

# A Comparative Study on User Characteristics of an E-car Pooling Service in Universities in Europe

Fivos Galatoulas, Sesil Koutra, Pawel Rycerski,  
Luis M. Ibarra Candanedo and Christos S. Ioakimidis<sup>(\*)</sup>

*ERA Chair (\*Holder) 'Net-Zero Energy Efficiency on City Districts, NZED' Unit, Research Institute for Energy,  
University of Mons, 56 Rue de l'Epargne, Mons, Belgium*

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**Abstract:** An impactful solution for confronting critical environmental problems may be pursued within the context of e-carpooling services. Nevertheless, a crucial part in our intervention through the introduction of efficient carpooling systems is that of the conceptualization of user preferences and attributes. This study presents a comparison between two surveys focused on a respondent sample consisting mainly of members of a university community. Specifically, the first survey involved students and employees of a private academic institution (University of Deusto, Bilbao, Spain) while the second members of a public institution in (University of Mons, Hainaut, Belgium).

## 1 INTRODUCTION

The mobility concept of e-carpooling offers not only an alternative means of covering the increasing requirements for human mobility, but also a low-cost measure to alleviate the effects for a number of problems, including traffic congestion, energy consumption and environmental degradation, among others (Bruglieri et al., 2011). Generally, carpooling aims at increasing the vehicle occupancy, focusing on the transportation of a group of individuals from a given origin to a specific destination at the same time (Katzev, 2003). In particular, it refers to the establishment of agreements between a driver and one or more passengers to share a ride in a single vehicle, rather than making the same trip individually (Dimitrakopoulos et al., 2012). The driver and the passenger(s), also referred to as “car poolers”, agree in advance to share the fuel and other relevant costs (e.g. toll fees) for a specific trip in order to have a mutual benefit on the transportation costs. Even though the term car sharing is sometimes used (mainly in the United Kingdom and to some extent in Australia and New Zealand) as a substitute for or interchangeably with what is known as carpooling in the academic and increasingly popular discourse (Kent and Dowling, 2013, Stillwater et al., 2009), a main difference in carpooling is that the individuals share a common route, not only the car (Katzev,

2003). In the most typical form of carpooling, both driver and car poolers have the same origin and destination, while more complex structures occur if they share only a part of a given trip (Vanoutrive et al., 2012). The innovative characteristic of e-carpooling is the combination of carpooling with the emerging electric vehicle technology.

In addition, transportation is considered as one of the primary fuel use sectors worldwide, while being responsible for a significant share of greenhouse gas (GHG) emissions. Given the imminent depletion of oil reserves and the resulting volatility of fuel prices in international markets, the widespread adoption of electric vehicles is often viewed as a feasible alternative to vehicles with internal combustion engines that could contribute, to a significant extent, to the decarbonisation of the transportation sector (Chan and Shaheen, 2012).

From the authors' point of view, the combined use of car sharing and carpooling services with electric vehicles can multiply the potential benefits in terms of reduction on the traffic congestion, air and noise pollution, as well as dependence on fossil fuels. To this end, this paper presents the results of two surveys, the first conducted at the University of Deusto (UD), Bilbao, Spain and the second at the University of Mons (UMONS), Belgium in an attempt to identify differences and similarities between the academic communities on their perception on the transition to

electromobility and alternative modes of transport. The purpose of this work is twofold, first to record the everyday practices and preferences of the employees and students regarding the use of public transport in different cities-countries, to explore their attitude towards the use of electric vehicles, including cars, scooters and bicycles, and the adoption of e-car sharing/carpooling as a means of transport and finally to examine the reasons behind the groups choice of mode of travel depending on the local transportation framework, national commuting statistics and possible implicate attributes.

## 2 METHOD

### 2.1 Survey Characteristics

A survey questionnaire was prepared and distributed to members of the university campus at both occasions via a Google platform. Each participant was selected randomly but asked to validate his academic identity. Respondents were explained broadly the concept of carpooling and were invited to carefully read questions before answering.

### 2.2 Description of Samples

Our sample in the first case, the survey conducted in 2014 at the UD, consisted of a representative sample of 124 students of which 49,2% were women. The purpose of this survey was to collect information on the use of public transport and analyze the attitude of the respondents towards new modes of transport and use of electric vehicles, including cars, scooters and bicycles. The questionnaire included an age indicator in order to divide the respondents into groups by year of tuition. The majority of the respondents belongs to the age group 17-18 years old (1st year), followed by 3rd year students and respondents from the final years having the lowest percentage, as shown in Fig. 1.

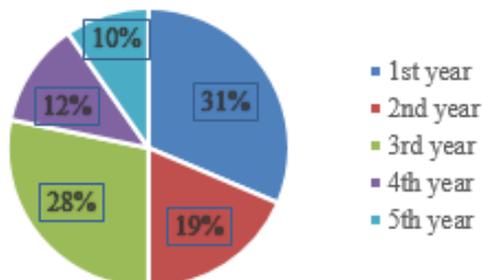


Figure 1: Percentage breakdown by age group of the UD sample.

The second under study survey (26 questions) was conducted at the UMONS campus during the period from 17/6 to 30/7/2015 in a sample of 59 students. The purpose of the survey was to gather data on the user preferences and analyse the attitude of the respondents regarding the concepts of carpooling and electro-mobility, in order to identify their characteristics as potential users of a university-based e-carpooling system in the city of Mons. The survey was based on a random sample of 59 Bachelor (51%) and Master (49%) students. More specifically, the sample consists mainly of students in their 1st (27%), 4th (22%) and 5th (27%) year of studies, as shown in Fig. 2.

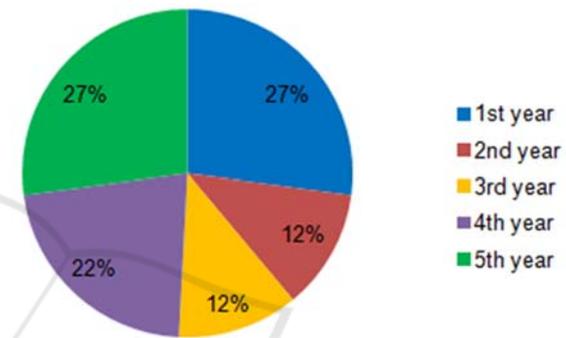


Figure 2: Survey characteristics.

## 3 RESULTS

In this section, the key results of each survey study are presented in order to provide the necessary information for evaluating the extent to which the two population samples differ in terms of response data.

### 3.1 Student Survey Study at the University of Deusto

The UD is located in Northern Spain in the heart of the economic and cultural capitals of the Basque Country - Bilbao and San Sebastian. UD was founded in 1886 due to the Basque community's desire for independent education and the Society of Jesus's wish to move its School of Higher Studies in Laguardia to a more central place. The university has more than 10.000 students and approximately 600 members of staff (Morigi and Trombetti, 2006).

#### 3.1.1 Part I: Driving Profile

The first query of the survey aimed to determine the percentage of the respondents that hold a driving license, with percentages of possession increasing

accordingly to year of tuition. Fig. 3 presents the percentage share of driving license holders per age group.



Figure 3: Percentage share of respondents holding a driving license.

The next query referred to private vehicle ownership. Of the respondents holding a driving license, a percentage of 45,7% owns a car. Accordingly, Fig. 4 illustrates the percentage of survey respondents that own a car in each age group.

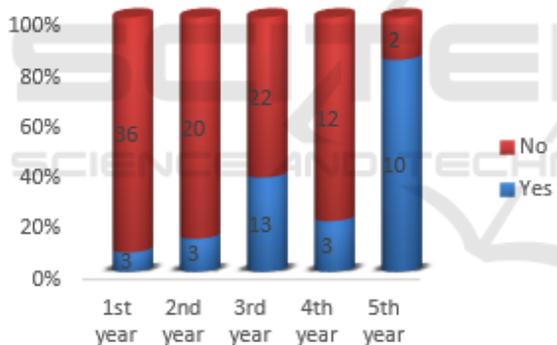


Figure 4: Percentage of total respondents owning a car.

### 3.1.2 Part II: Use of Public Transportation

Nearly a percentage of 80% of the respondents use public transport in Bilbao, most of which belong to freshman years, while more experienced students are ranked lower in terms of public transport use. The overwhelming majority of the respondents (95%) reported the use of the subway, because of the geographical coverage, with bus transport being also a widely used means of transport (65% of the respondents), given the good connections between buses and the fact that there are some areas not served by the Metro service. Most of the younger respondents (1<sup>st</sup>-2<sup>nd</sup> year) use it on a daily basis, while the rest use it at most twice a week

### 3.1.3 Part III: Use of New Technologies

Regarding the possession and use of new technologies in the form of a smart phone with internet access, a percentage of 70% of the respondents answered affirmatively (Fig. 5), with people in earlier years of their tuition stating that it is one of the primary means of communication, while the other groups mentioned having the basic skills to send emails and/or open files.

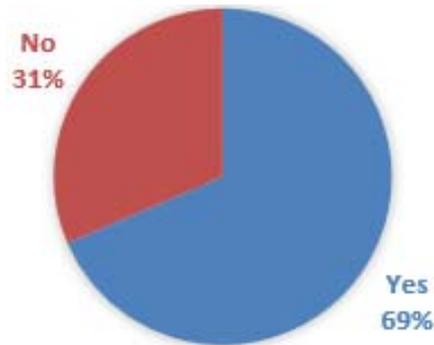


Figure 5: Percentage of Smartphone users.

### 3.1.4 Part IV: Residential Distribution

In terms of sociodemographic and transportation accessibility, the results of the survey also show that only 5% of the people interviewed reside between 30 and 75 km from Bilbao, while a percentage of 33% resides outside the city center but within a distance of 30 km. Fig. 6 presents the distribution of respondents following the query of the distance of their residence from the center of the city of Bilbao.

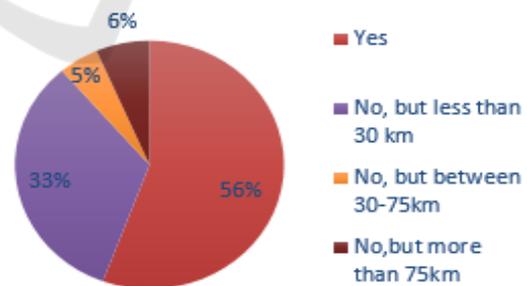


Figure 6: Distance of residence from the city centre.

### 3.1.5 Part V: Attitude towards Electromobility/ Carpooling

A key finding of this survey was that most of the respondents opt for an electric vehicle to move around Bilbao or within 30 km, while the order of preference is electric car, electric scooter and electric

bicycle with percentages of 53%, 37% and 10% respectively. Moreover, a percentage of 60% of our sample considers electric vehicles as an economic and environmental option, while the rest 40% stated that it is not only economic and environmental, but also offers quick access. Regarding the perception of the electric vehicle concept from the respondents, approximately 85% of them believe that an electric car has a single electric motor, while the remaining 15% reported that electric cars have both an electric motor and a gasoline engine.

In addition, the survey included a set of queries to identify the attitude towards electromobility and the willingness to use non-traditional modes of transport. Remarkably, only 35% of the people interviewed are not willing to rent an electric means of transport, while of the remaining 65%, a share of 75% would rent an electric car and the rest 25% would rent an electric scooter. A percentage of 85% of the participants in the survey reported that they would share a car to go to work or to the same destination with the same schedule. Equally important, a share of 73% of the respondents stated that, for electric transport services, they would pay the same amount with the daily cost of public transport, while the rest 27% is willing to pay 10% more.

In the last part of the survey, the participants were asked to express their opinion about the electric means of transport, specifically for the electric car. In general, the respondents believe that it is an expensive option, because of the cost of charging, and that there is a lack of the required infrastructure, as there are only a few charging points in the city. Furthermore, the survey participants note that electromobility will eventually be the most viable way for transportation purposes, a fact that should be also taken into account in the public sector. Regarding their opinion for MaaS, thus, car sharing and carpooling as alternative modes of transport, the participants consider this as an opportunity to save costs, prevent traffic congestions, meet new people, and in general they would share a car to go to their work with their colleagues or people that wish to move to the same place with the same schedule.

### 3.2 Student Survey Study at the University of Mons

This section presents the results of the survey conducted at UMONS, which is a French-speaking public university in the Hainaut province of Belgium, near the French-Belgian border and it is situated approximately 50 km from Brussels. UMONS was created in 2009 following the merger between the

University of Mons-Hainaut and the Faculty of Engineering of Mons. Today, the university has more than 6.000 students and more than 1.000 employees (Ioakimidis et al, 2016).

#### 3.2.1 Part I: Driving Profile

Framing their profile, the first query aimed to determine the respondents that hold a driving license and it was answered affirmatively by the majority of them (66.1%). With respect to the number of years holding a license as an indicator of the driving experience, more than 40% of the relevant respondents have held their license for 1-3 years, more than 30% of them have possessed their license for a longer period of 3-7 years, while significant is also the percentage of respondents with a driving license for more than 7 years (23.1%), as shown in Fig. 7.

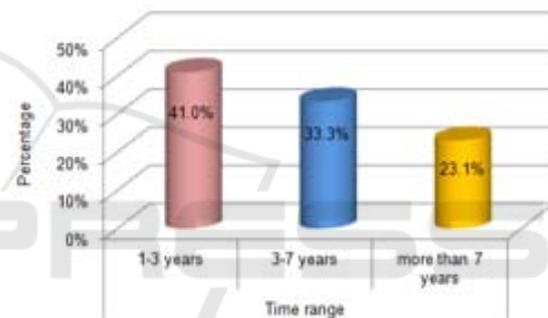


Figure 7: Time distribution of driving licence possession.

#### 3.2.2 Part II: Use of Public Transportation

A high share of the interviewed persons uses only the car for daily commuting to the university (25%), while interesting is also the number of users that prefer going on foot to their destination (17%). However, a significant part of the respondents combines public transportation (car-metro, bus-car, bus-foot, etc.) to cover the daily transport needs. Fig. 8 presents graphically the results discussed. In general, the overwhelming majority of survey participants makes use of public transportation (not necessarily for commuting to the university only) on a daily basis (86%), while only 7% of them once per week. Obviously, the good connections between the various means of transportation encourage the frequent use by commuters; however, the percentage of car use for commuting to the university still remains high (25%).

Two important issues regarding the use of public transportation are: (i) the estimated time from their home to the university, and (ii) the monthly expenses.

With respect to the estimated trip time, more than 30% of the interviewees need between 15-30 min for a single trip, while approximately 30% of them estimate 30-60 min per trip. Less than 5% of them need only 5 min (residence in Mons) and more than 10% take more than 60 min to arrive at the university (due to inadequate geographical coverage of public transportation, long distances, bad connections, etc.).

The second key factor and incentive for the encouragement of public transportation use is the indicator of monthly expenses. The majority of the respondents (more than 40%) spend less than 25€ per month for daily commuting to the university (obviously using public transportation), while a significant percentage of 17.4% of them spend more than 65€ monthly (possible car use).

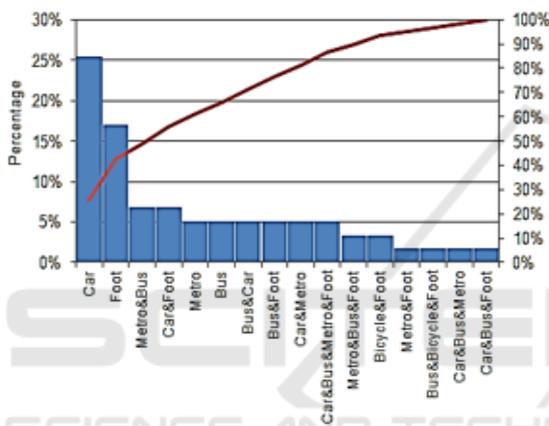


Figure 8: Use of means of transportation for commuting to the University.

### 3.2.3 Part III: Use of New Technologies

Regarding the possession and use of new technologies in the form of a smart phone with Internet access, a percentage of approximately 75% of the respondents answered affirmatively (Fig. 9), while more than 95% of them possess a personal computer with Internet access, considering them as primary means of communication.

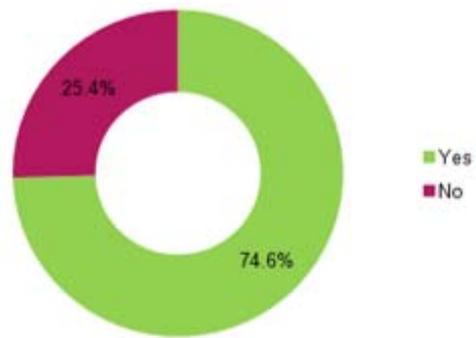


Figure 9: Possession of smart phone with Internet access.

### 3.2.4 Part IV: Residential Distribution

The results show that only 14% of the respondents reside in the city, while the rest of them prefer commuting as they reside in a distance between 10-35 km (30%) or in a distance of more than 35 km (approximately 40%) from the city centre (Fig. 10).

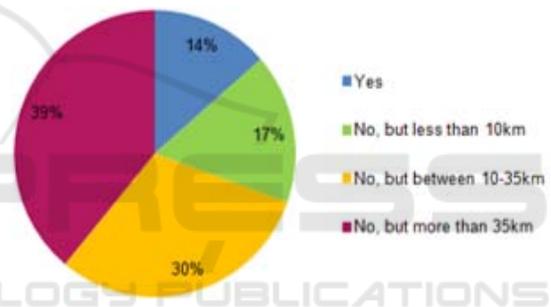


Figure 10: Residence in the city of Mons and distance from city centre.

### 3.2.5 Part V: Attitude towards Electromobility/ Carpooling

In addition, the survey included a set of queries to identify the willingness to use non-traditional mobility concepts. It is interesting to note that a remarkably high percentage of the respondents answer affirmatively to the idea of carpooling with one or more persons (almost 80%), while only 13.6% of them show no interest in this mobility concept, as depicted in Figure 11.

Following the willingness for carpooling, the respondents were asked for their potential participation in carpooling if financial or ecological criteria are promoted. Approximately 60% of the interviewees would opt for carpooling for financial reasons, while more than 50% of them are encouraged by ecological initiatives. It is interesting to note that more than 40% of them support the concept of carpooling even if they are not the drivers.

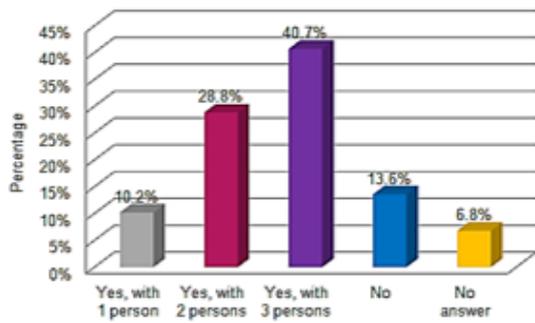


Figure 11: Willingness to carpool.

Another finding of the survey is that more than a half of the respondents (53%) opt for public transportation to move around Mons or within 30 km compared to EVs, while the preference for the latter is electric car (22%), electric bicycle (22%) and electric scooter (only 3%), as shown in Fig. 12.

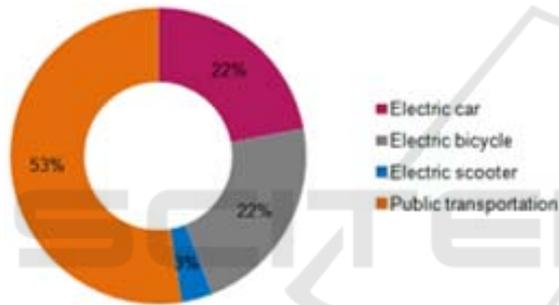


Figure 12: Preferable means of transportation in the city of Mons.

The main reasons for the users’ preferences on the means of transportation for the trips in the city of Mons are a combination of ecological, financial and time criteria (roughly 30%), while the combination of ecological and financial criteria is also crucial for the interviewees (approximately 24%). Moreover, the estimated time for quick access per se is also considered as important factor for the users’ choice. In the last part of the survey, the participants were asked to express their opinion about the electric means of transportation and their willingness to use them for daily commuting. Despite the fact that 1 out of 2 participants shows no interest in renting an EV for commuting to the university, an additional key finding regarding this part of the survey is that approximately 30% of them would prefer to rent an electric bicycle and roughly 20% would prefer an electric car. At a first glance, this finding indicates that the users are cautious about electro-mobility, considering EVs as an expensive or not an appropriate option for their daily commuting to the

university. A main reason for this perception can be attributed to the complex infrastructure required to support electro-mobility. On the other hand, almost 30% of the survey participants would share their rented EV in order to commute to the university, while 25% of them show no willingness for such a concept (the rest survey participants gave no answer). The last predictors examined the users’ willingness to be charged with extra fees for renting an EV compared to a conventional one. Specifically, a share of 54% of interviewees would not pay more to benefit from the use of an EV, while 19% of them could afford additional fees of more than 10% (only 3% report more than 25% for the possession and use of an EV).

#### 4 DISCUSSION

Despite the numerous environmental benefits deriving from the adoption of e-carpooling as a mode of transportation (reduction of air pollution, fuel consumption savings, cost-effectiveness and higher vehicular occupancy leading to a subsequent decrease of cars on highways), it has not yet sufficiently outspread in European cities. In our study, an attempt to identify the differences in motivation and preferences of students, belonging to two different University settings, concerning urban solutions on transportation was performed through the assessment of factual data and survey responses.

Both student population samples were similar in transportation accessibility, age distribution and agglomeration size. However, students in Bilbao reside closer to the center of the city than their fellow students in Mons.

Importantly, an impactful fact is Belgium’s high rate of daily commuters, claiming first place in the EU. On average, Belgians commute 53.2 minutes a day, compared to the European average of just less than 45 minutes. One in five Belgians spend two hours a day commuting. The time Belgians spend commuting scores to an average of nearly seven full days a year (Eurostat, 2016). On average, Europeans spend 45 minutes a day on public transport with the Spanish dedicating 51.6 minutes per day to commuting. From an unexperienced point of view these numbers would assimilate the mobility perspective of both regions, nonetheless one must take account of the average commuting distance per country, with Belgians topping cross-border rate of commuting in 2015 where more than one in five (21.9 %) persons commuted to work in a different region. This fact can explain the difference observed

in the query regarding preferable means of transport in the city, with public transportation gathering higher percentages in the UMONS student sample, while on the contrary students of the Basque institution selected the EV car as their optimal mean.

In addition, this can be explained to a great extent if viewed in the context of the economic incentives for the promotion of electric vehicles provided by the Governments of Spain and the Basque Country, given that they can be combined cumulatively in order to increase the total amount of subsidy. Recently, the Spanish Government approved the new program for subsidizing the purchase of battery electric vehicles with at least 4 wheels, depending on the range and the type of vehicle (Spanish Ministry of Industry, 2013). In the Basque Country in particular, the local Government provides subsidies for the purchase of a wider range of vehicles, including a maximum amount of 5000 € for a plug-in hybrid or a pure electric vehicle, as well as for an electric vehicle with range extender, 750 € for an electric motorbike and 400 € for an electric moped. Moreover, a gradually increasing per vehicle subsidy applies to the case of multiple vehicles (of the same category) purchase. Regarding the charging infrastructure, there is a subsidy of up to 40% of the cost of the complete installation (excluding IVA). For residential parking lots or fleets of electric vehicles, the maximum amount cannot exceed 500 € per charging point, while for public-use charging points the maximum economic assistance depends on the type of the installation, with a maximum amount of 2000 € for mode 3 charging and 5000 € for mode 4 (fast DC) charging (EVE, 2013).

In contrast, the results retrieved from the survey in UMONS, imply that electro-mobility has not spread to the full extent of its potential, but still from the user's perspective there are two major barriers in owning and/or using an electric car: (i) it costs more than a car with an internal combustion engine, and (ii) it has in general a limited range compared to a conventional vehicle. It is important to note that the total amount of the economic aid cannot exceed the 20% of the total eligible cost of the vehicle.

Similar acceptance rates were recorded in identifying the key factors that could assist in predicting the willingness to carpool. Specifically, the findings of the UMONS survey indicate that 4 out of 5 survey respondents would participate in carpools (80% for the first sample), while almost 3 out of 10 participants would rent and share (carpool) an EV in order to commute to the university, conflicting with the high EV acceptance rates scored in the Basque study. The reasons for carpooling in both targeted

samples recognized as incentives, financial gains, environmental awareness and time-saving. The findings of the first survey also include that 2 out of 3 respondents are willing to rent an electric means of transport, while a percentage of 85% of the respondents would share a car to go to work or to the same destination with the same schedule. Furthermore, this preliminary approach reveals that 1 out of 4 respondents is willing to pay a premium of 10% of the daily transportation cost with public means in order to use electric transport services in Bilbao.

The final aim of this study was to evaluate the level of acceptance and attitude towards the transition to electromobility. Initially, this work considers the geographical distribution of residence for the population under study, given that almost 9 out of 10 individuals reside close to the city of Bilbao. This implies that a significant part of the sample potentially combines different modes of transport in order to commute to and from the university. The results of the survey show that at least 4 out of 5 respondents use public means of transport to cover their transportation needs.

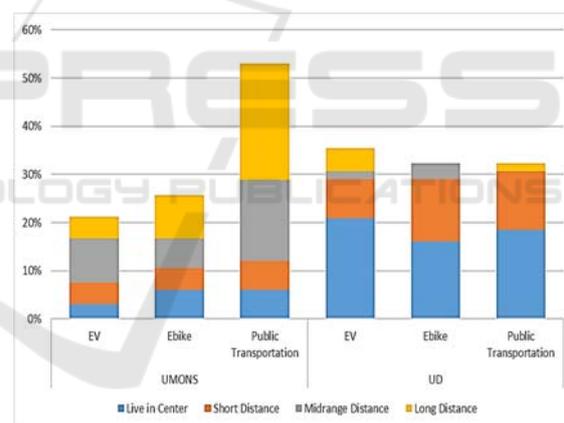


Figure 13: Comparative representation of preferable mode of transport per study group linked to distance from city centre.

Remarkably, most of the respondents from the UMONS study use a private vehicle (25%) with second preferred way of transfer being by foot, a fact connected to the short range distances a student must cover for inter-campus transport within the scale of Mons. The electric car is considered as the most popular choice, with electric scooters and bicycles being secondary options for students of UD when at the same time students in UMONS tend to be cautious with the concept of electromobility, as depicted in Fig.13.

## 5 CONCLUSIONS

The findings of this work indicate that both survey respondents are in support of public transportation, while the users' acceptance on renting an electric car in order to commute to the university is relatively low yet encouraging in the case of UMONS. Therefore, a university-based MaaS e-carpooling concept can be a promising solution as the total costs of owning and/or using an EV spread among many users and it becomes part of the public transportation system for complementing both local and long-distance trips.

To conclude, the results obtained within the frame of this work reveal that the members of the first case study show a positive attitude towards using both car sharing/carpooling services and electric vehicles. Future work includes a comprehensive study for examining the case of implementing a car sharing/carpooling service with electric vehicles within universities, addressing these issues by enlarging the sample base and recording preferences with objective measures.

## ACKNOWLEDGEMENTS

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