AAAI 2025 Workshop March 3, 2025, Philadelphia, PA, USA

Mining E-Scooter Safety Policies and Plans Using GPT-40 and Latent Dirichlet Allocation (LDA) Modeling



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Background:

Rising Popularity and Growing Safety Concerns



Source: https://nacto.org/wp-content/uploads/2024/08/Shared-microin-2023-snapshot_FINAL_July22-2024.pdf Fernandez, et al. 2024

Municipal Responses to E-scooter – Unprepared

"Throw the baby out with the bathwater"?

Austin rolls out new regulations, limits on escooters in city

<u>Olivia Dilley</u>, Senior News Reporter April 12, 2024



E-Scooter Trips in Austin, TX



https://thedailytexan.com/2024/04/12/austin-rolls-outnew-regulations-limits-on-e-scooters-in-city/ https://www.austintexas.gov/sites/default/files/files/Auditor/Audit_ Reports/Electric_Scooter_Enforcement_Program_August_2024.pdf

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Study Question, Methods, and Tasks

Question: What are the essential elements concerning e-scooter safety for municipal plans or policies?

Methods: Meta-study of e-scooter-related plans or policies in the U.S. cities

Tasks and Work Process:

- 1. Identify cities that operate e-scooter services (excluding e-scooters owned and used by individuals)
- 2. Explore and download (if available) documents related to e-scooter plans and regulations/policies
- 3. Study the contents of the documents and extract essential information about e-scooter safety
- 4. Synthesize study findings and develop guidelines or provide references for cities on What and How to Do concerning e-scooter safety

Study Question, Methods, and Tasks

1. Identify cities that operate e-scooter services (excluding e-scooters owned and used by individuals)

→ Focus on the cities with services provided by six major e-scooter operators (Bird, Lime, Spin, Veo, Lyft, and Wheels)

 \rightarrow 167 cities from 35 states



- 2. Explore and download (if available) documents related to e-scooter plans and regulations/policies
 - → Write Python scripts to search
 - → 270 documents

Study Question, Methods, and Tasks

- 3. Study the contents of the documents and extract essential information about escooter safety
 - **3.1** Develop a questionnaire containing questions related to e-scooter safety

3.2 Use GPT-4o as an "Artificial Investigator" to examine the contents of the documents, report the location (chapter #, page #, and line #) of the matched contents /texts

3.3 Download the matched contents /texts

3.4 Create a datafile storing the downloaded contents /texts 3.5 Run Latent Dirichlet Allocation (LDA) models to identify key topics (with keywords) concerning e-scooter safety

4. Synthesize study findings and develop guidelines or provide references for cities on What and How to Do concerning e-scooter safety

Factors Related to E-Scooter Safety

GPT-40 helped provide a comprehensive list of factors, but the information on the sources is unreliable.

Researchers conducted additional desktop search and lit review

Category	Element			
	Helmet Usage			
	Riding in Designated Areas			
	Education and Skill Training			
	Age Limitation			
Rider Behavior	Adherence to Traffic Laws			
Factors	Avoiding Risky Behaviors			
	Avoiding Risky Behaviors (Alcohol and Drug)			
	Yield of Way			
	Proper Parking			
	Others			
	Vehicle Design and Stability			
	Braking Systems			
	Caution Devices			
Vahiala Eastara	Lighting and Visibility			
venicle raciois	Speed Limiting Features			
	Durable and High-Quality Tires			
	Regular Maintenance and Inspections			
	Others			

Category	Element					
	Dedicated Scooter Lanes					
	Smooth and Well-Maintained Surfaces					
D 1	Adequate Signage and Traffic Signals					
Koadway	Parking Infrastructure					
Factors	Protected Intersections					
racions	Lighting and Visibility					
	Traffic Calming Measures					
	Others					
	Season and Weather Conditions					
	Time of Day					
External	Visibility					
Environment	Urban Built Environment (Specific Places)					
Factors	Urban Built Environment					
	Traffic Density and Direction/Flow					
	Others					
	Supervise and Regulate					
Supervision	Data Collection					
*	Responsible Department					

Questionnaire for GPT

Ouestionnaire Preface

Please note that all answers should be based on the provided text. You do not need to search for information from other sources. If the text does not contain relevant information, please respond with "No relevant information found." If the answer is yes, please make specific elaboration and cite the original regulation with the chapter/page/section number. Sometimes, scooter policies are included in the micro-mobility policy; please also check that carefully.

1. General Ouestion

1.1 Does the document contain chapters or sections explicitly for scooter plans or policies? (If Yes, please provide the page numbers of the chapters and sections.)

1.2 What keywords relevant to scooter safety appear in the document?

2. Scooter Safety Questions

2.1 Rider Behavior Factors Section (This section includes driver behavior and conditions such as speeding, violating traffic laws, driving under the influence of alcohol or drugs, inattention, and age, etc.)

2.1.0 The literature suggests the following key elements of rider behavior contribute to scooter safety: Helmet Usage, Riding in Designated Areas, Education and Skill Training, Adherence to Traffic Laws, Avoiding Risky Behaviors, Understanding and Respecting Road Conditions, Use of Reflective Gear and Lights, Proper Parking. Does this document contain any of these words? (If Yes, please retrieve the sentences and paragraphs containing the keywords. Please retrieve any tables containing the keywords. Please provide the page number and figure number of the figures that contain the keywords.)

2.1.1 Are users required to use protective gear, such as a helmet? Who provides it?

2.1.2 Is there any requirement for riding a scooter in designated areas in the document?

2.1.3 Are users required to attend safety education or skills training before riding a scooter?

2.1.4 Is there an age limitation for scooter use?

2.1.5 Does the document provide education and emphasize scooter traffic signals and rules?

2.1.6 Does the document emphasize avoiding risky behaviors such as rider distraction, speeding, failure to yield, riding in groups, and against-flow riding 2.1.7 How does the city deal with the alcohol and drug issues of the scooter? 2.1.8 How does the city deal with the interactions (right of way) between scooters, pedestrians, and other vehicles?

2.1.9 What are the city's regulations regarding scooter-safe parking? 2.1.10 Are there any other policies related to this section that have not been mentioned?

Pay GPT-4o as an "Artificial Investigator"

GPT-4o reads 270 documents from 167 cities and responds to the survey

Sample GPT-40 responses

1. General Question

1.1 Does the document contain chapters or sections explicitly for scooter plans or policies? (If Yes, please provide the page numbers of the chapters and sections.)

New York City_New York

Policy name: Article 34-D Operation of Electric Scooters

1.1 Yes, the document contains sections explicitly addressing scooter regulations. Some of the relevant sections include:

Vehicle & Traffic Law Section 1280: Effect of regulations

Vehicle & Traffic Law Section 1281: Traffic laws apply to persons operating electric scooters

Vehicle & Traffic Law Section 1282: Operating electric scooters

Vehicle & Traffic Law Section 1284: Riding on roadways, shoulders, and lanes reserved for non-motorized vehicles and devices

Vehicle & Traffic Law Section 1285: Lamps and other equipment

Vehicle & Traffic Law Section 1286: Operators to wear protective headgear

Vehicle & Traffic Law Section 1289: Operation of an electric scooter while under the influence of alcohol or drugs

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Sample GPT-40 responses

2.1.0 The literature suggests the following key elements of rider behavior contribute to scooter safety: Helmet Usage, Riding in Designated Areas, Education and Skill Training, Adherence to Traffic Laws, Avoiding Risky Behaviors, Understanding and Respecting Road Conditions, Use of Reflective Gear and Lights, Proper Parking. Does this document contain any of these words? (If Yes, please retrieve the sentences and paragraphs containing the keywords. Please retrieve any tables containing the keywords. Please provide the page number and figure number of the figures that contain the keywords.)

2.1.0 Yes, the document contains several of these keywords. Below are examples with citations:

Helmet Usage:

"No person sixteen or seventeen years of age shall ride upon, propel, or otherwise operate an electric scooter unless such person is wearing a helmet..." (Vehicle & Traffic Law Section 1286, p. 1286.1)

Adherence to Traffic Laws:

"Every person riding an electric scooter upon a roadway shall be granted all of the rights and shall be subject to all of the duties applicable to the driver of a vehicle..." (Vehicle & Traffic Law Section 1281, p. 1281.1)

Yielding Right of Way:

"Every person operating an electric scooter shall yield the right of way to pedestrians." (Vehicle & Traffic Law Section 1282, p. 1282.3)

Create a Datafile by Assembling GPT-4o Responses

	А	В	С	D	E	F	G	Н	I	J	К	L	М	N	0	Р	Q	R	S
	City	State	Bird	Lime	Spin	Veo	Lyft	Wheels	Total	Policy	1.1	1.2	2.1.0	2.1.1	2.1.2	2.1.3	2.1.4	2.1.5	2.1.6
1									operator	name								1. 6	
2	Auburn	Alabama	1						1		Updates or	operation,	storage, c	harging, par	PEMDs sho	build be alwa	ays operate	d in a safe a	PEMDs sho
3	Auburn	Alabama	1						1				they perta	The docun	nent mentic	ins helmet f	itting for bi	cycles durin	g the Bike Bi
4	Birmingham	Alabama	1			1			2		Birminghar	helmet, tra	Helmet: 'H	Helmets a	r riding on si	dewalks is	Bikes and s	Riders ope	No riding w
5	Birmingham	Alabama	1			1			2	ORDINANO	litle 10, Ch	Riding on s	idewalks, S	peed, Yield	1Sec 10-20-	Sec 12-22-	Sec 12-22-	Sec 12-22-	Sec 10-20-3
6	Mobile	Alabama		1					1	Mobile Are	Chapter 2:	Helmet, Ira	Helmet Us	ausers are r	equired to v	wear a helm	no person	under the a	Speeding: 'S
1	Mesa	Arizona	1	1					2								¢		.1 . 1
8	Phoenix	Arizona		1	1				2	Comprehe	Chapter 5:	Helmet, Tra	Helmet Us	ariders are	ethere is a r	equirement	tor riding s	cooters in c	the docume
9	Phoenix	Arizona		1	1				2	E-Scooter	the section	operate, ro	the docum	i 'Helmets a	Riders are	required to	Riders mus	st be over th	Riders are i
10	Scottsdale	Arizona	1	1	1				3	Ordinance	Section 17-	Helmet Spe	Helmet Us	any child c	scooters a	re permitte	no child un	ider the age	Speeding: '
11	Tempe	Arizona	1	1	1				3										
12	Fayetteville	Arkansas			1	1			2							_			
13	Alameda	California	1	1					2	Alameda B	icycle Mast	Helmet, Tra	Helmet Us	users are r	there is a r	equirement	no person	the docum	the docume
14	Albany	California		1		1			2	Ordinance	5-12: Doc	Helmet Spe	Helmet Us	age: Not ex	scooters a	re permitte	d to operate	e in designa	ted areas as
15	Berkeley	California			1	1			2	Ordinance	Chapter	Helmet Spe	the docur	nent contai	r motorized	scooters m	ust be park	ed in design	nated areas a
16	Burlingame	California		1					1	Bicycle & F	P The conte	nt is primar	ily focused	on bicycles	and pedest	rians.			
17	Burlingame	California		1					1	California	the docum	Motorized	scooter, he	e users are r	You can or	nly drive mo	Not explici	tly for scoo	ters, but for
18	Campbell	California	1						1										
19	Culver City	California	1						1	Bicycle & F	Chapter 1:	Helmet, Sp	Helmet Us	age: 'The Pl	ascooters m	ay be oper	ated in desig	gnated bike	Speeding: 'S
20	Culver City	California	1						1	Electric Sco	Section 1:	Helmet Sp	Helmet U	s users are r	n scooters n	nust be ope	operators	the operat	the docume
21	Emeryville	California				1			1	Shared Mo	Shared Mo	Helmet	Adherenc		scooters a	re permitte	d to operate	e in designa	ted areas as
22	Emeryville	California				1			1	Active Trai	nsportation	'Rolling,' w	hich includ	es the use o	of scooters a	s mentione	d in the gen	neral goals o	of the Active
23	El Cajon	California	1						1	Motorcycl	es, Mopeds,	,helmet, de	the docum	n users are r	motorized	scooters m	the docum	ent specifie	the docume
24	El Cerrito	California		1					1										
25	Imperial Beac	California		1					1	Motorcycl	The docun	helmet, spe	Helmet: 'Y	cusers are r	the docum	ent states:	'You can on	ly drive mo	torized scoo
26	Imperial Beac	California		1					1			Helmet, Rid	the docum	You must	You can or	nly drive mo	You must b	pe at least 1	6 years old α
27	La Mesa	California	1						1										

Assess Data Quantity and Quality

Section	Element	Question	with Content	with Content Proportion (%)	Section	Element	Question	with Content	with Content Proportion (%)
	Helmet Usage	2.1.1	115	55.83%		Dedicated Scooter Lanes	2.3.1	88	42.72%
	Riding in Designated Areas	2.1.2	127	61.65%		Smooth and Well-	232	12	5.83%
	Education and Skill	2.1.3	20	9.71%		Maintained Surfaces	2.0.2		5.0570
	Age Limitation	2.1.4	94	45.63%	Roadway Infrastructure	Traffic Signals	2.3.3	19	9.22%
	Adherence to Traffic Laws	2.1.5	60	29.13%	Factors	Parking Infrastructure	2.3.4	88	42.72%
Rider Behavior Factors	Avoiding Risky Behaviors	2.1.6	124	60.19%		Protected Intersections	2.3.5	19	9.22%
	Avoiding Risky Behaviors			17.96%		Lighting and Visibility	2.3.6	26	12.62%
	(Alcohol and Drug)	2.1.7	37			Traffic Calming Measures	2.3.7	11	5.34%
	Yield of Way	2.1.8	106	51.46%		Others	2.3.8	2	0.97%
	Proper Parking	2.1.9	85	41.26%		Season and Weather	2 / 1	11	5 2/1%
	Others	2.1.10	14	6.80%		Conditions	2.7.1	11	5.5470
	Vehicle Design and	2.2.1	14	6.00%		Time of Day	2.4.2	38	18.45%
	Stability	2.2.1	14	0.80%		Visibility	2.4.3	63	30.58%
	Braking Systems	2.2.2	52	25.24%	External Environment	Urban Built Environment	244	28	13 59%
	Caution Devices	vices 2.2.3 10 4.85% Factors (Specific Place d Visibility 2.2.4 72 34.95% Urban Built E		4.85%	Factors	(Specific Places)	2.1.1	20	13.3370
	Lighting and Visibility			Urban Built Environment	2.4.5	20	9.71%		
Vehicle Factors	Speed Limiting Features	2.2.5	72	34.95%		Traffic Density and	246	27	13 11%
	Durable and High-Quality	226	5	2 / 2%		Direction/Flow	2.4.0	27	13.11/0
	Tires	2.2.0	5	2.43/0		Others	2.4.7	2	<mark>0.97%</mark>
	Regular Maintenance and	227	20	0 71%		Supervise and Regulate	3.1	99	48.06%
	Inspections	2.2.1	20	9.71%	Supervision	Data Collection	3.2	35	16.99%
	Others	2.2.8	5	2.43%		Responsible Department	3.3	61	29.61%

Run Latent Dirichlet Allocation (LDA) Models

Identify central topics and keywords relevant to e-scooter safety

Category	Element	Highest Coherence Score	Торіс	Probability
	Helmet Usage	number of topics=1, 0.522	Topic: 0 Word: 0.083*"helmet" + 0.057*"users" + 0.055*"wear" + 0.047*"require" + 0.040*"helmets" + 0.032*"provide" + 0.029*"encourage" + 0.027*"bicycle" + 0.023*"age" + 0.022*"use"	1.000
	Riding in Designated Areas	number of topics=1, 0.595	Topic: 0 Word: 0.053*"scooters" + 0.036*"areas" + 0.030*"designate" + 0.029*"lanes" + 0.028*"bike" + 0.025*"sidewalks" + 0.023*"operate" + 0.022*"ride" + 0.021*"speed" + 0.021*"use"	1.000
Rider Behavior Factors	Education and Skill Training	number of topics=8, 0.506	Topic: 0 Word: 0.172*"users" + 0.097*"educate" + 0.096*"must" + 0.059*"operation" + 0.059*"share" + 0.059*"permittees" + 0.032*"emphasize" + 0.027*"user" + 0.027*"language" + 0.027*"quiz" Topic: 1 Word: 0.270*"education" + 0.076*"implement" + 0.074*"mecklenburg" + 0.074*"local" + 0.074*"curriculum" + 0.074*"county" + 0.055*"program" + 0.009*"traffic" + 0.005*"offense" + 0.005*"pedestrians" Topic: 4 Word: 0.199*"safe" + 0.107*"scooter" + 0.102*"rid" + 0.085*"require" + 0.079*"train" + 0.055*"include" + 0.034*"commercial" + 0.026*"cyclists" + 0.013*"rider" + 0.007*"rout" Topic: 6 Word: 0.154*"safety" + 0.134*"school" + 0.109*"attend" + 0.094*"skills" + 0.088*"bicycle" + 0.037*"seminars" + 0.037*"helmet" +	Topic 0 : 0.133 Topic 1 : 0.130 Topic 4 : 0.132 Topic 6 : 0.130

Run Latent Dirichlet Allocation (LDA) Models

Interpret results to inform planning/policymaking concerning e-scooter safety

Element	Question	Highest Coherence Score	Торіс	Probability
Helmet Usage	2.1.1	number of topics=1, 0.522	Topic: 0 Word: 0.083*" helmet " + 0.057*"users" + 0.055*"wear" + 0.047*" require " + 0.040*" helmets " + 0.032*"provide" + 0.029*" encourage " + 0.027*"bicycle" + 0.023*" age " + 0.022*"use"	1.000

Out of 227 documents

- \rightarrow 115 contain terms pertaining to 'helmet' or 'helmets'
- ightarrow 21 contain terms pertaining to 'age'
- \rightarrow 83 "require"
- \rightarrow 1 "encourage"

Helmet policies conditional to age, e.g., 15, 16, 18, or adults in general

Run Latent Dirichlet Allocation (LDA) Models

Interpret results to inform planning/policymaking concerning e-scooter safety

Element	Question	Highest Coherence Score	Торіс	Probability
Proper Parking	2.1.9	number of topics=4, 0.614	Topic: 0 Word: 0.082*"bike" + 0.055*"street" + 0.049*"sidewalk" + 0.031*"zone" + 0.031*"driveways" + 0.027*"ramp" + 0.021*"outline" + 0.021*"curb" + 0.019*"regulations" + 0.016*"cannot" (Infrastructure related)	Topic 0 : 0.219
			Topic: 1 Word: 0.118*"park" + 0.086*"scooters" + 0.074*"must" + 0.049*"pedestrian" + 0.043*"block" + 0.033*"access" + 0.030*"build" + 0.029*"sidewalks" + 0.025*"manner" + 0.023*"impede" (pedestrian related)	Topic 1 : 0.332
			Topic: 2 Word: 0.088*"park" + 0.053*"bicycle" + 0.053*"upright" + 0.051*"designate" + 0.047*"electric" + 0.044*"areas" + 0.032*"scooter" + 0.027*"various" + 0.019*"page" + 0.019*"28" <i>(bicycle related)</i>	Topic 2 : 0.237
			Topic: 3 Word: 0.065*"park" + 0.037*"proper" + 0.036*"locations" + 0.031*"detail" + 0.030*"emphasis" + 0.030*"increase" + 0.030*"provide" + 0.027*"city" + 0.019*"dockless" + 0.018*"specify" <i>(location related)</i>	Topic 3 : 0.223

Concluding Remarks

- Artificial Intelligence (AI) offers a great potential to assist research and practice
 - \rightarrow A great Artificial investigator in this project
- While embracing the power of AI, avoid falling into the trap embedded in AI? → AI (GPT) fabricates answers. Verification and validation are necessary and essential.
- GPT is not free; could become too expensive to use

Document Group	Time (n	ninutes)	Cost (\$)		
	ΑΡΙ	Website	ΑΡΙ	Website	
Group 1 (10 docs)	3:18	12:50	0.78		
Group 2 (10 docs)	3:26	8:50	0.44		
Group 3 (10 docs)	3:05	10:40	0.51	20/month	
Group 4 (10 docs)	2:30	13:30	0.37		
Group 5 (10 docs)	2:52	13:00	0.54		



The project received funding support from the USDOT University Transportation Center Program and the UT Austin Snell Endowment Research Grant