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## Public views towards implementation of automated vehicles in urban areas

Jinan Piao <sup>a,\*</sup>, Mike McDonald <sup>a</sup>, Nick Hounsell <sup>a</sup>, Matthieu Graindorge <sup>b</sup>, Tatiana Graindorge <sup>c</sup>, Nicolas Malhene <sup>c</sup>

<sup>a</sup> *Transportation Research Group, Southampton University, UK*

<sup>b</sup> *La Rochelle Urban Community, France*

<sup>c</sup> *La Rochelle Engineering School, France*

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### Abstract

In this paper, a study on public opinions towards implementation of automated vehicles in urban areas is reported which is based on a survey in La Rochelle. This was a part of the evaluation activities on the automated vehicle demonstrated in the city. According to the surveys, public attitudes were positive towards implementation of automated buses in urban areas. The most attractive benefit of automated buses would be lower bus fares because of no driver costs. About two thirds of people surveyed would consider taking automated buses if both automated and conventional buses were available on a route. Passenger security would be one of most concerned issues for automated buses especially during night time services. The public attitudes towards automated cars in urban areas were also positive. More than half of the people surveyed stated that they would consider using automated cars if they become available, with three quarters being interested in owning an automated cars, and one quarter in sharing automated cars through services such as car-sharing, car-pooling, or taxis.

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\* Corresponding author. Tel.: +44(0)2380593316; fax: +44(0)2380593152.

*E-mail address:* [jpiao@soton.ac.uk](mailto:jpiao@soton.ac.uk)

## 1. Introduction

Automated vehicles (AV) have a great potential to change travel and transport fundamentally. Not only will the technology reduce crashes, increase values of travel time, and reduce energy consumption and pollution, but also increase mobility and accessibility for all. Several studies have been reported to explore the potential applications of automated vehicles in many areas of urban transport (e.g. Amey et al 2011, Anderson et al 2014, Begg 2014, KPMG 2012, Lutin et al 2013, Schoettle et al 2014). In this paper, a survey based study is reported to assess public attitudes towards implementation of automated vehicles in urban areas.

This is a part of work of European CityMobil2 project ([www.citymobil2.eu](http://www.citymobil2.eu)) which aims to remove barriers for implementing automated transport systems in urban areas. The project focuses on demonstration and evaluation of public transport applications of automated vehicles. In Section 2, an overview of key attributes of automated vehicles and potential applications in urban areas is presented. In Section 3, survey method and respondents of the survey are described. In Section 4, details of the survey results are reported. In Section 5, a conclusion of the study is presented.

## 2. Automated vehicles and potential applications in urban areas

### 2.1. Automated vehicles

A fully automated vehicle would be capable of navigating in a road network, detecting obstacles in the surroundings, and running safely without human intervention. Several studies have been reported on the research and development of automated vehicles (e.g. Anderson et al 2014, Begg 2014, Forrest et al 2007, KPMG 2012, Lutin et al 2013, Schoettle et al 2014). Based on the studies reported, key features of automated vehicles can be summarized as follows:

Automated vehicles will avoid crashes caused by human errors which are believed to be the main reasons behind over 90 percent of all crashes such as driving under distraction, speeding, alcohol, drug involvement and/or fatigue. This will have a wide range of impacts on society including 1) avoid casualties to drivers and passenger, or and to other road users, 2) avoid loss due to damage of the vehicles, 3) reduce insurance premium cost for operators, 4) avoid traffic congestion and additional fuel consumption and pollution caused by the accidents.

Automated vehicles will improve fuel economy and reduce emissions. On the one hand, automated vehicle technology promises to reduce energy use because of reduced vehicle weight. Over the last two decades, vehicles have become increasingly heavy to meet more rigorous crash test standards. If crashes become exceedingly rare events, it may be possible to dramatically lighten vehicles (Anderson et al 2014). On the other hand, unlike human drivers often brake or accelerate too harshly, AV will improve fuel economy by controlling vehicle more accurately and consistently.

For automated vehicles, no human driving is needed which will have wide range of impacts. Firstly, AV will improve mobility and accessibility for all, especially those too young or too old to drive. Secondly, automated vehicles allow 'drivers' to use their time in a vehicle more productively, for example reading, interneting, and telephoning/messaging. Thirdly, AV will remove labour costs of vehicle operation. Not only will the transport service providers (e.g. buses and taxis) benefit from reduced operating costs, but end users benefit from reduced travel costs as well.

AV also promises to automatically locate itself and navigate in a network without human intervention. This will make it possible for automated vehicles to park themselves and then pick the users up later. On the one hand, such an attribute will obviate the need for nearby parking which enables redevelopment as adjacent parking lots becoming unnecessary. On the other hand, it will reduce waiting time and walk distance to access to a car.

### 2.2. Demonstration of automated buses in La Rochelle

In La Rochelle, an Automated Road Transport System (ARTS) was demonstrated which includes a fleet of 6 automated buses, station/stop facilities and a control centre. The buses had a riding capacity of 10 passengers and were equipped with GPS and other sensors for vehicle positioning, and radar and laser sensors for obstacle

detection. A public transport service was demonstrated on a route linking the Aquarium and the university campus with length of 1.4 km and 6 stations/stops (Fig. 1). The demonstration started from mid-December 2014 and lasted until end of April 2015 with a total of 14,661 people having ridden the buses.

As planned, several surveys were undertaken during and after the demonstration which targeted bus users, cyclists and pedestrians, stakeholders, and a wider public to assess the impacts on of the demonstration on their awareness and acceptance of automated vehicles in urban areas.



Fig. 1. An illustration of the automated buses demonstrated in La Rochelle.

### 3. Methods

#### 3.1. Survey approach

The survey was undertaken one month after the demonstration in La Rochelle which included 28 questions to address topics including: 1) Public awareness and understanding about automated vehicles, 2) Attractiveness and concerns of automated buses, 3) Attractiveness and concerns of automated taxis, 4) Attractiveness and concerns of sharing automated cars, 5) Attitudes towards owning or sharing automated cars.

Two survey methods were used: online questionnaire and telephone interview. Firstly, an online questionnaire was conducted targeting people working/studying/living around the route of the automated buses demonstrated in La Rochelle. A total of 148 people responded to the online survey. Then a telephone interview was undertaken to reach people in the wider areas of the La Rochelle. A total of 500 people participated in the interview.

After completion of the survey, some imbalances were found in the people surveyed (e.g. too many females in the telephone interview). In order to remove the bias, the data from the two surveys were put into one pool and resampled taking in account of distributions of age, gender, and education of people observed in La Rochelle. In situations where the distributions of people sampled did not match the local demographic trend observed, the extra number of the people were randomly removed. After resampling, a total of 425 people were selected for the study.

#### 3.2. Respondents

Five different demographic groups were considered including gender, age, education, employment, and travel modes. Fig. 2 shows demographic attributes of the people surveyed. In the surveys, adults over 18 years were targeted. Of the 425 people sampled, 53.6% were female and 46.4% male. The genders were evenly distributed for adults aged from 18 to 25, but the gap between females and males increases with the age. For people aged 65 and over, 59% were female and 41% were male. Of the people sampled, over one third of them received education of secondary school, about one fifth education of colleges, and about one third high education (Bachelor degree or

above). Of the people sampled, 52% were employed, 6% unemployed, 8% students, and 28% retired. Majority of the respondents travels by cars (66% as drivers and 4% as passengers). Other popular modes of commuting travels included buses (14%), cycling (11%), and walking (3%).

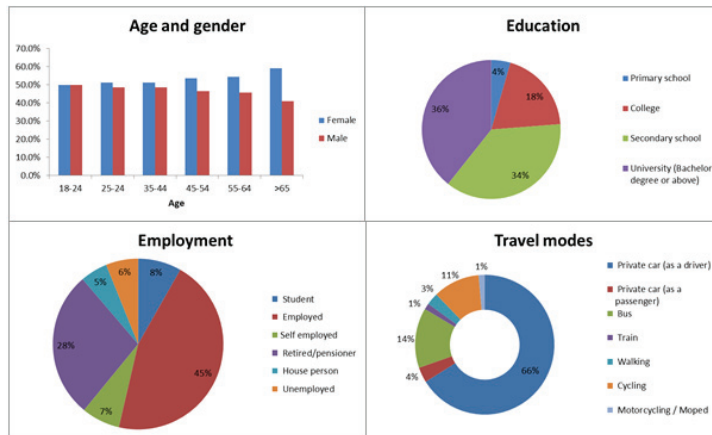


Fig. 2. Demographic attributes of the respondents

## 4. Results

### 4.1. Awareness and general attitudes

Of the people surveyed, 87% of them have heard of automated vehicles before participating in the survey. In the survey, a question was asked the participants how likely they thought automated vehicles would deliver the benefits expected. A majority of the respondents were optimistic that each of the benefits listed would occur (very likely or moderately likely). For the respondents, the most confident benefit was ‘reduced energy consumption’ (51% answered ‘very likely’), followed by ‘reduced pollutant emissions’ (45% ‘very likely’). The least confident benefit was ‘better navigation in a road network’ (17% answered ‘very unlikely’), followed by ‘Reduced congestion’ (19%). Some respondents were not sure of the potential benefits and selected the option of ‘Don’t know’ (Fig. 3).

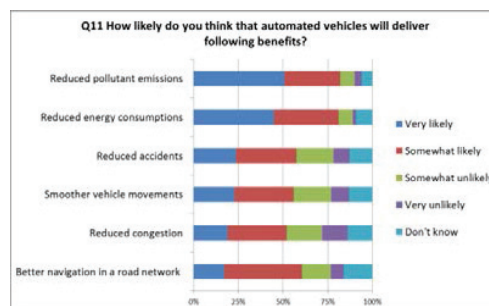


Fig. 3. Confidence levels to the benefits from automated vehicles.

In responding to the question of ‘How much do you think automated vehicle will improve safety’, 25% of the respondents answered that automated vehicles would be safer than human driven vehicles, 46% answered that automated vehicles would be as safe as human driven vehicles, and 39% answered that automated vehicles would be less safe than human driven vehicles (Fig. 4).

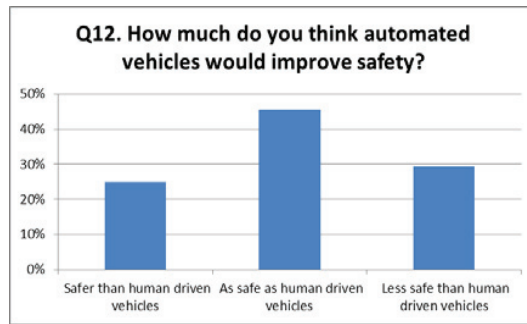


Fig. 4. Safety impacts of automated vehicles.

#### 4.2. Automated buses

Automated buses have a potential to reduce fares because of no driver costs. In the survey, a question was asked about attractiveness of such a benefit. A great majority of the respondents responded positively (44% answered “very attractive”, 26% “moderately attractive”, and 4% “slightly attractive”). Security and safety could be an issue for automated buses, especially during evening or night services. In the survey, a question was asked about how people concerned of the issue. Majority of the respondents expressed concerns, especially during evening/night time services, with 44% saying they were very concerned for evening/night services, compared to 22% for day time services.

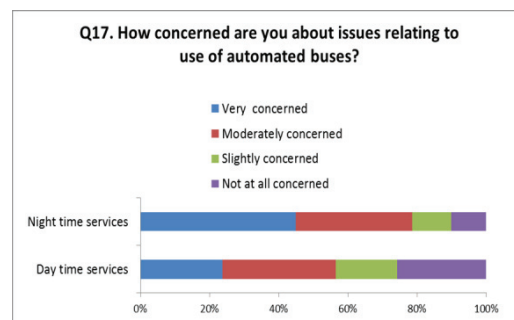


Fig. 5. Security and safety issues of automated buses.

For automated buses, the most attractive benefit would be lower bus fares because of no driver costs, and passenger security would be one of most concerned issues especially during night time services. About two thirds of the respondents stated that they would like to take automated buses if both human and automated buses were available on a route, and about a third preferred conventional buses. Of the users of automated buses, 60% stated that they would use automated buses with an on board staff, and 40% without. In the question, it was assumed that both the automated and human driven buses had same fares. In reality, automated buses would be expected to have lower fares compared to human driven buses because of no driver costs. However, the extent to which the fares are reduced depends on whether or not on-board staff are used, what kind of staff are used (labour costs compared to those of bus drivers), and when they are used (e.g. night services only). Any reductions in fares would be expected to increase the attractiveness of automated buses.

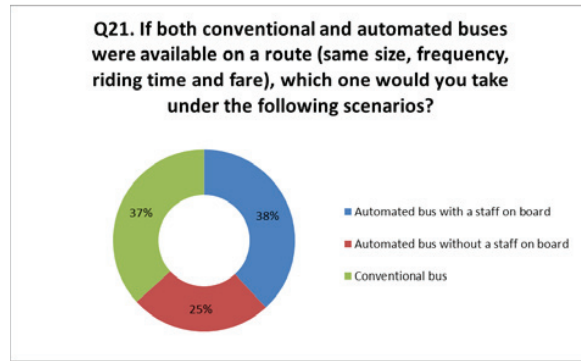


Fig. 6. Choice between automated and human driven buses.

### 4.3. Other potential applications in urban areas

#### Automated taxis

Automated taxis are expected to have several advantages compared to conventional taxis including lower fares, increased privacy and increased passenger spaces. In the survey, a question was asked about attractiveness of automated taxis. From the survey, majority of the respondents were interested in each of the three benefits addressed (very attractive, moderately attractive, or slightly attractive). Of the benefits, the most appealing one was ‘Reduced fares’ with 36% of the respondents claiming it ‘Very attractive’, this was followed by ‘Larger passenger space’ (27%), and ‘Increased privacy’ (20%).

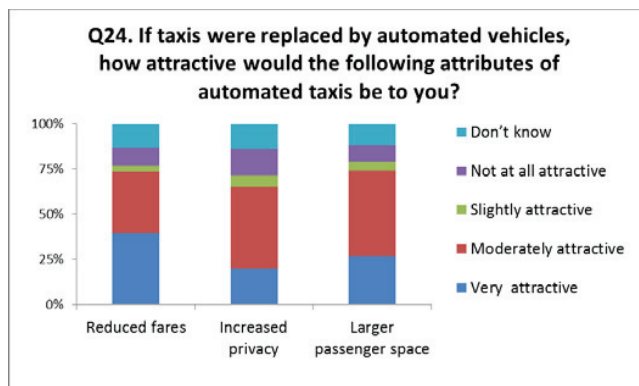


Fig. 7. Attractiveness of automated taxis.

#### Car-sharing

Compared to car-sharing services using conventional cars, automated cars are expected to have several advantages including larger passenger space, calling up remote cars, and releasing cars at desired place. Majority of the respondents were interested in the new features brought by the automated cars (very attractive, moderately attractive, or slightly attractive). Of the benefits, the most appealing one was ‘Releasing a car at a desired place’ with 35% claiming it very attractive, this was followed by ‘Calling up a distant automated car’ (31%), and Larger passenger space (18%). About one third answered ‘Don’t know’. This was likely due to that they did not have experiences of car-sharing services and not sure how they would be impacted.

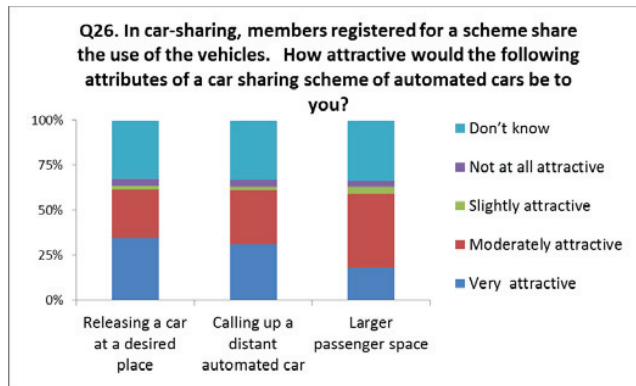


Fig. 8. Attractiveness of car sharing services with automated vehicles.

**Car-pooling**

Compared to conventional cars, automated cars are expected to have several advantages for car-pooling services including driverless, and increased passenger space. Majority of the respondents were interested in the three benefits listed (very attractive, moderately attractive, or slightly attractive). Of the benefits, the most appealing one was ‘Larger passenger space’ with 24 % of the respondents taking it as very attractive, this was followed by ‘Driverless’ (21%). There were a fifth of the people surveyed answered ‘Don’t know’. One possible reason is that they did not have experiences of car-pooling, and did not know how implementation of automated cars would impact on the service.

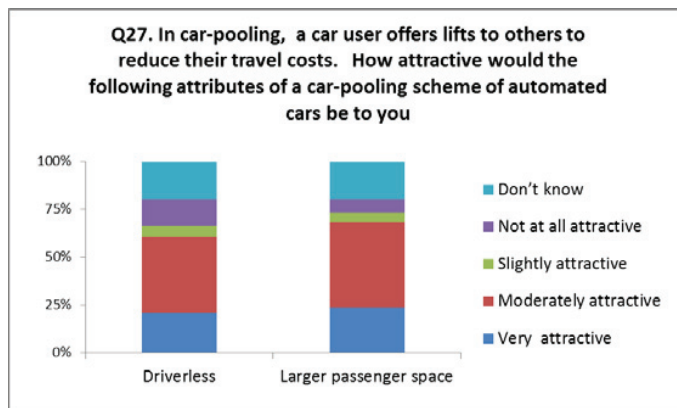


Fig. 9. Attractiveness of carpooling services with automated vehicles.

*4.4. Automated cars*

People’s attitudes towards automated cars were tested regarding attractiveness and risks of the vehicles. Majority of the respondents were interested in each of the 8 expected benefits listed (very attractive, moderately attractive, or slightly attractive). Of the benefits addressed, the most appealing ones were ‘Increase mobility for the elderly, disabled and others’ (58% answered ‘very attractive’) and ‘Reduce fuel consumptions and emissions’ (56% answered ‘very attractive’). The least appealing ones were: ‘No need to spend time and cost on learning how to drive’ (19% answered very attractive’) and ‘Allow ‘drivers’ to do other things while ‘driving’’ (20% answered ‘very attractive’).



Table 1. Answers to Q22: “Vehicle automation technology can also be applied to passenger cars. How attractive would the following attributes of an automated car be to you?”.

	Very attractive	Moderately attractive	Slightly attractive	Not at all attractive
Safer due to elimination of human errors in vehicle control	37%	45%	6%	12%
No need to spend time and cost on learning how to drive	19%	34%	11%	36%
Allow ‘drivers’ to do other things while ‘driving’	20%	42%	10%	28%
Increased mobility for the elderly, disabled and others	58%	36%	3%	3%
Automatically navigate through a road network	32%	53%	5%	11%
Reduced fuel consumptions and emissions	56%	37%	3%	4%
Reduced parking costs (Obviate the need of nearby parking)	49%	41%	3%	7%
Lower insurance rates	53%	39%	3%	5%

For automated cars, most respondents expressed some concerns to each of the issues listed (very concerned, moderately concerned, or slightly concerned). Of the issues, the most concerned was ‘Equipment or system failures’ (66% of the respondents answered ‘very concerned’), this was followed by the issue of ‘Legal liability in case of an accident’ (56%), and ‘Risk of vehicle security’ (54%).

Table 2. Answers to Q23: “How concerned are you about the following issues relating to use of automated cars?”.

	Very concerned	Moderately concerned	Slightly concerned	Not at all concerned
Equipment or system failures	66%	23%	5%	6%
Software/database not updated in time (e.g. road maps)	48%	33%	9%	10%
Higher vehicle purchasing cost	62%	24%	7%	6%
Risk of vehicle security (from hackers)	54%	28%	8%	11%
Risk of disclosing my location to others without my consent	47%	30%	9%	14%
Legal liability in case of an accident	56%	28%	9%	7%

More than half of the respondents stated that they would consider using automated cars if they became available, and about one third not consider using automated cars at all. Of the potential users of automated cars, 73% said they would like to own automated cars, and 27% to use them through services such as car sharing, pooling schemes and taxis. Elderly people showed lower interest in using automated cars than people in other age groups. For respondents aged over 65, 56% said they would consider using automated cars, compared to 62% for people aged between 18 and 34, and 61% for people aged between 35-64. For those who said they would consider using automated cars, young adults were more likely to own automated cars. For people aged 18-34, 52% stated that they would like to own automated cars, compared to 39% for people aged of 34-65, and 43% for people aged over 65. From the survey results, males were more likely to use automated cars than females. Of the male respondents, 64% stated that they would consider using automated cars, compared to 55% for the females. Males would be more likely to own an automated car than females, with 49% of the males stating that they would buy an automated car for private use, compared to 39% for the females. Regarding using automated cars through sharing cars (e.g. car-sharing, car-pooling, and taxis), similar trends were found between the female and male respondents. Respondents with high education (bachelor degree or above) were more positive towards automated cars, with 71% stating that they would consider using automated cars, compared to 52% for people with low education (below bachelor degree). For the respondents with high education, 28% stated that they would consider use automated cars through services such as car-sharing/car-pooling/taxis, compared to 8% for respondents with lower education. The percentages of people who would consider owning automated cars were similar regardless whether or not they received high education. Of the respondents with riding experience of the automated vehicles demonstrated in La Rochelle, 73% stated that they



would consider using automated cars, compared to 55% for respondents without the experience. Respondents with the riding experience were more interested in sharing than owning automated cars, with 43% of them stating that they would use automated cars through car-sharing/car-pooling/taxis and 29% would buy a car for private use, compared 7% and 48% respectively for respondents without the experience.

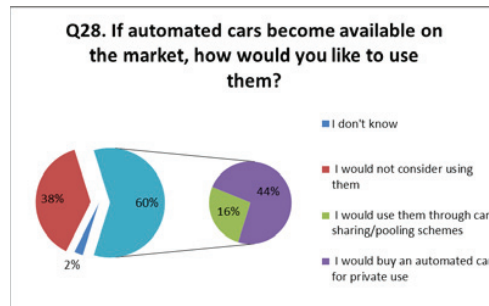


Fig. 10. Attitudes towards owning/sharing automated cars.

## 5. Influencing factors

Automated vehicles were expected to provide a wide range benefits which were appealing to most of the people surveyed. These expected benefits are believed to have positively influenced the attitudes of the people surveyed. In terms of benefits to a society as whole, they included 'Increased mobility for the elderly, disabled and others' (58% of the respondents answered very attractive), and 'Reduced fuel consumptions and emissions' (56% of the respondents answered very attractive). The most attractive benefits to end users included Reduced bus fares (64% of the respondents answered very attractive), 'Reduced insurance rates' (53% of the respondents answered very attractive), 'Reduced parking costs' (49% of the respondents answered very attractive), 'Safer driving due to elimination of human errors in vehicle control' (36% of the respondents answered very attractive), 'Reduced taxi fares' (36% of the respondents answered very attractive), and Allow 'drivers' to do other things while 'driving' (20% of the respondents answered very attractive).

Some issues were reflected in the survey which may have negatively influenced the attitudes of the people surveyed. These included safety, security, privacy and legal issues with the use of automated vehicles. For automated buses, the most concerned issue was security when no staff on board, especially during evening/night time services. For automated cars, the most concerned issues included 'Equipment or system failures' (66% of the respondents answered very concerned), 'Legal liability in case of an accident' (56% of the respondents answered very concerned), Risk of being hankered (54% of the respondents answered very concerned), and Risk of disclosing travel location (47% of the respondents answered very concerned).

Safety could be one of key factors influencing public attitudes towards automated vehicles. This was supported by the responses from the people surveyed. Of those who believed that automated vehicles would be safer than human driven vehicles, the majority of them stated that they would consider using automated vehicles (80% for buses, and 89% for cars); and of those who believed that automated vehicles would be less safe than human driven vehicles, the majority of them stated that they would not consider using automated vehicles (57% for buses and 65% for cars).

It seemed that there were some misconceptions about the benefits of automated vehicles, especially the safety benefits. Automated vehicles should be safer than human driven vehicles because of removing human errors. Currently, safer driving is one of the major driving forces for the development of automated vehicles and would be a prerequisite for implementation of automated vehicles on public roads in the future. From the survey, only a quarter of the respondents believed automated vehicles would be safer than human driven vehicles. This could be a result of low levels of awareness or/and understanding of the self-driving technology. In La Rochelle, although most respondents have previously heard of automated vehicles, only minority of them had experiences of riding automated buses demonstrated. The automated mini buses were demonstrated in experimental condition, where the

vehicle ran in low speed and with little interactions with other motorized vehicles. Although such demonstrations was very effective in increasing awareness and demonstrating the concept of automated vehicles, they were not enough to convince the public what automated vehicles can do in real conditions, especially the safety benefits. Further demonstrations are needed in the future to test automated vehicles (e.g. in operational speed and under different road/weather/traffic conditions), and to convince the public.

## 6. Conclusions

In general, public attitudes were positive towards implementation of automated vehicles in urban areas. For automated buses, the most attractive benefit of automated buses would be lower fares because of no driver costs. Majority of the people surveyed stated that they would prefer automated buses if both automated and conventional buses were available on a route. Passenger security would be one of most concerned issues for automated buses especially during night time services. The public also had positive attitudes towards other applications of automated vehicles in urban areas. More than half of the people surveyed stated that they would consider using automated cars if they become available. Of the people who stated they would consider using automated cars, about three quarters said they would like to own automated cars, and about one quarter to share automated cars through services such as car-sharing, car-pooling, or taxis. It seemed that there were some misconceptions about the benefits of automated vehicles, especially the safety benefits. Automated vehicles should be safer than human driven vehicles because of removing human errors. Safer than human driven vehicles is one of the major driving forces for the development of automated vehicles and would be a prerequisite for implementation of automated vehicles on public roads. From the survey, only a quarter of the respondents believe automated vehicles would be safer than human driven vehicles. This could be a result of low levels of awareness or/and understanding of the self-driving technology. In La Rochelle, demonstration of the automated mini buses was very successful to increase awareness and demonstration of automated vehicle concept. However, the vehicles were operated in low speed and with little interaction with other motorized traffic, which were not enough to convince the public what automated vehicles can do in real conditions, especially the safety benefits. Safe interactions with other road users would be one of key challenges for implementation of automated vehicles in urban areas. This implies that further researches are needed in the future to test automated vehicles in different road/weather/traffic conditions, and to convince the public.

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