User characteristics of an electric bike sharing system at UMONS as part of a smart district concept

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Abstract—The widespread deployment of electric vehicles (EVs), combined with the shift towards alternative modes of transportation, has the potential to alleviate the problems associated with the high use of private vehicles for commuting trips, mainly in urban areas. In this context, the present paper discusses a survey conducted at the University of Mons (UMONS), Belgium, in order to examine the characteristics and attitude of the students in this university community with respect to renting an electric bike (e-bike), as well as to identify the key factors that influence the use of an e-bike sharing system as integrated part of smart cities. The results of the survey indicate the preferences and intentions of the population under study to use such a system and provide some useful insight for its implementation in the city of Mons.

Index Terms—Bicycles, Electric vehicles, Road transportation.

I. INTRODUCTION

Recent years have witnessed a growing concern over the energy use and the resulting carbon emissions in the transportation sector, leading to intensified efforts towards the decrease of the impact from transportation activities, not only in regional, but also in global scale. It is indicative that the transportation sector in 2011 was responsible for 33% of the final energy consumption in Europe [1]. In this direction, the promotion of non-motorized modes of transportation has received significant attention in the frame of sustainable urbanism and vision of eco-mobility [2]. Generally, the focus is on the use of more efficient vehicle technologies, along with a shift to public transportation systems, encouraging also the users to adopt the use of vehicle sharing schemes, based on either bikes or cars [3].

Particularly, the mode of transportation that has been mostly in the foreground is cycling due to its low cost, zero carbon emissions, and benefits on human health [2]. Therefore, recent literature has focused on the determinants of bike sharing systems as part of the emerging smart and sustainable cities. The interest in bike sharing is of high relevance to policy makers with respect to the challenge of rethinking ways of creating shared value in the context of environment conservation, cultural continuity, as well as social and health return on investment [4].

Bike sharing schemes as alternative transportation systems have been rapidly growing in popularity worldwide. Cities around the world invest on bike sharing systems to improve their mobility plans and reduce the car dependency [3], [5]. Bike sharing systems have been overcoming many operational challenges over the years to provide fully automated, secure, and cost-effective systems [6]. The authors in [7] suggest that sharing systems based on electric bikes (e-bikes) provide a high-level service compared to conventional bike sharing systems, while maintaining low environmental impacts. E-bike sharing systems are expected to contribute, among others, to [8]:

- reduction of single occupancy journeys with cars, and thus ease of traffic congestion,
- reduction of CO₂ emissions from motorized traffic, and thus improvement of air quality,
- increase of physical activity levels and improvement of public health,
- improvement of accessibility and flexibility of mobility,
BACKGROUND ON BIKE SHARING SYSTEMS

Bike sharing systems exist for nearly half a century, however only few studies have systematically examined the demand or other operational parameters of these systems [7]. Bike sharing systems have taken many forms over the course of their development, ranging from systems with bikes freely available for a community to more technologically advanced and safe systems. Originally a concept from the revolutionary 1960s, the growth of bike sharing had been rather modest until the development of better methods for tracking bikes with the support of innovative technology systems, which significantly contributed to its rapid expansion in the recent years, as shown in Fig. 1 [10].

The services of bike sharing systems can be categorized into three (3) generations, as follows [11]:

- free-bike systems, where the bikes are available to the users without any cost,
- coin-deposit systems, where the users have to pay in order to unlock a bike from the docking station and use it, and
- information technology systems, based on automatic services and smart technological tools.

The first-generation bike system was introduced in Amsterdam in 1965; however it suffered from bike damages and thefts. The second-generation bike system was launched in Denmark in 1991; nevertheless it failed to successfully address the problems of vandalism and theft. To this end, third-generation bike sharing systems incorporate several technological improvements, such as automatic bike racks, telecommunication capabilities, mobile phones and smart cards, to unlock the bikes from the stations and enable automatic user identification [10], [11]. The first system of this generation was installed at the University of Portsmouth, England, in 1996 [12], while significant advances ever since have improved the security, accountability, monitoring and billing of this type of bike sharing systems. The cities of Lyon and Paris in France launched highly successful bike sharing programs in 2005 and 2007 respectively [12], [13]. France was the first to use a third-generation bike sharing system with smart card technology in 1998. The Vélo'v system run by the city of Lyon opened in 2001, providing the basis for the Vélib' system in Paris [10]. Table I presents the distribution of bike sharing schemes by country as reported in [14], revealing that the majority of systems in Europe are concentrated in France. The authors in [3] report that more than 300 bike sharing systems have been deployed around the world, with Europe having a remarkably high concentration of these systems (Fig. 2), roughly estimated at 78%. In addition, the data available in [15] reveal that advanced bike sharing programs are run by more than 700 cities in 57 countries.

It follows that existing bike sharing systems provide useful insight on best practices for the implementation of such applications, even though there is a number of local characteristics in each city that play a critical role, such as population density, topography, weather, infrastructure, and culture. Examples of most successful systems in European and other cities share the following common features, among others [10]:

- dense network of stations across the coverage area,
- fully automated locking system,
- wireless tracking system (e.g., radio frequency identification devices) to locate the bikes and identify the users,
- real time monitoring of bike station occupancy, and
- real time user information using various platforms and mobile devices.

III. POPULATION STUDY AND SURVEY

This section analyzes the data of the survey at the University of Mons (abbreviated as “UMONS”), which is a French-speaking 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 (Fig. 3).
Today, the University has more than 20,000 students and more than 1,000 employees [17].

<table>
<thead>
<tr>
<th>Country</th>
<th>Systems</th>
<th>Bike Fleet</th>
<th>Bike Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1</td>
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<td>n/a</td>
</tr>
<tr>
<td>Austria</td>
<td>1</td>
<td>1540</td>
<td>58</td>
</tr>
<tr>
<td>Belgium</td>
<td>1</td>
<td>250</td>
<td>23</td>
</tr>
<tr>
<td>Canada</td>
<td>1</td>
<td>2400</td>
<td>300</td>
</tr>
<tr>
<td>China</td>
<td>2</td>
<td>200</td>
<td>2</td>
</tr>
<tr>
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<td>2</td>
<td>2400</td>
<td>167</td>
</tr>
<tr>
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<td>39798</td>
<td>2643</td>
</tr>
<tr>
<td>Germany</td>
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<td>5800</td>
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</tr>
<tr>
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<td>246</td>
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</tr>
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</tr>
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<td>59</td>
</tr>
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<td>100</td>
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</tr>
<tr>
<td>Total</td>
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<td>69238</td>
<td>4630</td>
</tr>
</tbody>
</table>

Figure 2. Bike-sharing European Map (retrieved from [16]).

A. Survey Characteristics

The survey was carried out at the UMONS campus during the period of 17/06 to 30/07/2015 on a sample of 74 students. The purpose of this work is to collect information on the preferences and analyze the attitude of the respondents towards the use of e-bikes in the form of a vehicle sharing system. The analysis of the survey results consists of three parts: Part I includes main characteristics of the users’ profile, Part II identifies key factors that influence the decision for renting an e-bike, and Part III outlines other user preferences.

B. Analysis and Results

1) Part I: Profile of Users

The survey includes a sample of 74 students of Bachelor and Master level from the first to the last year of their studies, mainly students of 1st (29.7%), 4th (23.0%) and 5th year (27.0%), as shown in Fig. 4. The majority of the respondents are women (approximately 82% of them).

2) Part II: Key Factors for E-bike Rent

This part includes a series of queries concerning key issues for the e-bike rent, framing the reasons and initiatives for their use by the respondents. Specifically, the first query investigates the potential reasons of the e-bike rent. The majority of the respondents (26%) would rent an e-bike because of its ecological benefits, while a share of 20% because they consider e-bikes as practical and comfortable means of transportation. Other significant reasons include the
easiness to ride (15%), reduction of traffic congestion (15%), and the fact that e-bikes are considered cheap means of transportation compared to car or taxi (17%), while much smaller is the percentage of the respondents that would rent an e-bike because they like the feeling of riding it (3%), as shown in Fig. 5.

Figure 5. Reasons for e-bike rent.

Other reasons registered that could encourage respondents to the e-bike rent are the following: mainly the less tiredness (25%), more dependency (12.5%), no need for pedaling (12.5%), physical assistance (12.5%), no requirement for driving license (12.5%), and to stroll (12.5%), as presented in Fig. 6.

Figure 6. Other reasons for e-bike rent.

The next key issue that the survey explores is the duration that respondents would like to rent an e-bike (Fig. 7). Approximately 28% of the respondents would like to rent a bike for a whole day, 23% for less than 30 min, 20% for 1 to 6 hours (for their commuting during the day), 19% for 30 to 60 min, whereas only 8.1% of them for more than one day.

Two other points examined in this survey are: (i) the intentions and initiatives for an e-bike rent, and (ii) the reasons why a user would not accept the use of an e-bike. Fig. 8 shows the survey participants’ intentions for an e-bike rent, where 47% of them would use it to go to their workplace (or University), 18% and 14% of them for sightseeing and entertainment respectively, and 13% to go to another building of the University. Correspondingly, Fig. 9 presents the results regarding the reasons for not renting an e-bike. As expected, the main obstacle is the weather conditions (48%), and to a lesser extent the lack of adapted bike lanes in Mons (5%), as well as the fact that the users consider the bikes as unsafe and insecure means of transportation (14%) or because they prefer conventional bikes (8%) or public transportation (2%), among others.

Figure 7. Duration for an e-bike rent.

Figure 8. Intentions and initiatives for an e-bike rent.

Figure 9. Reasons for not renting an e-bike.

The present survey further investigates key indicators for an e-bike rent, discerning seven (7) factors that influence this decision (the importance given to each factor ranges from 1: not at all important to 5: very important), namely price, conditions, brand, color, quality, size and electric range. In this context, Fig. 10 shows the findings for the key factor of ‘price’. As expected, this indicator is very or fairly important for the potential users of e-bikes (55.4% and 32.4% of them respectively). Fig. 11 presents the survey results on the importance of the rent conditions as a key factor for renting an e-bike. The majority of the respondents consider this parameter as fairly important or very important, with shares of 40.5% and 36.5% respectively.
Additionally, other indicators of high importance for the encouragement of an e-bike rent are: (i) the quality, and (ii) the size of the e-bikes. Fig. 12 indicates the importance of the parameter of ‘quality’ at users’ behavior towards the e-bike rent. For the majority of them the e-bike quality is very or fairly important (35.1% and 32.4% respectively), while roughly 1 out of 4 users considers it as important.

An interesting finding of this survey is that less importance is given to the parameter of the ‘electric range’ of the bikes. As shown in Fig. 14, the indicator of the electric range is slightly important, important and fairly important for 28.4%, 32.4% and 16.2% of the users respectively.

Moreover, the survey concludes that there are also parameters, such as the ‘color’ or the ‘brand’ that have no noticeable importance for the e-bike rent. Specifically, more than 60% of the respondents consider that the color has no influence on their decision concerning an e-bike rent for commuting purposes, while approximately 25% of them consider it as slightly important. In the same direction, the survey results on the indicator of ‘brand’ converge to the fact that it has trivial importance for the users’ decision making concerning the e-bike rent, given that approximately 70% of them would ignore it as a criterion.

Another key issue regarding the e-bike rent includes the preference for the ways of payment. Fig. 15 presents the main results of this query: 46.2% of the respondents would prefer to pay in cash for the e-bike rent, followed by a percentage of 45.3% that would like to pay via online transactions, either with credit/debit cards or e-wallet services.

3) Part III: Recommendations and Other Issues

In the last part of the survey, the participants were asked to express their recommendations about alternative itineraries that could be useful during their daily commuting apart from the University (or their workplace). Approximately 80% of the participants would like to receive route suggestions for other interesting destinations (apart from the route to the University) during the rent period of the e-bikes.
This paper presents the results of an exploratory survey on a representative sample of students at UMONS, aiming at identifying the characteristics of the potential users of an e-bike sharing system, in support of the indicative mobility plan in the city of Mons, Belgium (Figs. 16 and 17). On the one hand, the results indicate the preferences, intentions and key factors affecting the decision of the survey participants to use such a system. On the other hand, the survey reveals the problematic points related to the e-bike rent in Mons, confirming that the harsh weather conditions are considered to be the most important obstacle, while other important issues include the lack of infrastructure, non-adapted bike lanes, and preference for public transportation or conventional bikes. This implies that further analysis in terms of policies and mobility plan would provide the basis for a better perception of the e-bike sharing system in the city of Mons, taking into account the user demand, as well as its daily variation, in order to ensure system availability, and thus user satisfaction.

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References


