

User Characteristics of an e-Carpooling System at UMONS as Part of a Smart District Concept*

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Abstract— Carpooling is a mobility concept that has the potential to effectively reduce the single occupancy trips with passenger cars, and thus energy consumption as well as traffic congestion, while coupled with electric vehicles (EVs) and intelligent transportation systems (ITS) can contribute to the smarter and more sustainable use of transportation networks as integrated part of smart cities. However, in practice, the success of carpooling systems has been limited by psychological barriers related to the level of trust for sharing a ride with strangers, and the necessity for convergence of schedules and trips for ride-matching. To this end, the present work advances the concept of a university-based carpooling system with EVs (e-carpooling), as a means of restricting the access to a closed community with a critical mass of users having the same origin/destination. In particular, this paper reports on the results of a preliminary survey conducted at University of Mons (UMONS), Belgium, in order to explore the characteristics of this user community with respect to the concepts of carpooling and electro-mobility. The results of the survey not only reveal the user preferences for the adoption of the proposed system, but also provide some useful insight for the implementation of the e-carpooling concept in the city of Mons.

I. INTRODUCTION

The mobility concept of 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 [1]. 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 [2]. 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 [3]. The driver

and the passenger(s), also referred to as “carpoolers”, 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 carsharing 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 [4,5], a key difference in carpooling is that the individuals share a common route, not only the car [2]. In the most typical form of carpooling, both driver and carpoolers have the same origin and destination, while more complex structures occur if they share only a part of a given trip [6].

Carpooling can be casual, organized as a service or flexible. In casual carpooling, the drivers form carpools with other passengers for purposes of commuting on an ad hoc basis in order to take advantage of fast high occupancy vehicle (HOV) lanes or to share the trip cost [7]. This practice is user-run and thus does not include any type of membership [8]. In organized carpooling, the users of the system typically join the service through a formal membership or by registering to the provider’s platform and, depending on the case, they may or may not participate in the same carpool every day [8]. Typical examples of this scheme include RideSearch (www.ridesearch.com), eRideShare (www.erideshare.com), and Carpoolworld (www.carpoolworld.com). The service may also operate on a point-based reward system, as in NuRide (www.nuride.com), whereby a member may earn points for participating in carpooling or green trips by taking public transportation or biking, while the points collected can be later redeemed as a reward, indicatively in the form of promotion coupons or discounts at local businesses [1]. Flexible carpooling is a semi-organized practice characterized by the non-necessity of prearrangement or fixed schedules for matching drivers and passengers [9]. Users can meet at designated parking lots, where common destinations are identified in order to establish the combinations of drivers and passengers by the order of arrival at the meeting point. The scheme proposed in [10] is based on high convergence of trips and uses also a membership system of transferable ride credits: the driver earns credits that can be used for a trip in the future, whereas the passenger gives a credit. In general, flexible carpooling offers the benefit of convenience without prior commitment, but with the main disadvantage that it requires a large number of participants [9].

Carpooling systems theoretically promise a great reduction of private vehicle use, but in practice their success has been limited by two main factors, namely psychological barriers related to the level of trust for sharing a ride with

*Research supported by the project E.U. RE-SIZED 621408 (Research Excellence for Solutions and Implementation of Net-Zero Energy City Districts).

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strangers, and the necessity for convergence of schedules and trips for ride-matching [11]. Reversely, these are the reasons that carpooling can provide an attractive mobility solution for universities by restricting the provision of the service to employees, faculty and students, as proposed within the frame of the projects PoliUniPool [1] and Carpool.UMD [12]. Moreover, the integration of electric vehicles (EVs) with carpooling (e-carpooling) and intelligent transportation systems (ITS) enables smarter and more sustainable use of transportation networks [13], thus it can multiply the potential benefits mainly in urban areas and during peak hours when most people commute to work.

In this context, the present paper reports a preliminary survey conducted at the University of Mons (abbreviated as “UMONS”), Belgium, in order to analyze the user characteristics and key factors that influence the use of a university-based e-carpooling system as integrated part of a smart district in the city of Mons, following a similar approach as in [14,15]. Although carpooling is far from being a new idea, mobility services based on this concept are now reaching the general population in many European countries, implying that there is a growing need to identify the extent to which the potential users are familiar with and willing to participate in such schemes. Given that relevant surveys, particularly on the field of e-carpooling, are scarce in the literature, this paper examines the case of the university students of UMONS as target population segment.

II. POPULATION STUDY AND SURVEY

This section analyzes the results of the survey conducted at 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. Today, the university has more than 20.000 students and more than 1.000 employees [16]. Fig. 1 illustrates the general plan of the campus in the urban area of the city of Mons.

A. Survey Characteristics

The 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 is to collect information on the user preferences and analyze 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 results are presented accordingly in seven (7) parts: Part I includes the characteristics of users’ profile and identity (data for the educational level, driving experience, etc), Part II is about the users’ attitude towards the public transportation (means, time, expenses, etc), Part III provides information about the familiarity of users with new technologies, Part IV identifies the user behavior regarding the concept of carpooling, Part V focuses on the trips in the city of Mons and use of EVs, Part VI encompasses the users’ attitude towards the benefits of peer-to-peer (P2P) service, and Part VII is related to the users’ opinion about electro-mobility and their willingness to promote its use for daily commuting.

B. Survey Results

1) Part I: Users’ profile

The survey was based on a random sample of 59 students of Bachelor (51%) and Master (49%) level. 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.

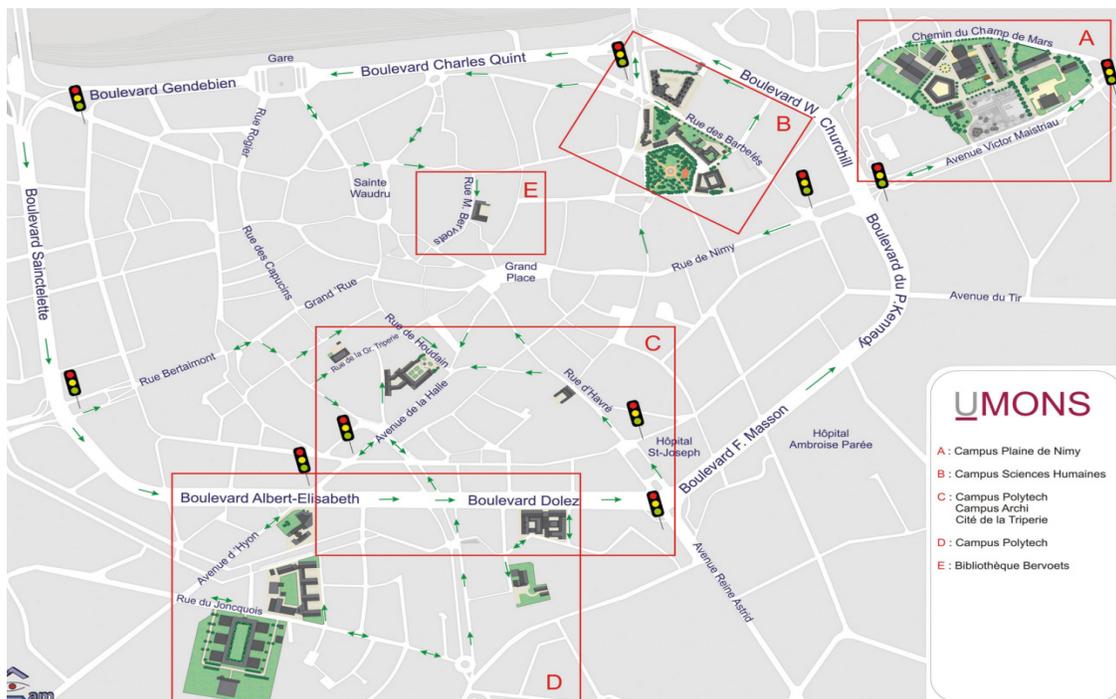


Figure 1. Departments of University of Mons, Belgium [16].

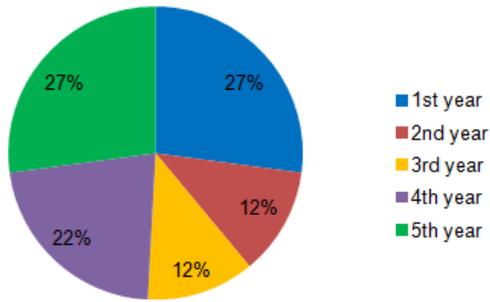


Figure 2. Survey participants: year of studies.

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. 3.

The next query refers to car possession and car parking space (including two cases: at home and at university). More than 60% of the respondents do not possess a car. From the positive answers, as expected, roughly 80% of the respondents possess a place at their home, approximately 5% of them at university, while a significant percentage (22.7%) of them do not have a parking place for their vehicle (neither at home nor at university), as illustrated in Fig. 4.

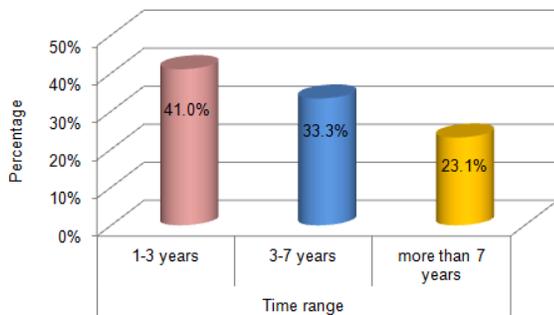


Figure 3. Time distribution of driving license possession.

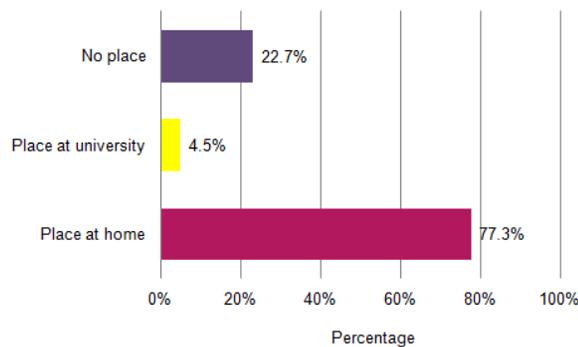


Figure 4. Possession of car parking place.

2) Part II: Use of Public Transportation

The next group of queries includes the use of public transportation and its related parameters, e.g. use of means of transportation for daily commuting to the university, frequency of public transportation use, estimated time from home to the university and monthly expenses for their trips.

A high share of the interviewed persons use 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. 5 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), as depicted in Fig. 6.

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 remarkable percentage of 17.4% of them spend more than 65€ monthly (possible car use), as shown in Fig. 7.

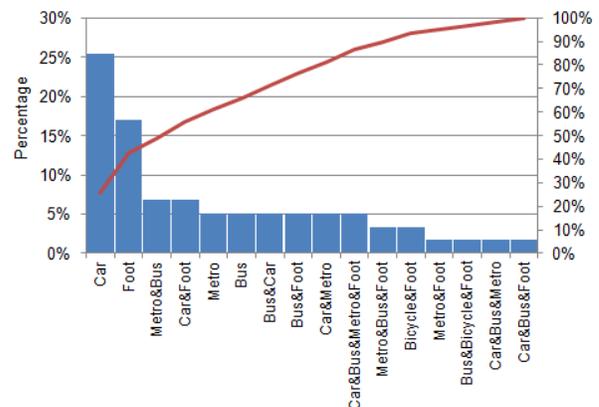


Figure 5. Use of means of transportation for commuting to the university.

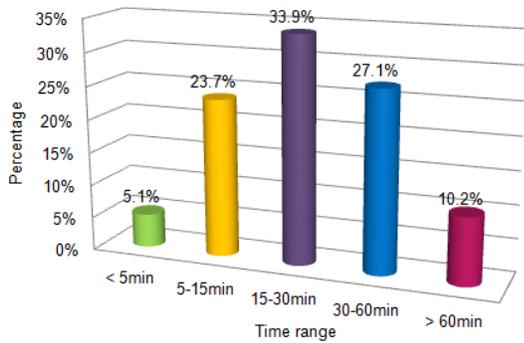


Figure 6. Estimated time from home to university.

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. 8), while more than 95% of them possess a personal computer with Internet access, considering them as primary means of communication.

4) Part IV: Carpooling and user's behavior

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 (Fig. 9).

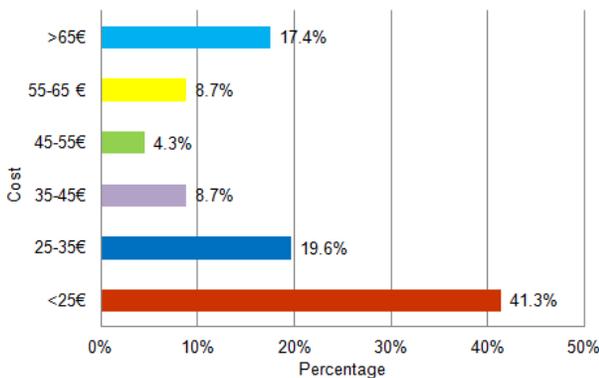


Figure 7. Monthly expenses for commuting to university.

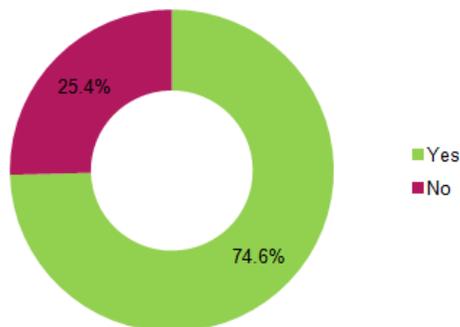


Figure 8. Possession of smart phone with Internet access.

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.

5) Part V: Trips in Mons and electro-mobility

This part of the survey examines two issues: (i) the characteristics of the trips in the city of Mons with respect to distance, and (ii) the preferences for EV use in the city. 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 center (Fig. 10).

A key 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. 11.

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 (Fig. 12).

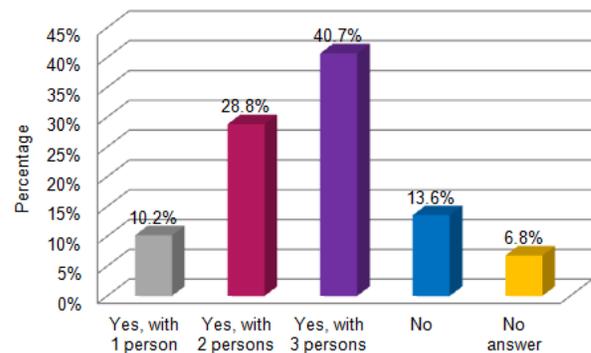


Figure 9. Willingness to carpool.

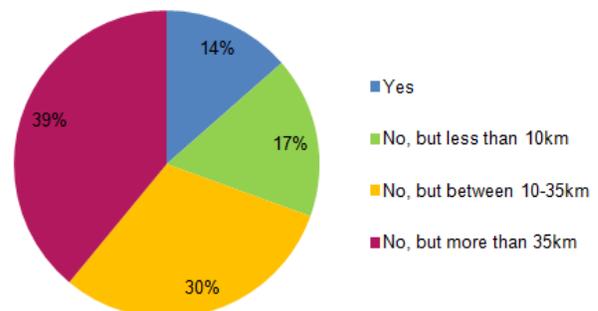


Figure 10. Residence in the city of Mons and distance from city center.

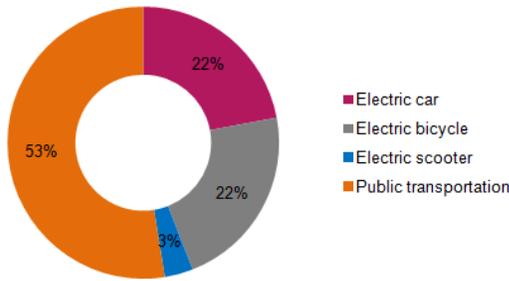


Figure 11. Preferable means of transportation in the city of Mons.

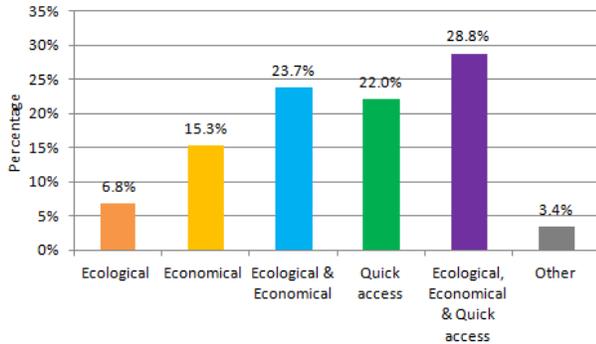


Figure 12. Reasons for choosing means of transportation.

6) Part VI: Peer-to-peer (P2P) and other services (users' behavior)

Part VI includes a series of queries to identify the users' attitude towards peer-to-peer (P2P) transportation services, which enable citizens (peers) to provide on-demand transportation to other citizens (peers) using their personal vehicles [17]. The survey participants seem to be cautious about the participation in P2P services, i.e. 47% of them provided a negative answer and only 36% would participate, even if they could benefit from the insurance's advantages (17% of the participants provided no answer). In case of participation, users prefer having mainly financial benefits (17%) to offer their vehicles for the intended application of the service, while 39% of the respondents are in favor of using another service for sharing their daily commuting.

7) Part VII: Willingness to rent an EV

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 (Fig. 13).

At a first glance, this finding indicates that the users are skeptical 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). Last, Fig. 14 presents the results on 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).

III. CONCLUSIONS

This paper summarizes the results of a survey conducted at UMONS with the aim to identify the characteristics of potential users of a university-based e-carpooling system as part of a smart district in the city of Mons, Belgium. The results obtained in the frame of this work indicate that most 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. Specifically, the findings of this work include that 4 out of 5 survey respondents would participate in carpools, while almost 3 out of 10 participants would rent and share (carpool) an EV in order to commute to the university. Moreover, the results 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. Therefore, the proposed university-based 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.

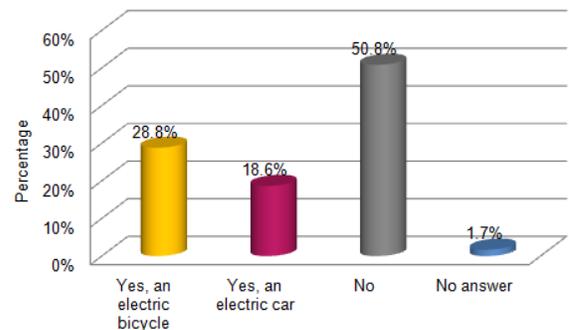


Figure 13. Willingness to rent an EV for commuting to university.

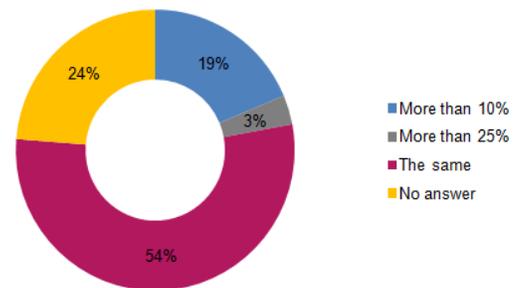


Figure 14. Willingness to pay extra charges for EV rent.

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