Safety Impacts of Congestion Pricing Policies

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Background

- A congestion pricing policy, or CPP, is a travel demand management strategy designed to alleviate roadway congestion by encouraging traffic shifts to alternate lanes, routes, or off-peak travel times.
- Toll-based strategies are often more popular and more heavily utilized, and include …
  - High Occupancy Toll (HOT) lanes
  - Express Toll lanes
  - Pricing on Entire Roads
  - Zone-based Pricing (Cordon- or area-based)
  - Regionwide Pricing

Purpose and Databases

Two structured reviews in order to…

1) describe the scope of and patterns in the CPP evidence base over time and identify research gaps
2) conduct a detailed review of safety-related impacts of these policies

- Searched four large databases from dates of inception through January/February 2021
- Used definition of toll-based policies as outlined by the US Federal Highway Administration
- Search filters tailored to review purpose

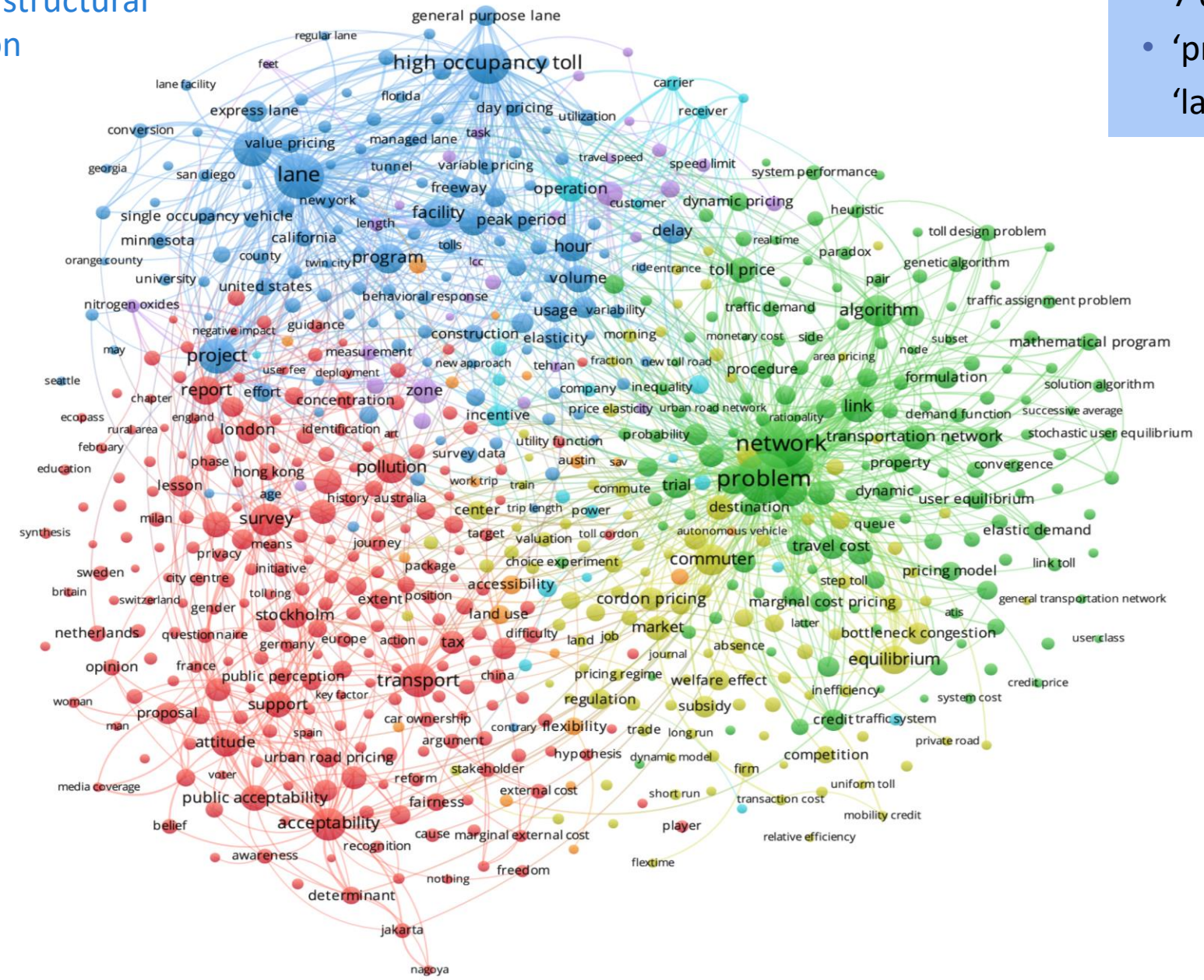
Scope of CPP evidence base over time

Methods

- Structured literature review using semi-supervised and machine learning methods, and bibliometric analysis of the final records
- Inclusion criteria:
  - Peer-reviewed publications or reports
  - Abstract/summary in English
  - Examined a road traffic-related toll-based CPP
  - Have a pricing component and a traffic congestion component
- 13,026 records identified from databases → 2,333 final records included in review
- Reference screening in Covidence
- VOSViewer to construct final network maps https://app.vosviewer.com/

Source: Singichetti et al., 2022

CPP types and structural implementation



- 7 distinct clusters
- ‘problem’, ‘network’ and ‘lane’

Transportation modeling methods and approaches

Population perceptions and relevant effects

Source: Singichetti et al., 2022

Key findings from bibliometric analysis

- Earliest publication year was 1956, notable increases starting in 1989
- Most common title and abstract terms: ‘problem’, ‘network’ and ‘lane’
- Themes in research: implementation, acceptability, modeling approaches

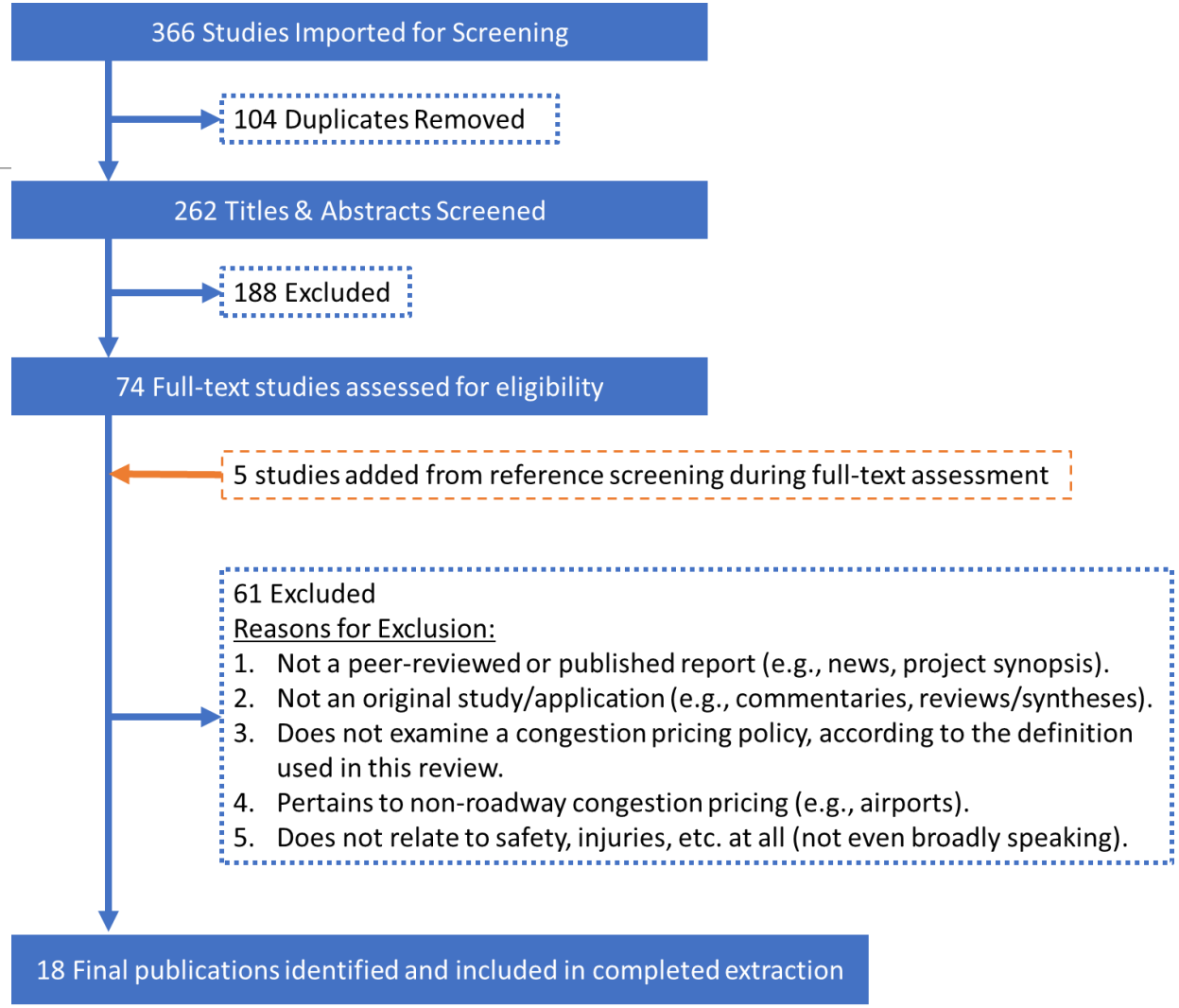
- *Gaps*
  - Impacts on specific road user types and modes (e.g., pedestrian, motorcycle[ist])
  - Equity- and safety-focused research

Source: Singichetti et al., 2022

Scoping review of CPP safety impacts

Methods

- Scoping review
- Inclusion criteria:
  - Peer-reviewed publications or reports
  - Abstract/summary in English
  - Discuss safety impacts of at least one road traffic-related toll-based CPP
  - Have a pricing component and a traffic congestion component
  - Policies focused on generating revenue and not congestion reduction were *excluded*



Source: Singichetti et al., 2021

Results

- Publication dates ranged from 1989 to 2021
- Peer-reviewed journal publications (n=16)
- Data type:
  - Observed data only (n=10)
  - Simulated data only (n=6)
  - Combination of both (n=2)
- Zone- and cordon-based CPP were the most commonly evaluated CPP type

Source: Singichetti et al., 2021

Results

- Most common type of safety outcome measured: Crashes (injury and non-injury)
- Potential safety benefits for multiple road users post-implementation
  - Overall crash reductions up to 35%
  - Changes in fatalities ranged from no changes to 33% reductions
- Trends varied by user type
  - Motorcycles: initial increase immediately post-implementation, followed by reversal
  - Bicycles: some studies showed same pattern as motorcycles, while others observed immediate decreases but long-term increases
  - Pedestrians: one study projected a decrease 10-years post-implementation, while another observed an immediate decrease followed by a slight increase by three years post-implementation

Source: Singichetti et al., 2021

Key findings of scoping review

- Study findings suggest that policies can have overall positive impacts on road user safety
- Trends in post-implementation impacts vary by road user type, and include some periods of increases in events
- Observed and estimated trends were attributed to transportation mode shifts resulting from CPP implementation (e.g., more motorcyclists=initial increase in injury/crashes)

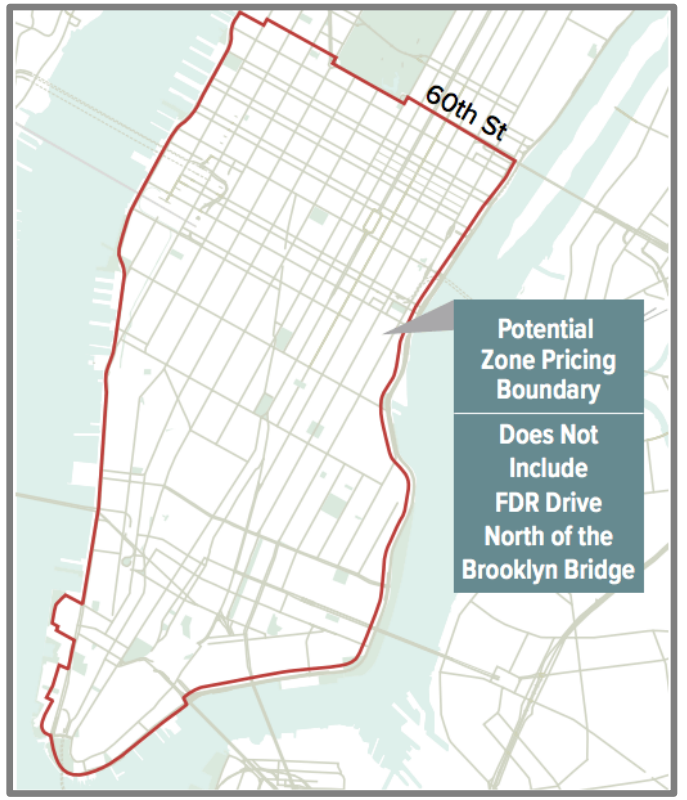
- *Next steps*
  - Further research on safety impacts of specific CPP types
  - Cities/regions must consider safety impacts when evaluating short- and long-term outcomes of CPP implementation

Source: Singichetti et al., 2021

CPP Impacts on Pedestrian Safety Using a System Dynamics Simulation Model

Purpose

To design an evidence-based system dynamics simulation model and to examine the impacts of multiple policy scenarios on pedestrian safety in Manhattan



System Dynamics Simulation Model

Step 1:

Creating a causal loop diagram

- Refined using an extensive, evidence-based model from previous work examining pedestrian injuries
- Use an iterative approach with systems-based interviews and consultations with individuals and groups with various relevant areas of expertise to tailor the diagram to the NYC/Manhattan context

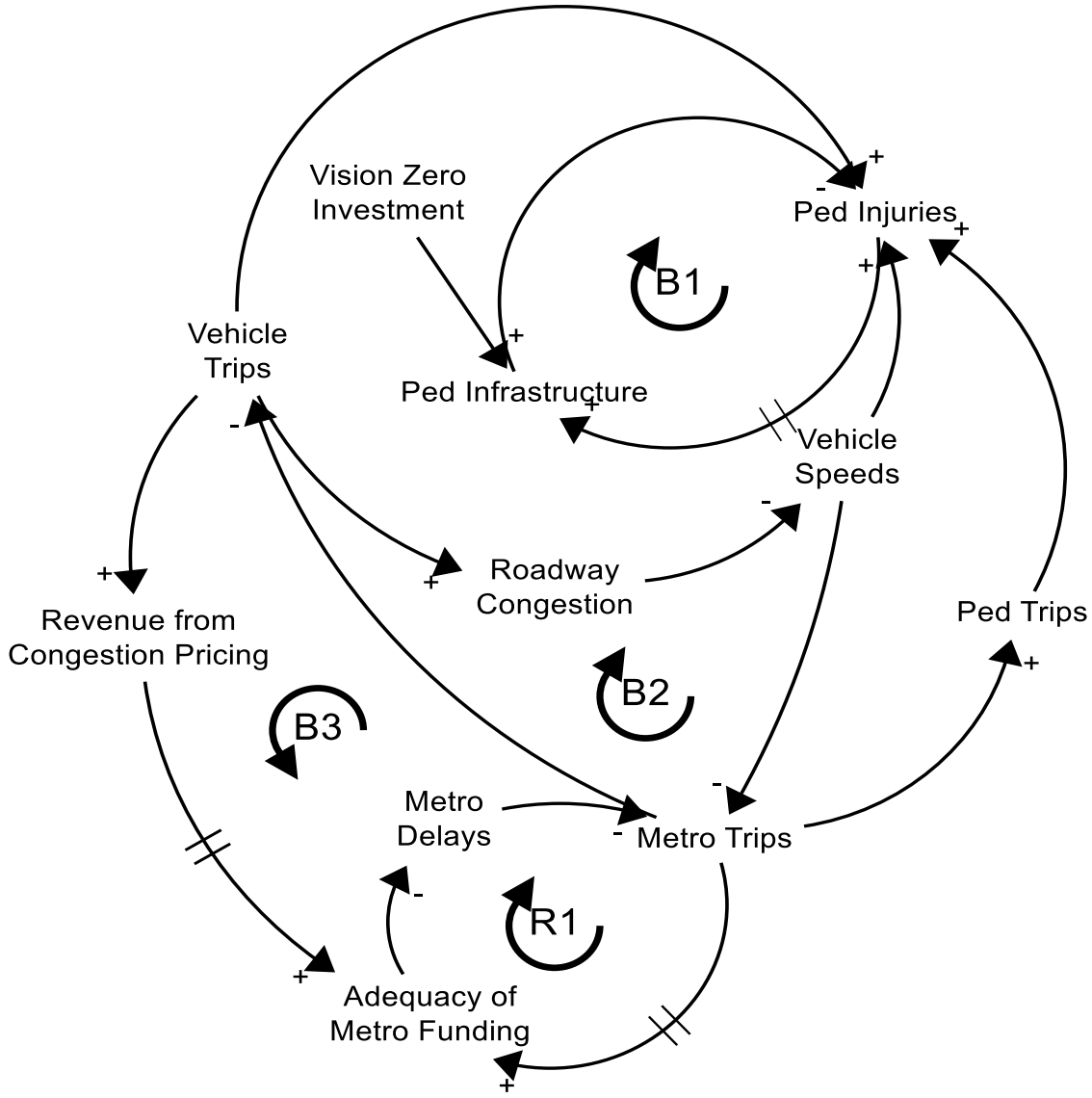


FIGURE 1. Causal loop diagram of feedback structure contributing to potential congestion pricing policy impacts on pedestrian injury

Source: Naumann et al., 2022

System Dynamics Simulation Model

Step 2:

Building the SD simulation model

- Build up the feedback loops using data from several sources
- Verify, validate, and calibrate the model
  - Compare and fit simulated data to observed trends to calibrate the model

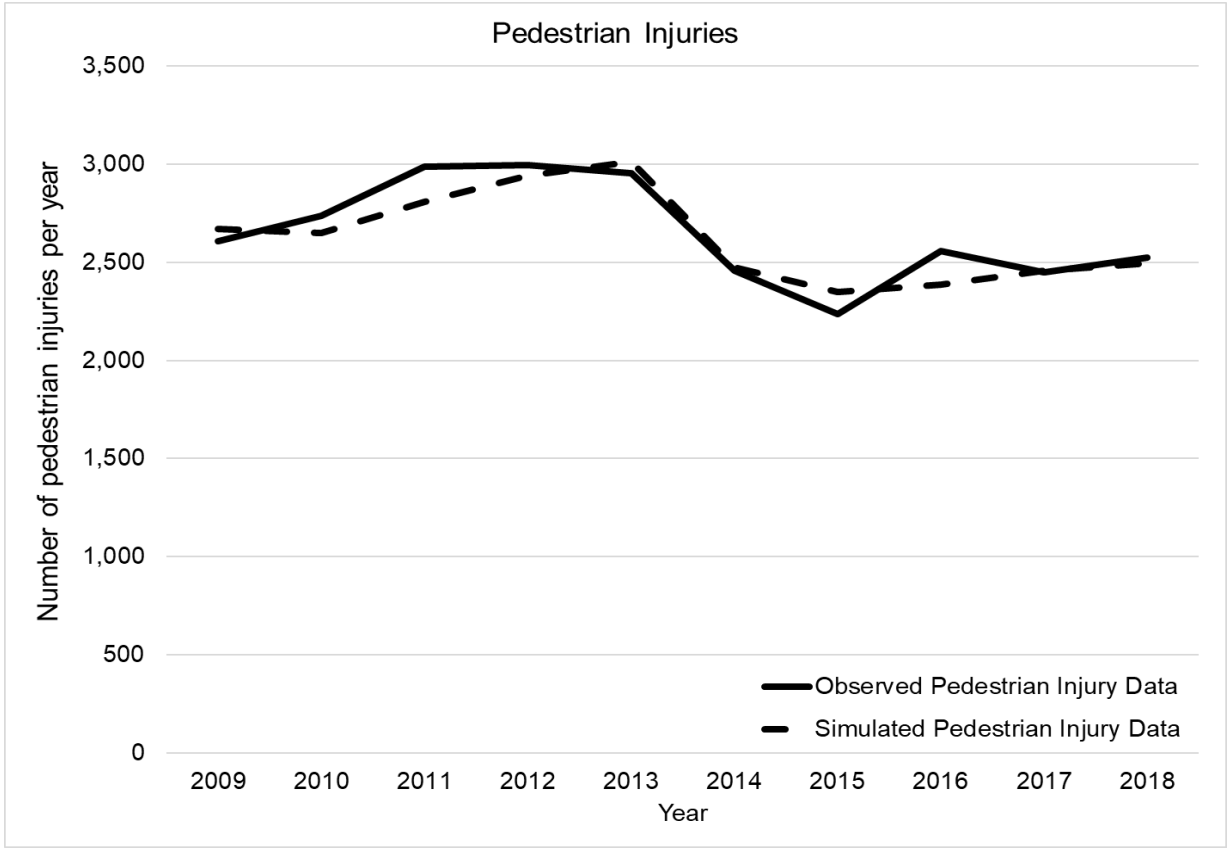
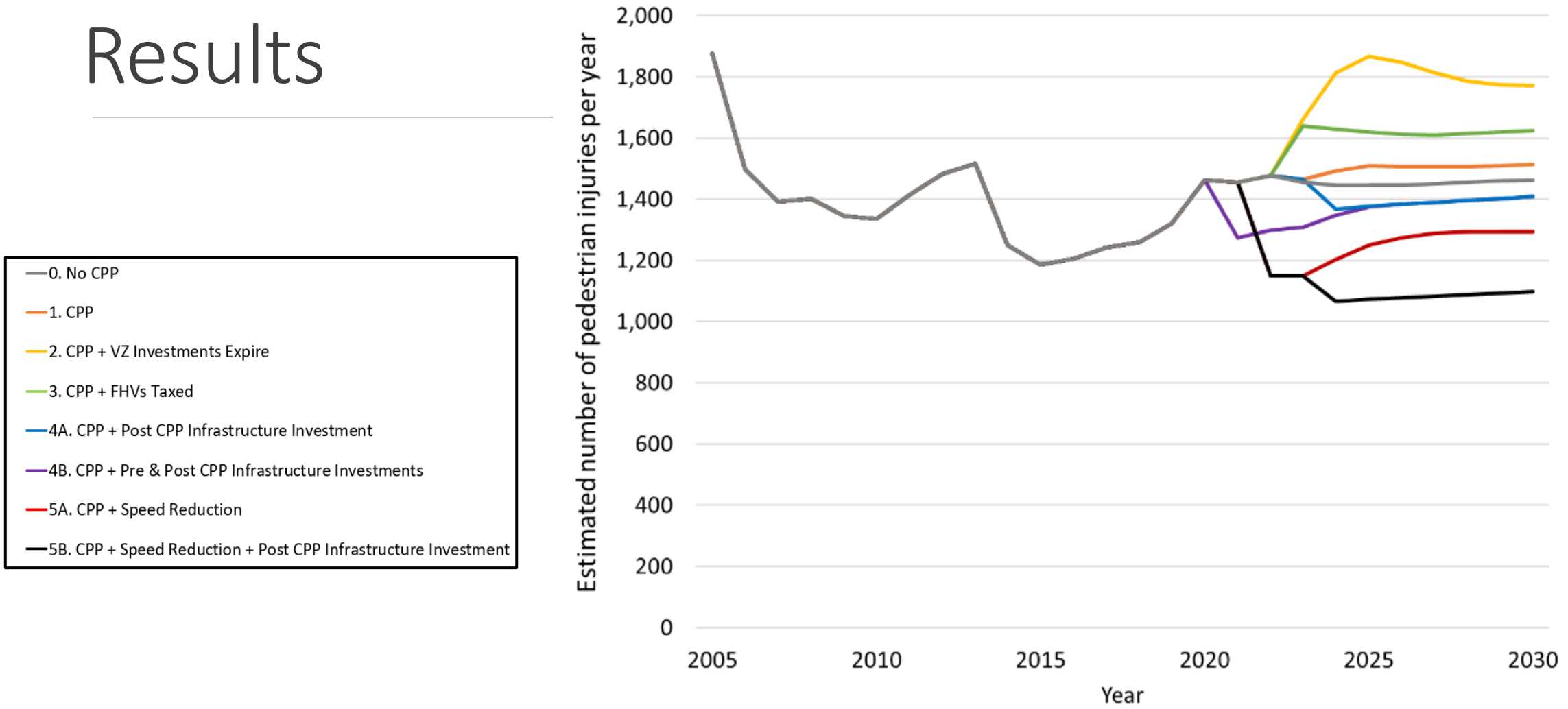


FIGURE 2A. Observed vs. simulated data in congestion pricing policy-related system dynamics model

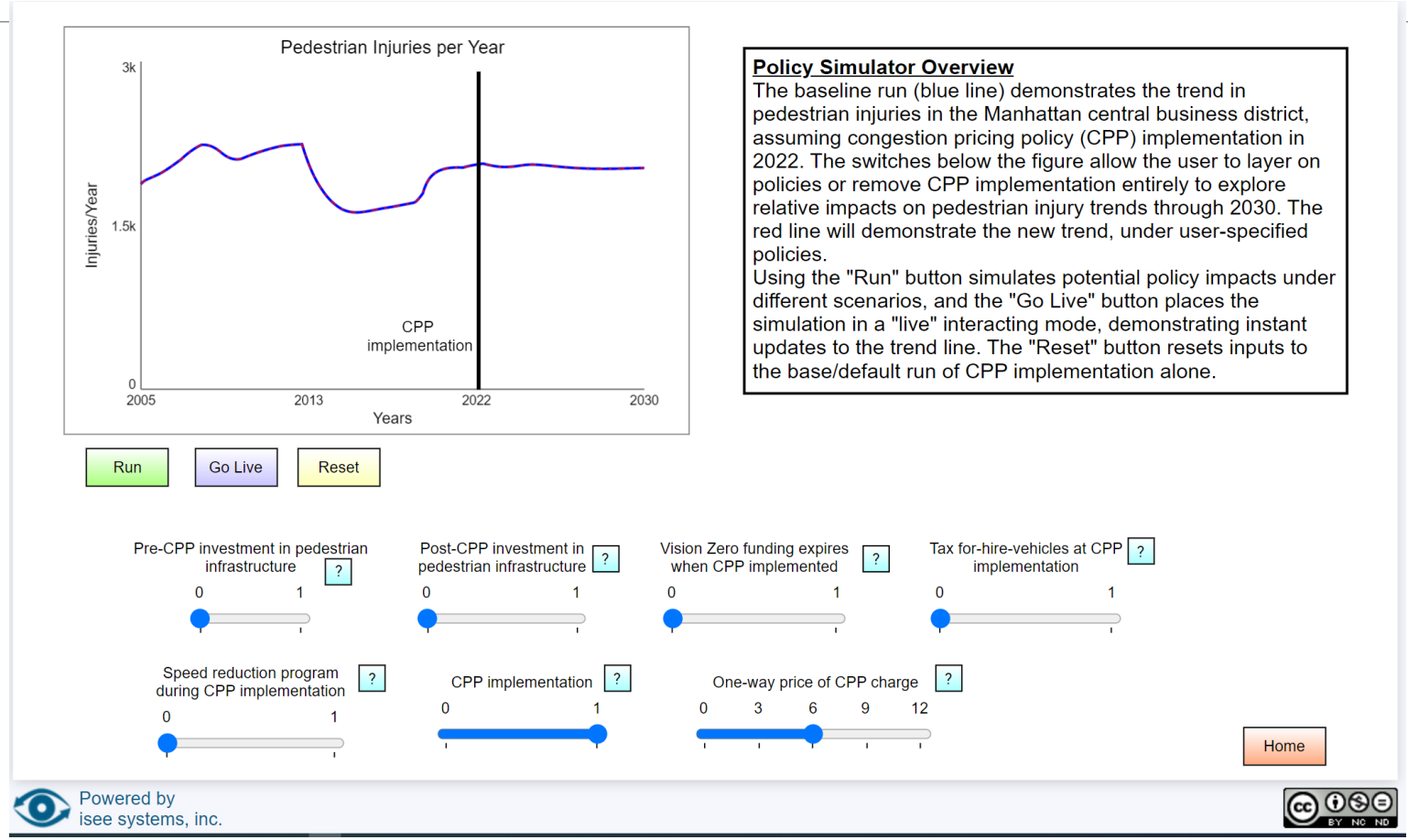
Source: Naumann et al., 2022

Simulation Results



Source: Naumann et al., 2022

Interactive Policy Simulator



bit.ly/CPPinjury ; Source: Naumann et al., 2022

Key findings from SD simulation

- All simulated scenarios resulted in improvements in vehicle congestion, with a reduction in the average daily vehicles traveling in and around this region of Manhattan
- For pedestrian safety, injury trends varied by scenario type, with some scenarios resulting in notable improvements in pedestrian safety (in addition to limiting congestion), while other scenarios resulted in decreased pedestrian safety

- Policy takeaways:
  - Implementing a CPP with other pedestrian efforts has strong potential for improvements in public health
  - Implementing a CPP while removing infrastructure investments could have a negative effect on pedestrian safety

Resources

Publications:

- Singichetti B, Dodd A, Conklin JL, Hassmiller Lich K, Sabounchi NS, Naumann RB. Trends and insights from Congestion Pricing policy research: a bibliometric analysis. Int. J. Environ. Res. Public Health. 2022; 19(12): 7189. DOI: 10.3390/ijerph19127189. PMID: 35742442 PMCID: PMC9222647
- Naumann RB, Sabounchi NS, Kuhlberg J, Singichetti B, Marshall SW, Hassmiller Lich K. Simulating congestion pricing policy impacts on pedestrian safety using a system dynamics approach. Accid Anal Prev. 2022; 171: 106662. DOI: 10.1016/j.aap.2022.106662
- Singichetti B, Conklin JL, Hassmiller Lich K, Sabounchi N, Naumann RB. Congestion Pricing Policies and Safety Implications: A Scoping Review. J Urban Health. 2021; 98: 754-771. DOI: 10.1007/s11524-021-00578-3.

Final Report: https://www.hsrc.unc.edu/publication/pubdetails.php?hsrc_id=1421

SD Simulation Model: bit.ly/CPPinjury

Additional road safety systems work and resources: www.roadsafety.unc.edu

Thank you!

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