Computational Analysis of Stakeholder Perspectives on Heavy-Duty Vehicle Electrification

Integrating Regulatory Comment Analysis with Community Planning

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Modeling Mobility Conference ‘25

Urban freight is facing a critical moment.

Cities must decarbonize freight while preserving economic vitality.

Balancing industry capabilities, climate goals and environmental justice is complex.

Planners lack insight into divergent stakeholder perspectives.

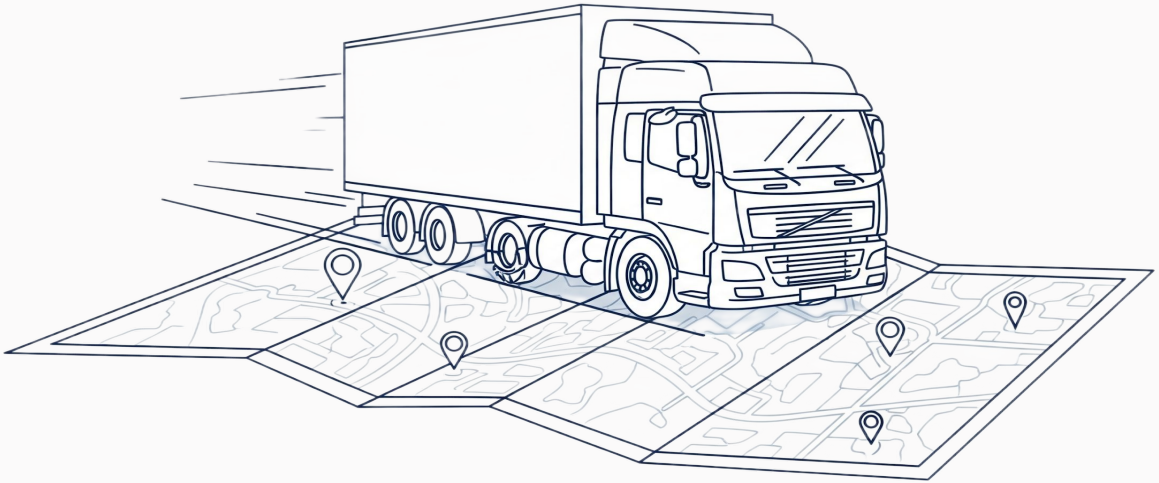
Why this matters for planning

Freight electrification decisions intersect with:

Environmental justice analysis

Long-range transportation plans

Local climate action plans



EPA's Emissions Standards for Heavy Duty Vehicles

Comment Data as Untapped Resource

All federal agencies are required to solicit public feedback on major rules. These comments are publicly available online.

1,171

Unique comments

4.7 M

Words analysed

Diverse

Stakeholder types: businesses (HDV and non-HDV), nonprofits, governments, and individuals

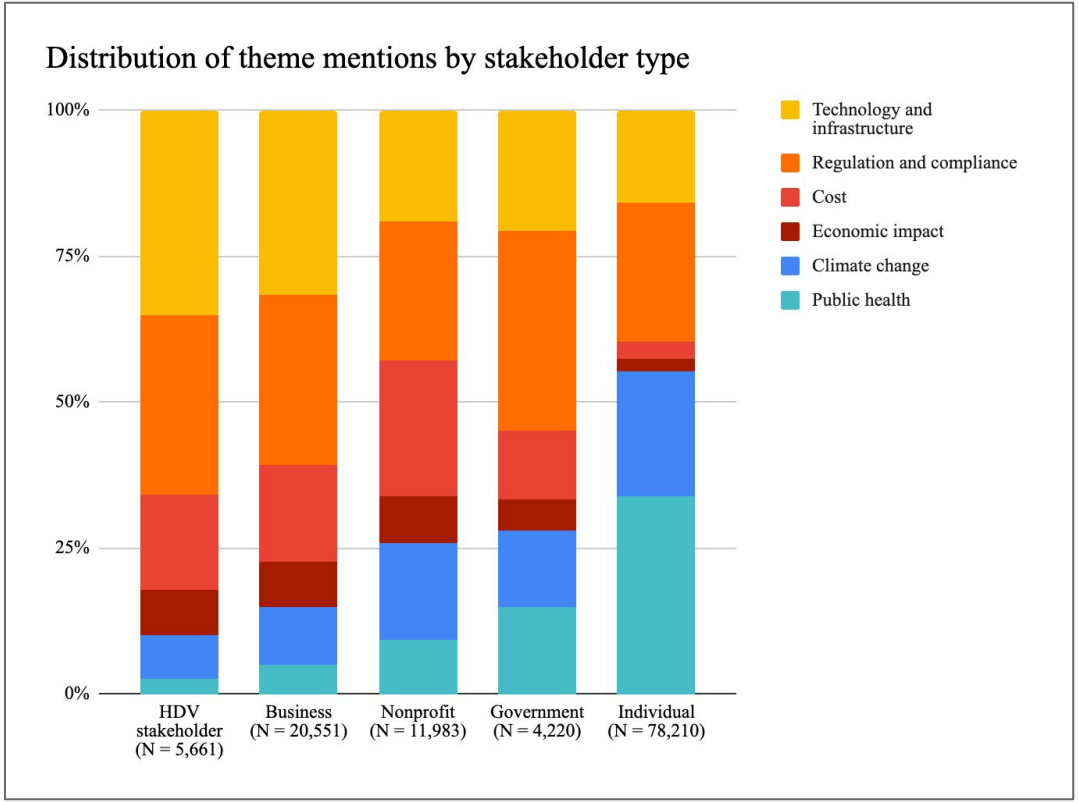
Methodology:

Stakeholder Categorization, Sentiment Analysis, and Topic Modeling

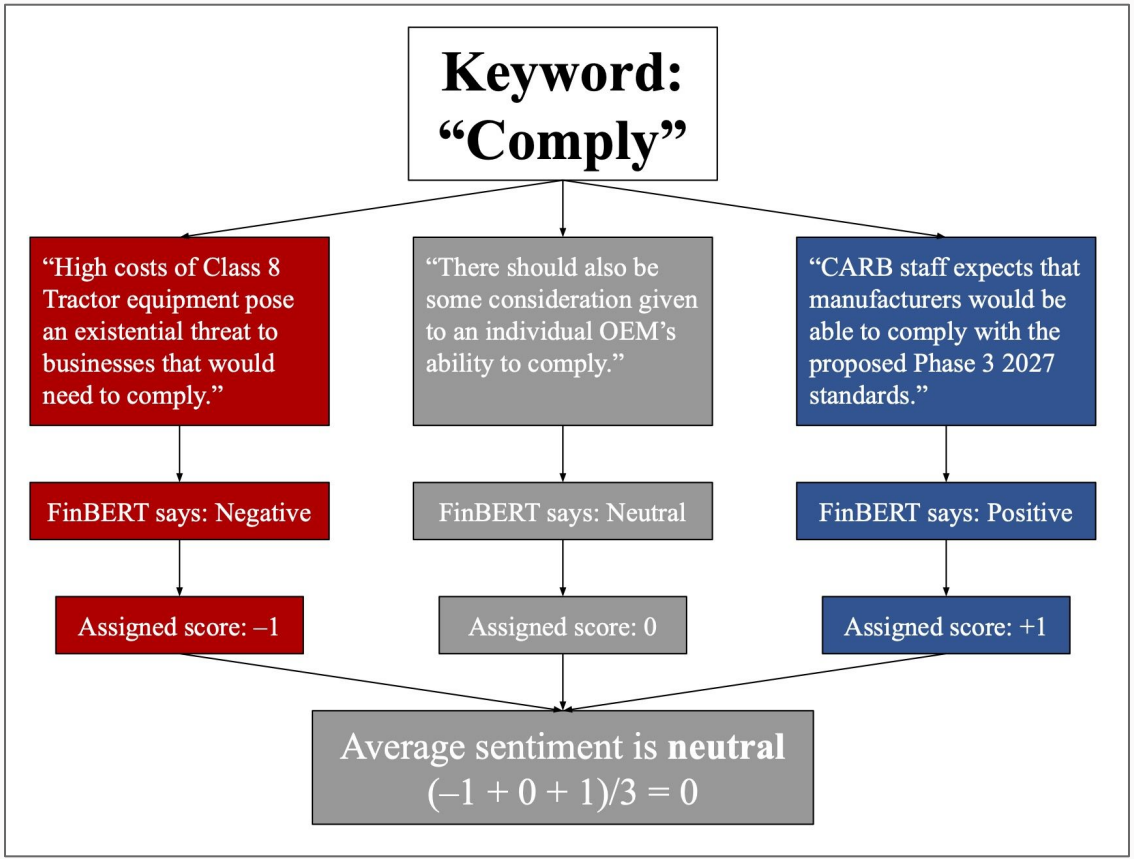
- Stakeholder categorization (3 dimensions)
  - Institutional type: business, nonprofit, government, individual
  - Regulatory relevance: HDV ownership, operation, or manufacturing
  - Comment sophistication: level of technical detail
- Theme identification
  - Six thematic categories developed through iterative refinement
  - Keyword lexicons of 123 terms per theme
- Sentiment analysis
  - Conducted with FinBERT to evaluate tone toward each theme
- Example application: Assessing procedural equity

Topic Modeling

- Used literature review & gen AI to develop lexicon: six themes of 123 words each
- HDV stakeholders and non-HDV business: financial and logistical themes
- Nonprofits and government: balanced
- Individuals: public health and climate change

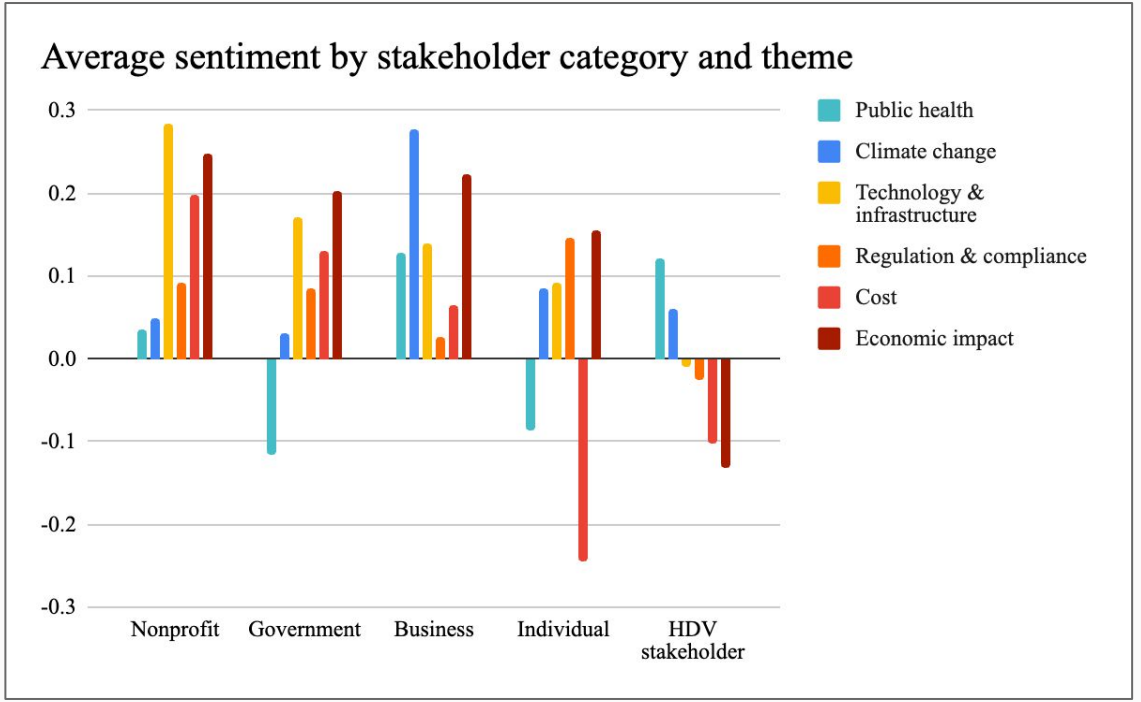


Sentiment analysis: an example



Sentiment analysis

- HDV stakeholders: consistently negative sentiment across themes, except health & climate change
- Non-HDV stakeholders: predominantly positive sentiment across most themes, with variation by stakeholder type



Application: Assessing Procedural Equity

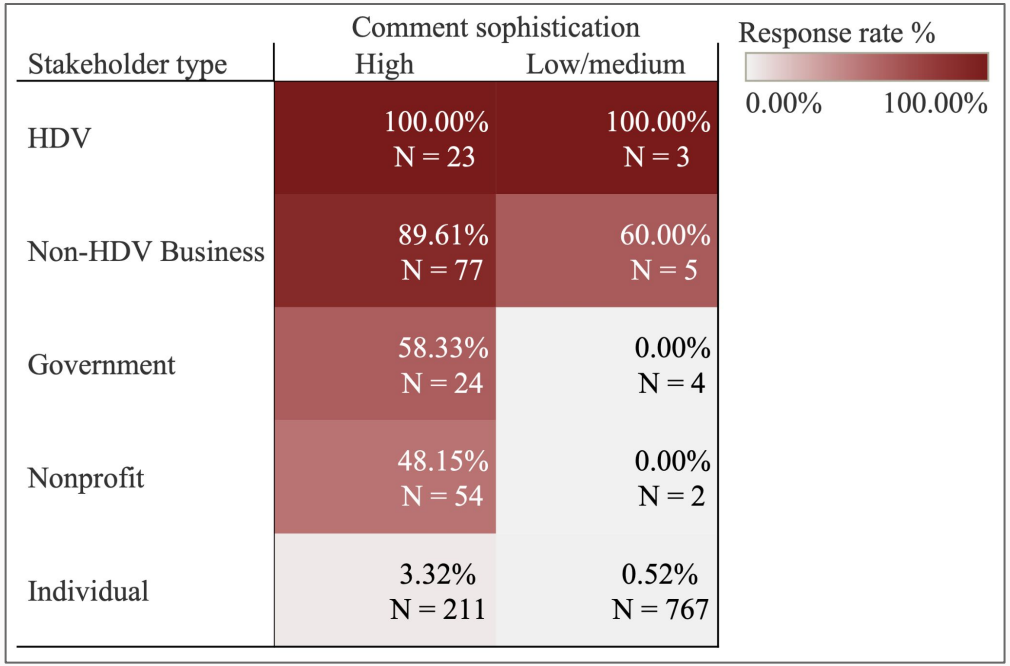
Data: Response-to-comment file from EPA.

Variables: Stakeholder type, regulatory relevance, comment sophistication.

Goal: Evaluate whether certain stakeholders or topics were given greater attention by EPA.

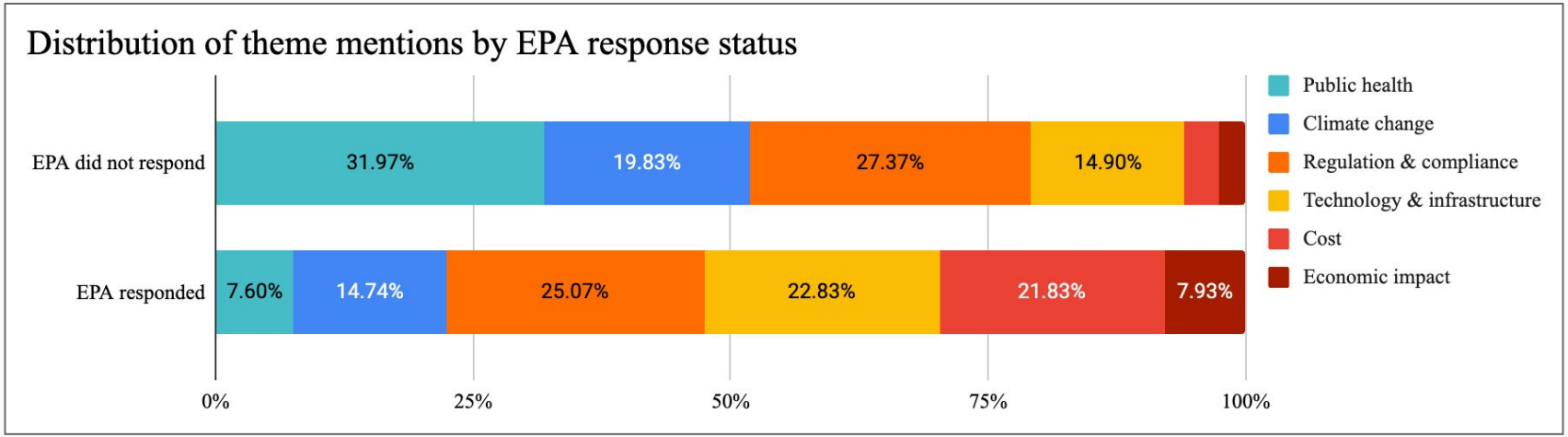
Regulatory responsiveness by stakeholder type

- HDV stakeholders: complete responsiveness
- Non-HDV businesses: high response rate
- Governments & nonprofits: moderate-to-low even when highly sophisticated
- Individuals: low even when highly sophisticated



Regulatory responsiveness by topic

- Commenters who received a response from EPA: financial and logistical themes
- Commenters who did not receive a response: public health and climate change



Procedural equity findings

Industry cost concerns dominate regulatory attention.

Public health and climate perspectives are under-weighted.

Stakeholders representing public interest (i.e. nonprofits and individuals) need more robust avenues for influence.

Consequences in final rule

Final rule was less stringent than proposed rule

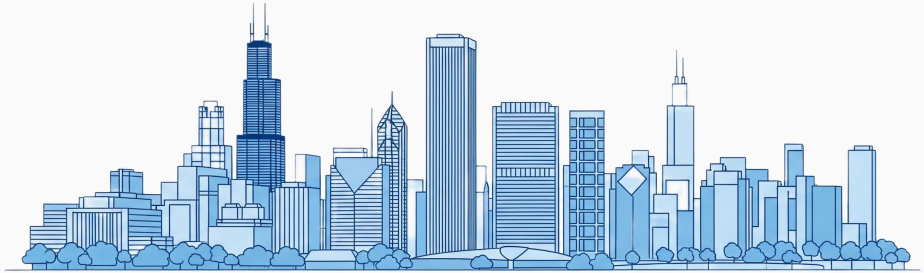
Estimated carbon emissions reduction dropped from 1.8 to 1 billion - a 44% decrease

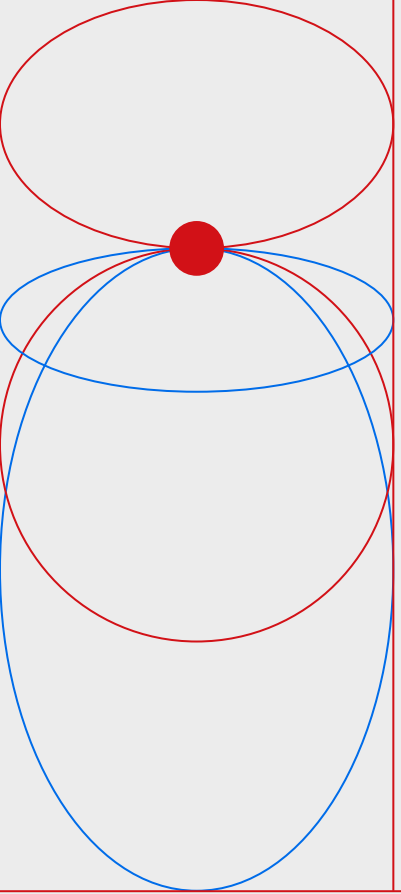
Applications in local planning

- Large comment archives and NLP tools are both open source.
  - Adapt method for other domains planners face: highway safety comments, land use/environmental review, etc.
- Anticipate stakeholder positions on local rules when imposing new rules.
- Use procedural equity findings to structure public engagement strategies.
  - Identify whose input is systematically underweighted at federal level, then prioritize those voices in local planning workshops.

Example: Fleet Turnover in Chicago

- HEI-funded project characterizing industry and community perspectives on equitable fleet turnover in Chicago.
- Applying sentiment, topic, and equity results to guide engagement with freight groups and community orgs.
- Findings inform interviews, agendas, and outreach so planners can anticipate industry barriers and community priorities.





Conclusion

1. Public comments harbour rich, actionable insights for local planning.
2. Procedural equity analysis reveals systemic biases in regulatory attention.
3. Open data and tools enable the design of inclusive and sustainable freight planning.