Computational Modelling and Simulation
Project 2 Proposal

Group 4

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<u>Research Question</u>:
What are the effects of different policy interventions on the integration of e-scooters into the urban transport system, and how do they influence traffic congestion in metropolitan areas?

<u>Context</u>:
E scooters have become a very widely accepted mode of transportation in densely populated cities all over the world. They are flexible, cost-effective and eco-friendly for commuters traveling short distances through traffic congested areas. They are a popular choice for thousands of commuters in Melbourne with companies like Lime and Neuron providing e-scooter rental services. However, recent prohibitions in Melbourne owing to safety concerns underscore the difficulty of effectively integrating it as well as the requirement for appropriate laws and regulations.This study aims to understand the role of e scooters urban traffic while also identifying how different policies can be implemented to make them safer.

<u>Background</u>:
There has been a surge in the number of research done to identify the impact of e-scooters in urban traffic since its widespread popularity. A case study in Sweden, demonstrates how the e-scooter has encouraged a modal shift where individuals have preferred using them instead of cars and public transport potentially reducing traffic congestion while reducing emissions. The study "The Effect of Shared E-Scooter Programs on Modal Shift: Evidence from Sweden" emphasizes this shift and its implications for more sustainable urban transport. It lays out different benefits and safety concerns that arise with e-scooters and how Sweden has managed them as well.
Gabriel Dias, et al. also explore the role e-scooter played in transportation during the Covid-19 pandemic in their paper, “The Role of Shared E-Scooter Systems in Urban Sustainability and Resilience during the Covid-19 Mobility Restrictions”. They show how e scooters have helped maintain urban mobility during the pandemic and recommend different policies that can make them more effective and safer today. They emphasize that what counts is stringent laws in place for fleet management, parking, infrastructure planning, regulation-a fact which can serve to extend our model in answering questions on interventions for the promotion of safety.
Stefan Gössling in, "Integrating E-Scooters in Urban Transportation: Problems, Policies, and the Prospect of System Change", investigates the problems that cities experience in accommodating e-scooters with respect to safety issues and improvements in infrastructure. These studies together point out the role of policies in integrating e-scooters into the urban transportation systems.

<u>Draft ODD description</u>:

Overview

- **Purpose**:
    - To evaluate the effects of various policy interventions on the integration of e-scooters into the urban transport system and to analyze how these interventions influence traffic congestion in metropolitan areas.
- **Entities, State Variables, and Scales**:
    - **Agents**:
        - **Commuters**: Individuals who choose between different modes of transportation (e-scooters, cars, buses, walking).

        - **Vehicles**: Cars and buses that share the road with e-scooters.
        - **E-Scooters**: E-scooters available for shared use, either docked or dockless.
        - **Policy Makers**: Entities that implement and modify policies affecting transportation (represented indirectly through scenarios).
    - **State Variables**:
        - **Commuter Mode Choice**: The selected mode of transportation for each commuter (e.g., car, bus, e-scooter).
        - **Traffic Density**: The number of vehicles (including e-scooters) on the road network at any given time.
        - **Congestion Level**: A measure of traffic flow efficiency, typically represented by average travel time, delay, or road capacity utilization.
        - **E-Scooter Availability**: The number and location of e-scooters available for use.
        - **Scooter Lane Availability**: The presence or absence of dedicated lanes for e-scooters.
        - **Parking Compliance**: The extent to which e-scooters are parked in designated areas versus cluttering sidewalks or roadways.
    - **Environment**:
        - **Urban Road Network**: A simulation of the city's road network, including roads, intersections, bus stops, and parking spots.
        - **Policy Scenarios**: Different policy environments, such as with or without dedicated scooter lanes, varying levels of parking enforcement, or the presence of financial incentives for e-scooter use.
    - **Scale**:
        - The model represents a full day in a metropolitan area with a population of 100,000 commuters. Each time step corresponds to one minute of real time. (TBF)

Design Concepts

- **Basic Principles**:
    - The model simulates the interaction between different transportation modes in an urban environment and how policy interventions can alter these interactions, influencing overall traffic congestion.
    - Policies such as dedicated lanes, parking regulations, and incentives for e-scooter use are implemented to observe their effects on commuter behavior and traffic flow.
- **Emergence**:
    - Traffic congestion levels, e-scooter adoption rates, and parking behavior emerge from the interactions between commuters, vehicles, e-scooters, and the policies in place. The effectiveness of policies in reducing congestion or improving transportation efficiency is an emergent property of the system.
- **Adaptation**:
    - Commuters adapt their transportation choices based on travel time, cost, and the availability of e-scooters or other modes of transport. Over time, commuters may shift their preferences in response to policy changes, such as the introduction of dedicated lanes or parking restrictions.
- **Objectives**:

- Commuters aim to minimize their travel time and cost, while policymakers aim to reduce traffic congestion and improve the efficiency of the transportation system.

- **Learning**:
    - The model could include a learning component where commuters adjust their mode choice over time based on past experiences, such as the perceived convenience of e-scooters or the efficiency of the overall transport system.
- **Sensing**:
    - Agents (commuters) sense travel time, traffic congestion, e-scooter availability, and the presence of policy interventions such as dedicated lanes or parking enforcement.
- **Interaction**:
    - Agents interact indirectly through the shared road space and the availability of e-scooters. The decisions of one commuter can affect the choices and outcomes of others, particularly in terms of traffic congestion and mode availability.
- **Stochasticity**:
    - The model includes randomness in commuter decisions (e.g., mode choice might have a probabilistic element) and in the availability of e-scooters (e.g., random distribution of scooters across the city).
- **Collectives**:
    - The system can be analyzed as a whole to assess collective outcomes, such as overall traffic congestion levels or the adoption rate of e-scooters under different policy scenarios.

Details

- **Initialization**:
    - The simulation begins with a set number of e-scooters distributed across the city, a predefined road network, and an initial distribution of commuter mode preferences based on historical or estimated data.
    - Policy interventions are initialized according to the scenario being tested, such as dedicated lanes being available or a certain level of parking enforcement.
- **Input Data**:
    - Real-world data on traffic flow, e-scooter usage patterns, and public transport schedules can be used to calibrate the model. Additionally, demographic data could inform commuter behavior and mode choice probabilities.
- **Submodels**:
    - **Mode Choice**: A probabilistic model where commuters choose between cars, buses, walking, or e-scooters based on factors such as travel time, cost, and availability of modes.
    - **Traffic Flow**: A simplified model of road capacity, traffic density, and congestion that simulates how vehicles and e-scooters move through the road network and interact at intersections.
    - **E-Scooter Availability**: A model that simulates the distribution, usage, and turnover of e-scooters, including the impact of parking regulations and enforcement.
    - **Policy Impact**: A submodel that implements the effects of policy interventions, such as dedicated lanes, parking regulations, or incentives, on commuter behavior and system outcomes.

<u>References</u>:

- K. Kazemzadeh and F. Sprei, "The effect of shared e-scooter programs on modal shift: Evidence from Sweden," *Sustainable Cities and Society*, vol. 101, p. 105097, 2024. doi: 10.1016/j.scs.2023.105097.
- S. Gössling, "Integrating e-scooters in urban transportation: Problems, policies, and the prospect of system change," *Transportation Research Part D: Transport and Environment*, vol. 79, p. 102230, 2020. doi: 10.1016/j.trd.2020.102230.
- S. Kythreotis, ‘Policy Recommendations for Integrating Shared Electric Scooters in Urban Mobility Systems: The Case of Sweden’, Dissertation, 2024.
- G. Dias, E. Arsenio, and P. Ribeiro, "The role of shared e-scooter systems in urban sustainability and resilience during the Covid-19 mobility restrictions," *Sustainability*, vol. 13, no. 13, p. 7084, 2021. doi: 10.3390/su13137084.