

# Bridging the Modal Gap: E-bicycle Integration Strategies for Car-Dependent Regions:

## Lessons from Metro – Detroit, Michigan

Greg Rybarczyk, Ph.D. & Alyssa Sklar

Department of Geospatial Science
University of Michigan-Flint, USA
Vanderbilt University Libraries' GIS Lab

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# When Motor City Meets E-Mobility

- Historically car-centric region ($14M invested in bike infrastructure since 2011 (Huffman, 2022)
- Moderate baseline active transportation: 13% of Detroit residents use walking/cycling for non-exercise trips (Gerber et al., 2017)
- 31,048 shared e-bike trips (2019-2020) (Zahertar & Lavrenz, 2024)
- Perfect test case for car-dependent North American cities



# Research Imperative

## Experience Impact

Positive experiences promote future ridership while negative experiences reduce adoption rates (Fishman & Cherry, 2016; Lee & Sener, 2023)

## Personal Factors

Age, physical ability, gender influence e-bicycling experiences and safety perceptions (Ling et al., 2017; MacArthur et al., 2018; Popovich et al., 2014)

## Social Challenges

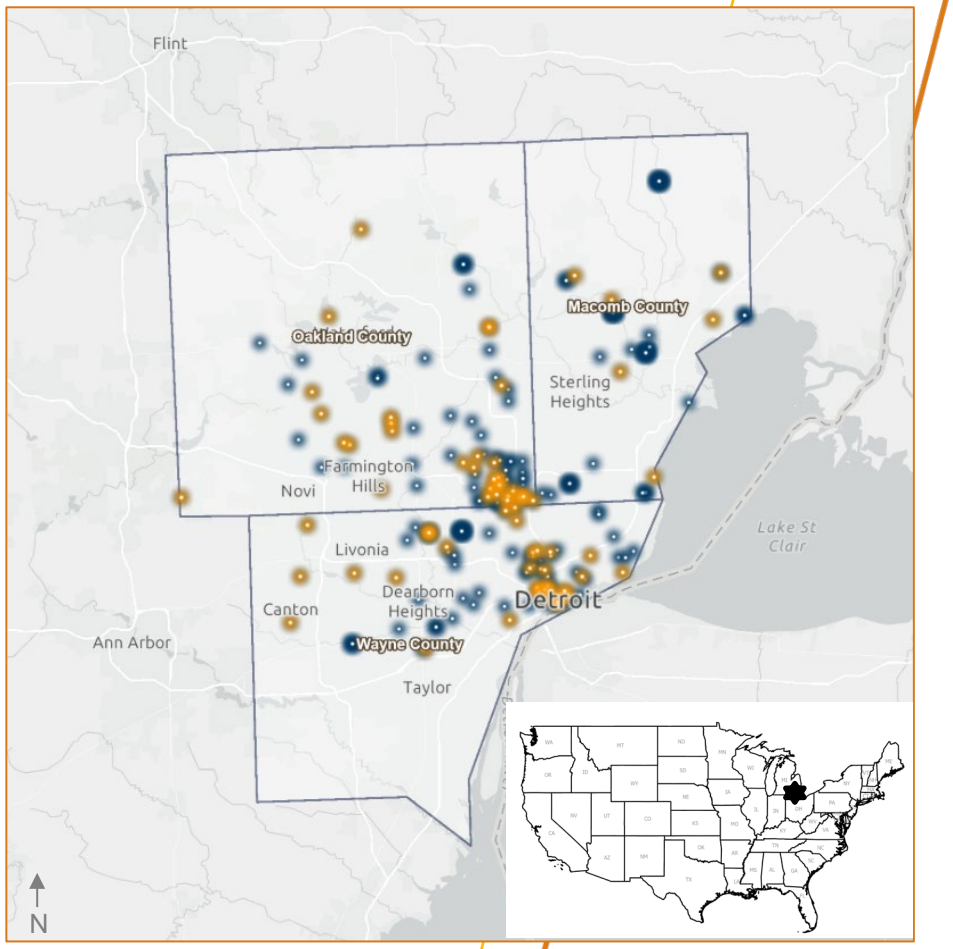
Stigma of "cheating" and perceptions as technology for older adults persist (Behrendt, 2018; Simsekoglu & Klöckner, 2019; Leger et al., 2019)

## Research Gap

Limits to objective studies. Analysis of experiential factors for e-bicycling in car-dependent regions is needed (Handy et al., 2014; Bigazzi & Wong, 2020)

# Study Design and Sample

- E-Survey instrument available to e-bicycle and non-ebike owners
- Sample:
  - **284** total sample
  - **74** current e-bike owners answered the open-ended questions:
- *"Do you have any positive experiences using your e-bike that you would like to share with us?" (n = 62)*
- *"Do you have any negative experiences using your e-bike that you would like to share with us?" (n = 69)*

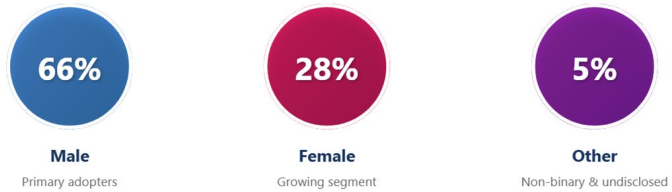


# Sample Demographics

## Age Distribution
Balanced representation across age groups



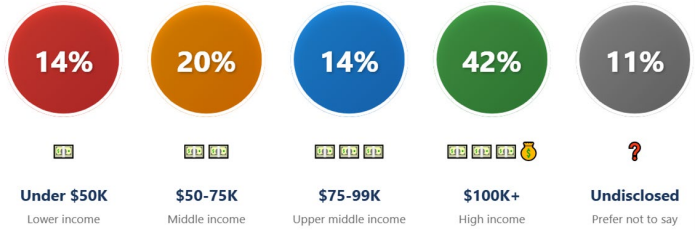

## Gender Distribution
Male-dominated sample with female representation



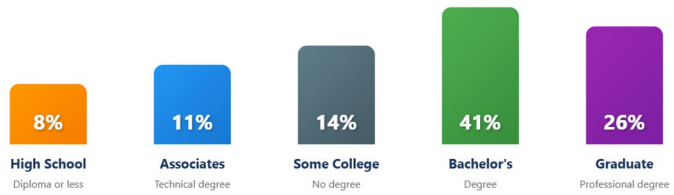

## Racial/Ethnic Composition
Complete demographic breakdown by race/ethnicity




## Household Income Distribution
Complete breakdown of income levels




## Educational Attainment
Complete breakdown of education levels



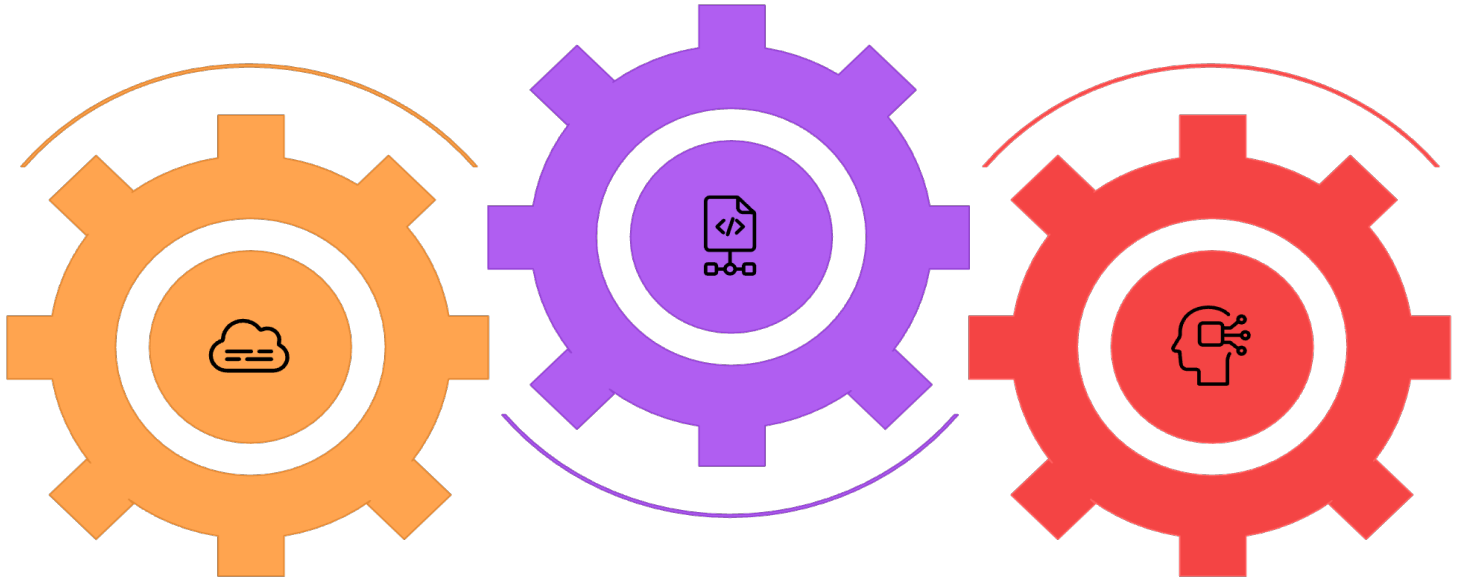

## E-bike Riding Frequency
Weekly riding patterns among e-bike owners



# **Methodology:** Integrated NLP Framework

## Biterm Topic Modeling (BTM)

Automatically discover thematic clusters across comments



## TF-IDF Text Mining

Automatically identify key linguistic patterns in responses

## Content Analysis

Manually categorize experiential themes from open-ended data

# Results

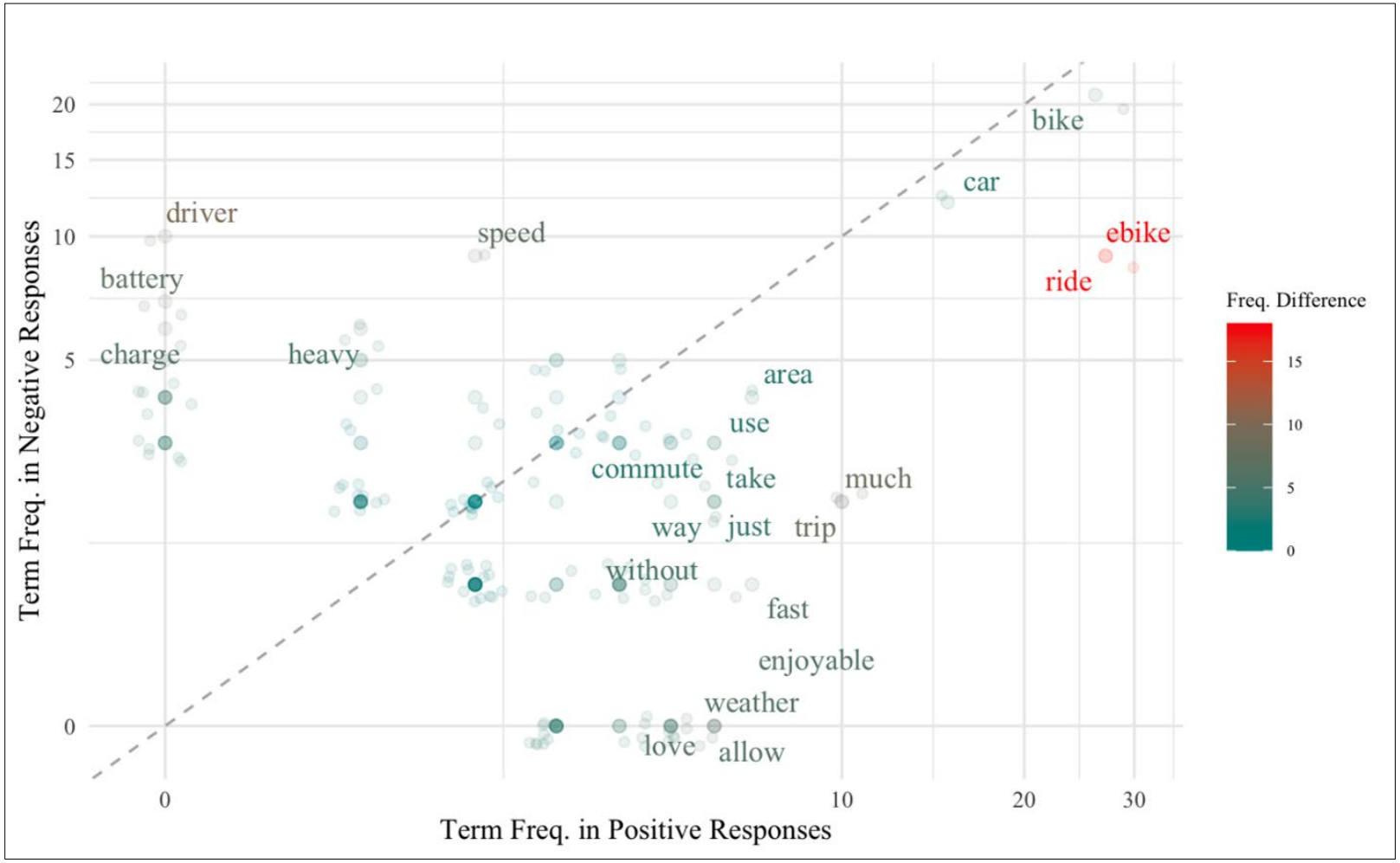
## TF-IDF Linguistic Patterns

| Positive Keywords | Weight | Negative Keywords | Weight |
|---|---|---|---|
| Ride | **4.03** | Driver | **3.28** |
| Bike | **2.80** | Battery | **3.02** |
| E-bike | **2.76** | Bike | **2.83** |
| Save | **2.49** | Heavy | **2.80** |

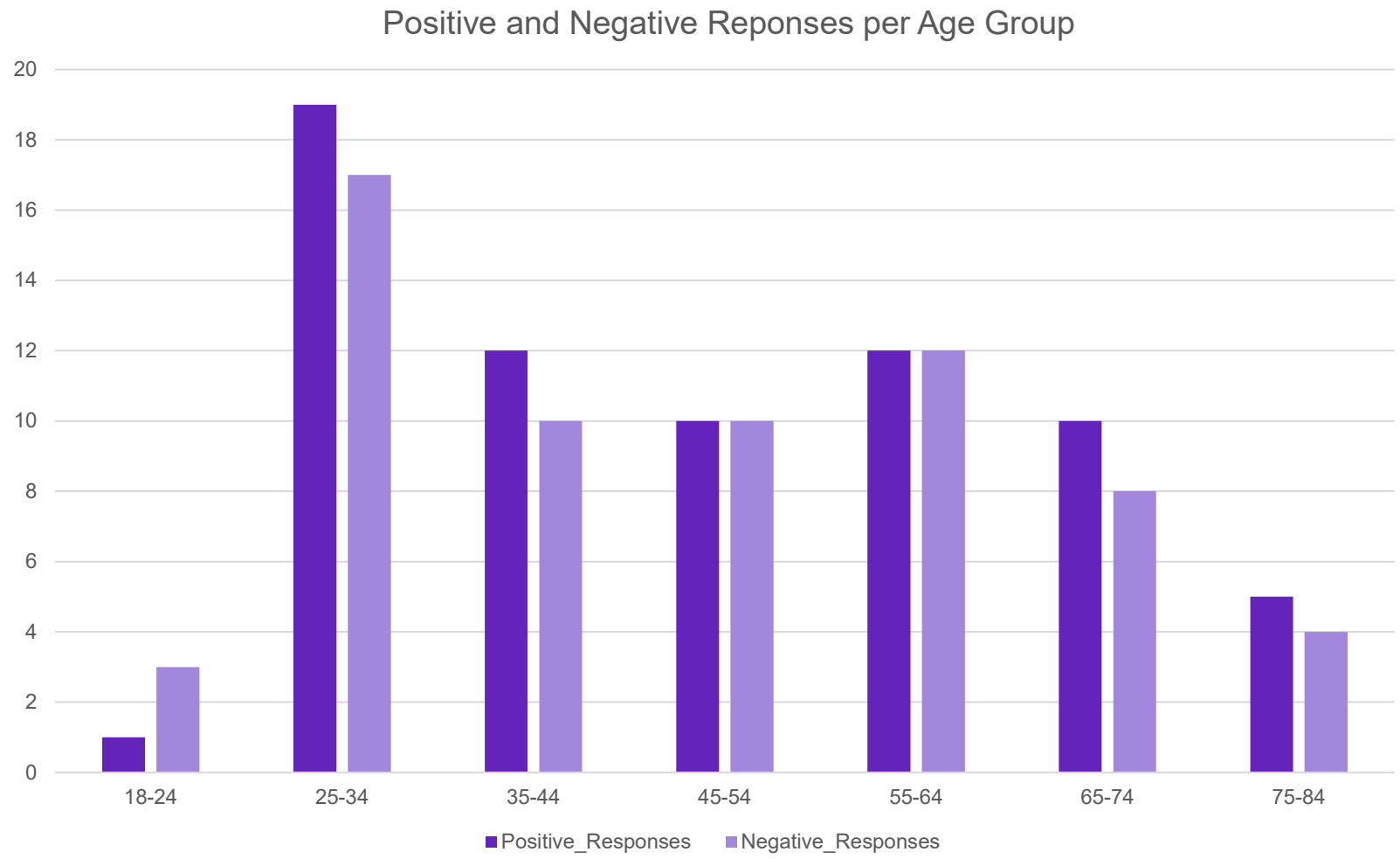
Higher TF-IDF weight scores indicate terms frequently appearing in one experience type but rare overall

# Results

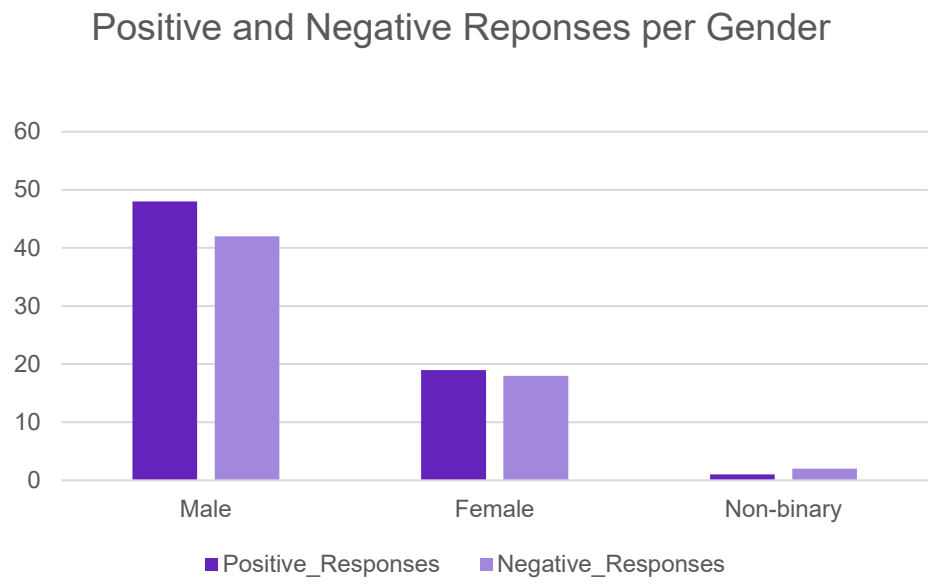
Positive and negative term similarities and differences

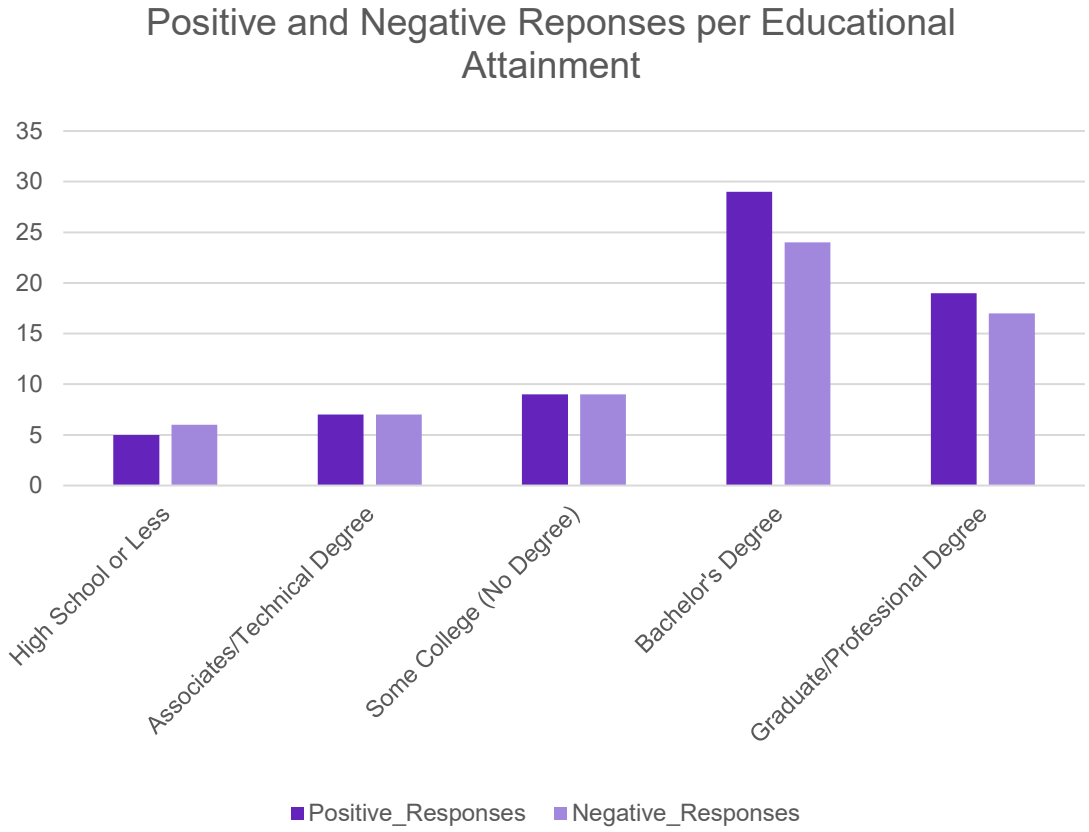


# Results


Positive and Negative Reponses per Age Group
20
18
16
14
12
10
8
6
4
2
0
18-24
25-34
35-44
45-54
55-64
65-74
75-84
Positive_Responses
Negative_Responses

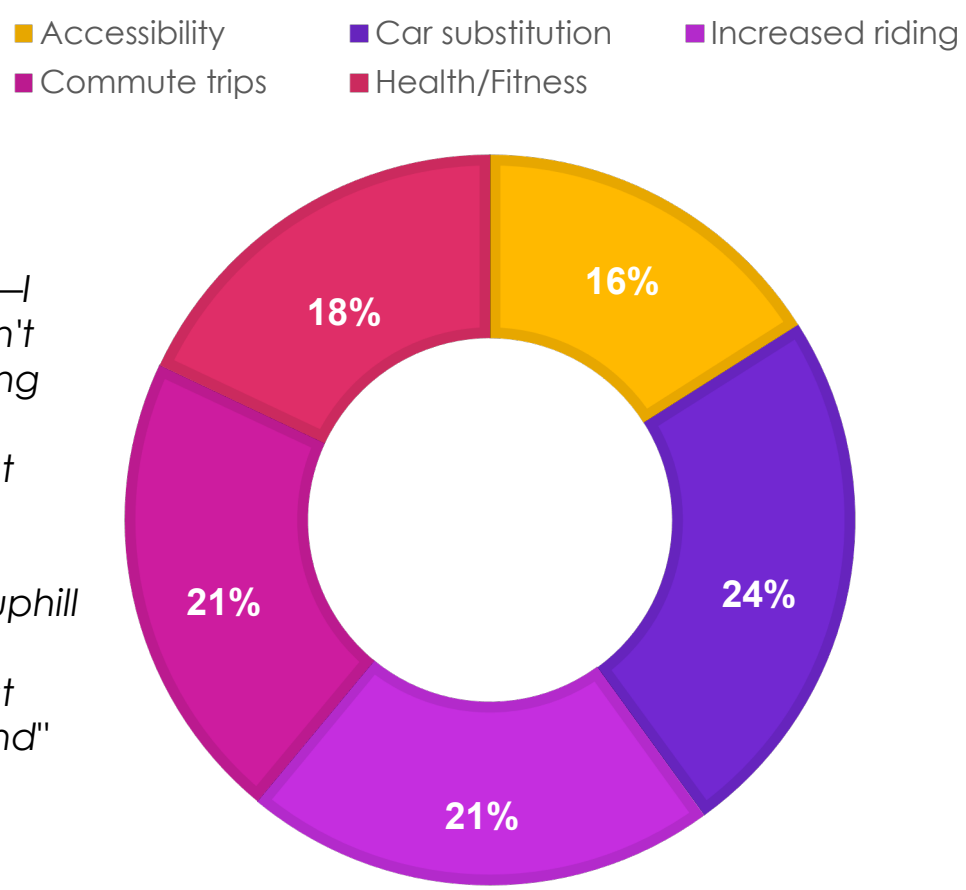
# Results


Positive and Negative Reponses per Gender
60
50
40
30
20
10
0
Male
Female
Non-binary
Positive_Responses
Negative_Responses


Positive and Negative Reponses per Educational Attainment
35
30
25
20
15
10
5
0
High School or Less
Associates/Technical Degree
Some College (No Degree)
Bachelor's Degree
Graduate/Professional Degree
Positive_Responses
Negative_Responses

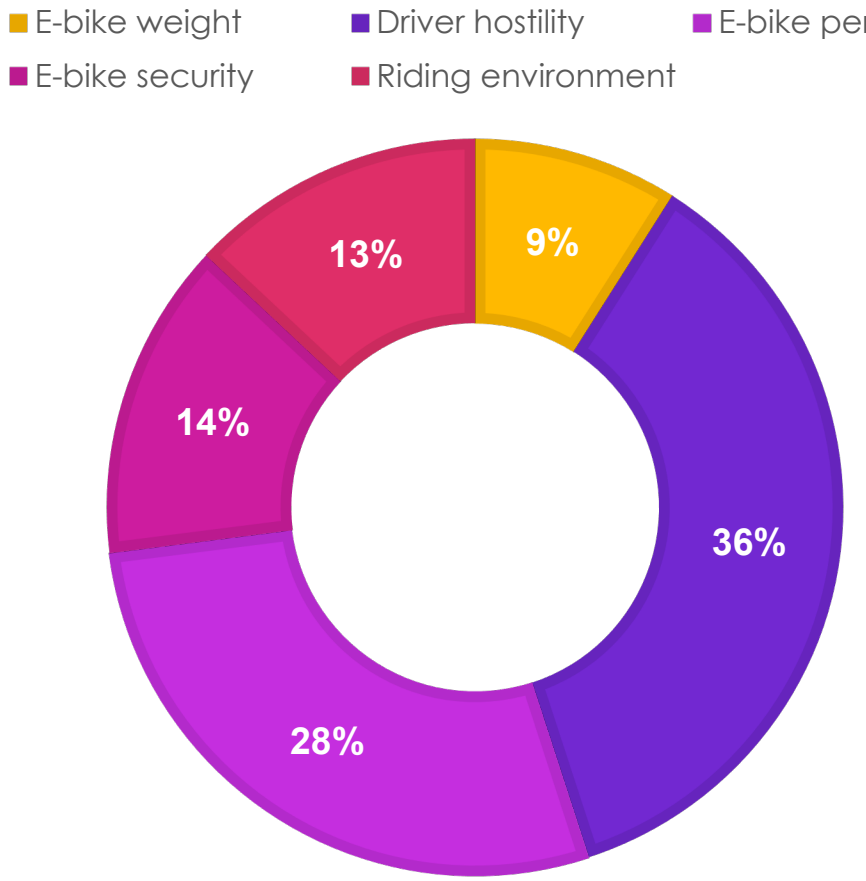
# Results

## Content Analysis: Proportions of **positive** themes




*"Bad knees—I wouldn't be riding much without (an e-bike), helps uphill and against the wind"*

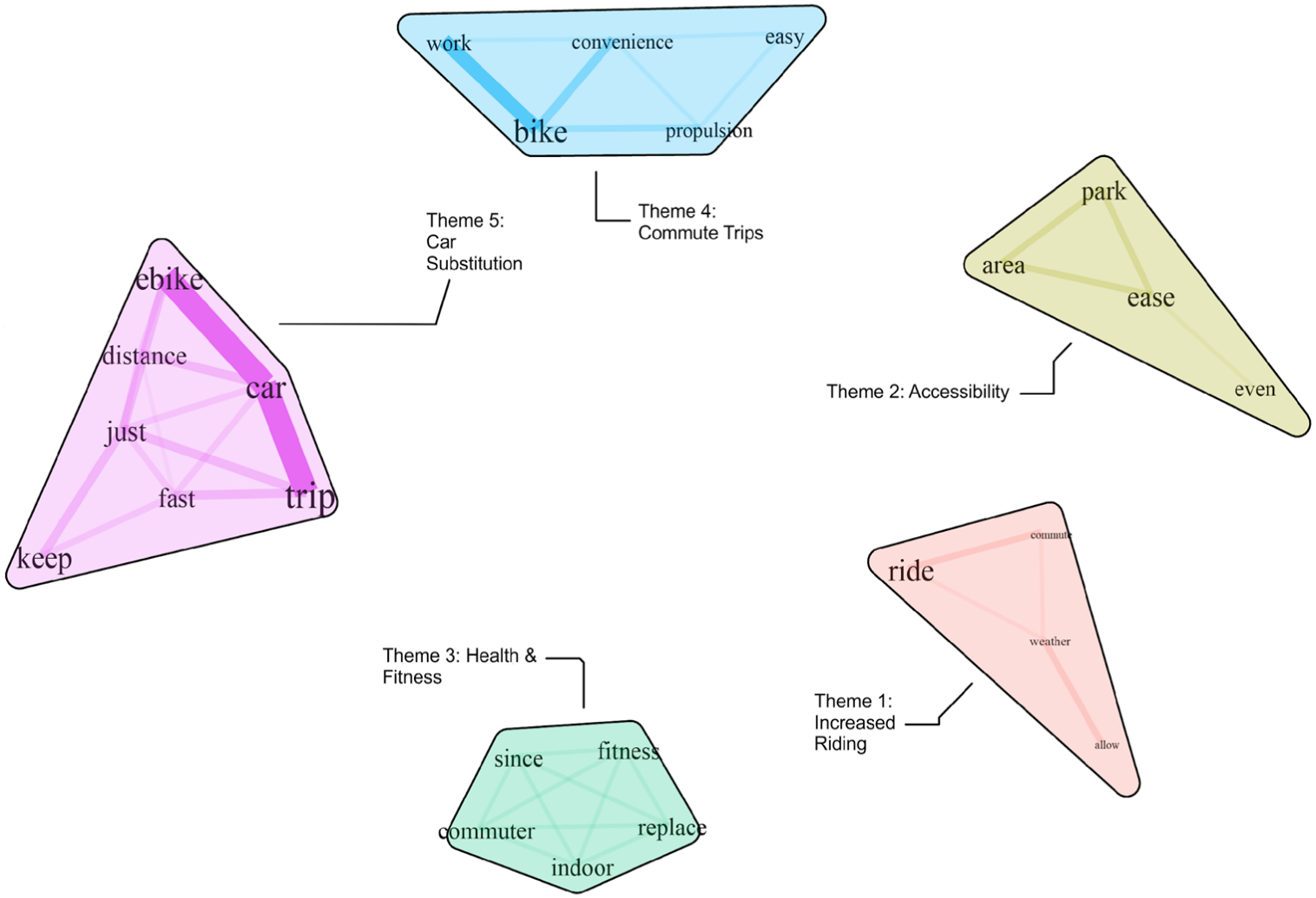
## Content Analysis: Proportions of **negative** themes




*"Driver very nearly hit me in shared bike lane. Such a gamble and they're so dangerous"*

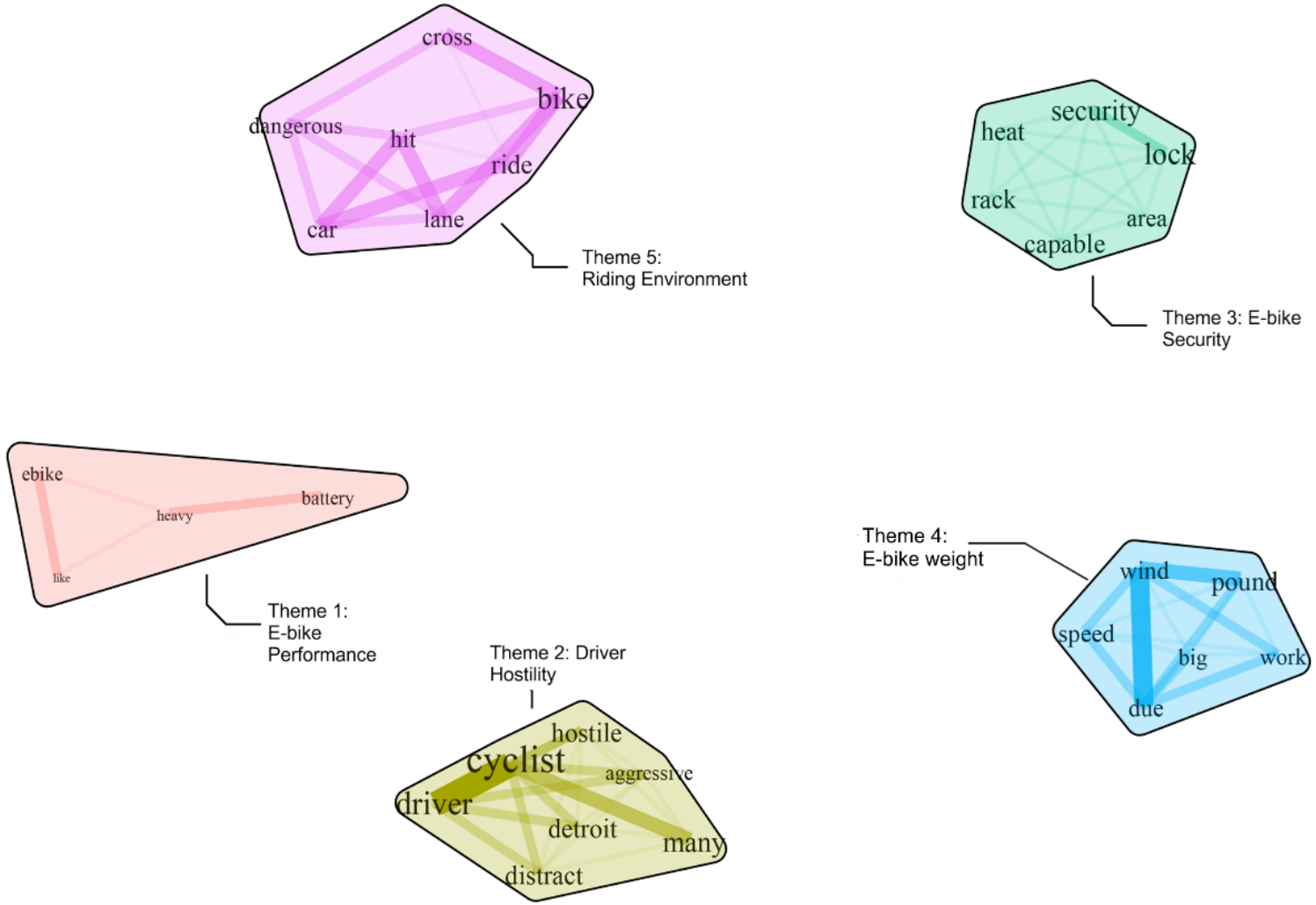
# Results

## Positive Biterm Model (NLP) Clusters



# Results

## Negative Biterm Model (NLP) Clusters



# Implications

## Enhancing E-mobility: Key Successes

- Accessibility
  - Overcome physical barriers, explore new areas
- Commuting
  - Efficient work trips with social connections
- Heath Benefits
  - Enables activity despite physical limitations
- Car Substitution
  - Possible e-bike trips replacing car trips

# Implications

## Interconnected Barriers to Adoption

- Technical Limitations
  - Battery range anxiety combined with heavy weight creates compound challenges
- Driver Hostility
  - Motorist conflicts exacerbated by inadequate infrastructure and higher e-bike speeds
- Security Concerns
  - Theft anxiety from perceived higher value undermines overall experience
- Traffic Environment
  - Driver encroachment especially at intersections elevate dangerous riding situations

# Policy and Research Outcomes

## Driver Education

- Campaigns targeting motorist awareness of e-bicycle characteristics and speeds
- Target 36% of negative experiences from driver hostility

## Protected Infrastructure

- E-bicycle-specific lanes with improved sightlines and physical separation (riding environment 13%)
- Respond to interconnected hostility + environment barriers

## Secure Parking

- Dedicated zones with surveillance and biometric security systems
- Address 14% of security-related negative experiences

## Key Innovations

- Computational discovery of experiential patterns confirmed by human interpretation, established a robust "transportation analysis toolkit" while maintaining the narrative authenticity essential for policy development
- Addressed how personal factors, social stigma, e-bike performance, and infrastructure interact to create compound barriers - moving beyond isolated demographic or technical analyses
- Findings inform policy decisions across car-dependent North American metropolitan areas pursuing similar transportation transitions




*Photo from MoGo, Detroit*

# Q & A

Thank you!

Rybarczyk, G., A. Sklar, L. Platt, and X. Yan. (2025) "E-bicyclist experiences in motor city: A mixed computational and content analysis approach for understanding sustainable micromobility," *Case Studies on Transport Policy*, doi: https://doi.org/10.1016/j.cstp.2025.101581

Greg Rybarczyk, Ph.D.
grybar@umich.edu