Micromobility in Thessaloniki, Greece, and Madrid, Spain: a comparative study

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Abstract. The purpose of this paper is to present the benefits, risks, problems, and ways to improve the service of Lime S electric scooters (e-scooters) in the cities of Thessaloniki, Greece, and Madrid, Spain. The aim of the paper is to present the service’s transportation benefits and to investigate the improvement rate it has offered in urban transport in these major cities. The methodology used is a literature review together with a questionnaire survey, which was distributed via the Internet to users of the service in the two cities. The content of the questions mainly focuses on the reasons why they use e-scooters, how happy they are with the service they are provided, and the ways in which it could be improved. Finally, we conclude that the more the Lime S service operates, the more the acceptance of the citizens of both cities it gains. Users respect the ease and speed of the travel they are provided, as well as the ecological character of the company. We can also see a demand for improving the service, both in the area of security, e.g., making helmets mandatory (≈57%), and in the legislative framework regulating its operation, e.g., compulsory ride on bicycle lanes (≈36%) and imposing age restrictions (≈29%). It is certain that in addition to the responsibility of the company for the users, the states and the users’ responsibilities are also important in order to ensure better and safer travels.

1. Introduction

Lime S electric scooters (e-scooters) are an urban single-person on-land transportation service, included in the broader concept of micromobility, founded in San Francisco, CA, in February 2018 [1]. They are e-scooters operating on a battery with two wheels used mainly on bicycle lanes and roads for short-distance trips or commutes [2]. As a means of transportation, it consists of three (3) key elements which are the following: i) the transportation infrastructure (bike lanes and road), ii) the e-scooters, and iii) the users [3].

Lime S e-scooters are a new and innovative way of transportation that has quickly won a big part of the global urban share of modal split. Through the years, Lime S has expanded worldwide and is now present in more than 57 cities in the United States of America (USA), 67 European cities, such as Thessaloniki, Madrid, Berlin, and Vienna, as well as 16 more cities worldwide, and 16 university campuses in the USA [4].

Lime S e-scooters provide a wide variety of advantages to its users, such as:
1. Cheap transportation: the cost to unlock an e-scooter is 1 €, and the cost of using it is 0.16 € per minute of usage [5] in Thessaloniki, Greece. This way, compared to other urban means of transportation, especially for short-distance routes, Lime S e-scooters are rather cheap.

2. Easy to use: in order to use an e-scooter, the only requirement is to download the company’s official application [3][5][6]. After downloading it, a potential user must find an e-scooter, the application has a map showing the close-by available e-scooters, and scan the e-scooter’s Quick Response (QR) code with their smartphone [3][6]. The e-scooter is then unlocked and ready to use.

3. Fast transportation: the e-scooters’ max speed is set to 23.8 km per hour, making it one of the fastest ways to travel inside a city [3].

4. Environmentally friendly: considering the fact that Lime S e-scooters operate with rechargeable electric batteries, emit almost zero emissions, and due to the company’s efforts to have urban trips with zero CO2 emissions, they are rightfully characterized as an environmentally friendly way to move [7].

5. Recreation: based on the ease of use, flexibility, and fast travel, people also use e-scooters for recreation. This way, cities like Thessaloniki and Madrid become more tourist-friendly, providing a pleasing way to move around landmarks and historical sites.

6. Employment: the company creates a plethora of jobs in the operating cities. People to recharge the e-scooters, engineers that deal with mechanical problems, coordinators that decide when an e-scooter needs to be collected are needed in cities that the company operates [8][9].

Lime S e-scooters, as a system, include the following characteristics:

1. two wheels,
2. one vertical and one horizontal axis that the user stands on,
3. the gas pedal on the right side of the handlebar,
4. break on the left side or both sides of the handlebar (depending on the e-scooter’s model),
5. a Global Positioning System (GPS) tracker that constantly works in order to know the e-scooter’s location at all times (geofence technology),
6. a maximum speed of 23.8 km per hour, and
7. maximum traveling distance of more than 32 kilometers [2][3].

The objectives of this research are the benefits, risks, problems, and ways to improve the service of Lime S e-scooters. The main aim is to present the company’s transport services and research the improvement rate it has offered to the urban transport in large cities such as Thessaloniki, Greece, and Madrid, Spain.

The following research uses Greek and international literature and a questionnaire filled by Greek and Spanish users, which was analyzed and gave specific results.

It should be noticed that the results of the current research are even more important in the case of mobility under the COVID-19 pandemic [10].

2. Methodology
This research is an effort to compare the usage of Lime-S e-scooters in two (2) European cities, in Thessaloniki, Greece, a city where Lime S e-scooters were operating for a few months (as of May 2019), and Madrid, Spain, where the e-scooters were operating for more than a year, and to estimate their effect in both cities’ transportation system. Therefore, it was considered extremely important to analyze the view of the people using Lime-S e-scooters in the cities.

First of all, the research starts by defining what Lime-S micromobility systems are, what their worth is and what the key components of an e-scooter are. Secondly, the “history” of Lime-S e-scooters is introduced as well as the usage and problems that citizens have encountered in both cities. The main research tool was a questionnaire developed especially for this research, including questions about the safety, the legal framework concerning the usage of the e-scooters, and their overall effectiveness in the two cities.
The aim of the questionnaire is to record and compare people’s opinions about the current way Lime S e-scooters are being used and benefit, or not, their lives considering the difference there is in the time e-scooters exist in the two cities. This could contribute to fulfilling the initial target of the research, the specification of those key elements that have flaws and that could be improved, in order to make Lime S e-scooters significantly better. Considering the fact that both Greek and Spanish users filled the questionnaire, through the results, it is possible to conclude which areas need improvement in each city.

The questionnaire was developed using the “Google Forms” platform and had a single straightforward layout, divided into three conceivable sections. The first section consists of a few personal and introductory questions such as gender, age, and whether the citizens have used Lime S e-scooters or not. The second section includes the core questions of the questionnaire, and it consists of thirteen (13) questions. Within these thirteen (13) questions, subjects like the safety, the levels of satisfaction, the effectiveness, and the ways of improvement are investigated. Answers are either in multiple-choice or 5-point, or 10-point Likert scales. The third section is the closing of the questionnaire with a few general multiple choice questions and a final question measuring the overall satisfaction of Lime S users. All questions are formed in a way that one (1) is the least and fine (5) or ten (10) is the most positive evaluation.

The same questionnaire was developed in both Greek, for the Greek users, and English, for the Spanish users, in order to have an exact comparison of the results in a comparative study manner. The way the questionnaire was distributed was through the Internet, posted on several social media groups, mainly on student groups, and sent as a personal message to friends and other contacts, asking the respondents to further disseminated it, applying, thus, a modified snowball sampling technique. In order to guarantee a satisfying number of answers, the questionnaire was re-opened from February 8th, 2020, until April 1st, 2020, after being initially open from February to April 2019. The total goal was to get as many answers as possible and in different periods.

Overall, there were more than 200 Greek participants and more than 100 Spanish participants. Invalid answers were deleted in order to protect data integrity. The difference in the number of the participants is mainly due to the difficulty of getting people to answer the questionnaire in Madrid and the difficulty to disperse the questionnaire via social media to Spanish users the same way it was done in Greece.

3. Results
In total, 325 fully filled questionnaires were obtained, 68.0% (221) from Greek users and 32.0% (104) from Spanish users.

The genders of the respondents were almost balanced in both cities. In Thessaloniki, 48.9% (108) were women, and 51.1% (113) were men. In Madrid, 51.9% (54) were women, and 48.1% (50) were men.

The ages of the respondents range from 15 to 28+. The vast majority of them, though, is between the ages of 18 and 23 in both cities, as these are the most common users of the Lime S e-scooters.

The percentage of respondents who have used Lime S e-scooters is particularly high, 77.3% in Thessaloniki and 78.6% in Madrid, indicating its high popularity despite its limited presence in the two cities.

The research shows a significant difference in the frequency of use of e-scooters between the two cities. In particular, we notice that 14% of users in Madrid use Lime S e-scooters one (1) or two (2) times daily, and 18% of them use the e-scooters three (3) or four (4) times weekly, in contrast to Thessaloniki where 62% of the people use them only once or twice a month.

Residents of Madrid use Lime S e-scooters almost equally for all transportation purposes. In contrast, in Thessaloniki, the use of Lime S e-scooters is mainly for recreational purposes, reaching almost 43%, as shown in Table 1. This is mainly due to the large number of e-scooters on the coastal front, where e-scooters are used mainly for recreational purposes, and the fact that Thessaloniki lacks an adequate and safe bicycling lane network in which e-scooters could safely move. This means that in
Thessaloniki, e-scooters are also used by tourists, another reason to consider the accessibility of the system [11].

Table 1. Main transportation purpose for which people use Lime S.

| City         | Commuting to/from work | Commuting to/from school | Running errands | Going-outs | Recreation | Other |
|--------------|------------------------|--------------------------|-----------------|-------------|------------|-------|
| Thessaloniki | 5.5%                   | 12.0%                    | 19.7%           | 14.2%       | 42.6%      | 6.0%  |
| Madrid       | 19.4%                  | 21.5%                    | 9.7%            | 21.5%       | 18.3%      | 9.7%  |

In both cities, asking about the easiness to find an e-scooter on a scale from one (1) to five (5), the largest number of responses the option four (4), which indicates that the number of e-scooters is sufficient to serve the needs of the carriers.

Regarding alternatives, it can be seen that in Madrid the largest share of people uses public transportation such as metro and bus. Moreover, a significant proportion of the commute is by walking but also in alternative ways that are not available in Greece, such as Uber. In Thessaloniki, on the other hand, as shown in Table 2, the largest share is on foot while public transport accounts for a much smaller proportion, thus underlining the difference in public transportation between the two cities in terms of quality. These facts combined prove that Thessaloniki needed a new means of transportation that would be reliable and economical such as Lime S e-scooters.

Table 2. Where do people use to ride Lime S e-scooters?

| City          | Sidewalks | Road | Bicycle lanes | All of them equally |
|---------------|-----------|------|---------------|---------------------|
| Thessaloniki  | 28.0%     | 25.8%| 24.2%         | 22.0%               |
| Madrid        | 21.1%     | 15.6%| 52.2%         | 11.1%               |

As shown in Table 3, the major differences between the two cities are found in the transport infrastructure, especially in the bike lanes’ availability. More than 50% of Madrid users use Lime S e-scooters on bike lanes, with a smaller percentage riding on roads and sidewalks. In Thessaloniki, due to the lack of bike lanes in main streets, the percentage of users that ride on them is much lower, making the use of Lime S e-scooters much less safe.

Table 3. Main contributing factors why people ride on sidewalks (2 choices each).

| City   | It’s more convenient | Offers a smoother ride transportation | Feels safer | Don’t know where I should ride | No specific reason |
|--------|----------------------|-------------------------------------|-------------|--------------------------------|-------------------|
| Thessaloniki |                     |                                     |             |                                |                   |
| Madrid  |                      |                                     |             |                                |                   |
The conclusions of the previous question are also supported by almost 88% of users in Thessaloniki and 91% of users in Madrid who stated that having a bicycle lane would make them definitely or most definitely opt for it over the road or sidewalk when asked “how much would a bike lane increase your likelihood of riding in it.”, as shown in Table 5.

**Table 5.** Likelihood of riding on a bike lane rather than a road or sidewalk if it was available.

| City       | Not at all | Possibly not | Maybe | Most definitely | Definitely |
|------------|------------|--------------|-------|-----------------|------------|
| Thessaloniki | 1.3%       | 0.0%         | 10.5% | 26.3%           | 61.8%      |
| Madrid     | 0.0%       | 2.2%         | 6.7%  | 60.0%           | 31.1%      |

In addition, we can easily discern the great difference of confidence shown by the residents of the two cities in the safety of using Lime S e-scooters. The majority of users in Madrid consider Lime S e-scooters a secure means of transportation, rating its safety as very good, as the answers are gathering around eight (8), while users in Thessaloniki rate it as less than mediocre, as the answers are gathering around four (4) and five (5), as shown in Table 6. This could be a result of the lack of confidence towards its service due to the limited time of the company’s presence in the city of Thessaloniki, but most probably of the limited bicycle lane network and the not bad quality of road safety for vulnerable road users in the city of Thessaloniki.

**Table 6.** The rating of Lime S e-scooters security.

| City       | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------|---|---|---|---|---|---|---|---|---|----|
| Thessaloniki | 3.9% | 9.2% | 13.2% | 15.8% | 27.6% | 11.8% | 7.9% | 6.6% | 2.6% | 1.3% |
| Madrid     | 0.0% | 0.0% | 0.0% | 0.0% | 7.9% | 7.9% | 26.3% | 25.0% | 25.0% | 7.9% |

Spanish users appear divided when asked whether there is a need to improve the safety of Lime S e-scooters or not (55.2% answered “yes”), while the overwhelming majority of Greek users are calling for improvements (87.7% answered “yes”).

Nevertheless, the residents of both cities are satisfied with what Lime S offers in general. Specifically, 77.7% in Madrid and 69.2% in Thessaloniki answered “yes” when asked if they are satisfied with the Lime S service.

Users of both cities agree on improving the technical specifications of e-scooters, such as brakes and stability, as shown in Table 7, but the utmost importance is given to helmets that, as they say, should be provided by the company itself.

**Table 7.** Main improvements that should be implemented (2 choices each).

| City       | Lower the speed limit | Improve stability | Improve the braking system | Helmets to be provided by the company | Other improvements |
|------------|-----------------------|-------------------|---------------------------|--------------------------------------|--------------------|
| Thessaloniki | 16.5%           | 47.9%             | 34.6%                     | 58.5%                                | 5.5%               |
| Madrid     | 30.4%           | 28.6%             | 37.5%                     | 55.4%                                | 1.8%               |

The citizens of the two cities disagree on the adequacy of the legislation involving micromobility and e-scooters in their respective countries. In particular, 43.3% of the users in Madrid consider the laws sufficient, while 87.2% of those in Thessaloniki consider the laws insufficient. Nevertheless, the
questionnaire survey took place before the new legislative framework regulating micromobility in Greece, and therefore these answers were expected but not updated.

When asked what should be added to make the legislative framework sufficient, the users underlined the need for the compulsory ride on bicycle lanes and the use of helmets. Moreover, they seem to agree on an age restriction, as shown in Table 8.

| City       | Age restriction (15+) | Compulsory ride on bicycle lanes | Compulsory driving license | Compulsory use of helmet | Other additions |
|------------|----------------------|----------------------------------|---------------------------|--------------------------|----------------|
| Thessaloniki | 30.6%               | 39.9%                            | 4.7%                      | 18.1%                    | 6.5%           |
| Madrid     | 27.7%               | 32.5%                            | 9.6%                      | 28.9%                    | 1.2%           |

In general, as shown in Table 9, the users in Madrid appear much more confident about the safety of the e-scooters than the users in Thessaloniki. Moreover, the availability of e-scooters is considered adequate by the residents of both cities. In addition, the residents of Madrid are not concerned about the price, while most of the residents of Thessaloniki consider it particularly high. This makes sense considering the wage difference between the two cities, as well as the recent financial crisis in Greece. Finally, in the case of witnessing or participating in an accident with a Lime S e-scooter, this does not differ significantly between the two cities with the rates of “no” being higher than “yes” (Table 9).

| Statement                                      | Thessaloniki | Madrid   |
|------------------------------------------------|--------------|----------|
| Lime S e-scooters have security flaws          | 90.2%        | 45.5%    |
| There should be more e-scooters available on the streets | 35.6%        | 56.2%    |
| The e-scooters’ price is high                  | 86.0%        | 41.0%    |
| I have witnessed an accident with a Lime S e-scooter | 23.1%        | 18.1%    |
| I have been involved in an accident with a Lime S e-scooter | 5.7%         | 6.7%     |

Last but not least, when the users were asked to give an overall rating of the service in each city on a scale from one (1) to ten (10), the answers were as expected. The ratings received in Madrid moved to levels between five (5) to ten (10), with the highest frequency appearing in the values of eight (8) and nine (9). On the other hand, the ratings in Thessaloniki mainly ranged between three (3) and eight (8) with the highest frequency appearing in the values six (6) and seven (7), as shown in Table 10. This is probably mainly due to the short amount of time that the e-scooters are found in Thessaloniki and demonstrates the lack of confidence of the residents in new forms of mobility compared to other European cities such as Madrid. However, these ratings are expected to increase as Lime will continue to gain popularity through operating in the city.

| City       | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------|---|---|---|---|---|---|---|---|---|----|
| Thessaloniki | 2.7% | 0.0% | 0.0% | 5.3% | 17.3% | 24.0% | 37.3% | 10.7% | 2.7% | 0.0% |
| Madrid     | 0.0% | 0.0% | 0.0% | 0.0% | 3.8% | 10.3% | 19.2% | 28.2% | 26.9% | 11.5% |

4. Discussion
The present research aimed to underline the benefits, risks, problems, and ways to improve the service of Lime e-scooters.
The problems that arise in Madrid are not sufficient to create a particular need for improved service. Even though Madrid’s authorities had banned Lime, and other operating companies, for distributing their e-scooters across the city without receiving an official authorization [12], they have now fully reconciled themselves to the existence of e-scooters on the streets of the city, and the residents themselves are receptive to any new transport solution such as that offered by Lime [13][14]. Infrastructure is also considered to be sufficient, creating a system safe for all road users. Two things that could be emphasized would be the need for complete compliance with traffic laws and the implementation of the company’s proposals in the case of Thessaloniki, such as mandatory helmet use, driving exclusively in authorized areas, and parking away from pedestrian zones [15]. By implementing the above, the operation of Lime in Madrid could be further improved.

On the other hand, Thessaloniki is experiencing problems in all the above-mentioned areas. Initially, the infrastructure of the city needs to be significantly improved as bicycle lanes are mainly found on the coastal front, and there are critical shortcomings in the central parts of the city. In addition, stakeholders related to the operation of the system, such as the Municipality of Thessaloniki, should assist with their attitude to the existence of the service and not impede its development, as it has been observed in the past by, for example, attempting to impose a maximum speed limit of 5 km per hour [16]. Finally, the citizens themselves should change their minds and embrace the new technologies that their city chooses to develop in order to avoid a recurrence of equipment vandalism and incompatibility with the rules of service use [17].

In both cities, the promotion of public transport [18][19][20][21] and the enhancement of walkability [22][23][24] could increase the use of e-scooters, as all these systems are complementary.

5. Conclusions
Based on all the above, we conclude that the Lime S service has gained the acceptance of the largest share of citizens in both cities. Users seem to respect the company for the ease and speed of the travel they are provided and the ecological character that characterizes the company.

Based on the responses we had, we can see the scope for improving the service, both in the area of security and in the legislative framework regulating its operation. It is certain that in addition to the responsibility of the company towards the users, the states’ and users’ responsibilities are equally important in order to ensure better and safer travels for everyone.

Proposals for future research could include the inclusion of users in the decision-making process of urban transportation systems using techniques like Conjoint Analysis [20][25]. Actually, some of the authors are currently working on such a survey and the results seem to be promising.

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