Japan Bilingual Publishing Co.

Transportation Development Research

https://ojs.bilpub.com/index.php/tdr

ARTICLE

Deriving Knowledge from E-Scooter Riders' Feedback at Pilot Study Stage: Case for a City in Ontario, Canada

Seun Daniel Oluwajana [1*], Olubunmi Philip Oluwajana [2], Temitope Elizabeth Oguntelure [3], Crystal Mingyue Wang [4], Soha Saiyed [5]

[1] *Lead Transportation Analyst/Consultant, Mobility Scope Consulting, Edmonton, Alberta T6W4C6, Canada*

[2] *Department of Earth Sciences, Adekunle Ajasin University, Akungba Akoko, Ondo State 342111, Nigeria*

[3] *Transportation Analyst, Mobility Scope Consulting, Akure, Ondo State 340001, Nigeria*

[4] *Rail Systems Specialist, WSP, Thornhill, Ontario L3T 7Z6, Canada*

[5] *Transportation Planner, R.J. Burnside & Associates Limited, Orangeville, Ontario L5N 8R9, Canada*

ABSTRACT

This paper examines the sentiments and opinions of e-scooter riders in Windsor, Ontario, highlighting key issues and concerns they have expressed. It involved text mining of feedback collected over a six-month pilot program (May to October 2021) using dictionary-based analysis. Analysis of monthly word frequencies in rider feedback revealed fluctuations, with June, July, and August showing higher correlations with May—the initial pilot month—compared to September and October. This indicates a fading novelty associated with e-scooters in the city. Although monthly sentiments varied significantly, the overall sentiment in May and June remained positive. The most common words contributing to positive sentiment included fun, awesome, and nice, while negative sentiments were largely represented by words such as slow, broken, and throttle. Feedback reveals that riders primarily regard e-scooters as a source of leisure rather than functional transportation. Correlation analysis of words linked to negative sentiments identified terms like "flat-tire" and "broken throttle," which emphasize significant concerns regarding e-scooter maintenance practices in Windsor. The findings underscore the need for a data-sharing policy and maintenance regulations while recommending a governance framework for e-scooters to ensure their sustainable benefits. It demonstrates that even with a limited feedback sample

*CORRESPONDING AUTHOR:

Seun Daniel Oluwajana, Lead Transportation Analyst/Consultant, Mobility Scope Consulting, Edmonton, Alberta T5J 0N3, Canada; Email: seunoluwajana@yahoo.com

ARTICLE INFO

Received: 26 June 2024 | Revised: 8 August 2024 | Accepted: 6 September 2024 | Published Online: 22 September 2024

DOI: https://doi.org/10.55121/tdr.v2i2.301

CITATION

Oluwajana, S.D., Oluwajana, O.P., Oguntelure, T.E., et al., 2024. Deriving Knowledge from E-Scooter Riders' Feedback at Pilot Study Stage: Case for a City in Ontario, Canada. Transportation Development Research. 2(2): 12–25. DOI: https://doi.org/10.55121/tdr.v2i2.301

during the pilot phase of shared e-scooter implementation, dictionary-based opinion and sentiment analysis can yield valuable insights into rider concerns, guiding immediate policy needs and fostering the functional use of e-scooters as a transportation option.

Keywords: E-Scooter; User Generated Content; Riders' Feedback; Text Mining; Opinion and Sentiment Analysisworks; YOLOv11; NPU

1. Introduction

As is a trend across the cities of the world, various electro mobility modes are now introduced to address the growing concerns about emissions generated by transportation modes that depend on fossil fuel [1,2]. This shift to electromobility modes such as electric bicycles (e-bikes) or electric scooters (e-scooters) has been partly enabled by environmental awareness and technological development. Technologically, the advancement in battery form and energy storing capacity has enabled electro mobility to be considered as a great option to address global warming and potentially reduce emission. The use of this technology induced form of mobility is flourishing and expanding. Owing to recent successes, and the need to diversify electro-mobility mode, service providers are now switching to e-scooters and gradually reducing their electric bike fleets [3]. This reduction has been due to the similarity in the advantages of e-bikes and e-scooters as modes to lower our societal carbon footprint and has led to its quick adoption across the cities of the world.

With about 136 million e-scooter trips recorded in 2019 and shared e-scooter accounting for 63.2% of the total micro mobility share, city authorities are evaluating methods to address the disruptive nature of e-scooter modes which has attracted more users than the alternate e-bikes [4]. These numbers are expected to rise with wider acceptance as a new urban mobility solution. While some cities are attempting to muddle through the process of addressing the disruptive nature of e-scooters, others still at the pilot stage can mitigate the problem (e.g., where and when it could be operated or parked and other operation challenges relating to maintenance) faced by cities that have e-scooter micromobility implementation at advance stage. These problems relating to e-scooters are peculiar with the dockless versions that operate on a free float and promote users' freedom on where they could be parked or picked up for use. Essentially, the dockless e-scooters do not have physical stations, thereby creating better flexibility in their use and has made them the preferred option over the docked counterpart in cities across the world [5]. An example of such cities that have implemented the dockless e-scooter micro-mobility program is Windsor, Ontario, Canada.

In 2021 between Spring and Fall months, the city of Windsor conducted a pilot study for e-scooter use within her jurisdiction. Interestingly, e-scooters have been widely received as an alternative mode by the residents of the city. While the local authority in Windsor has adopted e-scooter use, its governance remained under ratification. With authorities now seeking to establish policy and regulations guiding e-scooters, little is known about the users' view about the mode and the quality of service received [3]. However, micro participation which involves public engagement using social media to gather inputs from stakeholders (in our case, e-scooter users) provides a great opportunity to understand users' view and possibly incorporate them into planning process [6,7]. These views are functions of people's perceptions and public sentiments about changes in their cities and good indicators of life or service quality [8]. In the case of Windsor, they are expressed on smartphones used for renting e-scooters which in turn produce abundance of human mobility data containing locations, movements, and preferences of individuals [9]. These views in form of review expressed by users or riders can help gain insights into the preference of e-scooters riders within a city and can point to issues that require improvements at a minimal cost [10]. Thus, harnessing the power of micro participation and understanding of users' perspectives through analysis of feedback or reviews provides an opportunity for enhanced mobility planning process in the city. This study examines the feedback, i.e., reviews provided by riders to determine the level of satisfaction derived from e-scooter use in the city of Windsor, Ontario. It explores opinions and sentiments expressed and determined the keywords or groups of words that could point to likely maintenance practices that may aid in effective transportation planning and policy formulation.

2. Background Literature

In 2017, the first shared e-scooter deployment in the world was implemented in Santa Monica, United States and was a huge success. Ever since, e-scooter use as a mode of transportation has seen wider acceptance across many cities of the world, with competition between providers on the rise. Also, ridership has been on continual increase since its first introduction [11], and lately, attention is more focused on the dockless version which has been well received by municipal authorities. To a certain extent, the rise seen in e-scooter ridership has been predominantly fueled by private investments [12–14]. To another extent, the recent COVID-19 pandemic has also significantly contributed to the increase recorded in e-scooter ridership due to the perceived social distancing advantage [15–17]. However, the rise in e-scooter ridership in our society has been rapid with most municipal authorities quick to its adoption as a sustainable mode. Surprisingly, these adoptions are without adequate infrastructure planning to facilitate ridership. In most cases, pilots are conducted only for the program to be continued due to their perceived short-term benefits. Generally, these short-term benefits are based on the initial outlook with e-scooter deployment which usually appears promising as a means to reduce congestion within cities and promote sustainability. Over time, the excitement about the perceived derived benefits gradually fades out [11,17]. This is attributed to the improper planning that is associated with adoption of the e-scooter—a disruptive transportation technology in our cities. However, when the introduction of e-scooters is properly planned and integrated into our urban space they bring numerous benefits.

2.1. Benefits and Challenges with E-Scooter Micromobility Deployment in Our Society

The introduction of e-scooter shared mobility to our society has numerous benefits. These benefits are likely the same as those of shared e-bike systems due to the similarities between the two micromobility modes [12]. Recently, studies have highlighted that the potential benefit of e-scooter could be derived from the lessons learned from other cities that have implemented a bike sharing system [18]. Therefore, some of the benefits that e-scooter use could bring to any city include an increase in physical activities, thereby promoting good health, improved quality of social interaction and connection through increase in the amount of time spent on the street. Also, e-scooter ridership can increase environmental value through reduction in emission rate [19]. It can substantially contribute to transport equity through the provision of alternative modes that are accessible to all.

However, the quick and rapid adoption of e-scooters has caused public outcry in some quarters around the world and urban mobility planners are now faced with the challenges associated with e-scooters use as a form of micromobility in our society [17,18,20,21]. These challenges are usually non-spatial and spatial in nature. The non-spatial aspects of the challenges with e-scooter micromobility relate to permit, insurance, pricing, ridership requirements, public education, safety: helmet wearing and speed limitation. The spatial components of e-scooter challenges include identifying the locations for proper ridership within a city as it has been reported that most e-scooter rides occur on the sidewalks [22–24].

Another spatial component of the challenges that cities face relates to e-scooter parking, a problem that characterized the dockless version and has been extensively highlighted in literature [24]. Also associated with the spatial problem of the dockless e-scooter ridership is the geography of supply and demand (origin and destination of trips) that needed to be completely understood for rebalancing of these scooters. Other challenges with e-scooter deployment in our society relate to the understanding of geographic variances and service layout, which when not considered leads to uproar and resistance to acceptance of shared mobility forms. For instance, push back for the wider acceptance of e-bikes or likely e-scooter in the case of the city of Windsor could relate to the geography of opportunity, transportation equity, and the influence of gentrification.

Interestingly, in the city of Windsor, Ontario, dockless e-scooter mobility project is still at the pilot stage, which presents opportunities to address the likely challenges that may arise with their usages. An important way to understand these challenges that could arise with e-scooter deployment in the city is through analysis of the feedback received from riders. For example, examining the opinions expressed by riders relating to their experiences while operating these scooters and the quality of service will help understand likely challenges that may arise and attitudes towards the newly introduced micro-mobility mode. This is achievable through text mining of opinions and sentiments expressed, and lessons learned from comments and feedback given by e-scooter users can help determine the likely issues, perhaps, the maintenance practices that may arise or influence the safety of riders.

2.2. Text Mining in Urban Mobility Studies

Due to recent advances in natural language processing, information can now be extracted from non-numerical data that exist in long, short structured or unstructured texts usually stored as online reviews or feedback on social media [25]. This feedback is essential to effective mobility planning in the present age that we live in, where information about rides is easily obtainable. Thanks to the rapid development of telecommunication (enhanced compatibility of applications on smartphones and mobile devices) and big data technologies, users' orientations or perceptions and travel patterns can now be determined [26,27]. Also, riders of public transportation can now give their opinion about the service received. However, processing this data collected over big data technologies requires advanced statistical methods but when data is textual, text mining technique is a popular approach used [28]. Thus, text mining - a key information extraction technique for non-numeric analysis has found numerous applications [29]. In transportation planning, it has found application in determination of public transit riders' satisfaction [30], urban planning [26], sustainable transportation logistics [31], and the impact of COVID on shared mobility [32,33].

Recently, reviews obtained from the app of two major micro-mobility service companies were used to investigate the factors that influence e-scooter riders' satisfaction using text mining [3]. The research benefited from abundance of data and in total 12,000 riders' reviews were used to generate topics of interest to riders. They found that price, safety, and customer service are critical to riders' satisfaction. Also, maps, refunds, payments, app interfaces, and ease of use are also critical factors that determine how satisfied riders are. Logistic regression models were used to predict gender-based differences in reviews obtained from riders. The result from the model suggests that riders' level of satisfaction varies with topic and gender. Women were found to be more satisfied and expressed more positive sentiments than men. It was emphasized that the development of methods to evaluate riders' satisfaction will enable understanding of riders' needs and factors that serve as barriers to e-scooter usage. It was recommended that policy should be focused on improving ease of use, safety and addressing app issues and that policy approach to e-scooter ridership should incorporate opinion mining.

It is however worth noting that the research by Aman et al, used data from two service providers – Bird and Lime but does not identify how users' satisfaction varies between the two micromobility companies. Data were treated as though both companies' modes of operation were the same and they use the same app and type of e-scooters. Notwithstanding, the research opens doors for the use of text mining and opinion analysis in understanding e-scooter sentiments.

Also, text mining has been used to understand e-scooter micro-mobility safety. For example, due to the absence of comprehensive databases to facilitate the study of e-scooter crashes or accidents, text mining of media reports has been used to create crash databases [34]. Aside from the crash record, the demography, crash type and locations were uncovered. The research found through text mining that between the years 2017 and 2019, 169 e-scooter crashes occurred in the United States. It was highlighted that although randomly distributed across states of the United States, the number of reported e-scooter crashes is on the rise. Interestingly, children and the elderly were noticed to be vulnerable riders of e-scooters and are more likely to be involved in crashes. Compared with daytime, fatal crashes are likely to occur during nighttime, on arterial roads and at intersections. When riding is done on sidewalks that are unpaved, riders have a higher risk of falling off and the falls are likely due to uneven surfaces. The research highlights the need for discussion on the use of helmets, riding under the influence and data needs. It also emphasizes the need for safety countermeasures to mitigate e-scooter crashes. The research is another example of the importance of text mining in gaining safety insight into the use of e-scooters in our society [34]. This research points to the growing importance and the use of text mining approach and in general, has broadly used two approaches for studying textual data. The first is the machine learning (ML) technique while the other technique is lexicon-based which uses a dictionary of words expressing positive and negative sentiments and both have their advantages [25]. ML approaches require training and testing data for calibration and validation of the corpus of documents that is examined. Its uses are influenced by the available data size. On the other hand, the Dictionary (lexicon-based) approach offers a simpler approach to conduct sentiment analysis where a domain-specific dictionary is used. Whether ML or lexicon approach, depending on the preferred choice used by researchers, both offer opportunities to understand expressed opinions. The current study joins research that uses text mining to understand opinions and sentiments expressed by customers/users of electric scooters (e-scooters) in the city of Windsor.

3. Method

3.1. Data Source

This study used feedback provided by e-scooter riders in the city of Windsor during the initial 6 months pilot study between May and October 2021. These feedback or reviews were collected by the service provider and made available to the city officials in Excel format. **Figure 1** shows examples of e-scooters used by riders in the city of Windsor. In the picture, they are parked around the city of Windsor central business district.

Figure 1. E-Scooter in Windsor, Ontario.

The feedback supplied by the service provider, Bird Inc, to the city was not in a ready to use format because the review stars were combined with the texts in the feedback—they were in an unstructured format. Also, the feedback obtained was not in a combined format—it was provided monthly, and samples of feedback sizes varied significantly across the 6-month period (see **Figure 2**).

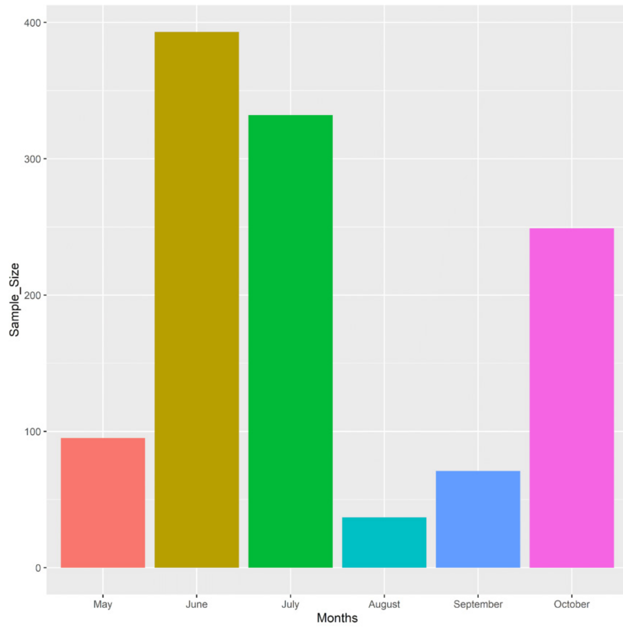

Figure 2. Sample Size Distribution of Monthly E-Scooter Rider's Feedback During the Pilot Study.

The month of May has the fewest feedback. Only 95 were reported. This is considered logical because of the novelty factor of the e-scooter program in Windsor. As the months of the pilot progressed and as expected, the sample size increased but later dropped. The month of June has the highest sample size in terms of feedback while August has the fewest. The reason for the low sample size seen in some months of the pilot study is outside the scope of this study. This study believed that the interest of riders in giving feedback dropped significantly after using the e-scooter. It may also be a result of data quality issues or seasonal effects, and it is outside the scope of the current study.

3.2. Text Processing and Dictionary-Based Text Mining Approach Adopted

In the current study, we used a dictionary-based method to analyze feedback from e-scooter riders in Windsor, Ontario, Canada. Our approach is quantitative, aiming to evaluate the overall sentiments expressed in the feedback by calculating the total sentiment scores for each word in the riders' comments/feedback. There are various dictionary-based methods available in the R programming environment; however, we specifically employed the Bing dictionary, developed by Saif Mohammad and Peter Turney described by Silge, and Robinson. [35]. This dictionary helps us extract information from the non-numerical data typically found in online reviews or social media feedback from e-scooter riders in the city of Windsor.

Before applying the text mining approach adopted, preliminary preprocessing was done using R-language and text separated from non-word strings representing stars. After preprocessing, text indexing, i.e., the process of converting text into individual words was done. This process consisted of two steps: tokenization, and stopwords removal. The first step in text indexing, known as tokenization, is the process of breaking sentences into individual or groups of individual words by considering the spacing between them. Feedback from each of the riders existing in sentence form was separated into words based on the white space between them. Two approaches were considered in tokenization of texts. The first approach broke sentences into unigrams, i.e., one word each considering the spacing between them. The second approach used bigram, i.e., sequence of two words before consideration of the spacing between them. These two approaches were chosen to 1.) Determine the words commonly used to describe e-scooter use in the city 2.) Understand sentiments expressed by riders and 3.) The correlation between two consecutive words used by riders and to highlight prevalent concerns. These steps were then followed by stop word removal which is the deletion of words in grammar that are articles, conjunctions, and prepositions. Essentially, words such as "to", and "if" that are frequently used in English language were removed to improve efficiency in text processing.

Stopwords existing in preloaded dictionaries or packages in R language were used for our analysis. However, the process of stop word removal for unigrams is a step that involves direct comparison with a selected stopwords dictionary. To remove the stop words from bigrams, words were separated into different columns, compared with the stopwords database and any stopwords that existed were removed before re-uniting the two words. The analysis also revealed that there are some words, such as didn't, wouldn't, won't, wasn't, and don't, that express negation but may not give stand-alone sentiments for the unigram. These were added to the list of stop-words for our unigram analysis. Also, excluded are numerical values and the company name Bird. The top words that occurred in each of the 6 months were examined to determine the lesson that could be derived from the feedback given by riders. These words were compared with Bing dictionary to understand how opinions and sentiments expressed by riders varied across the pilot study period. Lexicons in Bing dictionary consist of many English words that are assigned scores based on the type of sentiments—positive/negative that they express. For example, emotions like joy are classified as positive sentiments while anger and sadness are negative sentiments and categorized using binary [35].

This study asks questions and determines if the feedback given can give insight into use: functional or fun and highlights any likely issues that may be associated with e-scooters in the city of Windsor. Can the riders' feedback at a pilot study give an indication of the purpose of the trip made by e-scooters or point towards policies for e-scooter governance? Hence correlations between consecutive words in the feedback obtained from riders were further used to provide answers to these questions.

4. Findings

4.1. Riders' Experience from E-Scooter Use During the City's Pilot Study

Across the pilot study, the word fun ranks higher in the feedback given by e-scooter riders and is a frequent description of e-scooter rides in the city of Windsor. This suggests that they are not used for their functional purpose—transportation but rather as a playful urban mobility mode. This finding is consistent with previous research that e-scooters are either used for functional or fun purposes [19,36–39]. When used for fun, they are sometimes ridden in a playful manner and not necessary for transportation purposes, hence defeating the purpose for which e-scooters were introduced. The fun use of e-scooters within the city gives indications that a proper integration of e-scooters with other modes of transportation is required for their functional use to be achieved. For example, integration of e-scooter ridership with transit system will cause a shift in the perceived use from recreational/leisure/fun mode to commuting. Thus, users will understand that the purpose of the introduction of scooters to Windsor is to enhance city sustainability and not replace modes such as walking and cycling. Interestingly, not only positive feedback words were expressed by e-scooter riders in the city of Windsor during the study period. As early as the month of May when the pilot study was initiated, there have been complaints by users. This complaint relates to tire, pass, speed, battery and in some cases, parking. Parking complaints relate to the scooter app malfunction causing some difficulty in ending trips. Another relates to users guarding their rented e-scooter with dogs. This was perhaps done to maintain the availability of e-scooters at the expense of other users. It reflects the misunderstanding of the purpose of the introduction of these scooters to the city.

The opinion in feedback passed by riders during the months of pilot study reflects the maintenance practices of the vendor in the city. The scooter battery not being charged is an indication that fixed battery scooters may not be the best alternative to service Windsor. The types with replaceable batteries could be the environmentally efficient type. Hence, it has been reported that scooters with replaceable batteries could help reduce the carbon footprints associated with transportation, collection, charging of e-scooters and redistribution to locations of interest [40].

4.1.1. How Riders' Opinion Varied about E-Scooter Micromobility During the Pilot Study?

Opinions compared using the frequencies of words used in each of the months showed that although dominated by the word fun, the monthly choice of words used by riders varied. This was determined using correlation analysis by comparing the frequencies of words used to describe e-scooter services during the pilot study in the city. Correlation analysis provided insight into how opinions of riders about e-scooters changed over time from the first month of introduction. It examined the effect of the buzz of novelty induced by transportation technology on opinions shared by e-scooter users in the city during the initial months of introduction. It showed that there exists a great relationship between the opinions expressed by riders in June and August when compared with May—the initial month of the pilot study. The month of May has a correlation of 0.733 ($P < 0.0001$) with June but July (0.766, $P < 0.0001$) and August (0.766, $P < 0.0001$) have the highest correlation with May, which later dropped across the remaining months to the lowest in September (0.269, $P > 0.1$). However, the correlation between the words frequently used in the month of May and October was at 0.581 ($P < 0.001$). See **Figure 3** for the correlation plot between the frequencies of words used by riders in their feedback.

The patterns seen in correlation across the months of the pilot study were unsurprising as it is expected that favorable weather conditions during the Spring and Summer months will promote high e-scooter use in the city. Hence the large sample size of feedback in June and July. This high usage is also deemed to be induced by novelty factor, and perceived utility of these e-scooters as a new mode in the city. As people get to use any new equipment or in this case e-scooter, the perceived advantages fade and novelty buzz faints causing the level of satisfaction, or opinions expressed by users to vary. This was evident by the sudden drop in correlation between the frequency of words used in May, September, and October.

Also, the drop in correlation between the month of May – the first month and later months of the pilot study can be attributed to seasonal effect as it is expected that rides will decline during the cold fall months— September and October. Although the study used 6-month pilot study data, it could be inferred that more ridership evident by the feedback received occurred during the Spring and Summer months, but a decline will be seen in Fall months. This suggests that any e-scooter integration policy could be evaluated for success when implemented in Spring and Summer months rather than in Fall months when ridership is on the decline. While the frequency and correlation analysis revealed that opinion expressed varied across the months of e-scooter pilot study in the city of Windsor, sentiment analysis was used to evaluate the predominant sentiments in monthly feedback given by e-scooter riders.

4.1.2. Understanding Sentiment Expressed by Riders during the Pilot Period

Sentiments expressed in riders' feedback were not positive all through and varied by months of the pilot study (see **Figure 4**). As the month progresses, there are greater

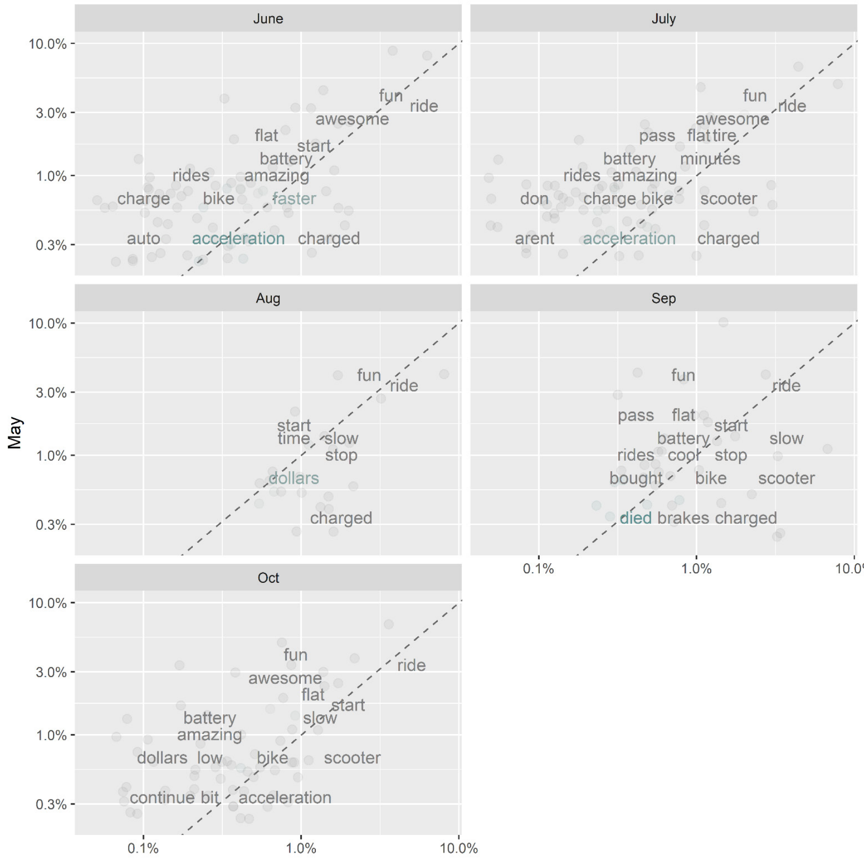

Figure 3. Correlation between Word Proportion in the First Month and Other Months of the Pilot Study.

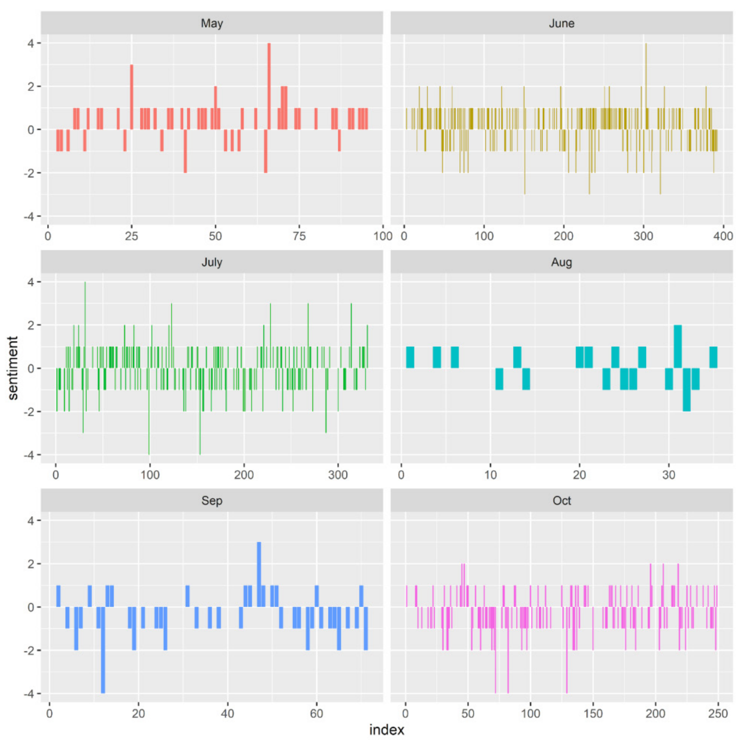

Figure 4. Variation in Riders' Sentiment Across the Six Months Study Period.

variations in e-scooter riders' sentiments and they were not significantly influenced by the monthly sample size of the feedback. However, the length of feedback words or reviews used by riders to express their level of satisfaction or dissatisfaction increased and consequently, more variation was seen in sentiments expressed towards the later months. The trajectory of the sentiment plots for all the months of the study are distinctively different from each other implying that different sentiments (concern or appreciation) were expressed by riders. The cumulative difference in the sentiments scores expressed by users for each of the months when summed up did not balance out as neutral i.e., zero. The cumulative value for the months of May, June and August was positive, implying that the sentiments expressed by e-scooter riders were more positive. However, for July, September and October, negative sentiment superseded.

The overall positive sentiments seen in May and June feedback are due to the novelty effect of the e-scooters in the city induced by the willingness of the people to try the new fun mode. However, for the remaining months of the study period except for August with fewest sample size, negative sentiments expressed by riders are results of possible decline in the level of satisfaction. This showed that with greater acceptance, mixed sentiments are likely about e-scooters in the city.

Further analysis of the predominant words contributing to positive and negative sentiments focusing on the top 10 words showed that words associated with positive sentiments relate to pleasures derived from using e-scooters and include fun, awesome, nice, love etc. It extends the argument that e-scooters are not necessarily used for commuting in the city but rather they are a fun recreational mode. Words relating to speed, cost, and others pointing to maintenance issues that are required to be addressed by the service provider top those contributing to negative sentiments. Other words include slow, broken, throttle, expensive, etc., and are quite difficult to interpret individually as words (see **Figure 5** for top 10 words sentiment contributing words and the word cloud on **Figure 6** for another grasp of positive and negative sentiment keywords in riders' feedback). Thus, pairwise correlations of words existing in the rider's feedback were required.

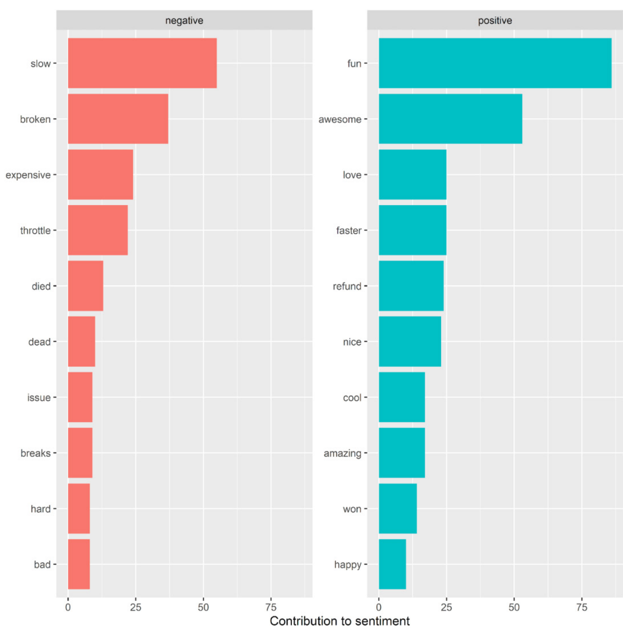

Figure 5. Top Ten Words Contributing to Riders' Sentiment in Windsor, Ontario.

Figure 6. Word Cloud for the Top 100 Riders' Sentiments in Windsor.

4.1.3. Exploring Patterns through Pairwise Words Correlation of Riders' Feedback

While previous analysis identified words contributing to positive and negative sentiments expressed by e-scooter riders, complete interpretations of these words without looking into their co-locating words is challenging. This is especially true for those contributing to negative sentiments because they are individual words such as broken, dead, died, tire, or flat etc. Thus, words that co-locate, i.e., those occurring together in the riders' feedback, were examined using pairwise correlations of the counts of words. The word fun did not co-locate with other words such as trip or travel that gives indication of the use of e-scooters for commuting purposes validating that they are not used for short trips usually made by cars in the city of Windsor. Rather, it was found that flat and tire are highly correlated, and broken and throttle are moderately correlated in the feedback obtained from e-scooter riders in the city of Windsor. Further, parking was found to be moderately correlated with zones and money. The correlation patterns seen between these three words (parking, zones, and money) suggest that there are rides that are quite difficult to end. Especially when the riders are in the parking zone but the app malfunctions and resulted in unnecessary charges to be incurred. A similar pattern could be seen when the words that "zone" is associated with are examined (see **Figure 7**).

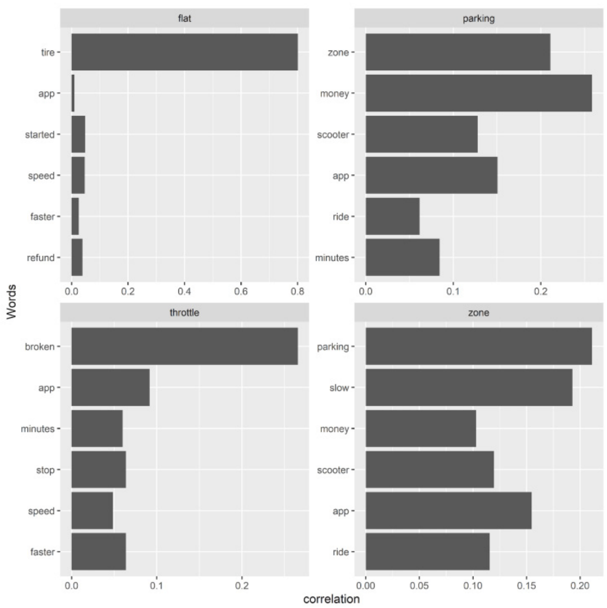

Figure 7. Pairwise Correlation Between Keywords Associated with Selected Words of Interest.

The graphical representation of correlated words is shown in **Figure 8**. From the plot, it could be seen that word pairs that dominated the sentiments expressed by e-scooter riders in the city of Windsor, Ontario, were highlighted. Broken and throttle, and flat tire are the common pairings that dominate the bigram (two associated words) pairing. Other words found together are "start–stop–fun", "ride-started-time-refund" among others (see **Figure 8**).

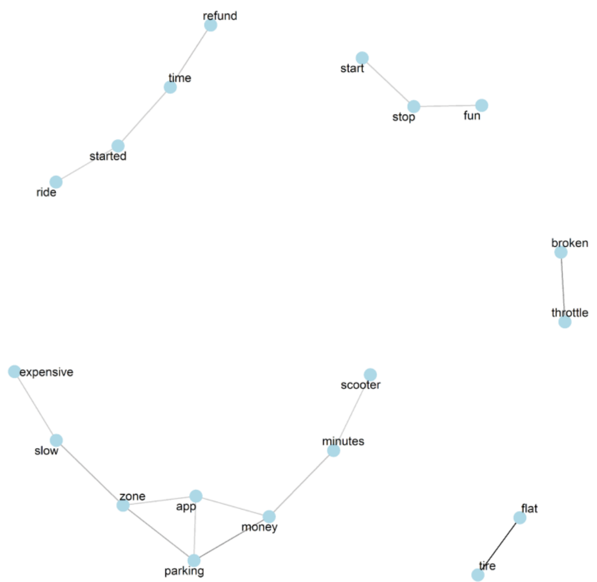

Figure 8. Word Pairs in E-Scooter Riders' Feedback (with at least a Correlation of 0.15).

5. Conclusions and Recommendation

The study analyzed opinions and sentiments expressed by e-scooter riders using feedback obtained over the 6-month (May to October) period in the city of Windsor, Ontario, utilizing a dictionary-based approach. It showed that the popular words used to express sentiment, determined by their frequencies, are significantly different across the study period. The word fun was predominantly used in the feedback obtained to describe riders' experience, signifying that currently, e-scooters are not used for the functional purpose of transportation in the city. Correlation analysis to examine the similarity in the choice of words used to express sentiments or opinions all showed positive relationships but the strength of relationships varied across the study period. The month of May – the beginning of the pilot for e-scooter in the city of Windsor, showed higher correlation with June, July and August and was attributed to the effect of novelty because more people are interested in using the new micro-mobility modes. However, as the months progressed from September to October, the correlation dropped significantly. This sudden and significant drop was linked to the disappearance of the buzz of the novelty of e-scooters as a new mode of transportation within the city and the seasonality effect. It is believed that ridership declined in cold fall months of the pilot study period.

Sentiment analysis using the Bing dictionary showed variations in sentiments expressed across the six months and were significantly different from one another. Overall, the cumulative sentiments expressed in May, June, and August about e-scooters in Windsor were positive while they were negative for the months of July, September, and October. Fun, awesome and nice ranked among the top ten words contributing to positive sentiments expressed by e-scooter riders in the city of Windsor, Ontario validating the findings that e-scooters are not considered as functional transportation modes within the city during the initial six-month pilot study. Across the six-month period, the top ten words generating negative sentiments include slow, broken, and expensive. While words contributing to negative sentiments point to poor e-scooters maintenance practices in the city of Windsor, for ease of interpretation, the study used co-location word analysis to identify the words they associate with. This need was evident by overrepresentation of words relating to poor maintenance practices in top 100-word cloud plot. Therefore, bigram analysis was used to examine correlation between two consecutive words used in the feedback provided by riders. The word fun which was frequently used in feedback is not associated with other words such as travel, trip or commuting that might give indication of e-scooter use for transportation mode. This finding is consistent with other works that showed that e-scooters are used as fun mode [41,42]. It was also found that "flat tire", and "broken throttle" are associated. These are words that have been initially identified as contributing to negative sentiments and point to the need for improved e-scooter maintenance practices in the city. Other correlated consecutive words that were prevalent in riders' feedback relate to parking zones. These findings have several implications for the city.

Firstly, the implication of the use of fun to describe e-scooter ridership in the city of Windsor means that e-micromobility e-scooters are perceived as a mode to be used for leisure and recreational purposes and are likely replacing other sustainable modes of transportation like cycling and walking. This is not the desired result for e-scooter's introduction to any city. In all cases, e-scooters are expected to replace car use for short trips and not replace walking or cycling. This finding points towards the need for integration of e-scooter micro mobility modes with transits system in the city of Windsor. Integrating e-scooters with the transit system will cause a perception shift from e-scooters as recreational to commuting modes for first and last-mile trips. This will require that the city strategically position the location of virtual e-scooter parking zones within the city.

Secondly, sentiment and opinion analysis showed that the maintenance practices by the e-scooter provider are subject to questions. It was found that dead scooters (presumable due to uncharged batteries), broken throttle, and flat tires rank high among the concerns expressed by e-scooter riders in the city of Windsor. Most of these concerns are those that could result in trauma causing accidents for users. At the point of conducting this research, there are no regulations guiding maintenance practices of the e-scooter provider in the city of Windsor. At present, the provider operates on a Carte Blanc on how maintenance of these e-scooters is done. A policy could be set such that a certain level of maintenance concern could warrant a review of license to operate within the city. If otherwise, e-scooter ridership could be unsafe and lead to more injury or in the worst-case fatality. Concerning the issue of dead batteries that were raised by users, it will be appropriate for the city to specify the type of e-scooter (fixed or replaceable battery types) that could operate within her jurisdiction. The city could emulate some parts of the world where replaceable battery types are only allowed.

The advantages of using the replaceable battery e-scooter are numerous. Apart from the service reliability or efficiency that will be enhanced, the cost-emission that has been reported with collection of these scooters for charging, transportation and redistribution will be reduced. Although out of the scope of this study, other regulations that govern the riding of e-scooters in the city of Windsor are still lacking. Regulations that determine where, when, and how they could be ridden need formulation. Currently, no clear regulations or guidelines mandate the use of helmets and the speed at which e-scooters can travel in the city nor enforcement strategies. It is believed that regulations in this direction will be necessary because sentiments expressed by the users are expected over time to include safety concerns that are associated with injuries and riding on the sidewalk. Data regulation is also critical to proper study of the performance of e-scooter in the city of Windsor, Canada. Currently, the service provider only includes a few variables in the data collected. The purpose of the trips made by e-scooter users is not clearly defined. Availability of the purpose for e-scooter trips will help validate if they are used for commuting or fun. It is recommended that the city has an input on the rider parameters that are required to be collected by service providers and that dictionary-based approaches to sentiment analysis could help gain insight through micro participation at the pilot stage of e-scooter implementation.

While the research discussed in this paper used dictionary-based approaches to evaluate opinions and sentiments of e-scooter riders in Windsor, there are other approaches that could be used to achieve the same objectives. Future research could compare other machine learning approaches with the dictionary-based method as more data is collected. Perhaps more insights could be gained from the e-scooter feedback. Also, this paper used unigram and bigram analysis; as more feedback is gathered with continuous usage of e-scooters, a sentence-level analysis of sentiments could be interesting.

Author Contributions

Conceptualization, S.D.O., O.P.O. and T.E.O.; methodology, S.D.O.; software, S.D.O.; validation, S.D.O., T.E.O., C.M.W. and S.S.; formal analysis, S.D.O.; investigation, S.D.O.; resources, S.D.O.; data curation, S.D.O.; writing—original draft preparation, S.D.O.; writing—review and editing, S.D.O., O.P.O., T.E.O., C.M.W. and S.S.; visualization, S.D.O.; supervision, S.D.O.; project administration, S.D.O. and T.E.O. All authors have read and agreed to the published version of the manuscript.

Funding

This work received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Acknowledgments

Special appreciation to the city of Windsor for the brief work experience of the lead author with their organization which facilitated access to abundant data resources that was collaboratively analyzed and led to the findings published. We could not have done this without the opportunity to work in the city.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Latinopoulos, C., Patrier, A., Sivakumar, A., 2021. Planning for e-scooter use in metropolitan cities: A case study for Paris. Transportation Research Part D: Transport and Environment. 100, 103037. DOI: https://doi.org/10.1016/j.trd.2021.103037

[2] Kazemzadeh, K., Sprei, F., 2022. Towards an electric scooter level of service: A review and framework. Travel Behaviour and Society. 29, 149–164. DOI: https://doi.org/10.1016/j.tbs.2022.06.005

[3] Aman, J.J., Smith-Colin, J., Zhang, W., 2021. Listen to E-scooter riders: Mining rider satisfaction factors from app store reviews. Transportation Research Part D: Transport and Environment. 95, 102856. DOI: https://doi.org/10.1016/j.trd.2021.102856

[4] Wang, K., Qian, X., Fitch, D.T., et al., 2023. What travel modes do shared e-scooters displace? A review of recent research findings. Transport Reviews. 43(1), 5–31.

[5] Kong, V., Leszczynski, A., 2022. Dockless micromobility sharing in Calgary: A spatial equity comparison of e-bikes and e-scooters. Canadian Journal of Urban Research. 31(1), 97–110.

[6] Evans-Cowley, J.S., Griffin, G., 2012. Microparticipation with social media for community engagement

in transportation planning. Transportation Research Record. 2307(1), 90–98.

[7] Dhini, A., Hardaya, I.S., Surjandari, I., 2017. Clustering and visualization of community complaints and proposals using text mining and geographic information system. Proceedings of the 2017 3rd International Conference on Science in Information Technology (ICSITech); 25 October 2017; Bandung, Indonesia. IEEE. pp. 132–137.

[8] Gao, Y., Chen, Y., Mu, L., et al., 2022. Measuring urban sentiments from social media data: a dual-polarity metric approach. Journal of Geographical Systems. 24(2), 199–221.

[9] Kapp, A., 2024. Collection, usage and privacy of mobility data in the enterprise and public administrations. Proceedings on Privacy Enhancing Technologies. 2022(4), 440–456. DOI: https://doi.org/10.48550/arXiv.2407.03732

[10] Skiera, B., Yan, S., Daxenberger, J., et al., 2022. Using information-seeking argument mining to improve service. Journal of Service Research. 25(4), 537–548.

[11] Field, C., Jon, I., 2021. E-scooters: A new smart mobility option? The case of Brisbane, Australia. Planning Theory & Practice. 22(3), 368–396.

[12] Yang, H., Huo, J., Bao, Y., et al., 2021. Impact of e-scooter sharing on bike sharing in Chicago. Transportation Research Part A: Policy and Practice. 154, 23–36.

[13] Hawa, L., Cui, B., Sun, L., et al., 2021. Scoot over: Determinants of shared electric scooter presence in Washington DC. Case Studies on Transport Policy. 9(2), 418–430.

[14] Bozzi, A.D., Aguilera, A., 2021. Shared E-scooters: A review of uses, health and environmental impacts, and policy implications of a new micro-mobility service. Sustainability. 13(16), 8676. DOI: https://doi.org/10.3390/su13168676

[15] Jiao, J., Bai, S., Choi, S.J., 2021. Understanding e-scooter incidents patterns in street network perspective: a case study of travis county, Texas. Sustainability. 13(19), 10583. DOI: https://doi.org/10.3390/su131910583

[16] Dias, G., Arsenio, E., Ribeiro, P., 2021. The role of shared e-scooter systems in urban sustainability and resilience during the covid-19 mobility restrictions. Sustainability. 13(13), 7084. DOI: https://doi.org/10.3390/su13137084

[17] Glavić, D., Trpković, A., Milenković, M., et al., 2021. The e-scooter potential to change urban mobility—Belgrade case study. Sustainability. 13(11), 5948. DOI: https://doi.org/10.3390/su13115948

[18] Lo, D., Mintrom, C., Robinson, K., et al., 2020. Shared micromobility: The influence of regulation on travel mode choice. New Zealand Geographer. 76(2), 135–146.

[19] Gebhardt, L., Wolf, C., Seiffert, R., 2021. "I'll take the E-scooter instead of my car"—The potential of E-scooters as a substitute for car trips in Germany. Sustainability. 13(13), 7361. DOI: https://doi.org/10.3390/su13137361

[20] Reck, D.J., Haitao, H., Guidon, S., et al., 2021. Explaining shared micromobility usage, competition and mode choice by modelling empirical data from Zurich, Switzerland. Transportation Research Part C: Emerging Technologies. 124, 102947. DOI: https://doi.org/10.1016/j.trc.2020.102947

[21] Almannaa, M.H., Alsahhaf, F.A., Ashqar, H.I., et al., 2021. Perception analysis of E-scooter riders and non-riders in Riyadh, Saudi Arabia: Survey outputs. Sustainability. 13(2), 863. DOI: https://doi.org/10.3390/su13020863

[22] Sikka, N., Vila, C., Stratton, M., et al., 2019. Sharing the sidewalk: A case of E-scooter related pedestrian injury. The American Journal of Emergency Medicine. 37(9), 1807.e5–1807.e7.

[23] Merlin, L.A., Yan, X., Xu, Y., et al., 2021. A segment-level model of shared, electric scooter origins and destinations. Transportation Research Part D: Transport and Environment. 92, 102709. DOI: https://doi.org/10.1016/j.trd.2021.102709

[24] Bai, S., Jiao, J., 2022. From shared micro-mobility to shared responsibility: Using crowdsourcing to understand dockless vehicle violations in Austin, Texas. Journal of Urban Affairs. 44(9), 1341–1353.

[25] Ali, F., Kwak, D., Khan, P., et al., 2019. Transportation sentiment analysis using word embedding and ontology-based topic modeling. Knowledge-Based Systems. 174, 27–42. DOI: https://doi.org/10.1016/j.knosys.2019.02.033

[26] Hao, J., Zhu, J., Zhong, R., 2015. The rise of big data on urban studies and planning practices in China: Review and open research issues. Journal of Urban Management. 4(2), 92–124. DOI: https://doi.org/10.1016/j.jum.2015.11.002

[27] Abbasi, A., Rashidi, T.H., Maghrebi, M., et al., 2015. Utilising location based social media in travel survey methods: bringing Twitter data into the play. Proceedings of the 8th ACM SIGSPATIAL International Workshop on Location-Based Social Networks; 3 November 2015; Seattle, WA, USA. ACM. pp. 1–9.

[28] Zhu, L., Yu, F.R., Wang, Y., et al., 2018. Big data analytics in intelligent transportation systems: A survey. IEEE Transactions on Intelligent Transportation Systems. 20(1), 383–398. DOI: https://doi.org/10.1109/TITS.2018.2815678

[29] Lin, C., Wang, G., 2017. Failure cause extraction of railway switches based on text mining. Proceedings of the 2017 International Conference on Computer Science and Artificial Intelligence; 5 December 2017; Shanghai, China. ACM. pp. 237–241. DOI: https://

doi.org/10.1145/3168390.3168402

[30] Choi, S., Ko, J., Kim, D., 2021. Investigating commuters' satisfaction with public transit: A latent class modeling approach. Transportation Research Part D: Transport and Environment. 99, 103015. DOI: https://doi.org/10.1016/j.trd.2021.103015

[31] Sai, F., 2019. Survey of Sustainable Logistics Services via Text Mining. Journal of Mechanics Engineering and Automation. 9(3). DOI: https://doi.org/10.17265/2159-5275/2019.03.004

[32] Shokouhyar, S., Shokoohyar, S., Sobhani, A., et al., 2021. Shared mobility in post-COVID era: New challenges and opportunities. Sustainable Cities and Society. 67, 102714. DOI: https://doi.org/10.1016/j.scs.2021.102714

[33] Ridhwan, K.M., Hargreaves, C.A., 2021. Leveraging Twitter data to understand public sentiment for the COVID-19 outbreak in Singapore. International Journal of Information Management Data Insights. 1(2), 100021. DOI: https://doi.org/10.1016/j.jjimei.2021.100021

[34] Yang, H., Ma, Q., Wang, Z., et al., 2020. Safety of micro-mobility: Analysis of E-Scooter crashes by mining news reports. Accident Analysis & Prevention. 143, 105608. DOI: https://doi.org/10.1016/j.aap.2020.105608

[35] Silge, J., Robinson, D., 2017. Text Mining with R: A Tidy Approach. O'Reilly: Boston, MA, USA. pp. 1–193.

[36] Lloyd, M., 2022. Weaving fun and functionality. A study of everyday urban e-scootering. Etnografia e Ricerca Qualitativa. 15(2), 241–262. DOI: https://doi.org/10.3240/103668

[37] Krier, C., Chrétien, J., Lagadic, M., et al., 2021. How do shared dockless e-scooter services affect mobility practices in Paris? A survey-based estimation of modal shift. Transportation Research Record. 2675(11), 291–304.

[38] Bieliński, T., Ważna, A., 2020. Electric scooter sharing and bike sharing user behaviour and characteristics. Sustainability. 12(22), 9640. DOI: https://doi.org/10.3390/su12229640

[39] Kjærup, M., Skov, M.B., Van Berkel, N., 2021. E-scooter sustainability–a clash of needs, perspectives, and experiences. Proceedings of the IFIP Conference on Human-Computer Interaction; 26 August 2021; Bari, Italy. Springer: Cham, Switzerland. pp. 365–383.

[40] Severengiz, S., Schelte, N., Bracke, S., 2021. Analysis of the environmental impact of e-scooter sharing services considering product reliability characteristics and durability. Procedia CIRP. 96, 181–188.

[41] Kopplin, C.S., Brand, B.M., Reichenberger, Y., 2021. Consumer acceptance of shared e-scooters for urban and short-distance mobility. Transportation Research Part D: Transport and Environment. 91, 102680. DOI: https://doi.org/10.1016/j.trd.2020.102680

[42] Dibaj, S., Hosseinzadeh, A., Mladenović, M.N., et al., 2021. Where have shared e-scooters taken us so far? A review of mobility patterns, usage frequency, and personas. Sustainability. 13(21), 11792. DOI: https://doi.org/10.3390/su132111792