



# A multi-criteria approach to prioritize electric-scooters ordinances. A case of Bloomington City, Indiana

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## ABSTRACT

Shared electric scooters have recently emerged as an alternative mode of transportation in many cities around the globe. However, they can become a nuisance to residents when they are not well regulated. The approaches to prioritizing laws and regulations of shared electric scooters have not been explored extensively. Therefore, this study presented a multi-criteria approach for prioritizing electric scooter ordinances using Bloomington, Indiana's survey data. The study applied a descriptive analysis, text mining, and logistic regression on 1,891 responses. The responses were based on a questionnaire with 13 predefined ordinances and an additional comment section. The three criteria- the frequency of selection of ordinances, the sequence of selection of ordinances, and the ordinances associated with additional comments were used. Results revealed a great variation in the priorities of the ordinances when the three criteria are used. The frequency of selection criteria would highly favor the ordinance related to enforcing scooter riders to follow traffic laws, while both sequence of selection and additional comments would favor prohibiting scooters from the sidewalks. The policy implications of the multi-criteria and individual criteria are also presented. It is expected that jurisdictions would apply the approach presented in this study and the associated proposed alternatives when prioritizing the ordinances for electric scooters.

## 1. Background

Shared electric scooters have recently emerged as an alternative mode of transportation for trips that are too short to drive and too long to walk. In the United States, various companies, including Lime, Bird, Spin, Bolt, Beam, Scoot, Green & Yellow, and Jump, have been operating electric scooters since 2017 (Ma et al., 2021a; Srivastava, 2021). As of December 2019, electric scooters were operating in over 150 cities (Ma et al., 2021a).

Before granting a license to electric scooter operators, most jurisdictions provide laws and guidelines that the operators and riders must follow. In setting up laws and guidelines for shared electric scooters, jurisdictions normally collect residents' preferences for the proposed laws and regulations. Cities such as Bloomington, Charlotte, Tucson, Spokane, Columbus, and Charlottesville are a few examples of the jurisdictions that surveyed their residents to collect their preferences on the proposed ordinances (PBIC, 2019). Traditionally, a list of proposed ordinances is presented for residents to select their preferences. The most frequently selected proposed ordinances are given higher

preferences and are used to set higher fines (Bloomington, 2019; Herrman & Newmark, 2019). In addition to the predefined ordinances, some survey questionnaires give respondents a chance to provide their views that may not necessarily be covered in the proposed predefined ordinances. The results of such views are typically presented as raw texts (Bloomington, 2019).

Although setting regulations/laws based on the most frequently selected ordinances has been dominantly utilized, some philosophical questions can be raised. First, are there alternative approaches that can be used to understand the respondents' preferences? Second, can the additional comments be analyzed to gain insights? And third, is there a way to link the contents of the additional comments to the proposed predefined ordinances? It is assumed that, naturally, respondents would select the most important ordinance first. Thus, alternative approaches to analyzing the selected ordinances would reveal the most frequently selected and the selection sequence. Some respondents might provide valuable information in the comments that might complement or oppose the predefined ordinances (Aman & Smith-Colin, 2021). Such insights can only be explored if advanced analytics are applied. A linkage

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between the proposed ordinances and the key contents of the additional comments would provide a clue about the respondents who support/oppose the proposed. The project answers to all three questions provide a chance to prioritize the ordinances while considering different perspectives.

Therefore, this study utilizes the scooter ordinance survey data from Bloomington, Indiana, as a case study to explore alternative ways of prioritizing ordinances using a multi-criteria approach. The exploration considers the frequency, sequence, and additional residents' views are considered. The findings are expected to provide a methodology to be used by practitioners when prioritizing ordinances or setting up other measures that involve residents' participation. The rest of the manuscript is organized as follows. The next section presents the literature review, followed by the methodology section, where the case study and data description, along with the analytical methods applied, are discussed. The results and discussion section is then presented, followed by the conclusions, and study limitations.

## 2. Literature review

Shared electric scooters, which private companies normally operate, have emerged as an alternative mode of transportation for trips that are longer to walk but shorter to drive. The 2018 statistics showed that 85,000 e-scooters were available in over 150 cities in the United States alone. (Ma et al., 2021a).

Shared electric scooter riders and operators are supposed to adhere to the laws and guidelines set by the jurisdictions. A study by Ma et al. (2021a,b) examined guidelines for shared electric scooters across 156 cities in the United States. The authors reported that among 156 cities, 39 % have scooter guidelines only, 12 % have both guidelines and laws, 30 % have no guidelines, and 19 % did not provide a permanent operational license after the pilot program. For cities with guidelines, the authors divided e-scooter guidelines into 16 key attributes: parking location, riding locations, sidewalk restrictions, and helmet usage, among others. Similarly, Janssen et al., (2020) assessed scooter policies across eight American mid-sized cities. The assessment focused on key factors such as fleet caps, permitting fees, and equity, among others. Another comprehensive study by Wood et al. (2019) collected and analyzed e-scooter policies from 81 cities that have e-scooters. Using e-scooter policies from 81 cities, the authors found that four cities had statewide e-scooter regulations, five cities had no regulations, 29 had permanent policies/contracts, and 43 had temporary/pilot programs. Further, a study by Anderson-Hall and Bordenkircher (2018) developed the e-scooter regulation breakdown for all cities operating e-scooter in 2018. The guideline indicated which cities are operating e-scooters and which cities have ceased. The authors outlined the reasons for ceasing e-scooter operations. The most cited reason for desisting e-scooters in San Francisco, Nashville, Denver, Scottsdale, Charlotte, and Honolulu, among others, was the blocking of the sidewalks.

The responses from the survey are normally used to develop ordinances for operating scooters. These ordinances vary by jurisdiction depending on the residents' stated preferences in the surveys. However, studies show several common items in multiple cities/states (Bloomington, 2019; PBIC, 2019; Riggs et al., 2021). For instance, the ordinances for sidewalk prohibition were passed in Memphis, Texas, and Providence, while parking location ordinances are in Spokane, Charlotte, and Charlottesville. Further, riding locations ordinances are in Austin, Spokane, and Columbus, sidewalk restrictions ordinances are in Washington and California, while helmet usage ordinances are common in Miami and New York (Herrman & Newmark, 2019; Ma et al., 2021a, b).

Furthermore, survey responses are used to develop fines associated with the guidance/ordinances (Herrman & Newmark, 2019; Nikiforiadis et al., 2021; Sareen et al., 2021; Verkehrswende, 2019). A study by Herrman & Newmark, (2019) reported that by 2018, the operating company was supposed to pay \$500 for illegal parking and \$100 for

parking outside the operating zone in Louisville, Kentucky. On the other hand, the reckless ride and DUI rider could face up to \$250 and \$1000 fines, respectively, in San Diego, California (Herrman & Newmark, 2019). The two fines differ significantly, suggesting that the difference may be explained by the residents' favor for one ordinance over the other, among other factors.

Apart from the United States, other countries, especially in Europe, have documented Scooter laws and guidelines. A study by Sokolowski, (2020) provides a comprehensive review of electric scooter laws across European Union countries. This study summarized various aspects related to scooters, including age limit, speed, license need, insurance, engine power, and helmet use, among others. For instance, according to (Sokolowski, 2020), children under 12 years need supervisors to ride scooters in Austria. On the other hand, Riders in Germany need to be at least 14 years old, while no age limit is set for riding scooters in the Netherlands. In Austria, any offenses are penalized with a maximum administrative fine which can be determined by the respective authority based on the provisions of the Austrian Road Traffic Act. Maximum riding speed is 20kph in Germany, Sweden, and Italy, while in Lithuania and Luxembourg, it is 25 kph. Obstructing pedestrian paths may result in a fine in Malta, while in Slovenia, scooters operating in pedestrian paths that exceed pedestrian speed are subjected to a 500 EUR fine. Furthermore, operating a scooter on the sidewalks in Paris, France, results in a fine (Verkehrswende, 2019). Similarly, sidewalk obstruction is an offense whose fine can be as much as €500 in Bergen, Norway (Sareen et al., 2021). Further, a person can be fined for not wearing a helmet while riding a scooter in Paris, France (Gössling, 2020). Such fines can be paid by the rider or the company operating the scooters.

The reviewed literature provided detailed explanations of the available laws and regulations governing electric scooters across the United States and globally. However, the approaches to prioritizing such guidelines have not been well explored. As such, little knowledge is available on the approaches to prioritize rules and laws for the ordinance in a given jurisdiction. A Bloomington scooter report (Bloomington, 2019) indicated that upon developing guidelines/laws, researchers normally analyze survey responses using descriptive analysis to determine the residents' preferences. The predefined ordinances with high frequencies are given high priority. Although the descriptive analysis provides simple and relatively easy results to stakeholders, it can be misleading. This means the most selected ordinance might not be the most preferred ordinance. Furthermore, the simple descriptive analysis does not provide a deep understanding of the residents who are against electric scooters. Therefore, this study presents a multi-criteria approach for prioritizing electric scooter ordinances. The study utilizes the electric scooter ordinance survey from Bloomington, Indiana. The next section presents in detail the methodology applied in this study.

## 3. Methodology

This study used data collected from Bloomington city, Indiana, whereby residents were asked about the scooter guidelines that they would want to see included in the ordinance. The case study and data description are presented to facilitate a better understanding of the methodology applied in this study. The applied analytical approaches are then presented.

### 3.1. Case study and data description

Two scooter companies, Bird and Lime scooters, have been operating in Bloomington under trial deployment city since late 2018 (WTHR.com, 2018). Bird scooters started its trial operations on September 13 with 100 scooters, while 450 Lime scooters started operating on September 29, 2018. In 2020, the VeoRide scooter company joined the first two companies in the city. Before the survey, there were over 70 complaints about scooters. (Askins, 2020).

The city prepared a survey questionnaire to solicit information on the

ordinances that residents would give their priority. The survey data was collected between March 4–8, 2019, using a Google form. The survey targeted Bloomington residents, while another separate survey (not included in this study) targeted University of Indiana students, faculty, and visitors. The survey was shared through the city's website, Facebook, Twitter, Nextdoor, and local media outlets. The question posed to residents was, "What would you like to see included in a scooter ordinance for the city?". The residents were given the following 13 predefined rules to select and an additional option to provide their views.

1. Riders must follow all traffic laws.
2. Designated parking areas for scooters
3. Scooter companies must maintain a 24-hour phone number for reporting concerns.
4. Scooter companies must pay for a license to operate in Bloomington.
5. Rules governing the safe distance scooters must give pedestrians.
6. Scooter companies are held accountable for scooter parking mistakes.
7. Scooters are prohibited from sidewalks.
8. A cap on the total number of scooters operating in the city.
9. Rules governing scooters' maximum speed.
10. Rules enforcing the dismount zones in the downtown area.
11. Riders must be 18 years of age or older.
12. Scooter companies must make scooters available in low-income areas.
13. Limited hours for scooter availability

Thus, residents were required to choose one or more of the 13 ordinances above. Within five days of the survey, a total of 1,891 survey responses were collected from Bloomington residents. In addition to the selected ordinances, about 457 respondents provided additional views under the "other" category. The city prepared a report detailing its findings (Bloomington, 2019).

Later in 2019, the city council passed an ordinance that provides guidelines for dismounting scooters when passing pedestrians, parking restrictions, and parking on the sidewalk (B-Square, 2019). Additionally, the city government has recently directed scooters to be used only from 5 a.m. to 11p.m. daily following the scooter-related death of an Indiana University student in September 2022 (Montgomery, 2022).

This study presents a multi-criteria approach for setting electric scooter ordinances using a Bloomington, Indiana, case study. The three criteria applied are

- a) the frequency of selection of ordinances,
- b) the sequence of selection of ordinances, and
- c) the ordinances associated with additional comments that are against electric scooters.

The study applied descriptive analysis, text mining, and logistic regression to develop these criteria. The descriptive analysis is intended to understand the frequency of selected ordinances and the selection sequence. The text mining approach was applied to understand the nature of the comments that respondents provided in addition to selecting the ordinances. Lastly, the logistic regression was applied to relate the selected ordinance and the added comments by the respondents. Multi-criteria approach provides a better prioritization of available options (Pamucar et al., 2022). The following section provides more details on the text network and logistic regression.

### 3.2. Text network

Text network analysis (TNA) is used to reveal information contained in text data using a network made of nodes and links/edges (Kutela et al., 2021; Kutela & Teng, 2021). The nodes normally represent the keywords, while the links imply connections between keywords. The

distance between nodes (i.e., the length of the edge) represents the separation of the keywords in a sentence/comment. Further, keywords with similar ideas are enclosed in a community (Kutela et al., 2022a; Kutela et al., 2022b). A typical example of such a network is presented in Fig. 1.

TNA follows three major steps: text cleaning and formatting, creating the matrix of keywords and plotting the network, and extracting keywords and other metrics for detailed discussion.

During text cleaning and formatting, the unstructured text data is normalized and transformed into a corpus of words (Kutela et al., 2022d; Paranyushkin, 2011). The cleaning and formatting involve the removal of punctuations, symbols, and signs and formatting the text data into lowercase. The corpus of keywords is then transformed into a matrix of keywords whereby the keywords are listed down, and their frequency of occurrences are tabulated. The algorithm starts by identifying the first keyword and moves to the next. If the next keyword is similar to the previous one, a frequency of 1 is added; otherwise, a new keyword is added. A matrix of keywords is formed then the first pair of words is plotted on the network. This process continues as the algorithm searches for new pairs. If the same set of keywords is spotted, the weight of the keyword and the link in the network increases (Kim et al., 2018; Kutela et al., 2022e; Paranyushkin, 2011).

Lastly, quantitative details generated from the text network are extracted for further detailed analysis (Kutela et al., 2022c; Yoon & Park, 2004). This study considers the co-occurrences of keywords in the text network. The analysis was performed in the R 4.1.1 environment (R Core Team, 2021) using the *quanteda* package (Benoit et al., 2018). Since the analysis involved a large dataset, 50 most frequent keywords were used for the corpus analysis as previously applied in text mining studies.

### 3.3. Logistic regression

Logistic regression is applied to determine the ordinances associated with the negative perceptions toward scooters. The negative perceptions are extracted from respondents' narratives suggesting that the city should ban scooters. The logistic regression model has been used for regression because of its flexibility in interpreting the odds ratios (Kutela & Teng, 2020; Mwendu & Kutela, 2020; Woodridge, 2012). The logit regression model is given by:

$$\text{logit}(P_i) = \ln\left(\frac{P_i}{1 - P_i}\right) = \beta X + \epsilon \quad (1)$$

From Equation (1),  $P_i$  is the probability of a ban scooter response,  $\beta$  is a fixed-effects parameters matrix,  $X$  is an explanatory/predictor variables matrix, and  $\epsilon$  matrix of error terms. The predefined ordinances served as predictors in the regression analysis.

This study expands on analyzing the responses presented in the 2019 scooter survey report (Bloomington, 2019) and presents alternative ways of prioritizing ordinances using the survey results as a case study.

## 4. Results and discussions

This section presents the results and discussion. It is divided into four main sections: the frequency of ordinance selection results, sequence of selection of ordinance results, additional comments analysis results, and the multi-criteria ranking.

### 4.1. Frequency of selection of ordinance

Fig. 2 presents the frequency of selections of ordinances. This is the common methodology used by several jurisdictions, including Bloomington. The Bloomington scooter survey (Bloomington, 2019) presented these results to indicate the selection frequencies.

According to Fig. 2, the "riders must follow all traffic laws" ordinance was the most selected option (1655), followed by "designated parking

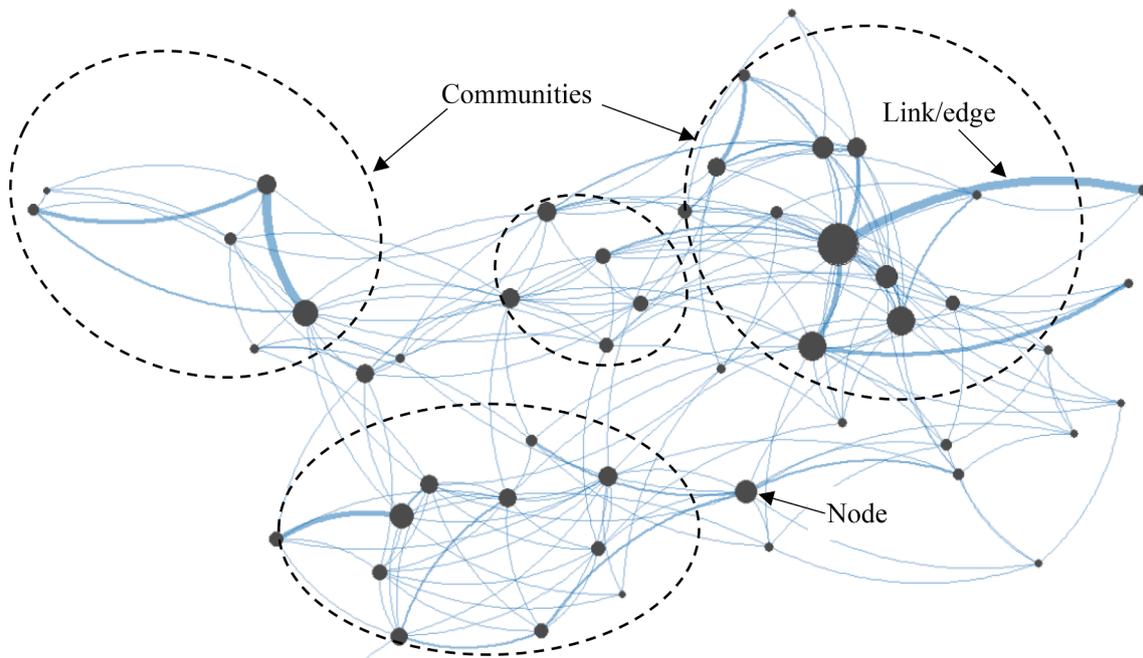


Fig. 1. A Typical Example of Text Network (Kutela et al., 2021).

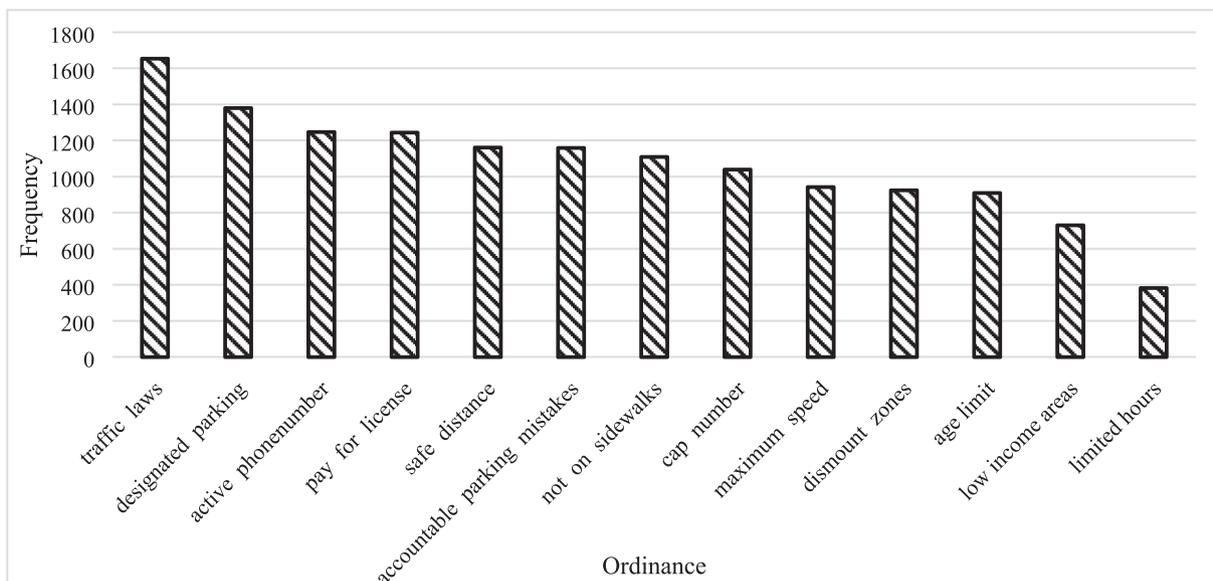


Fig. 2. Frequency of Ordinances Selections (Bloomington, 2019).

areas for scooters” with 1381 selections. On the other hand, the least selected option was “limited hours for scooter availability,” with 383 selections, followed by “scooter companies must make scooters available in low-income areas,” with 731 selections.

Based on the findings in this section, it can be concluded that the ordinance that requires riders to follow traffic laws is the most important as it is the most selected ordinance. Thus, if the city sets fines for ordinance violations, this ordinance would be given more weight. On the other hand, the “Limited hours for scooter availability” ordinance would be given less weight.

4.2. The ordinance’s selection sequence

The frequency of ordinance selection is a good indicator of how residents prefer one ordinance over the other. However, it does not

indicate the selection sequence when multiple options exist. Residents would likely start by selecting the most preferred ordinances first and then move on to the least preferred ones. To understand the selection sequence, the number of ordinances selected by each resident was first determined. According to Fig. 3, although residents were given 13 ordinances to choose from, it revealed that most residents selected between six and eleven ordinances.

Nine ordinances were selected 193 times, making it the most selected group. Six ordinances were selected 191 times, making it the second most selected group. Among the residents, 75 selected all 13 ordinances, and 35 did not select any of the ordinances. The number of ordinances selected indicated varying preferences among residents. The fact that there are residents who chose all 13 ordinances while others did not choose any ordinance shows great variability in residents’ preferences.

The number of ordinances selected revealed great variability in

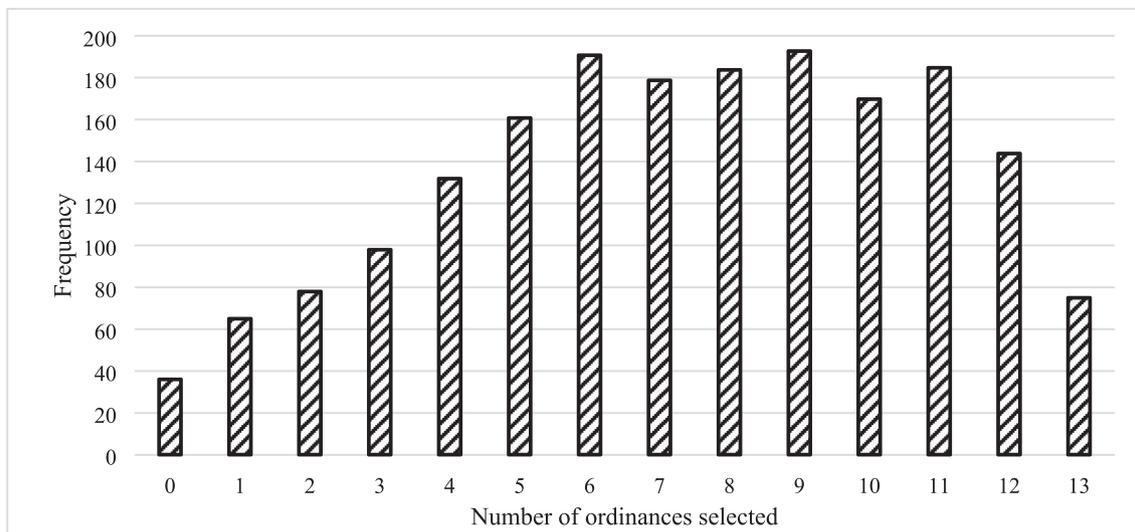


Fig. 3. Number of ordinances selected.

ordinance preferences; however, it does not reveal the order of preference. To understand the order of preferences for the ordinances, the first to the last selected ordinances were identified. Although the selection sequence was not enforced in the survey design (Bloomington, 2019), it is assumed that respondents would first select their most preferred ordinances before selecting their least preferred ones. Thus, the tallying of the first to the last selected ordinances was performed for residents who selected multiple ordinances.

Fig. 4 presents the sequence of ordinance selection. It can be observed that “Scooters prohibited from sidewalks” was the first preferred choice by residents. Among the 1882 responses, this ordinance received 1110 responses as the first choice. On the other hand, “designated parking areas for scooters” was ranked the second choice, with 483 selections. “Designated parking areas for scooters” received the most selections, with 898 selections, while other ordinances had relatively low frequencies.

The “scooter companies held accountable for scooter parking mistakes” ordinance was the third most selected, followed by the “scooter

companies must pay for a license to operate in *Bloomington*”. The “riders must follow all traffic laws” ordinance, which was the most selected ordinance, does not appear as the top selection until choice 10. However, this ordinance has had a substantial number of selections for each choice. The analysis implies that if the city would prioritize the ordinances based on the selection frequency, the “riders must follow all traffic laws” would be the priority. On the other hand, if the city would prioritize ordinances by the first selected, then the “Scooters prohibited from sidewalks” would be the priority.

The ordinance selection sequence provides another dimension of preferences for ordinances. Although the “riders must follow all traffic laws” was the most selected ordinance (Fig. 2), it was not the first choice for most residents (Fig. 4). Similarly, “Scooters are prohibited from sidewalks” was the seventh-ranked in Fig. 2, but it was the first selected ordinance (Fig. 4). This implies that the most selected ordinance is not always the most preferred. Thus, setting enforcement measures such as fines based on the most selected ordinance might not capture the best preferences of the residents.

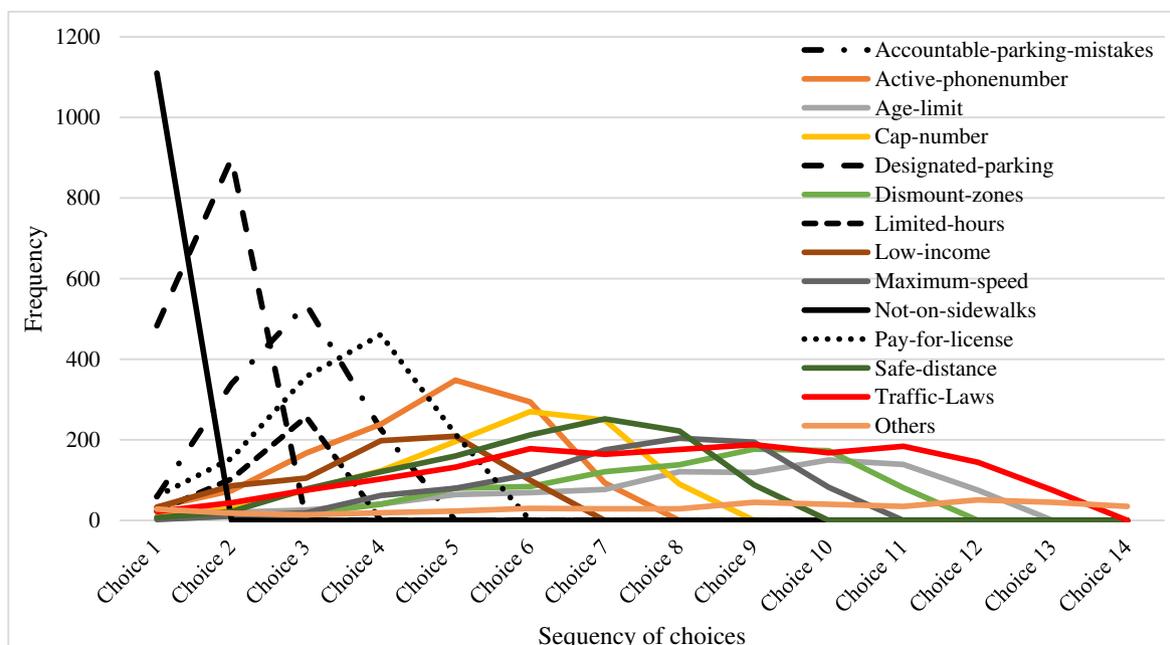


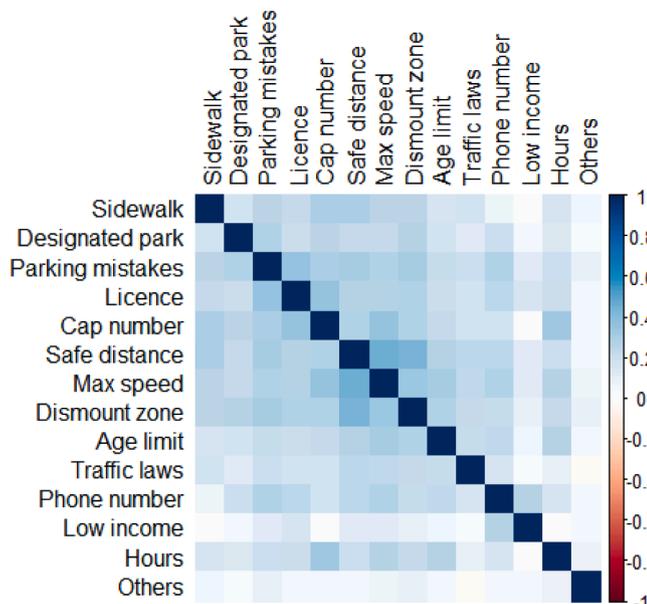
Fig. 4. The Sequence Selection of Ordinances.



**Table 1**  
Summary of the Text Network results.

Rank	Frequency Analysis			Co-occurrence Frequency		Collocation Analysis	
	Keywords	Count	Doc Freq	Keywords	Count	Keywords	z-value
1	rider	107	88	ban scooters	52	traffic laws	13.00
2	bicycle	81	66	rider helmet	30	wear helmet	11.97
3	sidewalk	81	65	wear helmet	27	helmet required	10.45
4	park	76	63	bicycle lane	24	parking areas	10.17
5	company	76	62	bicycles sidewalk	19	riders wear	9.96
6	helmet	63	60	parking areas	18	bicycles lanes	9.87
7	ban	63	60	helmet required	16	follow traffic	9.58
8	scooter	52	52	company city	13	held accountable	8.74
9	rule	51	46	rider rules	12	designated parking	8.27
10	enforce	50	44	block sidewalk	12	block sidewalks	7.73
11	use	48	42	company rider	11	safe distance	7.66
12	city	47	36	bicycle parking	11	just ban	7.61
13	ride	40	31	ride bicycles	11	block handicap	7.53
14	area	36	26	rider sidewalk	11	ban scooters	7.41
15	law	34	31	use sidewalk	10	held responsible	7.17

Key: Doc Freq = Document Frequency.



**Fig. 6.** Variables' Correlation Matrix.

Fig. 6 presents the variables' correlation matrix. The darker the square's color, the higher the correlation between the two variables. It can be observed that the variables (ordinances) have no significant correlation. Thus, all variables were used in the logistic regression model to predict the likelihood of a scooter banning.

Table 2 presents logistic regression results on banning electric scooters. This model intends to determine the likelihood of the selected ordinances being associated with banning scooters. The discussion and interpretation of the model are based on the Odds Ratios (ORs) and their statistical significance. Results show that five variables are statistically significant at a 90 % confidence interval. These predictors are "not on sidewalks," "cap numbers," "maximum speed," "limited hours," and "traffic laws."

Results indicate that respondents who chose the "not on sidewalk" ordinance are over 3.6 times more likely to comment on banning electric scooters. The observation suggests that although this ordinance is ranked 7th in the selection, it is the most important predictor for people who do not want electric scooters in the city. People may not want electric scooters because they are either left on the sidewalks or are being operated on them (Ma et al., 2021b; Sikka et al., 2019).

Further, respondents who chose the cap number of electric scooters

**Table 2**  
Logistic Regression Results.

	Estimate	Odds Ratio	Std. Error	Z-Stat	P-value
Not on sidewalks	1.283	3.607	0.481	2.665	0.008
Designated parking	-0.674	0.509	0.442	-1.526	0.127
Accountable parking mistakes	0.011	1.011	0.487	0.022	0.983
Pay for license	-0.454	0.635	0.500	-0.908	0.364
Cap number	0.909	2.481	0.529	1.718	0.086
Safe distance	-0.217	0.805	0.501	-0.433	0.665
Maximum speed	0.965	2.625	0.518	1.864	0.062
Dismount zones	0.016	1.016	0.444	0.036	0.971
Age limit	0.503	1.654	0.415	1.212	0.225
Traffic laws	-1.208	0.299	0.592	-2.041	0.041
Active phone number	-0.455	0.634	0.439	-1.036	0.300
Low income	-0.316	0.729	0.349	-0.904	0.366
Limited hours	0.798	2.221	0.365	2.184	0.029
(Intercept)	-2.462	0.085	0.570	-4.318	<0.001

are about 2.8 times more likely to comment negatively on banning them. A relatively small number of respondents selected this ordinance as it is ranked 8th in the selections Fig. 2. The cap number for electric scooters intends to limit the number of scooters. Thus, it is logical that people who opted for this ordinance are likely to recommend for ban scooters.

The ordinance targeted at limiting maximum speed is also associated with banning scooters. The OR value for this ordinance is 2.83, which implies that respondents are about 2.8 times more likely to suggest banning electric scooters. The group of respondents might understand the relationship between speed and injuries.

Furthermore, the ordinance related to the "Limited hours for scooter availability" is associated with an increased likelihood of banning scooters. Results in Table 2 show that respondents who chose this ordinance are more than two times more likely to suggest banning scooters. The observation can be explained by the fact that this group of respondents already hesitantly on the scooters' all-day operations; thus, they are likely not to allow scooter operations.

Conversely, Respondents who chose traffic laws ordinances are less likely to recommend banning electric scooters. Results show that this group of respondents is 71 % less likely to comment on banning electric scooters in the city. The observation suggests that respondents who target traffic laws to be tightened for scooters are confident that riders will follow the laws and operate accordingly. Thus, they are less likely to recommend banning scooters.

Additionally, the remaining ordinances showed no statistical significance difference at a 95 % confidence level. However, the ordinances varied in their influence on banning electric scooters. The ordinances

associated with an increased likelihood of banning electric scooters include accountable parking mistakes, dismount zones, and age limits. Respondents who choose the dismount zones ordinance can be associated with banning scooters as they might need a clear, uninterrupted space. Respondents who are proponents of the age limit might be sensitive to how young people ride scooters and are more likely to be involved in injury crashes (Aizpuru et al., 2019). On the other hand, respondents who selected the remaining five ordinances are less likely to recommend banning scooters. These are designated parking, pay for a license, safe distance, active phone number, and low income. It is understood that researchers are exploring the utilization of scooters in low-income communities. These results suggest that respondents do want scooters in low-income communities. Further, designated parking for scooters would reduce the chance of scatteredness in the streets. Thus, it is logical that respondents who choose designated parking are likely to welcome scooters in the city.

4.6. Multi-criteria ranking

Table 3 presents the summary of the multi-criteria ranking of the ordinances. The selection frequency ranking is based on the results in Fig. 2, while the first-choice frequency ranking is based on the results in Fig. 4. Similarly, the ban scooter ranking is based on the logistic regression results in Table 2. The ordinances were ranked based on their

**Table 3**  
Multi-criteria Ranking.

Ordinance	Ranking				Overall Rank
	Selection Frequency	First choice	Ban Scooter	Overall score	
Riders must follow all traffic laws	1	9	13	23	7
Designated parking areas for scooters	2	2	12	16	2
Scooter companies must maintain a 24-hour phone number for reporting concerns	3	5	11	19	5
Scooter companies must pay for a license to operate in Bloomington	4	4	10	18	4
Rules governing the safe distance scooters must give pedestrians	5	7	8	20	6
Scooter companies are held accountable for scooter parking mistakes	6	3	7	16	2
Scooters are prohibited from sidewalks	7	1	1	9	1
A cap on the total number of scooters operating in the city	8	6	3	17	3
Rules governing scooters' maximum speed	9	8	2	19	5
Rules enforcing the dismount zones in the downtown area	10	10	6	26	9
Riders must be 18 years of age or older	11	11	5	27	10
Scooter companies must make scooters available in low-income areas	12	4	9	25	8
Limited hours for scooter availability	13	3	4	20	6

odds ratios for the ban scooter ranking. The higher the odds ratios, the higher the ranks.

According to the frequency of selection of ordinances, the *riders must follow all traffic laws* is most selected ordinances. However, the same ordinance is the ninth when considering the frequency of the first choice and the last when it is associated with banning scooters in the city. On the other hand, *Scooters are prohibited from sidewalks* in the seventh selected ordinance when the selection frequency is considered. But it is the first in terms of the frequency of the first choice as well as when banning scooters is considered. Thus, the overall score, which is the sum of the rankings of the ordinances for the three criteria, provides a relatively better way of prioritizing the ordinances.

According to the overall rank in Table 3, the *Scooters are prohibited from sidewalks* is the highest-ranked, while *Riders must be 18 years of age or older* is the lowest-ranked ordinance. By considering the approach applied in this study, the *Scooters are prohibited from sidewalks* ordinance should be given higher priority. This can be in terms of fines, education to the riders, or other enforcement forms. Furthermore, multiple ordinances are equally ranked. For instance, ranks 2, 5, and 6 have two ordinances each. In such scenarios, the jurisdiction might decide which ordinance has more weight than the other.

5. Conclusions

This study presented a multi-criteria approach for prioritizing electric scooter ordinances using the Bloomington, Indiana, survey data. The study applied a descriptive analysis, text mining, and logistic regression to the survey responses, which had 13 predefined ordinances selected and additional comments. The three criteria applied are the frequency of the ordinances, the selection sequence of ordinances, and the ordinances associated with additional comments against the electric scooters. Results revealed a great variation in the priorities of the ordinances when the three criteria are used. For instance, when the frequency of the ordinance selection is applied, the ordinance related to following traffic laws is the highest ranked. But the same ordinance is mid to low ranked when the other two criteria are used.

This study presents alternative approaches to the jurisdictions whenever they want to prioritize the laws and regulations for electric scooters or any other ordinances. The use of simple descriptive analysis of the frequency of selection of ordinances provides a relatively simple and easily implementable approach to policymakers, but it can be misleading to a certain extent. This study shows that an extensive analysis of the same responses can provide relatively better outcomes for decision-making. For instance, instead of focusing on the *Riders must follow all traffic laws* ordinance, which had the highest frequency, policymakers may also weigh in on the *Scooters are prohibited from sidewalks* ordinance, which was the most selected as the first choice. It should be noted that the overall ranking is based on the addition of individual rankings. However, the jurisdiction may decide on alternative ways to provide an overall ranking. For instance, one ordinance might be assigned more weight than the others based on the jurisdiction's preferences or experience. Thus, the overall ranking of the ordinances might change.

6. Study limitations

Although this study has presented alternative approaches for prioritizing ordinances, it has some shortfalls that future studies can address. First, since data collection involved social media, which can be accessed worldwide, there is a chance that some respondents are not from Bloomington, Indiana. However, this number is expected to be relatively small. Future studies may restrict the survey to the residents of a particular jurisdiction by including such a question and terminating a survey if a respondent does not reside in the jurisdiction. Second, in the survey, respondents were not asked to rank the first and the last ordinances. To produce the rankings, authors assumed that respondents

would select the most preferred ordinance first. Thus, the first to the last ordinances' ranking was based on the sequence they appeared in the responses. However, such an assumption might not be valid in all situations. In future studies, respondents should be asked to rank the ordinances. Lastly, text network analysis is not the only way of analyzing text data. Future studies may utilize sentiment analysis to explore the polarity of the respondents' comments and associate them with predefined ordinances.

### CRedit authorship contribution statement

**Boniphace Kutela:** Conceptualization, Methodology, Data curation, Writing – original draft, Writing – review & editing. **Rafael John Mwekh'iga:** Data curation, Writing – original draft, Writing – review & editing.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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