Human-electric hybrid vehicles: Implications of new non-auto mobility options for street design and policy in the Vancouver region

Executive Summary

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Research Team

Dr. Alexander Bigazzi, Principal Investigator and Corresponding Author (alex.bigazzi@ubc.ca)
Department of Civil Engineering and School of Community and Regional Planning, University of British Columbia

Amir Hassanpour, Graduate Research Assistant,
Department of Civil Engineering, University of British Columbia

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research on active transportation

1 Background and objectives

The focus of urban transportation planning and design has shifted towards more multi-modal systems that provide travellers with enhanced transportation options. At the same time, technological and commercial developments have increased the availability and perceived popularity of low-power vehicles such as electric bicycles, scooters, and skateboards. These new mobility options create opportunities to address enduring challenges related to traffic congestion, air pollution, climate change, public health, and energy consumption. However, due to the variety of sizes and speeds that these vehicles come in, they may present new challenges to urban transport systems, in particular regarding street space allocation and design. Already, pedestrian-bicycle interactions in spaces shared by non-automobile travellers are seen as a safety issue, supported by surprisingly high numbers of incidents with physical contact between travellers (Gkekas, Bigazzi, and Gill 2020). Therefore, it is paramount that we capture the potential benefits of more diverse travel options while mitigating the risks of a wider variety of vehicles within constrained city street spaces, especially in places like Metro Vancouver, where walking and cycling are already at relatively high levels.

The objectives of this research are to address the following questions:

- How will new non-auto mobility options (electric bicycles and other no-/low-power vehicles) impact speed dynamics on non-auto facilities and interactions among non-auto travellers? How are the speeds of vehicles and the perceptions of comfort for non-auto travellers influenced by the presence of electric-assist and microenvironment factors (path grade, facility design, season, other path users, etc.)?
- Given these new non-auto mobility options, what transportation system policies, plans, and designs are needed to mitigate conflicts among non-auto modes? Is the Vancouver region ready to accommodate these new modes with existing infrastructure and policies?

2 Overview of methods

The study methods are summarized in Figure 1. The project included an extensive data collection campaign at 12 sampling locations across Metro Vancouver (over 4 seasons) to gather information on mode shares and speed profiles of all types of vehicles used in off-street paths, and path users' comfort in sharing the path with each vehicle type.

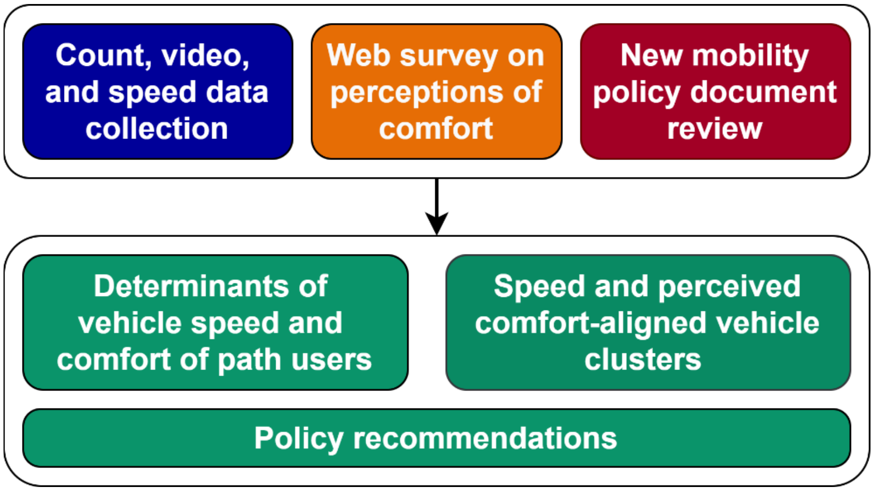

Figure 1. Study methods

After data collection, the following processed datasets were created: 1) mode share and speed profile datasets based on 25,282 observations of passing vehicles, and 2) a comfort rating dataset based on 1,054 survey responses from path users (Figure 2). Speeds and comfort ratings were investigated using mixed-effects regression models to analyze the effects of electric-assist, microenvironment factors, and sociodemographic indicators on speed and comfort. K-means clustering was used to group 25 vehicle types into four speed and comfort-aligned clusters (Figure 3). Lastly, a review of transportation policy, planning, and design documents in Metro Vancouver related to these emerging vehicles was conducted to examine alignment with the empirical results and to identify opportunities to better prepare for increased usage of new mobility devices.

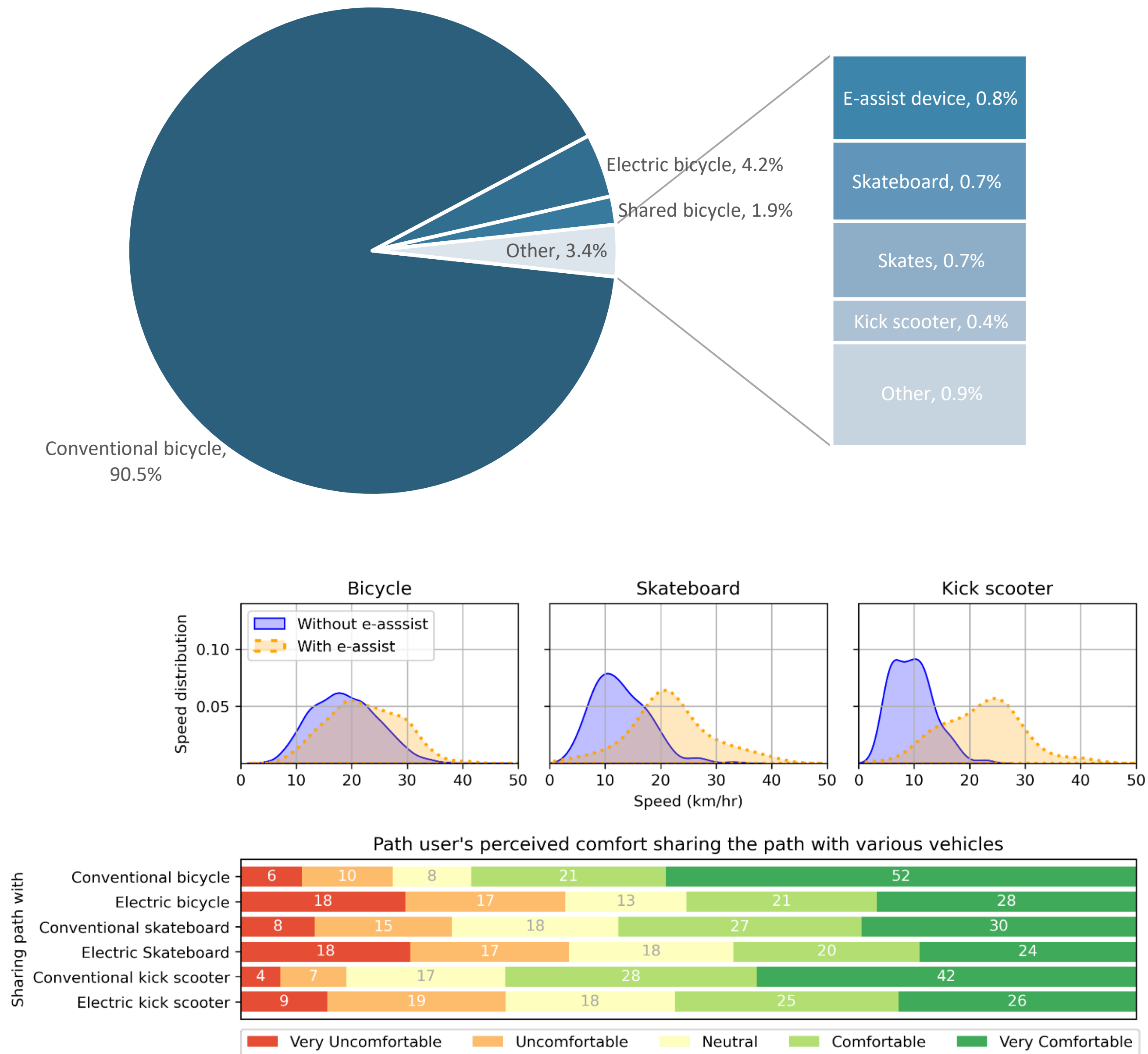

Figure 2. Observed mode shares (top) and speed profiles (middle), along with path users' comfort sharing the path with each vehicle type (bottom).

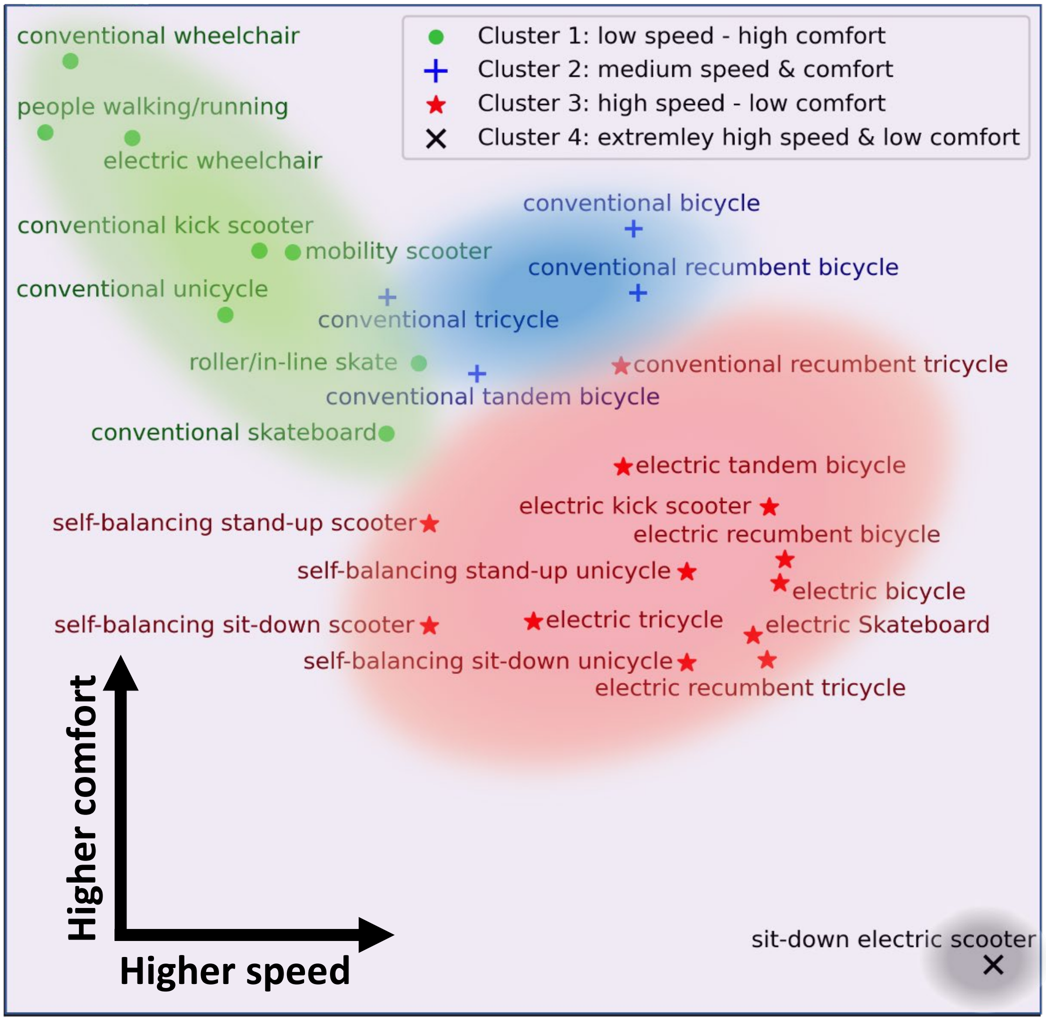

Figure 3. Clustering of vehicles into four speed and comfort-aligned clusters

3 Key findings

1. Conventional bicycles are still the dominant vehicle on off-street paths, with a mode share of more than 90%; a wide range of new mobility devices are present in cycling facilities, but their mode share is currently extremely low (far less than perceived by the public).
2. On average, electric-assist increases bicycle, skateboard, and kick scooter speeds by 4, 10, and 14 km/hr (21%, 83%, and 156%), respectively, over human-powered speeds (more on up-hills). This effect tends to homogenize average speeds around 20-22 km/hr, which may provide a potential safety benefit due to reduced frequency of overtaking conflicts and reduced speed differences while overtaking.
3. Except for sit-down electric scooters (moped-style motorcycles), electric-assist vehicles on paths rarely exceed the 32 km/hr regulatory limit for motor assisted cycles (7% - much less than car speed violations). However, 44% of the observed electric kick scooter speeds would violate the 24 km/hr limit in the new Provincial electric kick scooter pilot project regulations.

4. Most travellers, including pedestrians, are comfortable sharing off-street paths with all the observed vehicle types except sit-down electric scooters.
5. Electric-assist in a vehicle reduces comfort for other path users equivalent to a 9 km/hr faster vehicle, all else (including speed) equal. Previous experience of an incident reduces traveller comfort equivalent to an 11 km/hr faster vehicle (all else equal).
6. The effect of electric-assist on speed is less than commonly perceived by the public; eliminating this perception bias would have the same effect on comfort as a 2 km/hr decrease in actual speeds.
7. We propose four speed- and comfort-aligned clusters of non-automobile vehicles using off-street paths for design and policy (Figure 3): 1) low-speed, 2) conventional bicycles, 3) electric-assist, and 4) moped-style scooters.
8. The negative impact on path user comfort of each additional Cluster 2 vehicle (conventional bicycle) is equivalent to 2.1 Cluster 1 vehicles (e.g., wheelchair); the negative impact of each additional Cluster 3 vehicle (electric-assist device) is equivalent to 1.3 Cluster 2 vehicles or 2.8 Cluster 1 vehicles. These comfort-equivalents can be used to make volume adjustments for new mobility devices in multi-use path design, such as thresholds for pedestrian segregation.

3.1 Conclusion and recommendations

1. The region is generally ready to accommodate new mobility devices in off-street paths without major effects on speeds and with only slight reductions in path user comfort (even with much higher mode shares of electric-assist vehicles).
2. Pedestrian discomfort justifies reduced volume thresholds for separating pedestrians from other travellers on multi-use paths and greenways that accommodate new mobility devices.
3. We should work to eliminate the use of (moped-style) sit-down electric scooters on off-street paths and cycling facilities, which are clear speed and comfort outliers.
4. Other than for moped-style scooters, the current 32 km/hr regulatory limit on electric-assist cycle speeds appears to be effective, and further enforcement is not needed at this time. However, achieving lower speeds for other electric-assist devices (e.g., the 24 km/hr limit in the Provincial electric kick scooter pilot) may require additional vehicle-level speed control strategies. Monitoring of electric kick scooter speeds during the pilot program is recommended.
5. Active transportation design guidelines should be updated to reflect real-world speeds, particularly for electric-assist bicycles and devices. The 30 km/hr design speed for cycling facilities suggested in the B.C. Active Transportation Design Guidelines is appropriate, even for facilities with a large share of electric-assist new mobility devices (as currently used). Further research is needed to include other design aspects of new devices such as stopping distances and turning radii.