), which contrasts with the percentage of men, which stands at 54%, composed of those who state that their level of knowledge is basic (42%) or null (12%). Considering the average age of the respondents, it can be assumed that this gap appears because in previous generations the professional profiles were clearly biased, with technical studies being a male-dominated sector, while business-related studies presented greater gender parity. Hence, women respondents linked to the automotive sector, due to social and cultural circumstances, may be in departments further away from technological aspects such as autonomous driving. Fortunately, nowadays there is increasing parity in all higher education studies, and it is more than likely that as generations pass these differences will even out.

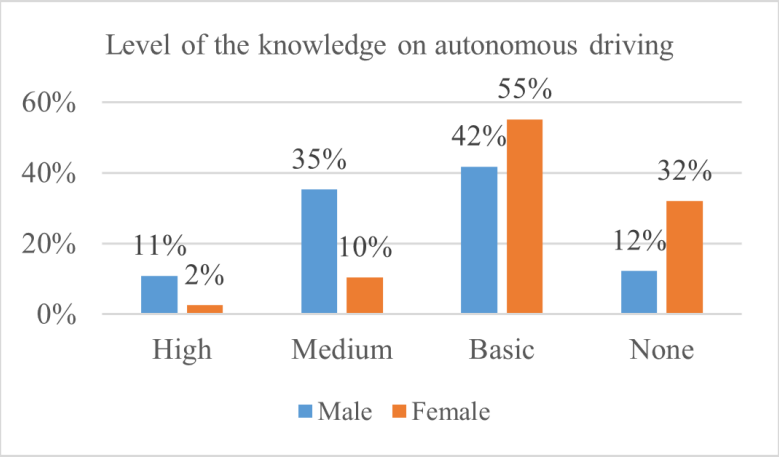

Figure 5. Future users' knowledge on autonomous driving.

This correlation in gender is also noticeable when respondents are asked whether they would like all vehicles to be driverless in the future, as shown in Figure 6, although in this case the difference is much smaller (56% vs. 46%). This gender-related difference is likely correlated with the responses shown in Figure 5, where most women claim to have limited knowledge in autonomous driving, unlike men; therefore, the fear of an unknown technology may be what pushes down this acceptance among female respondents. Furthermore, analyzing Figure 6, it can be seen how, among the respondents, there is not a high acceptance of the idea that all vehicles should circulate without a driver. Evidently, this survey was conducted among people who have not been able to interact with a fully autonomous vehicle, and there is a significant percentage of people who are not knowledgeable enough about the technology to accept the idea that the driver's role will disappear in cars. This fact demonstrates that there is still much work to be done to popularize this technology among the public in order to achieve a higher percentage of people who are not afraid or prejudiced about the predominance of this technology in the future of mobility. All this is a motivation to continue developing technologies on the ATLAS platform, in order to be able to hold new events and demonstrations that increase the number of people who have been able to interact with an autonomous vehicle. If this is achieved, not only will the degree of acceptance of the technology improve but opinions about it will be more reliable as they will come from people who know autonomous driving first-hand.

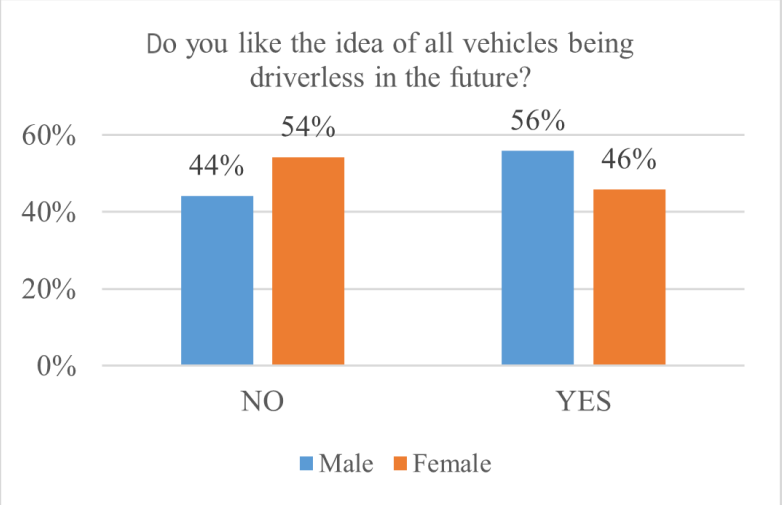

Figure 6. Acceptance of driverless vehicles in the future by future users.

4.2.1. Last-Mile Delivery Use Case

In this section, the analysis of results focuses on the survey segment dedicated to the technology of autonomous mobile systems used as a parcel delivery service for what in the logistics sector is called the "last mile", i.e., the final part of a product's supply chain to a final customer.

As mentioned in Section 3, this technology, directly linked to autonomous driving, will become a reality in society even before systems such as robotaxis [36]. It has been decided to include this technology in the study performed because it is part of autonomous mobility, it is an incipient technology in the market, it is linked to the insurance sector, it interacts with open traffic on public roads, and because of its social impact. Thus, statistics such as those shown in Figure 7 allow us to evaluate the degree of acceptance and inclusion of this technology in society. According to the survey conducted, if we look at the diagram on the left, the results suggest that this type of services linked to autonomous and intelligent mobility are highly demanded by society, so much so that 76% of respondents state that they like the idea of delivery companies using autonomous vehicles to make deliveries.

In contrast, when it comes to robotaxi services, as shown in the diagram on the right, user confidence drops to 58% when answering whether they would feel comfortable interacting with or taking a ride in an autonomous vehicle. This difference suggests that autonomous driving has yet to overcome the barrier of user acceptance when the use of such technology implies that the user himself is embarked in the vehicle, meaning that in the event of an incident there is a potential risk to human life and safety.

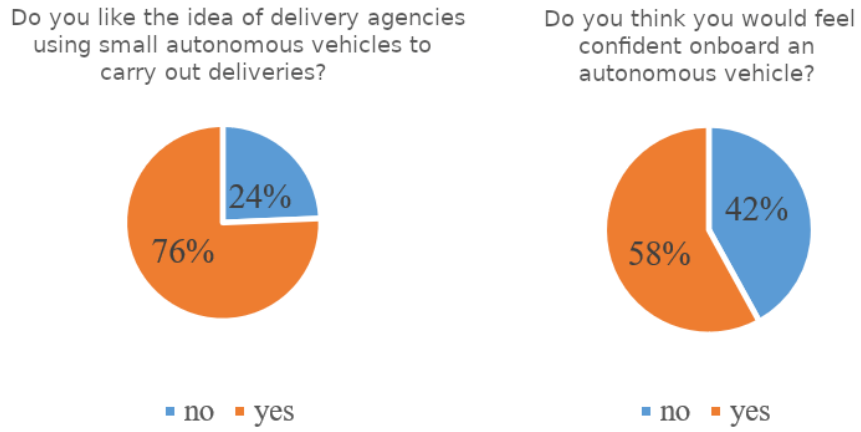

Figure 7. Future users' acceptance of autonomous delivery robots vs. autonomous vehicles.

This analysis becomes clearer when looking at the following diagram, Figure 8. As can be seen in the figure, the fact that companies in the logistics sector implement small autonomous robots for last-mile delivery does not lead to people rejecting the service, given that a large majority, 85%, state that they would continue to use home delivery services to the same extent as if this technology was not introduced.

In this way, it can be concluded that potential users of autonomous transportation technologies are willing to accept such technologies as they consider them to be beneficial for the progress of society. However, to achieve widespread acceptance of self-driving passenger cars and robotaxis, it is necessary to demonstrate to the public that these vehicles are indeed safer than human drivers.

4.2.2. Human-Autonomous Vehicle Coexistence Acceptance

Furthermore, another of the most interesting sections of the future users' survey consisted of questions about the users' acceptance of co-existing with autonomous passenger vehicles. Respondents' answers are depicted in Figure 9.

As shown in Figure 7, the confidence percentage in the use of passenger vehicles decreases significantly (from 76% to 58%) with respect to the use of robots for parcel

delivery. However, in Figure 9 it can be seen that this confidence increases slightly (up to 60%) when respondents are asked if they would be comfortable sharing space with autonomous vehicles.

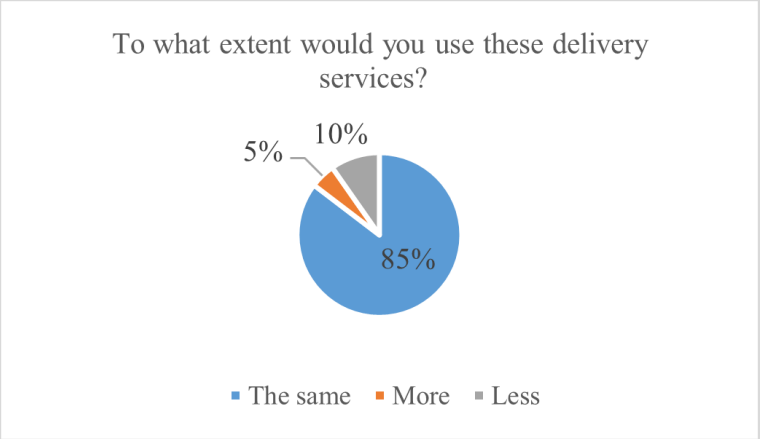

Figure 8. Future users' willingness to use autonomous delivery services.

Furthermore, Figure 9 suggests that age is not a determining factor when it comes to the confidence of users in the hypothetical situation of driving among autonomous vehicles. While it is true that the acceptance percentage fluctuates between 50% (for the 41–45 age group) and 70% for people in their early 30s, there does not appear to be a direct correlation between age and confidence in sharing space with AVs. This is contrary to the popular belief that younger people are more open-minded about new technologies.

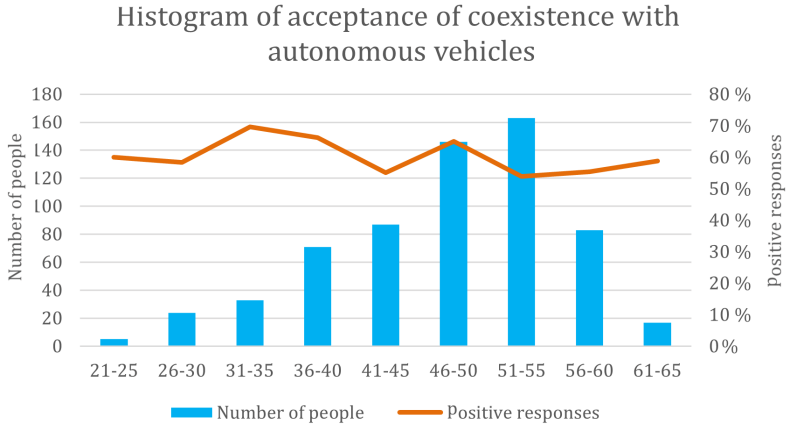

Figure 9. Age vs. confidence of future users driving among autonomous vehicles.

4.2.3. Autonomous Vehicles and Insurance Expectations

Lastly, potential future users were asked about their expectations regarding autonomous vehicles in the insurance sector (Figure 10).

The results reveal the following observations:

- Of all respondents, 96% believe that autonomous vehicles will continue to require insurance.
- More than 90% of respondents believe that insurance should be equal in price, cheaper or non-existent.

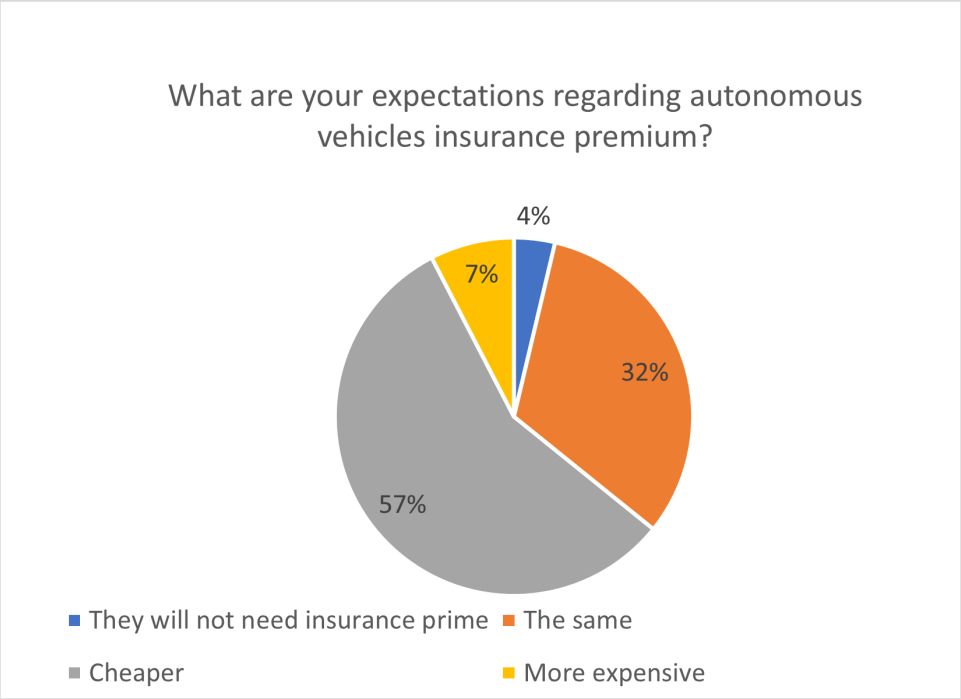

Figure 10. Expectations on the insurance premium of autonomous vehicles among future users.

It is interesting to find that 96% of respondents believe that autonomous vehicles will continue to require insurance. Moreover, most (57%) think that this insurance should be cheaper. Based on the premise that autonomous vehicles' accident rate would be lower, it seems that the higher cost of the technology associated with autonomous driving is not perceived by the general public; therefore, they expect lower insurance rates. This demonstrates that users expect the future self-driving car to be more efficient and safer than current manned vehicles; have fewer accidents; and, hence, have fewer claims and cheaper insurance.

4.3. Discussion

This section aims to further expand the findings that have been presented in this document, with the intention of contrasting the results of the different surveys that have been studied. The first, and most obvious, of all the conclusions that can be inferred, comparing the results of the survey on first-time users and future users, is that being able to test an autonomous vehicle first-hand reduces user rejection, which in users who have not tried an AV is around 50%; conversely, this value rises to values above 80% when we ask users who have tried these vehicles. This demonstrates the premise that these types of demonstrations and activities, aimed at attracting users to these technologies, are justified.

This discovery, indicating a 30% increase in acceptance for a technology as complex, intimidating, and disruptive as autonomous driving after a firsthand experience, highlights the remarkable effectiveness of bridging the gap between technology and society through hands-on demonstrations.

We hope that this finding encourages other laboratories and autonomous vehicles' developers to showcase their work to the general public, beyond conferences and publications, to demonstrate that this technology is real, is safe, and is not intended to take away our freedom to drive but to make our lives easier. Because, as evidenced by this study, the more informed individuals are, and once they can actually test an autonomous car and sit in it, the less rejection they feel towards it, and the more open they are to integrating it into their lives. This holds significant importance as even the most groundbreaking technology is rendered worthless if society is unprepared or unwilling to embrace it. Therefore, this stands as the most crucial conclusion we wish to convey from the conducted study.

Furthermore, it has also been found that this technology is better accepted when there is no risk to human life, as demonstrated in Section 4.3 of the article. This information is valuable for stakeholders in autonomous vehicles as it suggests that a strategic point of introduction for autonomous driving into society could involve deploying autonomous vehicles that do not transport people and pose minimal risk in case of malfunction, such as small delivery robots.

On the other hand, another discovery made is that it is important to note that these adaptations towards autonomous driving have to be made with care, with the intention of avoiding generating further rejection by the users. This is corroborated by the surveyed users who have had accidents in the last 10 years since many do not seem to be interested in using these systems (only 34%, despite the fact that they can increase their safety). Similarly, the percentage of users dissatisfied with ADAS systems remains high at 14% of those surveyed who had such a system.

Finally, and related to insurance cost projections, there is a general expectation of a reduction in insurance premiums, despite the extra costs that these advanced systems entail, which concludes that future insurance policies must anticipate and ensure that these systems are indeed statistically safer, in order to incorporate them into insurance premiums. Once again, this underscores the significance of bringing autonomous vehicle technology closer to end-users. A noteworthy observation is that individuals who have not tested an autonomous vehicle and are unfamiliar with the concept tend to believe that insurance policies should be cheaper for AVs. This misconception indicates a lack of awareness about the substantial costs associated with such vehicles. This reiterates the importance of educating society about this technology since the lack of knowledge of this technology not only leads to rejection but also fosters unrealistic expectations.

5. Conclusions and Future Work

This article explores the evolution of autonomous vehicle acceptance by examining two different user groups. The first group comprises "current users" of the technology, individuals who have had the opportunity to test the ATLAS autonomous vehicle during demonstrations conducted by CESVIMAP, UC3M, and UPM. The second group consists of "potential future users", a sizable cohort connected to the automotive sector who have not yet experienced being driven by a vehicle with autonomous capabilities.

The study has been conducted after identifying a weakness in the current state of the art concerning AV acceptance. Usually, autonomous driving surveys are not incorporated as part of demonstrations or exhibitions in which people can get into a fully autonomous vehicle and experience it, in order to have a more realistic image of this type of technology. Hence, studying how people's expectations and opinions change after this experience may shed some light on how to accelerate the acceptance of such a delicate technology as autonomous vehicles.

The results presented in this study prove that the acceptance of the autonomous vehicle is in the majority. However, a significant proportion of potential future users still express discomfort with the idea of traveling in or between autonomous vehicles. Nevertheless, as it has been observed and presented in this paper, it is anticipated that these users will gain confidence in autonomous vehicles as the technology becomes more popular and, consequently, they have the opportunity to test them and become familiar with them. Furthermore, the results presented in this study suggest that the first step towards autonomous mobility may come through the introduction of small parcel delivery robots in our cities.

Regarding auto insurance, the study conducted in this paper suggests that the public expects autonomous vehicles to still require insurance coverage. Simultaneously, it indicates that there is an anticipation of a reduction in insurance rates due to the potential decrease in accidents and insurance claims resulting from the adoption of autonomous vehicles. Nevertheless, it appears that the general public does not consider (or is not aware of) the substantial costs associated with the on-board systems of autonomous vehicles.

The emphasis of the study presented lies on the positive evolution of user acceptance following a first-hand encounter with an autonomous vehicle. It highlights the importance of bridging the gap between this technology and end users through practical demonstrations to enhance public acceptance.

The implications of this finding suggest that maximizing direct autonomous car–human interaction reduces peoples' wariness of this technology and accelerates its introduction into society. Consequently, the study strives to encourage other autonomous vehicles' developers to actively engage in dissemination efforts, familiarizing people with the revolution in mobility that is autonomous driving, so that it is embraced as it is, a tool that makes transportation less burdensome and dangerous.

Nevertheless, this study, although complete and able to extract interesting insights into user acceptance, has certain limitations that should be acknowledged and addressed in future iterations of the research. While the survey conducted among automotive experts with no real experience with AVs managed to reach 629 respondents, the survey with testers of the autonomous car ATLAS only garnered 27 respondents. This significant difference in numbers poses challenges for extracting descriptive statistics and makes comparisons difficult. However, it is crucial to consider that the survey conducted during real demonstrations requires a much greater deployment of resources than the online survey for future users. It involves preparing ATLAS, ensuring safety, closing streets with the assistance of local authorities, and convincing non-experts to test these vehicles, limiting the number of people who can be interviewed at a demonstration. Nevertheless, the number and variety of respondents is enough to provide the important conclusions that this work provides. On the other hand, the survey, although related to the insurance sector from its conception, has few questions directly related to this field as it was not the main objective of the study. However, for future demonstrations, it would be beneficial to focus the study on this field, inquiring into the users' opinion about the insurance of future VAs and their pricing, which would allow ne to compare how their views evolve compared to the survey conducted among future users.

In terms of future lines of research, this study is conceived as a foundational point for a series of forthcoming studies and investigations. These will utilize platforms like ATLAS or other autonomous systems to conduct a multitude of experiments and demonstrations in order to collect extensive data for the purpose of identifying new risks associated with autonomous vehicles. Such analyses will delve into the advantages and/or disadvantages of employing different sensing techniques (i.e., radar, LiDAR, or camera), among many other aspects. Moreover, to further comprehend the evolution of acceptance post hands-on testing, it is planned to use these future demonstrations and experiments to conduct surveys among volunteers/current users both before and after testing an autonomous vehicle. This approach aims to observe and analyze how an individual's opinion evolves after direct exposure to autonomous driving. All these experiments and analyses, as well as future works that encompass acceptance methodologies such as SEM and PLS-SEM, have the potential to aid insurance companies in formulating policies and strategies that align with the requirements and expectations of autonomous vehicle users.

The results of the survey conducted among future users can be found at https://docs.google.com/spreadsheets/d/1scgPaWBPnZ0dlffOqEXKFIdHtcunxp_u/edit?usp=drive_link&ouid=104297437178023010797&rtpof=true&sd=true (accessed on 20 November 2023).

Author Contributions: Conceptualization, R.E. and F.G.; methodology, R.E., Á.M., M.Á.d.M. and M.P.; software, Á.M., M.Á.d.M. and M.P.; validation, R.E. and F.G.; writing—original draft preparation, R.E., Á.M. and M.P.; writing—review and editing, Á.M., M.Á.d.M., M.P. and F.G.; supervision, F.G. and J.B.; and funding acquisition, F.G. All authors have read and agreed to the published version of the manuscript.

Funding: This work has been supported by the Spanish Government through the projects ID2021-128327OA-I00 and TED2021-129374A-I00 funded by MCIN/AEI/10.13039/501100011033, by the European Union NextGenerationEU/PRTR and Madrid Government (Comunidad de Madrid-Spain) under the Multiannual Agreement with UC3M ("Fostering Young Doctors Research", APBI-CM-

UC3M), and in the context of the V PRICIT (Research and Technological Innovation Regional Programme) and by the Netherlands' Government through SUMMALAB.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data available in a publicly accessible repository. This data can be found here: https://docs.google.com/spreadsheets/d/1scgPaWBPnZ0dlffOqEXKFIdHtcunxp_u/edit?usp=sharing&ouid=104297437178023010797&rtpof=true&sd=true (accessed on 20 November 2023).

Acknowledgments: The authors want to acknowledge the work and support of the members of the Autonomous Mobility and Perception Lab (AMPL) that helped and assisted in the public demonstration: Sergio Campos Novoa, Carmen Barbero Ruiz, Diego Martin Maeso, David Mataix Borrell, Victoria Frutos Navarro, and Borja Perez Frutos.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Future users survey question set.

Question	Type or Response
1. Age	numerical
2. Sex	numerical
3. Do you have your own car?	Yes/No
4. Do you drive regularly?	Yes/No
5. Have you had any accidents—of any intensity—in the last 10 years?	No/Yes, in a city/Yes, on a road
6. Are you interested in the automotive world?	1 to 5
7. Do you know what driving assistance systems, also known as ADAS, are?	Yes/No
8. Can you tell us if your vehicle has any of these systems?	Yes/No
9. Are you happy with the performance of the ADAS systems currently installed in your car?	Yes/No
10. Would you like your car to have ADAS systems, even if it does not currently have them?	Yes/No
11. What knowledge do you have about autonomous driving?	1 to 4
12. Have you tried an autonomous vehicle? Level 2 or higher	Yes/No
13. Do you think the autonomous vehicle already exists?	Yes/No
14. Do you like the idea that one day all vehicles will circulate without a driver?	Yes/No
15. Do you think you would feel confident onboard an autonomous vehicle?	Yes/No
16. Would you feel comfortable driving around the city among autonomous vehicles?	Yes/No

Table A1. *Cont.*

Question	Type or Response
17. In your opinion, will car insurance still be necessary when vehicles become autonomous?	Yes/No
18. And, if car insurance still existed, should the policy be more expensive or cheaper?	Same/Cheaper/More Expensive
19. Would you like to test an autonomous vehicle?	Yes/No
20. Do you like the idea of delivery agencies using small autonomous vehicles to carry out deliveries?	Yes/No
21. Do you think you would feel comfortable driving around the city between autonomous vehicles for parcel, courier, or food delivery?	Yes/No
22. Would you find it interesting if your home orders were delivered by these vehicles?	Yes/No
23. Would you use this home delivery service more/less/equally?	Same/More/Less

Table A2. Current users survey question set.

Question	Type or Response
1. Age	Age range
2. Gender	Man/Woman/I prefer not to say it
3. Driving Experience	None/<1 year/1 to 5 years/5 to 10 years/>10 years
4. Owned Car	Yes/No
5. Usual mean of transport (commuting home—work))	Own Vehicle/Public Transport/Walking/Bicycle
6. Interest in the automotive world	Very High/High/Neutral/Little/Very Little or None
7. Level of knowledge in the field of autonomous vehicles	Very High/High/Neutral/Little/Very Little or None
8. If I use this vehicle, will I arrive at my destination safe and sound?	Strongly Agree/Agree/Neutral/Disagree/ Strongly disagree
9. I would like to interact with the vehicle	Strongly Agree/Agree/Neutral/Disagree/ Strongly disagree
10. I would be proud to show a self-driving car like this to people who are close to me	Strongly Agree/Agree/Neutral/Disagree/ Strongly disagree
11. I see myself ready to use an autonomous vehicle	Strongly Agree/Agree/Neutral/Disagree/ Strongly disagree
12. The vehicle scares me	Strongly Agree/Agree/Neutral/Disagree/ Strongly disagree
13. I think I could have an accident using this vehicle	Strongly Agree/Agree/Neutral/Disagree/ Strongly disagree

Table A2. *Cont.*

Question	Type or Response
14. I am worried to use this vehicle	Strongly Agree/Agree/Neutral/Disagree/ Strongly disagree
15. Assuming I had access to this vehicle, I would use it	Strongly Agree/Agree/Neutral/Disagree/ Strongly disagree
16. I have felt safe while in the vehicle	Strongly Agree/Agree/Neutral/Disagree/ Strongly disagree
17. I would encourage people whose opinion is important to me to use this type of vehicle	Strongly Agree/Agree/Neutral/Disagree/ Strongly disagree
18. My expectations were positive before getting into the vehicle	Strongly Agree/Agree/ Neutral/Disagree/ Strongly disagree
19. My experience with the vehicle has been positive	Strongly Agree/Agree/Neutral/Disagree/ Strongly disagree

References

1. *SAE J3016:2021;* Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. Society of Automotive Engineers: Warrendale, PA, USA, 2021.
2. Skeete, J.P. Level 5 autonomy: The new face of disruption in road transport. *Technol. Forecast. Soc. Chang.* **2018**, *134*, 22–34. [CrossRef]
3. *Real Decreto Legislativo 8/2004, de 29 de Octubre, por el que se Aprueba el Texto Refundido de la Ley Sobre Responsabilidad Civil y Seguro en la Circulación de Vehículos a Motor*; Boletín Oficial del Estado: Madrid, Spain, 2004.
4. Rumar, K. The role of perceptual and cognitive filters in observed behavior. In *Human Behavior and Traffic Safety*; Springer: Berlin/Heidelberg, Germany, 1985; pp. 151–170.
5. Smith, B.W. *Human Error as a Cause of Vehicle Crashes*; Standford Centre for Internet and Society: Stanford, CA, USA, 2013.
6. Herrmann, A.; Brenner, W.; Stadler, R. *Autonomous Driving: How the Driverless Revolution Will Change the World*; Emerald Group Publishing: Leeds, UK, 2018.
7. European Parliament. Regulation (EU) 2019/2144 of the European Parliament and of the Council of 27 November 2019 on Type-Approval Requirements for Motor Vehicles and Their Trailers, and Systems, Components and Separate Technical Units Intended for such Vehicles, as Regards Their General Safety and the Protection of Vehicle Occupants and Vulnerable Road Users, Amending Regulation (EU) 2018/858 of the European Parliament and of the Council and Repealing Regulations. EUR-Lex. Available online: https://eur-lex.europa.eu/eli/reg/2019/2144/2022-07-06 (accessed on 28 July 2023).
8. Jürgens, F.; Ehrich, H.; Schulte, L.E. Approval Requirements for Automated and Connected Vehicles. *ATZ Worldw.* **2021**, *123*, 44–49. [CrossRef]
9. Répás, J.; Berek, L. Security and Safety Systems on Modern Vehicles. In *Vehicle and Automotive Engineering 4: Select Proceedings of the 4th VAE2022, Miskolc, Hungary* ; Springer: Berlin/Heidelberg, Germany, 2022; pp. 84–100.
10. Xu, S.; Peng, H. Design and comparison of fuel-saving speed planning algorithms for automated vehicles. *IEEE Access* **2018**, *6*, 9070–9080. [CrossRef]
11. Olin, P.; Aggoune, K.; Tang, L.; Confer, K.; Kirwan, J.; Deshpande, S.R.; Gupta, S.; Tulpule, P.; Canova, M.; Rizzoni, G. *Reducing Fuel Consumption by Using Information from Connected and Automated Vehicle Modules to Optimize Propulsion System Control*; Technical Report, SAE Technical Paper; SAE: Byron Bay, Australia, 2019.
12. Cabri, G.; Gherardini, L.; Montangero, M.; Muzzini, F. About auction strategies for intersection management when human-driven and autonomous vehicles coexist. *Multimed. Tools Appl.* **2021**, *80*, 15921–15936. [CrossRef]
13. Sonnleitner, J.; Friedrich, M.; Richter, E. Impacts of highly automated vehicles on travel demand: Macroscopic modeling methods and some results. *Transportation* **2022**, *49*, 927–950. [CrossRef]
14. Kapser, S.; Abdelrahman, M. Acceptance of autonomous delivery vehicles for last-mile delivery in Germany–Extending UTAUT2 with risk perceptions. *Transp. Res. Part C Emerg. Technol.* **2020**, *111*, 210–225. [CrossRef]
15. Reed, S.; Campbell, A.M.; Thomas, B.W. The value of autonomous vehicles for last-mile deliveries in urban environments. *Manag. Sci.* **2022**, *68*, 280–299. [CrossRef]
16. Kyriakidis, M.; de Winter, J.C.; Stanton, N.; Bellet, T.; van Arem, B.; Brookhuis, K.; Martens, M.H.; Bengler, K.; Andersson, J.; Merat, N.; et al. A human factors perspective on automated driving. *Theor. Issues Ergon. Sci.* **2019**, *20*, 223–249. [CrossRef]
17. Olaverri-Monreal, C. Promoting trust in self-driving vehicles. *Nat. Electron.* **2020**, *3*, 292–294. [CrossRef]
18. Biondi, F.; Alvarez, I.; Jeong, K.A. Human–vehicle cooperation in automated driving: A multidisciplinary review and appraisal. *Int. J. Hum.-Interact.* **2019**, *35*, 932–946. [CrossRef]

19. Othman, K. Public acceptance and perception of autonomous vehicles: A comprehensive review. *AI Ethics* **2021**, *1*, 355–387. [CrossRef] [PubMed]
20. Strauch, C.; Mühl, K.; Patro, K.; Grabmaier, C.; Reithinger, S.; Baumann, M.; Huckauf, A. Real autonomous driving from a passenger's perspective: Two experimental investigations using gaze behaviour and trust ratings in field and simulator. *Transp. Res. Part F Traffic Psychol. Behav.* **2019**, *66*, 15–28. [CrossRef]
21. Xu, Z.; Zhang, K.; Min, H.; Wang, Z.; Zhao, X.; Liu, P. What drives people to accept automated vehicles? Findings from a field experiment. *Transp. Res. Part C Emerg. Technol.* **2018**, *95*, 320–334. [CrossRef]
22. Patella, S.M.; Grazieschi, G.; Gatta, V.; Marcucci, E.; Carrese, S. The adoption of green vehicles in last mile logistics: A systematic review. *Sustainability* **2020**, *13*, 6. [CrossRef]
23. Ilková, V.; Ilka, A. Legal aspects of autonomous vehicles—An overview. In Proceedings of the 2017 21st International Conference on Process Control (PC), Strbske Pleso, Slovakia, 6–9 June 2017; pp. 428–433. [CrossRef]
24. Peterson, R.W. New technology-old law: Autonomous vehicles and California's insurance framework. *Santa Clara Law Rev.* **2012**, *52*, 1341.
25. Schroll, C. Splitting the bill: Creating a national car insurance fund to pay for accidents in autonomous vehicles. *Northwestern Univ. Law Rev.* **2014**, *109*, 803.
26. Geistfeld, M.A. A roadmap for autonomous vehicles: State tort liability, automobile insurance, and federal safety regulation. *Calif. Law Rev.* **2017**, *105*, 1611.
27. Claus, S.; Silk, N.; Wiltshire, C. *Potential Impacts of Autonomous Vehicles on the UK Insurance Sector*; Bank of England Quarterly Bulletin: London, UK, 2017; p. Q1.
28. Xu, X.; Fan, C.K. Autonomous vehicles, risk perceptions and insurance demand: An individual survey in China. *Transp. Res. Part A Policy Pract.* **2019**, *124*, 549–556. [CrossRef]
29. Raj, A.; Kumar, J.A.; Bansal, P. A multicriteria decision making approach to study barriers to the adoption of autonomous vehicles. *Transp. Res. Part A Policy Pract.* **2020**, *133*, 122–137. [CrossRef]
30. de Miguel, M.Á.; Moreno, F.M.; Marín-Plaza, P.; Al-Kaff, A.; Palos, M.; Martín, D.; Encinar-Martín, R.; García, F. A Research Platform for Autonomous Vehicles Technologies Research in the Insurance Sector. *Appl. Sci.* **2020**, *10*, 5655. [CrossRef]
31. Marin-Plaza, P.; Yagüe, D.; Royo, F.; de Miguel, M.Á.; Moreno, F.M.; Ruiz-de-la Cuadra, A.; Viadero-Monasterio, F.; Garcia, J.; San Roman, J.L.; Armingol, J.M. Project ARES: Driverless transportation system. challenges and approaches in an unstructured road. *Electronics* **2021**, *10*, 1753. [CrossRef]
32. Alfandari, L.; Ljubić, I.; da Silva, M.D.M. A tailored Benders decomposition approach for last-mile delivery with autonomous robots. *Eur. J. Oper. Res.* **2022**, *299*, 510–525. [CrossRef]
33. Boysen, N.; Fedtke, S.; Schwerdfeger, S. Last-mile delivery concepts: A survey from an operational research perspective. *Or Spectr.* **2021**, *43*, 1–58. [CrossRef]
34. Lemardelé, C.; Estrada, M.; Pagès, L.; Bachofner, M. Potentialities of drones and ground autonomous delivery devices for last-mile logistics. *Transp. Res. Part E Logist. Transp. Rev.* **2021**, *149*, 102325. [CrossRef]
35. Carrasco, A.M.; Gankhuyag, D.; Paraiso, M.A.d.M.; Lorite, M.P.; Olaverri-Monreal, C.; Fernandez, F.G. Evaluating the acceptance of autonomous vehicles in the future. In Proceedings of the 2023 IEEE Intelligent Vehicles Symposium (IV), Anchorage, AK, USA, 4–7 June 2023. [CrossRef]
36. Vosooghi, R.; Kamel, J.; Puchinger, J.; Leblond, V.; Jankovic, M. Robo-Taxi service fleet sizing: Assessing the impact of user trust and willingness-to-use. *Transportation* **2019**, *46*, 1997–2015. [CrossRef]