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How and Where Should I Ride This Thing? "Rules of the Road" For Personal Transportation Devices

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MINETA TRANSPORTATION INSTITUTE

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REPORT 19-10

HOW AND WHERE SHOULD I RIDE THIS THING? “RULES OF THE ROAD” FOR PERSONAL TRANSPORTATION DEVICES

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16. Abstract

In recent years, "Personal Transportation Devices" (PTDs) have exploded onto streets and sidewalks. These small devices transport individual persons at slow speeds and are either human-powered or motorized. Examples include electric (kick) scooters, skateboards, e-skateboards, roller blades, and Segways. One key to successfully integrating PTDs into community streets will be the implementation of consistent and suitable regulations over user behavior: "rules of the road" for PTD riders. To help local officials identify appropriate rules for rider behavior, this report documents and analyzes existing PTD regulations across 176 jurisdictions and then presents recommendations for a set of state-level "rules of the road" designed to balance safety and freedom of movement for all road users, including PTD riders.

To identify the current state of PTD rules of the road, we documented and analyzed the existing regulations at three levels of government: all 50 states and 5 U.S. territories, 101 cities, and 20 college campuses. This review found that PTD users operate in a murky regulatory environment, with rules often poorly defined, contradictory, or altogether absent.

Results of this analysis, a literature review, and interviews with 21 stakeholders, were used to craft a model state-level regulatory code that aims to introduce consistent and well-grounded regulation of PTDs. The general philosophy underpinning the model legislation is that PTD rules should protect public safety, permit PTD use as a convenient travel option, be easy to understand and remember, allow for new devices without new regulations, and be based on facts about PTD use and users. Working from these principles, core recommended elements of the recommended PTD regulations are as follows: states should set comprehensive regulations for PTD riders (with local gov-ernments given flexibility to limit certain uses when necessitated by local conditions); PTDs should be regulated as a class, not device-by-device; and PTD users should be permitted to ride on both streets and sidewalks, subject to rules that protect safety and free movement for all travelers.

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EXECUTIVE SUMMARY

Every weekday morning in San Francisco's SoMa district, a stream of workers disembark from the city's commuter rail station carrying an assortment of small, wheeled devices—kick scooters, electric skateboards, hoverboards, and more—which they use to roll on to their offices. These "personal transportation devices" (PTDs)—also termed "micromobility" modes of transportation—are small devices that provide low-speed, flexible mobility for individual travelers.

In 2018 and 2019, the sudden influx of new devices on city roadways and sidewalks across the United States raised a variety of thorny regulatory and facilities management questions, with one controversial set of questions relating to appropriate "rules of the road" for riders on the many new device types.[1] Conventional modes of transportation already compete for contested space on streets and sidewalks, and adding PTDs to the mix introduces new users and new devices with different capabilities. While existing law clearly regulates walking, bicycling, and driving motor vehicles, most PTD riders are unsure what rules guide their behavior. At the same time, public officials are realizing that their existing vehicle codes often fail to clearly identify rules for how riders may use the many new devices.

This report tackles questions about the regulatory environment guiding PTD riders in two ways. First, we collected and analyzed existing regulations across different levels of government. Second, we developed a recommended state-level PTD "rules of the road" model code that aims to balance public safety with freedom of travel and mobility.

Readers should note that this report does *not* address the important questions related to how governments regulate and contract with corporate entities renting PTDs for public use. While critically important, that topic is outside the scope of this report.

STUDY METHODS

The first phase of the study entailed documenting and analyzing the existing regulations at three levels of government: the "states" (all 50 states and five U.S. territories), 101 cities, and 20 college campuses. For each entity we reviewed relevant legal code and other regulations to identify (1) definitions of all transportation modes that would include some form of PTD and (2) all regulations that govern how a person operates a PTD.

With this analysis of practice complete, we turned to the second task of drawing up a model state regulatory code for PTDs that is consistent and well-grounded in available evidence. The resulting code is also informed by a literature review and interviews with 21 stakeholders.

FINDINGS: CURRENT "RULES OF THE ROAD" FOR PTD USERS

Our review of existing regulations in states, cities, and university campuses revealed that PTD users operate in a murky regulatory environment, with rules often poorly defined,

[1] Todd Litman and Robin Blair, Managing Personal Mobility Devices (PMDs) on Nonmotorized Facilities (Victoria Transport Policy Institute, 2017).

contradictory, or altogether absent.

One key finding is that specific regulations for PTDs were relatively uncommon in regulatory documents. For many PTD types, the device is neither directly defined nor regulated in the relevant legal code. For example, electric skateboards were defined and regulated in only 7% of the state codes and 10% of the city codes reviewed. At the state level, regulations for different PTDs existed in no more than 30% of states, with the notable exception of Electric Personal Assistive Mobility Devices (EPAMDs). Regulations were somewhat more common at the city level, particularly for non-motorized PTDs. University campuses had the most PTD regulations. However, in the absence of regulations specific to their device, PTD riders were not necessarily unregulated; in most cases, state definitions for either "vehicles" or "pedestrians" encompassed some PTDs.

When governments do write rules about how operators may use PTDs, those rules fall into four primary categories: user behaviors explicitly required (e.g., users must wear helmets); user behaviors explicitly allowed (e.g., users may ride on streets); user behavior explicitly prohibited (e.g., users may not ride on sidewalks); and user behaviors explicitly exempted (e.g., users need not register their device with the state).

Reflecting the finding that there is "no normal" in PTD regulations, many types of inconsistencies were found in the regulations examined for the study. These differences are often not just a matter of degree, with one jurisdiction writing stricter rules and another writing more relaxed rules. Rather, inconsistent rules can be polar opposites of each other. Key problems include the following:

- **PTDs are often subject to regulations for other modes in contradictory ways.** For example, Segway-style devices are regulated as vehicles in Nebraska but as pedestrians in Idaho.

- **Regulations for a specific device type vary widely from place to place.** For example, depending on location, riding a motorized (kick) scooter is prohibited on sidewalks, allowed on sidewalks, or required to be on sidewalks.

- **Individual jurisdictions regulate functionally similar devices differently.** For example, even though motorized kick scooters and electric skateboards both have similar speeds, in California the two devices are subject to different driver's license, helmet, sidewalk riding, and speed limit regulations.

- **Many entities entirely prohibit use of specific PTDs, either through an outright ban or through combinations of regulations that preclude PTD use in certain situations.** For example, some entities prohibit riding PTDs not only on sidewalks but also on high-speed arterials. As a result, riders cannot legally travel in any way along certain corridors.

RECOMMENDED RULES OF THE ROAD FOR PTDS

Drawing on the results of this analysis, a literature review, and interviews with 21

stakeholders, we crafted a language for state-level regulatory code that provides consistent and well-grounded “rules of the road” for PTD operators. The general philosophy underpinning the model legislation is that PTD rules should protect public safety, permit PTD use as a convenient travel option, be easy to understand and remember, and allow for new devices without new regulations.

Working from these principles, we determined four core recommended aspects of PTD regulations:

- Regulate PTDs at the state level. States are the appropriate entity to set baseline regulations for PTD riders, though local jurisdictions should have flexibility to limit certain uses when necessitated by local conditions.

- Regulate PTDs as a class, not device by device.

- Craft PTD rules that mimic bicycle rules, where appropriate.

- Permit PTD users to ride on both streets and sidewalks, subject to rules that protect safety and free movement for all travelers.

Chapter 7 of the report provides the exact language of the recommended code, along with a discussion of the proposed content.

I. INTRODUCTION

Figure 1. Examples of Personal Trans-portation Devices (PTDs)

Sources: See Appendix A

Every weekday morning in San Francisco's SoMa district, a stream of workers disembark from the city's commuter rail station carrying an assortment of small, wheeled devices—kick scooters, electric skateboards, hoverboards, and more—which they use to roll onward to their offices. Down the California coast in Long Beach and Los Angeles, people of all ages and walks of life hop on electric kick scooters to run errands, head to the gym, buy groceries, catch the bus, and cruise along the beach boardwalk—all without having to get in a car and sit in traffic.

These "personal transportation devices" (PTDs)—also termed "micromobility" modes of transportation—are a growing set of devices that provide low-speed, flexible mobility for individual travelers. In recent years, both the number of PTD types and their use has exploded (Figure 1).

The sudden influx of new devices on city roadways and sidewalks has raised a variety of thorny regulatory and facilities management questions, with one controversial set of questions relating to the "rules of the road" for riders on the many device types. Conventional modes of transportation already compete for contested space on streets and sidewalks, and adding PTDs to the mix introduces new users and new devices with different capabilities. While existing law clearly regulates walking, bicycling, and driving motor vehicles, most PTD riders are unsure what rules guide their behavior. At the same time, public officials are realizing that their existing vehicle codes often fail to clearly identify rules for the many new device types.

This report tackles questions about the regulatory environment guiding PTD riders in two ways. First, we collected and analyzed existing regulations across different levels of government. Second, we developed a recommended state-level "rules of the road" model code that aims to balance goals of public safety with freedom of travel.

Readers should note that this report does *not* address the important questions related to how governments regulate and contract with corporate entities renting PTDs for public use. While critically important, that topic is outside the scope of this report.

PTDS DEFINED

There is no consensus on a definition of the class of devices that this report defines as "personal transportation devices" (PTDs). While perhaps not catchy, the term PTD is descriptive. This report defines PTDs as encompassing the wide array of devices that transport individual persons, provide mobility in a niche between walking and riding in automobiles or transit vehicles, and have the following characteristics:

- *Small*: Many PTDs are small enough to be carried when not in use or can fit inside transit vehicles or automobiles for multi-modal trips. In addition, the devices are not substantially wider than a standing adult. This definition excludes some larger, heavier, faster devices that transport individual people, such as motorcycles, mopeds, golf carts, and quadricycles.

- *Low speed*: PTDs travel faster than walking, but markedly slower than typical automobile operational speeds.

- *Human or motor-powered*: PTDs can be either human powered or motorized—for example, both kick scooters or electrified kick scooters are PTDs and so are hoverboards or skateboards.

For the purposes of this study, the term PTD excludes bicycles, electric bicycles, and their derivatives. We defer to the large body of research on bicycles and instead focus on less-studied, emerging devices for which few jurisdictions have implemented use regulations.

PTDS: A GROWING PRESENCE ON STREETS AND SIDEWALKS

The potential for extensive PTD use is more than theoretical. In California in 2012, travelers riding non-motorized PTDs such as skateboards and kick scooters logged nearly 50 million miles.[2] Contributing to those miles are Los Angeles transit riders skating for approximately 30,000 trips per day to and from bus stops and rail stations, as well as thousands of skateboard commuters at California university campuses. In addition, growing evidence suggests that a wide swath of the population may use PTDs, including elderly populations—a finding contrary to stereotypes that PTD users are mostly young and male.[3]

Since late 2017, the use of electric kick scooters has increased dramatically through the emergence of shared scooter programs in many U.S. cities. In the small beach city of Santa Monica, California, one of the earliest cities with scooter share operations, one company reported more than half a million rides in its first nine months of operations.[4] A 2018 survey by Populus about electric shared scooters found that in less than one year since their introduction, 3.6 percent of adults in cities where shared scooters are available had used the devices.[5] Populus noted that this figure represents a faster rate of adoption than those for other forms of shared mobility, such as bike share and car share.

Populus also found strong favorability for scooters in ten cities surveyed. Seventy percent of over 7,000 respondents had a positive view of scooters.[6] Favorability was highest among respondents with incomes of $50,000 or below. Similarly, in Portland, Oregon, a survey conducted after an electric scooter pilot found strong but slightly lower favorability at 62 percent.[7] Support was relatively high for people of color (74 percent) and respondents under 35 years of age (71 percent).

To date, PTD users are found riding both in the roadway and on sidewalks. For example, recent studies indicate that electric scooter riders prefer using low-speed streets and bicycle infrastructure, ranking sidewalks as their least preferred option. However, 40% of Portland scooter riders reported riding at least sometimes on sidewalks.

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[2] Kevin Fang and Susan Handy, "Skateboarding for Transportation: Exploring the Factors Behind an Unconvential Mode Choice Among University Skateboard Commuters," *Transportation* 46, no. 1 (2017): 1–21.

[3] Populus Technologies Inc., *The Micro-mobility Revolution: The Introduction and Adoption of Electric Scooters in the United States*. (Transportatition Research Information Services: 2018), 1–18; Portland Bureau of Transportation, *2018 E-Scooter Findings Report* (Portland Bureau of Transportation: 2019), 1–36; Populus Technologies Inc., *Measuring Equitable Access to New Mobility: A Case Study of Shared Bikes and Electric Scooters.* (Populus Technologies Inc: 2018), 1–10; Jonine Jancey, et al., "Pedestrian and Motorized Mobility Scooter Safety of Older People," *Traffic Injury Prevention* 14, no.6 (2013): 647–653.

[4] "Lime, Bird Scooter Companies Both Laud City's Pilot Program for Electric Transports," *Santa Monica Observer*, June 13, 2018, https://www.smobserved.com/story/2018/06/13/news/lime-bird-scooter-companies-both-laud-citys-pilot-program-for-electric-transports/3487.html.

[5] Populus Technologies, Inc, *The Micro-mobility Revolution: The Introduction and Adoption of Electric Scooters in the United States* (Transportatition Research Information Services: 2018), 1–18.

[6] Populus Technologies, Inc, *The Micro-mobility Revolution: The Introduction and Adoption of Electric Scooters in the United States* (Transportatition Research Information Services: 2018), 1–18.

[7] Portland Bureau of Transportation, *2018 E-Scooter Findings Report* (Portland Bureau of Transportation: 2019), 1–36.

PTDS: OPPORTUNITIES AND CHALLENGES

Greater use of PTDs has the potential to benefit both individual travelers and communities. PTDs demonstrate potential to reduce vehicle-miles-traveled, address gaps in transportation networks, and improve mobility access for low-income communities.[8] At the same time, PTDs create genuine safety challenges and other issues which need to be addressed before they can be integrated fully into cities. The central challenge of this report was to identify rules of the road that successfully permit PTD use where it is beneficial, or at least suitable, while also protecting the safety and right to convenient travel of pedestrians and those using other modes of transportation. This section expands upon the opportunities and concerns that rules of the road must address.

Potential Benefits for Riders and Communities

From the traveler's perspective, PTDs offer a fast, affordable way to move short distances, such as trips within a neighborhood. Transit passengers can use PTDs to go to and from transit stops that are further than a quick walk from their origin and destination points.

PTDs also provide greater options for mobility to populations with less access to traditional modes of transportation. For example, many low-income travelers who cannot purchase or lease a vehicle could afford to own a PTD. Indeed, the emerging data on who uses PTDs in the U.S. indicates that dockless bikes and scooters are being adopted at higher rates by members of traditionally underserved communities.[9] There is also evidence to suggest that aging populations may benefit from the autonomy that PTD mobility offers, especially when seniors are no longer able to drive a car.[10]

From a community perspective, every time travelers replace an auto trip with a PTD trip (or a PTD-plus-public-transit trip), fewer cars are on the road emitting air pollutants and greenhouse gases, causing traffic congestion, raising the risk of severe collisions, and competing for parking spots. For example, one survey found that 34% of scooter trips in Portland, Oregon, replaced driving a personal car or using a rideshare service (i.e., Uber, Lyft, or taxi). Visitors and tourists in Portland replaced car trips with electric scooters at an even higher rate (48 percent).[11]

Concerns About PTD Use

Despite many potential benefits, PTDs have also raised numerous concerns—most notably about parking, safety, and public health.

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[8] Susan Shaheen and Nelson Chan, "Mobility and the Sharing Economy: Potential to Facilitate the First- and Last-Mile Public Transit Connections," *Built Environment* 42, no. 4 (2016): 573–588.

[9] Meghan McCarty Carino, "Scooters Could Improve Mobility in Low-Income Areas, But They Have an Image Problem," *Marketplace,* December 5, 2018, https://www.marketplace.org/2018/12/05/wealth-poverty/scooters-could-improve-mobility-low-income-areas-they-have-image-problem.

[10] Jonine Jancey, et al., "Pedestrian and Motorized Mobility Scooter Safety of Older People," *Traffic Injury Prevention* 14, 6 (2013): 647–653.

[11] Portland Bureau of Transportation, *2018 E-Scooter Findings Report* (Portland Bureau of Transportation: 2019), 1–36

Although not a widespread concern among the general public, some advocates for bicycling and walking fear that use of PTDs discourages use of active modes; these modes are superior to at least some PTDs by at least some metrics (physical activity benefits, lower risks of harming other users, and zero emissions). Though only time will tell how widespread PTD use may change mode choice overall, some initial evidence does show motorized PTD trips substituting for active travel trips. In the Portland pilot study, 35% of e-scooter trips replaced walking trips, and 4% replaced bicycling trips.[12]

Parking is a much more widely-discussed concern. While recent studies suggest that the majority of scooters may be parked correctly (i.e., in the street furniture zone and/or out of the way of pedestrian travel),[13] there is no question that inappropriately-parked scooters can create hazards for persons with visual impairments and persons with limited mobility who use wheelchairs or other mobility devices.[14] Residents have also complained that scooters parked haphazardly look messy, reducing the attractiveness of public spaces.[15] Finally, because PTDs parked on public sidewalks and streets are almost all rented rather than privately-owned, there exists concern about private companies making a profit from the use of public space.

The greatest set of concerns regarding PTDs pertains to their use on sidewalks. Pedestrian advocates fear that having motorized vehicles traveling with pedestrians creates unsafe circumstances for others using the sidewalk, particularly for older adults and families with young children. City officials have also expressed concern regarding liability issues that may arise due to sidewalk PTD use (e.g., in the case of an incident caused by poor city sidewalk infrastructure or a collision between a pedestrian and a PTD user).[16]

PTDS: LIMITED RESEARCH AND POLICY GUIDANCE ON REGULATING AS A CLASS

Policymakers looking to revise vehicle codes to comprehensively regulate PTDs as a collection of device types will find very few resources discussing potential avenues for legislation. Only two reports do so explicitly for the U.S. context. A 2017 report by Litman and Blair looks at rules of the road in a small sample of locations and proposes regulatory strategies for governments to consider.[17] In 2018, the National Association of City Transportation Officials (NACTO) issued a report entitled *Guidelines for the Regulation*

[12] Portland Bureau of Transportation, *2018 E-Scooter Findings Report* (Portland Bureau of Transportation: 2019), 1–36.
[13] Kevin Fang et al., *Where Do Riders Park Dockless, Shared Electric Scooters? Findings from San José, California* (Mineta Transportation Institute, 2018), 1–6.
[14] Peter Holley, "Pedestrians and E-scooters are Clashing in the Struggle for Sidewalk Space," *The Washington Post*, January 11, 2019, https://www.washingtonpost.com/business/economy/pedestrians-and-e-scooters-are-clashing-in-the-struggle-for-sidewalk-space/2019/01/11/4ccc60b0-0ebe-11e9-831f-3aa2c2be4cbd_story.html?utm_term=.357332234932.
[15] Trevor Bach, "Scooting Toward Confrontation: the Rapid Ride of Electric Scooters has Inspired a Fierce Debate over the Hot New Technology's Appropriate Place in Urban Life," *US News*, October 2, 2018, https://www.usnews.com/news/cities/articles/2018-10-02/how-electric-scooters-are-transforming-cities.
[16] Tony Gill, "Like the Swallows of Capistrano, Electric Scooters Return: E-Assist Bikes and Scooters Taking Over Utah," *Salt Lake Magazine,* March 12, 2019, https://www.saltlakemagazine.com/electric-scooters/.
[17] Todd Litman and Robin Blair, *Managing Personal Mobility Devices (PMDs) on Nonmotorized Facilities* (Victoria Transport Policy Institute: 2017), 1–20.

and Management of Shared Active Transportation.[18] The NACTO report recommends that certain regulations be standard across cities and further discusses different regulatory options for subjects the authors deem appropriate for local discretion.[19]

Our literature review also identified a handful of reports from outside the US that discuss regulations for safely integrating PTDs along with other transportation modes. These reports come from Singapore,[20] Australia,[21] New Zealand,[22] and Canada.[23] Collectively, these resources suggest numerous avenues to promoting public safety, including educating users in the rules for the road, providing training that teaches users how to ride safely and courteously, enacting practical and adequate safeguards for shared-use facilities and pedestrian paths, categorizing PTDs into a clear set of types and establishing corresponding regulations for each type, and developing new regulatory frameworks informed by observations of user behavior.[24]

OVERVIEW OF STUDY METHODS

This report tackles questions about the regulatory environment guiding PTD riders in two ways. First, we collected and analyzed existing regulations across different levels of government. Then, we developed a recommended state-level "rules of the road" model code that aims to balance goals of public safety with freedom of travel.

That first task entailed documenting and analyzing the existing regulations at three levels of government: the "states" (all 50 states plus 5 U.S. territories), 101 cities, and 20 college campuses. At each level of government, we looked for: (1) definitions of all transportation modes that may include some form of PTDs and (2) all regulations that would apply to how a person operates a PTD. After collecting the existing regulations, we determined the degree to which PTDs are or are not regulated, also looking for patterns in regulations such as consistency (or lack thereof) from place to place or device to device.

With this analysis of practice complete, we turned to the second task, drawing up a model state regulatory code for consistent and rational regulation of PTDs. The resulting code is informed by interviews with 21 stakeholders, as well as a literature review and the analysis of existing PTD regulations.

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[18] National Association of City Transportation Officials, *Guidelines for the Regulation and Management of Shared Active Transportation* (National Association of City Transportation Officials: 2018), 1–41.

[19] Ibid.

[20] Active Mobility Advisory Panel, *Recommendations on Rules and Code of Conduct for Cycling and the Use of Personal Mobility Devices* (Coordinating Minister for Infrastructure and Minister for Transport: 2016), 1–30.

[21] Rebekah Smith et al., *New Personal Transportation Devices: Safety and Regulations* (ARRB Group, Australia: 2016), 1–13.

[22] ViaStrada Limited, *Regulations and Safety for Electric Bicycles and Other Low-powered Vehicles* (New Zealand Transport Agency Research Organization: 2017), 1–182.

[23] Pierre Lavallée, *Pilot Project for Evaluating Motorized Personal Transportation Devices: Segways and Electric Scooters* (Transportation Developmente Centre Transport Canada: 2004), 1–72.

[24] Active Mobility Advisory Panel, Recommendations on Rules and Code of Conduct for Cycling and the Use of Personal Mobility Devices (Coordinating Minister for Infrastructure and Minister for Transport: 2016), 1–30; Rebekah Smith et al., *New Personal Transportation Devices: Safety and Regulations* (ARRB Group, Australia: 2016), 1–13; ViaStrada Limited, *Regulations and Safety for Electric Bicycles and Other Low-powered Vehicles* (New Zealand Transport Agency Research Organization: 2017), 1–182; Pierre Lavallée, *Pilot Project for Evaluating Motorized Personal Transportation Devices: Segways and Electric Scooters* (Transportation Development Centre Transport Canada: 2004), 1–72.

OVERVIEW OF REPORT CONTENTS

The remainder of this report is organized as follows. Chapter 2 describes basic operating and physical characteristics for a wide variety of PTD types. Next, Chapter 3 discusses the methods used in this report. Chapters 4, 5, and 6 then present the findings from the analysis of existing regulations of PTDs. Finally, Chapter 7 lays out proposed model state regulations and the reasoning behind the recommendations, and Chapter 8 concludes the report with a summary of findings, suggestions for policymakers, and recommendations for future research.

II. WHEELS OF TOMORROW? THE WIDE ARRAY OF PTDS

An ever-expanding set of PTDs are on the market: some are developed by tech startups and others by name-brand corporations. PTDs can be both non-motorized or motorized (e.g., kick scooters versus electrified kick scooters) and can utilize new technology or old (e.g., hoverboards versus skateboards).

When considering how PTDs should be regulated, it is helpful to understand their specifications and capabilities, as well as how users operate them. The first section of this chapter describes conceptually how the devices move, including propulsion, braking, and turning. The next section classifies PTDs into five groups and discusses key characteristics of each group (dimensions, weight, maximum speed, motor power, and range). The final section further explores device speed with available data on how fast users actually travel, compared to maximum specifications.

HOW DEVICES MOVE

Forward Travel

Users of PTDs move themselves forward in a variety of different ways. Human-powered PTDs rely on their users kicking or pushing themselves forward (e.g., skateboards, kick scooters, and in-line skates) or utilizing arm power (wheelchairs). To increase speed, riders simply work harder at kicking or pushing their device.

As for motorized PTDs, most are propelled by batteries and electric motors, though a few have internal combustion engines. For devices that are tall enough to reach hand level, forward speeds can be controlled through hard-wired hand controls. For devices that are shorter in height, riders control forward speeds with either remote hand controls or foot pedals. Finally, several relatively recent motorized devices change speed in response to shifts in the rider's weight.

Braking

Human-powered devices generally lack mechanical brakes, instead relying on riders slowing down with their feet or maneuvering the device in a way that slows them down.

Motorized PTDs are typically equipped with some sort of mechanical brake, including regenerative braking systems. Brakes can be hand-operated through a hard-wired control or remote controls, can be foot-operated through foot pedals, or can detect shifts in rider weight to slow down.

Turning

Turning capabilities depend on the device height rather than its source of power. Tall PTDs generally have handlebars that allow for hand-controlled turning. This functionality is not possible in PTDs that are short in height, which thus generally turn based on shifts in rider weight.

PTD DIMENSIONS, SPEEDS, AND RANGES

This section groups PTDs into five categories, based on the devices' source of propulsion and traditional purpose:

- Human-powered devices traditionally used for recreation (e.g., skateboards and kick scooters)
- Motorized versions of traditional recreational devices (e.g. electric skateboards, electric [kick] scooters)
- Purpose-built electric-powered devices (e.g., Segways)
- Devices built to aid persons with mobility disabilities (e.g., wheelchairs)
- Ridable versions of everyday objects (e.g., ridable carry-on luggage)

The following sections describe key dimensions, maximum speeds, motor power, and range for each category. The data were gathered by examining the retail specifications for a selection of devices listed online for sale.

Human-Powered Devices Traditionally Used for Recreation

The simplest PTDs are human-powered devices that have a long history of mostly recreational use, though some riders have always used them as an option for getting where one needs to go. This class of PTDs includes skateboards, kick scooters, and roller/in-line skates. Skateboards come in many variants, but they generally consist of a long, narrow platform or "deck" that riders stand on and ride on four small wheels. Kick scooters similarly consist of a long, narrow platform, but they ride on two slightly larger wheels. Additionally, kick scooters have a vertical beam that comes up from the platform and contains handlebars at the top. Roller/in-line skates are essentially shoes with wheels, so they are "worn" rather than ridden; both forms of skates typically have four wheels, with roller-skate wheels arranged in two rows of four and in-line skate wheels aligned as a single line. In-line skates are sometimes referred to as *Rollerblades* after a specific brand name.

Table 1 presents typical physical characteristics for existing versions of these device types (e.g., dimensions, wheel size, and weight). The devices are narrow (no more than about a foot wide) but can be as long as 60 inches. In addition, the devices are all relatively light, with weights only reaching around 8 pounds, and they have small wheels from 2 to 5 inches in diameter.

Table 1. Typical Dimensions and Weight of Selected Human-Powered PTDs

	Dimensions[a]	Wheel Diameter	Device Weight
Skateboards: conventional or trick	L: 28 – 32” W: 7.5 – 8.25” H: 4.0”	2 – 3”	6 lbs
Skateboards: longboards	L: 30 – 60” W: 7.5 – 9.0” H: 4” – 5”	2 – 3”	8 lbs
Kick scooters	L: 24” W: 11” H: 30 – 45”	5”	5 lbs
In-line skates	L: 12” W: 3.3 – 5.0” H: 4.5”	2 – 3”	8 lbs

[a] “L” denotes device length, “W” denotes device width, and “H” denotes device height.

Among the human-powered devices, skateboards have had the most use as a mode of functional transportation. This fact may be due in part to the ease of using and storing a skateboard in comparison to the two other modes (e.g., in-line/roller skates require changing footwear). Skateboarding occasionally appears as a mode choice option on travel surveys, with some college campus commuting surveys reporting skateboard mode shares in the low-high single digits.[25] Data on the use of kick scooters and roller/in-line skates are less readily available. However, multiple cases of fatalities incurred by kick scooter riders at least minimally implies their use as a mode of transportation.[26] In-line skating also attracted some attention in transportation research following a peak in in-line skating in the 1990s.[27]

Motorized Versions of Traditional Recreational Devices

As their name implies, motorized skateboards and motorized (kick) scooters are versions of human-powered skateboards and kick scooters that add a motor, energy supply, and brakes (Figure 1). Today, motorized skateboards and scooters on the market are generally electric-powered, though there are some models with internal combustion engines that run on liquid fuel such as gasoline or propane. Older ICE-powered devices triggered complaints about noise and air pollution, leading to some restrictions such as a California statewide ban in 1977.[28]

[25] Kevin Fang and Susan Handy, “Skateboarding for Transportation: Exploring the Factors Behind an Unconvential Mode Choice Among University Skateboard Commuters,” *Transportation* 46, no. 1 (2017): 1–21.
[26] Kevin Fang and Susan Handy, “Skate and Die? The Safety Performance of Skateboard Travel: A Look at Injury Data, Fatality Data, and Rider Behavior,” *Journal of Transport and Health,* 7, part b (2017): 288–297.
[27] Elizabeth Birriel et al., “The Operational Characteristics of Inline Skaters,” *Transportation Research Record* 1773 (2001): 47–55.
[28] “Governor Signs Electronic Skateboard Bill into Law,” *Turlock Journal*, October 13, 2015, https://www.turlockjournal.com/news/government/governor-signs-electronic-skateboard-bill-into-law/.

Figure 2. Electric Skateboard (Battery Pack and Drive Components Visible under Deck)

Source: https://thewirecutter.com/wp-content/uploads/2017/11/electric-skateboards-lowres-0093.jpg.

Tables 2, 3, and 4 present examples of these device types' physical characteristics based on a selection of devices on the market as of 2019. In addition to the dimensions reported for human-powered PTDs (dimension, wheel diameter, and device weight), the tables show three other key characteristics that influence how the devices are used: motor power, maximum speed, and range. Motorized versions of traditional recreational devices are similar in size to their human-powered counterparts. However, the presence of batteries and drive systems make motorized versions notably heavier. Electric scooters are generally heavier than electric skateboards, and ICE-powered devices are generally heavier than electric-powered devices.

Table 2. Selected Characteristics for a Sample of Electric Skateboard Models

	Dimensions[a]	Wheel Diameter	Device Weight	Motor Power	Maximum Speed	Range*
Inboard M1	L: 37.5” W: 11.25” H: 5.0”	3.1”	14.5 lbs	2.1 HP	22 mph	7 miles
ZBoard 2 Blue	L: 38.0” W: 9.5” H: 5.5”	3.5”	17.0 lbs	1.3 HP	20 mph	16 miles
Marbel 2.0	L: 38.0” W: 10.0” H: 5.0”	3.0 – 4.0”	12.9 lbs	2.7 HP	26 mph	18 miles
Blink Lite	L: 30.0” W: 10.0” H: 6.0”	2.8”	7.7 lbs	0.6 HP	10 mph	5 miles
Evolve GT Street	L: 38.0” W: 12.0” H: 5.0”	3.3”	17.0 lbs	4 HP	22 – 26 mph	19 miles
Halo Board	L: 36.0” W: 9.75” H: 5.0”	3.3”	14.0 lbs	4 HP	22 mph	12 miles

[a] “L” denotes device length, “W” denotes device width, and “H” denotes device height.

Table 3. Selected Characteristics for a Sample of Electric (Kick) Scooter Models

	Dimensions[a]	Wheel Diameter	Device Weight	Motor Power	Maximum Speed	Range*
Razor E300	L: 42.0” W: 17.0” H: 41.0”	10.0”	46.0 lbs	0.3 HP	15 mph	40 minutes
Hover – XLS	L: 37.5” W: 21.2” H: 42.24”	10.0”	50.7 lbs	0.3 HP	20 mph	20 miles
GoPed ESR750	L: 34.0” W: 14.5” H: 44.0”	8.0”	47.0 lbs	1.0 HP	18 mph	18 – 22 miles
Pulse RF-200	L: 31.0” W: 18.0” H: 35.0”	7.87”	25.0 lbs	0.2 HP	10 mph	40 minutes
Razor Ecosmart Metro	L: 59.5” W: 20.25” H: 41.5”	16”	67.0 lbs	0.3 HP	20 mph	40 minutes

*Some manufacturers reporting the range in minutes and others use miles.
[a] “L” denotes device length, “W” denotes device width, and “H” denotes device height.

Table 4. Selected Characteristics for a Sample of Motorized Skateboards/ Motorized Scooters with Internal Combustion Engines

	Dimensions[a]	Wheel Diameter	Device Weight	Engine Power	Maximum Speed	Range
Moto Tec Wheelman V2 (skateboard)	L: 45” W: 12” H: 17”	14.0”	53 lbs	2.0 HP	25 mph	30 miles
SkaterX (skateboard)	L: 31” W: 20” H: 55”	3.5”	50 lbs	1.5 HP	25 mph	25 miles
Evo 2x BIG (scooter)	L: 50” W: 25” H: 42”	10.0”	53 lbs	1.5 HP	30 – 35 mph	20 miles
X-Treme XG 575 DS (scooter)	L: 50” W: 12” H: 43”	11.0”	52 lbs	2.0 HP	35 mph	20 miles

[a] “L” denotes device length, “W” denotes device width, and “H” denotes device height.

Purpose-Built Electric Devices

Electric Personal Assistive Mobility Devices (EPAMDs)

Several other electric-powered devices have been developed specifically for the purpose of providing personal transportation. The trailblazer of these devices, the *Segway*, was unveiled in 2001. Given that this term is a brand name, in regulations, Segways and their competitors are often referred to as “electronic personal assistive mobility devices” (EPAMDs). The traditional EPAMD is made up of a platform that a rider stands on while facing forward; the device rolls on two relatively large wheels (19 inches in diameter on the first-generation Segway). A vertical post extends from the platform to handlebars.

Since the introduction of the original version, Segway and its competitors have introduced additional devices evolving from the EPAMD design. These devices have the same base as older EPAMDs, but they lack the tall vertical beam seen in earlier generations that rises to the abdominal level. Instead, newer devices have a shorter vertical beam that goes between a rider’s legs to knee level; the rider can occasionally lean on this beam for balance. The smaller dimensions also manifest in lower device weight in newer variants. Improvements in battery technology over time also presumably allow for lower weights.

Figure 3. Evolution of Segway Devices over Time: 1st Generation, 3rd Generation, Smaller Variant

Sources: https://msu.edu/~luckie/segway/i167/i167.html, http://www.segway.com/products/professional/segway-i2-se, and http://www.segway.com/products/consumer-lifestyle/segway-s-plus.

Table 5. Selected Characteristics for a Sample of Electronic Personal Assistive Mobility Devices

	Dimensions[a]	Wheel Diameter	Device Weight	Motor Power	Maximum Speed	Range
Segway i167 (1st generation)	L: 19.0" W: 25.0" H: 50.0"	19"	83 lbs	2.0 HP	12.5 mph	8 – 12 miles
Segway i2 (2nd generation)	L: 25.5" W: 25.0" H: 51.0"	19"	105 lbs	2.0 HP	12.5 mph	24 miles
Segway i2 SE (3rd generation)	L: 25.5" W: 25.0" H: 51.0"	19"	105 lbs	2.0 HP	12.5 mph	24 miles
Airwheel S3 (Segway competitor)	L: 23.0" W: 24.0" H: 50.0"	14"	50 lbs	1.3 HP	11.0 mph	27 – 31 miles
Robo Z1-D (Segway competitor)	L: 22.8" W: 17.0" H: 33.4"	19"	99 – 135 lbs	2.7 HP	12.5	18 – 22 miles
Segway miniPlus (smaller variant)	L: 23.0" W: 11.0" H: 24.0"	11"	36 lbs	2.0 HP	12.5	22 miles
Ninebot miniPro (smaller variant)	L: 10.3" W: 21.5" H: 34.0"	10"	28 lbs	2.0 HP	10.0 mph	14 miles

[a] "L" denotes device length, "W" denotes device width, and "H" denotes device height.

Hoverboards

Hoverboards burst onto the scene as a device and cultural phenomenon in 2015.[29] Similar in design to EPAMDs, but lacking a pole, hoverboards consist of a wide, short (in length) platform, with two wheels arranged on the left and right side. However, the platform and wheels are smaller than those of EPAMDs, and hoverboards have no vertical component.

[29] Ritchie King, "Christmas 2015 Was Filled With Hoverboards—and Hoverboard Injuries," *FiveThirtyEight.com*, November 22, 2016, https://fivethirtyeight.com/features/christmas-2015-was-filled-with-hoverboards-and-hoverboard-injuries/.

Figure 4. Hoverboard

Source: https://ihubdeal.com/pub/media/catalog/product/cache/image/1000x1320/e9c3970ab036de70892d86c6d221abfe/h/o/hoverboard-99635.jpg

Table 6. Selected Characteristics for a Sample of Hoverboards

	Dimensions[a]	Wheel Diameter	Device Weight	Motor Power	Maximum Speed	Range
Swagtron T1	L: 7.0” W: 23.0” H: 7.0”	5.0”	22.0 lbs	0.3 HP	8 mph	7–12 miles
Phunkee Duck Monster	L: 8.0” W: 26.4” H: 9.6”	8.5”	32.0 lbs	1.0 HP	10 mph	10 miles
Halo Rover	L: 8.7” W: 27.5” H: 9.1”	8.5”	32.0 lbs	1.0 HP	10 mph	7 miles
Epikgo Classic	W: 8.5” L: 23.0” H: 9.5”	8.5”	32.2 lbs	1.0 HP	9 mph	7 miles
Go Trax Hoverfly ECO	W: 7.0” L: 23.0” H: 8.0”	6.5	25.5 lbs	0.7 HP	7 mph	12 miles

[a] “L” denotes device length, “W” denotes device width, and “H” denotes device height.

Electric Unicycles

Another model of PTDs on the market can be described as electric unicycles (or e-unicycles), rolling on one wheel rather than two or four. Examples of these devices include the *Solowheel* and *Ninebot One*, which are comprised of a single, relatively large wheel (approximately 14 inches in diameter) and two pedal-sized platforms to the left and right of the wheel. The *Kiwano KO1* has a similar base to the other two but also has a vertical post that is used as a handle to control the device.

Some other electric unicycles, such as the *Onewheel* and *Halo Board Extreme*, have riders stand on a deck that runs in front of and behind the wheel. In this case, riders stand as if they are on a skateboard, so these devices can be conceptualized as electric unicycle/skateboard hybrids.

Figure 5. Examples of E-unicycles: Ninebot One S1, Kiwano KO1, Onewheel XR (L–R)

Sources: http://www.segway.com/products/consumer-lifestyle/ninebot-one-s1, https://www.kiwano.co/products/ko1-electric-scooter, and https://onewheel.com/products/onewheel-xr.

Table 7. Selected Characteristics for a Sample of Electric Unicycles (E-Unicycles)

	Dimensions[a]	Wheel Diameter	Device Weight	Motor Power	Maximum Speed	Range
Solowheel	L: 17.0” W: 14.0” H: 19.0”	16.0”	22 lbs	2.0 HP	10.0 mph	10 miles
Ninebot One S1	L: 16.6 W: 7.2 H: 17.6”	14.0”	25 lbs	1.3 HP	12.5 mph	15 miles
Ninebot One C+	L: 18.0” W: 7.0” H: 19.0”	16.0”	30 lbs	0.6 HP	12.5 mph	15 miles
Kiwano KO1	L: 8.5” W: 17.0” H: 42.5”	8.5”	35 lbs	1.3 HP	15.0 mph	15 miles

[a] “L” denotes device length, “W” denotes device width, and “H” denotes device height.

Table 8. Selected Characteristics for a Sample of E-Unicycle/Skateboard Hybrids

	Dimensions[a]	Wheel Diameter	Device Weight	Motor Power	Maximum Speed	Range
Onewheel XR	L: 30.0” W: 9.0” H: 11.5”	11.5”	27 lbs	1.0 HP	19 mph	18 miles
Onewheel	L: 30” W: 9.0” H: 11.5”	11.5”	25 lbs	0.8 HP	12 mph	6 miles
Trotter E-Skateboard	L: 29.2” W: 10.2” H: 11.2”	11.2”	30 lbs	0.9 HP	12 mph	15 miles

[a] “L” denotes device length, “W” denotes device width, and “H” denotes device height.

Auto Company Concept Vehicles

At least two major auto companies have explored PTDs, represented by Toyota’s *i-Real* and Honda’s *Uni-Cub*. The Toyota i-Real is a compact, three-wheeled, electrically powered PTD designed for use in the “pedestrian sphere.” While detailed specifications on the i-Real are scant, it is known to feature two travel modes. A low-speed mode shortens the device’s wheelbase and raises its rider up so as to be closer to pedestrian eye level. This mode is meant to allow the i-Real to easily navigate around pedestrian traffic. The high-speed mode extends the wheelbase, lowering the rider and the center of gravity for improved stability. Another interesting feature of the i-Real is its use of proximity sensors to aid in the safe operation of the device. When the sensors detect a possible collision, the rider will be warned with an auditory alert combined with vibration, and people nearby will be alerted by lights and chimes.

Designed for use in indoor areas with open floor plans, Honda offers the Uni-Cub and the marginally smaller Uni-Cub β. The UniCub is designed to operate hands-free, featuring Honda’s two-wheel “Omni Tracking System,” which allows the devices to move forward, backward, laterally, and rotationally.

Figure 6. Toyota i-Real (Left) and Honda Uni-Cub β (Right)

Source: https://www.toyota-global.com/showroom/toyota_design/award/i_real/ and https://global.honda/innovation/robotics/UNI-CUB.html.

Table 9. Selected Characteristics for a Selection of Auto Company Concept Vehicles

	Dimensions[a]	Wheel Diameter	Device Weight	Motor Power	Maximum Speed	Range
Toyota i-Real	L: 39.2” W: 27.6” H: 56.3”	Unavailable	Unavailable	Unavailable	18.6 mph	18.6 miles
Honda Uni-Cub	L: 20.5” W: 13.6” H: 29.3”	Unavailable	Unavailable	Unavailable	3.7 mph	3.7 miles

[a] “L” denotes device length, “W” denotes device width, and “H” denotes device height.

Aids for Persons with Mobility Disabilities

Wheelchairs

A wheelchair is a manually-operated device used to aid the movement of persons with mobility impairments. The device is built around a frame to which all other components are attached: a seat/seatback, push handles, arm/footrests, a brake, and wheels. In addition to two small swivel-mounted caster wheels located in the front of the wheelchair, manual wheelchairs also have push rims mounted to the outside of the chair’s wheels. These push rims allow the rider to propel themselves forward by using their arms.

Electric Wheelchairs/Powerchairs/Mobility Scooters

Many motorized devices provide mobility assistance for disabled people. Different terms are used to describe these devices, including electric wheelchairs, powerchairs, and

mobility scooters. Table 10 shows the characteristics for a sample of the devices, which tend to have fairly small wheels, weigh in at up to 255 pounds, and travel at maximum speeds no greater than 5.5 mph.

Table 10. Selected Characteristics for a Sample of Electric Wheelchairs/ Powerchairs/Mobility Scooters

	Dimensions[a]	Wheel Size	Device Weight	Motor Power	Maximum Speed	Range
Alante Sport Power Wheelchair	L: 40.5” W: 22.3” H: 52.0”	6.0”	157 lbs	0.3 HP	3.5 mph	16.5
Zip’r Mantis Power Wheelchair	L: 42.3” W: 26.0” H: 56.8”	10.0”	189 lbs	0.3 HP	4.9 mph	15.0
Whill Model M Power Wheelchair	L: 43.0” W: 23.6” H: 42.0”	12.5”	255 lbs	2.0 HP	5.5 mph	15.0
Pride Go Go Folding Scooter	L: 36.6” W: 19.1” H: 37.2”	8.0”	56 lbs	0.4 HP	3.7 mph	9.3
Phoenix HD 4	L: 41.5” W: 21.7” H: 38.0”	9.0”	121 lbs	0.5 HP	4.0 mph	12.0

[a] “L” denotes device length, “W” denotes device width, and “H” denotes device height.

Rideable Versions of Everyday Objects

In addition to devices specifically designed for travel, versions of everyday objects with a non-transportation purpose have been given motors, thus becoming rideable PTDs. Two examples of powered rideable objects include rideable luggage and rideable beverage coolers. Designed to relieve stress and increase enjoyment at airports, the *Modobag* brand rideable suitcase is a four-wheeled, battery-powered device which a traveler sits astride and controls with an extendable handlebar. The *Modobag* has a top speed of 6.5 miles per hour and a travel range of around 6 miles.

A rideable beverage cooler resembles a go-cart but replaces the go-cart seat with a large cooler upon which the rider sits. The device is steered by a vertical handlebar, can have either three or four wheels, and can be electric- or gasoline-powered. Some gas-powered models are marketed as all-terrain vehicles and feature knobby tires, side footrest platforms, and high ground clearance.

Figure 7. Ridable Suitcase and Motorized Cooler

Sources: http://www.modobag.com/features.html and https://www.lovethisitem.com/homepage/ice-chest-scooter-cruzin-cooler/.

Table 11. Selected Characteristics for Rideable Suitcase and Motorized Cooler

	Dimensions[a]	Wheel Diameter	Device Weight	Motor Power	Maximum Speed	Range
Modobag	L: 22.0” W: 9.0” H: 14.0”	Unavailable	20 lbs	0.2 HP	11.0 mph	6 miles
Cruzin Cooler	L: 34.0” W: 18.0” H: 26.0”	Unavailable	85 lbs	0.7 HP	13.0 mph	30 – 240 minutes

[a] “L” denotes device length, “W” denotes device width, and “H” denotes device height.

Summary of Characteristics Across Devices Types

A look across all the different device types shows variations but also reveals considerable similarities, especially with respect to functional capabilities and device width.

Looking at the device “footprint” on a sidewalk or street, width varies less than length. The devices are mostly two feet or less in width—roughly equivalent to a standing adult. Indeed, for most devices, the rider will be wider than the device itself. Length, however, ranges from 8.5 inches to 60 inches, though many devices are no longer than 36 inches (three feet). Longboard-type skateboards are a notable outlier in length.

Whether a device is shorter in length than in width, or vice versa, is somewhat dependent on how the rider is oriented on a device. For example, devices such as EPAMDs and hoverboards have riders stand with their legs side-by-side. This position allows the devices to be short in length. Conversely, devices such as human-powered or motorized scooters or skateboards have riders stand with their legs front-to-back, which allows the devices to

be narrower in width but necessitates longer length. Devices tend not to be both relatively long and relatively wide.

Wheel size exhibits notable variation, ranging from 2 to 19 inches in diameter. Human-powered PTDs tend to have smaller wheels, with many newer motorized devices trending toward larger wheels (with the exception of motorized skateboards).

In terms of weight, most PTDs are far lighter than the average adult. Human-powered PTDs are generally very light, starting around 5 pounds. Mobility scooters for persons with disabilities are a notable outlier ranging up to 255 pounds. However, outside of mobility scooters, no device in this study's inventory was greater than 135 pounds, and most were less than 75 pounds.

Despite variations in design characteristics across device types (both within and across groups), the devices do not vary a great deal in functionality. Notably, horsepower, range, and maximum speed are roughly equivalent, with a few outliers. For example, motor power does not exceed 2 horsepower across all devices, the majority of devices reach maximum speed at 10 to 15 miles per hour, and the device ranges typically fall under 20 miles.

Table 12. Summary of Characteristics, by Device Type

	Dimensions[a]	Wheel Diameter	Weight	Motor Power	Max Speed	Range[b]
Skates/scooters	L: 12.0–60.0” W: 3.3–11.0” H: 4.0–30.0”	2.0 – 5.0”	5.0 – 8.0 lbs	Not applicable	Not applicable	Not applicable
Electric skateboards (E-skateboards)	L: 30.0–38.0” W: 9.5–12.0” H: 5.0–6.0”	2.8 – 4.0”	7.7 – 17.0 lbs	0.6 HP – 4.0 HP	10.0 – 26.0 mph	5.0 – 19.0 miles
Electric scooters (E-scooters)	L: 31.0–59.5” W: 14.5–21.2” H: 35.0–44.0”	7.9 – 16.0”	25.0 – 67.0 lbs	0.2 HP – 1.0 HP	10.0 – 20.0 mph	18.0 miles – 40.0 min.
Internal Combustion Engine (ICE) skateboards	L: 31.0–45.0” W: 12.0–20.0” H: 17.0–55.0”	3.5 – 14.0”	50.0 – 53.0 lbs	1.5 HP – 2.0HP	25.0 mph	25.0 – 30.0 miles
Internal combustion engine (ICE) scooters	L: 50.0” W: 12.0–25.0” H: 42.0–43.0”	10.0 – 11.0”	52.0 – 53.0 lbs	1.5 HP – 2.0 HP	30.0 – 35 mph	20 miles
Electric EPAMDs	L: 10.3–25.5” W: 11.0–25.0” H: 24.0–51.0”	10.0 – 19.0”	28.0 – 135.0	1.3 HP – 2.7 HP	10.0 – 12.5 mph	8.0 – 31.0 miles
Hoverboards	L: 7.0–8.7” W: 23.0–27.5” H: 7.0–9.6”	5.0 – 8.5”	22.0 – 32.2 lbs	0.3 HP – 1.0 HP	8.0 – 10.0 mph	7.0 – 12.0 miles
Electric unicycles (E-unicycles)	L: 8.5–18.0” W: 7.0–17.0” H: 42.5–19.0”	8.5 – 16.0”	22 – 35 lbs	0.6 HP – 2.0 HP	10.0 –1 5.0 mph	10.0 – 15 miles
E-unicycle/skateboard hybrids	L: 29.2–30.0” W: 9.0–10.2” H: 11.2–11.5”	11.2 – 11.5”	25.0 – 30.0 lbs	0.8 HP – 1.0 HP	12.0 – 19.0 mph	6.0 – 18.0 miles
Auto concept vehicles	L: 20.5–39.2” W: 13.6–27.6” H: 29.3–56.3”	Unavailable	Unavailable	Unavailable	3.7 – 18.6 mph	3.7 miles
Mobility scooters	L: 36.6–43.0” W: 19.1–26.0” H: 37.2–56.8”	6.0 – 12.5”	56 – 255 lbs	0.3 HP – 2.0 HP	3.5–5.5 mph	16.5 – 9.3 miles
Ridable objects	L: 22.0–34.0” W: 9.0–18.0” H: 14.0–26.0”	Unavailable	20 – 80 lbs	0.2 HP – 0.7 HP	11.0–13.0 mph	6 miles; 30–240 minutes

[a] “L” denotes device length, “W” denotes device width, and “H” denotes device height.

[b] Some manufacturers report range in miles and other report range in minutes.

OPERATIONAL SPEEDS

As outlined above, theoretical maximum speeds for motorized PTDs can be found by looking at the devices' technical specifications. However, manufacturer-specified top speeds are not the speeds at which riders typically operate, just as drivers of cars rarely if ever drive at the fastest speeds mechanically possible. Some PTDs allow their riders to selectively reduce the maximum possible speed. For example, the *Boosted Board* electric skateboard has four settings that vary in acceleration potential and maximum speed (range between 11 and 22 mph). Hence, while manufacturers state a given maximum speed, for some devices, only the most confident riders (those who enable the highest setting) can reach that maximum.

Data are scarce on how fast PTD riders travel, but Table 12 shows the findings from available studies of PTD user speeds. For the sake of comparison, the table also shows pedestrian (walking and running) and bicyclist speeds.

Data are relatively more available for human-powered PTDs; studies find in-line skaters and skateboarders travel at just under 10 miles per hour on average, and kick scooter riders travel at 7.5 mph.[30] Data are much less available for motorized PTDs. A 2004 study by the Federal Highway Administration found that Segway users traveled 9.3 mph on average, but this finding is based on only four observations. A more recent study of electric scooter users in downtown San José, California, found speeds varying by transportation facility. On streets, electric scooter riders traveled 11 mph on average. Riders traveled slightly slower on facilities shared with pedestrians (10 mph on mixed-use paths, and 9 mph on sidewalks).[31]

Overall, average PTD riders are generally 2 to 3 times faster than average pedestrians and slightly slower than bicyclists. Available data show average riders of in-line skates, kick scooters, skateboards, EPAMDs, and electric scooters on sidewalks and mixed-use paths are all typically slower than bicyclists. Additionally, the limited operational data available from electric scooters show that even riders at the 85th percentile travel markedly slower than device's maximum speeds.[32]

[30] Elizabeth Birriel et al., "The Operational Characteristics of Inline Skaters," *Transportation Research Record* 1773 (2001): 47–55; Kevin Fang and Susan Handy, "Skateboarding for Transportation: Exploring the Factors Behind an Unconvential Mode Choice Among University Skateboard Commuters," *Transportation* 46, 1 (2017): 1–21; United States Federal Highway Administration, *Characteristics of Emerging Road and Trail Users and Their Safety* (Federal Highway Administration: 2004), 1–4, http://www.fhwa.dot.gov/publications/research/safety/04103/01.cfm.

[31] Frank Arellano and Kevin Fang, "Sunday Drivers or Fast and Furious: Speed and Rider Behaviour of Electric Scooter Share Users in Downtown San José, California" (Paper presented at the Transportation Research Board Annual Meeting, Washington, D.C., January 13–17, 2019).

[32] Frank Arellano and Kevin Fang, "Sunday Drivers or Fast and Furious: Speed and Rider Behaviour of Electric Scooter Share Users in Downtown San José, California" (paper presented at the Transportation Research Board Annual Meeting, Washington, D.C., January 13–17, 2019).

Table 13. Operational Speeds of Pedestrians, Bicyclists, and PTD Users

Mode/Device	N	Average Speed	Speed Range[a]	Source
Pedestrians, walking				
Younger (13–64)	3,458	3.4 mph	1.3 – n/a mph	Knoblauch, Pietrucha, and Nitzburg, 1996
Older (65+)	3,671	2.8 mph	1.0 – n/a mph	Knoblauch, Pietrucha, and Nitzburg, 1996
Pedestrians, jogging (young adults)	115	6.8 mph	n/a	Barreira, Rowe, and Kang, 2010
Bicycles				
Mixed-use path	367	10.6 mph	7.0 – 13.7 mph	FHWA, 2004
Mixed-use path	100	11.6 mph	9 – 14.2 mph	Fang and Handy, 2017
Street	133	11.8 mph	8.8 – 14.5 mph	Arellano and Fang, 2019
In-line skates				
Mixed-use paths and streets	741	9.9 mph	7.1 – 12.6 mph	Birriel, Pernia, Lu, and Petritsch, 2001
Mixed-use path	53	9.9 mph	7.5 – 14.3 mph	FHWA, 2004
Kick scooters (mixed-use path)	22	7.5 mph	5.6 – 9.3 mph	FHWA, 2004
Skateboards (mixed-use path)	100	9.7 mph	8.0 – 11.4 mph	Fang and Handy, 2017
EPAMDs (mixed-use path)	4	9.3 mph	8.7 – 10.6 mph	FHWA, 2004
Motorized scooters				
Sidewalks	109	9 mph	6.7 – 11 mph	Arellano and Fang, 2019
Mixed-use paths	109	9.6 mph	6.7 – 12.2 mph	Arellano and Fang, 2019
Streets	109	11.1 mph	9.6 – 12.4 mph	Arellano and Fang, 2019

[a] 15th–85th percentile.

[b] See Bibliography for complete citations.

III. METHODOLOGY

The project relied on three phases of work: a literature review, collection and analysis of regulatory codes for PTD users, and development of proposed model state regulatory code that drew on the prior study phases, plus interviews with 20 stakeholders. This chapter describes the process used in each study phase.

LITERATURE REVIEW

The study began with a thorough search for existing research on PTDs. Given the novelty of many PTD types, we expected that there might not be much existing literature specifically about PTDs—a hypothesis confirmed through a wide-ranging literature search on any aspect of PTDs and their use.

The databases and other search sites consulted included resources with particularly strong coverage of both the transportation literature and legal literature, as well as more generalist resources. Databases searched included Academic Search Complete, CQ Researcher, Google Scholar, HeinOnline, Law Technology Today, LegalTrac, LexisNexis Academic (including searches in law reviews and newspaper articles), ProQuest Dissertations, Regulatory Review, ScienceDirect, Transport Research International Documentation (TRID), and Westlaw.

For each source, we searched a wide variety of keywords and phrases covering both classes of devices and specific device types. Search terms included: personal transportation device, micro-mobility, personal mobility device, portable transport device, human transporter, mobility scooter, mobility aid, power chairs, mobility assistance device, skateboard, rollerblade, hoverboard, kick scooter, and Segway.

We did not carry out a comprehensive search on bicycle regulations—since this mode was outside the study focus—but did search for regulations on bicycling in locations shared with pedestrians: footpaths, sidewalks, and shared-use paths.

COLLECTION AND ANALYSIS OF REGULATORY CODE

A primary goal of this study was to document and analyze the regulatory environment for PTDs. To begin, we compiled a set of regulations from three environments—states, cities, and college campuses. The search focused on compiling the “rules of the road” users are to follow when riding PTDs. (The search did not address regulations associated with the permitting of fleets of shared PTDs in cities, such as for dockless electric scooter companies.) After identifying the relevant regulatory texts from all the jurisdictions, a content analysis process was used to identify commonalities across places, as well as outlier examples (e.g., approaches that were unique or particularly comprehensive).

The regulatory search took place in the fall of 2017 and spring of 2018. Some jurisdictions have, of course, since modified their code.

Locations Selected for Analysis

States

We reviewed the traffic/vehicle code for all 50 states, plus the five territories for which relevant codes were available (Puerto Rico, Guam, American Samoa, the U.S. Virgin Islands, and the Northern Mariana Islands).

Cities

We reviewed the municipal traffic regulations in 101 cities (Table 13), designing the sample to capture a wide variety of municipal forms, governments from different US regions, and cities likely to have relatively large numbers of PTD users. We excluded cities without online municipal codes and cities with populations under 1,000 residents. (We limited our search to cities with populations greater than 1,000 after finding that smaller cities frequently did not have readily-available codes.) Four groups of cities were selected, as follows.

Group 1: Largest Cities by State and the District of Columbia (51)

First, we reviewed codes for the largest cities in all 50 states, plus Washington, D.C., hypothesizing that larger cities would see greater absolute numbers of PTDs, all else being equal, and thus may be more likely to have PTD regulations. Selecting the largest city in every state also ensured geographic spread.

Group 2: "Leading Edge Cities" (18)

The second set of non-random cities in the sample were a group of "leading edge" cities selected on the premise that they may have experienced higher early adoption of PTDs and thus could be more likely to have PTD regulations.

Given that many PTDs are new technology, we hypothesized that cities with a prevalence of "tech" workers may have more PTD early adopters. We identified cities with relatively large contingents of tech workers based on articles about tech industry jobs.[33] Additionally, we included several cities with relatively high rates of bicycle use. The use of bicycles in such cities demonstrate a pre-existing amenability to alternative, person-sized vehicles. Furthermore, infrastructure built for bicyclists is also likely conducive for PTD use.

Group 3: "Bedroom" Communities (12)

The large cities and "leading edge" cities included in the prior two steps tend to skew young demographically. Thus, for contrast, we included a selection of traditional suburban "bedroom communities" that have different demographic distributions and perhaps have different sensibilities towards alternative transportation than the initial set of cities in the

[33] Zameena Mejia, "The 10 Best Cities for Getting a Job in Tech Beyond Silicon Valley," *cnbc.com*, July 27, 2017, https://www.cnbc.com/2017/07/27/tech-jobs-silicon-valley.html.

sample. The cities included here are relatively populous, automobile-oriented suburbs on the periphery of some of the largest cities in the country.

Group 4: Randomly-Selected Cities (20)

The sample was rounded out with a random selection of cities. These cities were selected by creating a list of all cities in the United States, assigning each city a random number, and then selecting the first 20 cities not already in the sample that exceeded the threshold of 1,000 residents or more in population and had municipal codes available online.

Table 14. Cities Reviewed

Largest in States (51)		"Leading Edge" (18)	Randomly Selected (20)
Albuquerque, NM	Kansas City, MO	Bellevue, WA	Alliance, OH
Anchorage, AK	Las Vegas, NV	Berkeley, CA	Atchison, KS
Atlanta, GA	Little Rock, AR	Boulder, CO	Hawarden, IA
Baltimore, MD	Los Angeles, CA	Cambridge, MA	Hutchinson, MN
Billings, MT	Manchester, NH	Corvallis, OR	Independence, KY
Birmingham, AL	Memphis, TN	Davis, CA	Lincoln, ND
Boise City, ID	Milwaukee, WI	Eugene, OR	Little Elm, TX
Boston, MA	Minneapolis, MN	Fort Collins, CO	Lowry Crossing, TX
Bowling Green, KY	New Orleans, LA	Gainesville, FL	Missouri City, TX
Bridgeport, CT	New York City, NY	Key West, FL	Monahans, TX
Burlington, VT	Newark, NJ	Menlo Park, CA	Mount Morris, MI
Charleston, WV	Oklahoma City, OK	Mountain View, CA	North Miami, FL
Charleston, SC	Omaha, NE	Oakland, CA	North Ogden, UT
Charlotte, NC	Philadelphia, PA	Palo Alto, CA	Norwich, NY
Cheyenne, WY	Phoenix, AZ	San Francisco, CA	Portland, MI
Chicago, IL	Portland, ME	San Jose, CA	Rockport, TX
Columbus, OH	Portland, OR	Somerville, MA	San Juan Capistrano, CA
Denver, CO	Providence, RI	Tucson, AZ	Sioux Center, IA
Des Moines, IA	Salt Lake City, UT		Texarkana, AR
Detroit, MI	Seattle, WA	"Bedroom Communities" (12)	Williamsport, PA
Fargo, ND	Sioux Falls, SD	Arlington, TX	
Honolulu, HI	Virginia Beach, VA	Beaverton, OR	
Houston, TX	Washington, DC	Brentwood, TN	
Indianapolis, IN	Wichita, KS	Brockton, MA	
Jackson, MS	Wilmington, DE	Clifton, NJ	
Jacksonville, FL		Lake Forest, CA	
		Livermore, CA	
		Naperville, IL	
		Overland Park, KS	
		Pompano Beach, FL	
		Rochester Hills, MI	
		Roswell, GA	

Universities

We searched for PTD regulations at 20 university campuses (Table 14). The campuses were selected to include a mix of both public and private universities of varying geographic settings (e.g. urban vs. suburban vs. "college town"; compact vs. sprawling layout). Seven of the universities are in California. The remaining 13 were spread throughout other regions of the United States.

Table 15. Universities Reviewed

Arizona State University	University of California at Santa Barbara
Columbia University	University of Colorado
Florida State University	University of Minnesota
Massachusetts Institute of Technology	University of Maryland
Portland State University	University of Missouri
San Diego State University	University of Nevada at Las Vegas
San Jose State University	University of Oregon
Stanford University	University of Southern California
University of California at Davis	University of Texas at Austin
University of California at Los Angeles	University of Washington

Data Sources

After selecting places for analysis, we searched for their respective transportation regulatory documents. For states, we looked for their "vehicle codes." These codes were readily available online, usually on government websites but occasionally hosted on a third-party website. For cities, we looked for their "municipal codes." These codes are also readily available online and are typically hosted by third-party websites.

Campus regulations are somewhat trickier to find, as universities do not have "laws" in the same way states and cities do. Thus, for campuses, research assistants reviewed the following materials to gather information for each university: websites of campus transportation and parking departments; websites of campus police departments; student handbooks; campus "buildings and grounds" policies; and campus search engines.

Regulation Search Strategy

Once appropriate documents for each state, city, or campus were assembled, members of the research team followed a multi-step process to identify the definitions and regulations of PTDs and other key modes contained therein.

First, we searched for and recorded the definitions of different modes of transportation. In particular, we searched for definitions for four conventional modes: "vehicle," "motor vehicle," "bicycle," and "pedestrian," as well as other modes we could find that were smaller than automobiles. These smaller modes would include PTDs, as discussed in Chapter 2, but would also include some larger/faster devices such as electric bicycles and mopeds. The researchers used a detailed list of keywords to identify all relevant PTD modes, searching both for specific devices (such as 'motorized scooter', 'electric wheelchair', 'Segway', and 'hoverboard') and *classes* of devices (such as 'personal transportation devices', 'personal mobility device', 'human transporter', and 'coaster').

For each mode defined, we searched for and recorded the relevant regulations. For all PTD modes we recorded any available regulations. For bicycles, we recorded only two types

of regulations—rules for using bicycles on sidewalks and shared-use paths—which may be instructive for future PTD regulations. No regulations were recorded for vehicles, motor vehicles, or pedestrians.

Two research assistants independently compiled all of the relevant text from every jurisdiction. To create the final dataset, these independently-created datasets were merged and cross-checked against each other, with discrepancies reviewed and corrected.

Data Analysis

After populating the database of definitions and regulations, we performed a content analysis on the regulations to look for patterns regarding how governments and campuses have defined and regulated traditional and PTD modes. This work included a review of which modes were defined and regulated, as well as the types of behaviors that were permitted or prohibited. These finer codes were then synthesized into larger categorical themes to asses which characteristics were typically included in device definitions (e.g., size, number of wheels) and which considerations were typically included in regulations of use (e.g., assigning all rights and duties of pedestrians to users).

FORMULATION OF RECOMMENDED MODEL REGULATORY CODE

After performing the content analysis, various regulatory trends, both positive and negative, became apparent. Using these lessons and findings from the literature review, we crafted a first-pass draft of model regulatory code at the state government level that outlines a carefully-reasoned set of “rules of the road” for PTD operators.

After preparing a working draft of the model regulatory code, we interviewed 21 experts to gather feedback on the draft regulations (Table 15). The interviewees were selected to represent a wide array of perspectives and included government staff, industry staff, attorneys with expertise in legal writing, bicycling advocates, senior citizen advocates, and transportation planners. In addition to incorporating opinions from different stakeholder groups, we also sought to represent expert perspectives from across the United States.

The interviews took place over the phone or in person and lasted from 30 to 60 minutes. Interviewers took detailed notes and, in some cases, audio-recorded the interview.

Each expert interviewed was given time to review the draft model code prior to the interview, during which they were asked for feedback on the language and potential impacts of the drafted language. After each two or three interviews, the research team discussed the feedback and determined whether and how to revise the model regulations based on the expert suggestions provided. The draft regulations were then revised before being sent to additional interview participants for review. This iterative process continued until numerous stakeholders’ perspectives, concerns, and feedback were incorporated in the drafting process.

Table 16. Stakeholders Interviewed[a]

Name	Organization	Title
Martha “Marty” G. Baker	Maryland Department of Transportation	Deputy Director, Bicycle and Pedestrian Access; and Manager, Intermodal Policy and Programs, Office of Planning and Capital Programming
Virginia Dize	National Aging and Disability Transportation Center	Co-Director
Jonathan Kennedy	City of San Francisco, CA	Deputy City Attorney
Matthew Kopko	Bird	Director of Public Policy
Ria Hutabarat Lo	City of Mountain View, CA	Transportation Manager
David Pimentel	University of Idaho	Associate Dean & Associate Professor of Law
Kevin Pula	National Conference of State Legislatures	Senior Policy Specialist
Jonathan Quinsey	Arizona Department of Environmental Quality	Attorney
Esther Rivera	California Walks	State Policy Manager
Caroline Samponaro	Lyft	Head of Bike, Scooter, and Pedestrian Policy
Douglas Shinkle	National Conference of State Legislatures	Transportation Program Director
Ryan Smith	City of San José, CA	Transportation Specialist
Ryan Snyder	Transpogroup	Principal, Director of Active Transportation Planning
Daniel Soto	Sonoma State University	Professor
Jamey M. B. Volker	Volker Law Offices	Of Counsel
Emily Warren	Lime	Senior Director, Policy & Public Affairs

[a] We interviewed an additional five experts who wished to remain anonymous.

IV. OVERALL REGULATORY ENVIRONMENT FOR PTDS

This chapter discusses some of the broad patterns in PTD regulations including the presence or absence of regulations on different kinds PTDs, topics commonly seen in regulations, how regulations address where users can ride, and the relationship between regulations at different levels of government.

The most important finding from the analysis is quite simple. The detailed review of PTD regulations revealed that there was no “normal”: PTD regulations varied wildly from place to place and device to device in terms of content, specificity, and form.

ARE PTDS EXPLICITLY REGULATED?

PTD-Specific Regulations Are Uncommon

Overall, specific regulations concerning PTDs were found to be relatively uncommon in regulatory documents. Table 16 identifies the frequency of regulations governing the use of PTDs in states and cities and on campuses. At the state level, regulations for different PTDs existed in no more than 30% of states, with the notable exception of EPAMDs. Regulations were somewhat more common at the city level, particularly for non-motorized PTDs. University campuses had the most PTD regulations. Like with cities, regulations on non-motorized PTDs were particularly common; nearly all campuses had rules for skateboards and in-line/roller skates. Additionally, motorized scooters were regulated in a majority of campuses, as were hoverboards, despite hoverboards not being regulated in any state or city. However, even on university campuses, most PTDs were not directly regulated.

Table 17. PTD Types Regulated by the States, Cities, and Universities Reviewed

	States	Cities	Universities
Skateboards	8 (15%)	67 (66%)	19 (95%)
In-line/roller skates	5 (9%)	68 (67%)	19 (95%)
Kick scooters	8 (15%)	46 (46%)	6 (30%)
Motorized skateboards	4 (7%)	10 (10%)	5 (25%)
Motorized (kick) scooters	16 (29%)	38 (38%)	12 (60%)
EPAMDs	38 (69%)	13 (13%)	7 (35%)
Hoverboards	0 (0%)	0 (0%)	13 (65%)
E-unicycles	0 (0%)	0 (0%)	1 (5%)

Note: We reviewed 55 states/territories, 101 cities, and 20 universities.

A full inventory of what devices are regulated in states, cities, and campuses can be found in Appendix B.

PTD Users Often Subject to Regulations for Other Modes

PTD riders are not necessarily unregulated in the absence of regulations specific to their device. In most cases, state definitions for either “vehicles” or “pedestrians” encompass some PTDs (Table 17).

Motorized PTDs most often—but with many exceptions—fall under the definition of “vehicles.” All but three states define the term “vehicle”, and most define the term as including all devices that can move or transport people on a road, with specified exceptions (e.g., trains, animal-drawn carriages, mobile homes). Given this typical definition, and absent other specific regulations on PTDs, motorized PTDs could be considered to be vehicles in 51 states and territories. In one state, Nebraska, the definition of “vehicles” includes only six specific devices: motor vehicles, all-terrain vehicles, utility-type vehicles, minibikes, trailers, and semitrailers. None of these device types, including “motor vehicles,” appear to encompass motorized PTDs.

There is also little consistency with respect to how state vehicle codes define and classify human-powered PTDs. More than half of states exclude human-powered devices in their definition of vehicles. However, in 20 states, human-powered PTDs could be considered vehicles. Additionally, in three states (California, Massachusetts, and Washington), human-powered PTDs are defined as pedestrians. Each of these three states includes language classifying devices propelled by human power as pedestrians (with bicycles excepted).

EPAMDs are a notable outlier in that they are frequently called out by name in vehicle and pedestrian definitions. In 13 states, the vehicle definition specifically excludes EPAMDs. Puzzlingly, in four of these states (Maryland, Ohio, Oklahoma, and Wisconsin), non-motorized PTDs fall under the definition of vehicles, even though EPAMDs do not. Additionally, seven states specifically include EPAMDs in the definition of pedestrians. In six of these states, EPAMDs are pedestrians, while human-powered PTDs are not. Further, in three states (California, Kansas, and Mississippi), EPAMDs are specifically defined as pedestrians, although they are not specifically excluded from the vehicle definition.

Table 18. Do State "Vehicle" and "Pedestrian" Definitions Encompass PTDs?

	Definition of Vehicle Could Encompass…			Definition of Pedestrian Could Encompass…	
	Human-Powered PTDs	EPAMDs	Other Motorized PTDs	Human-Powered PTDs	EPAMDs
Alabama	No	No	Yes	No	No
Alaska	Yes	Yes	Yes	No	No
Arizona	No	Yes	Yes	No	Yes
Arkansas	No	Yes	Yes	No	No
California	No	Yes	Yes	Yes	Yes
Colorado	Yes	Yes	Yes	No	No
Connecticut	No	Yes	Yes	No	No
Connecticut	No	Yes	Yes	n/a	n/a
Florida	Yes	Yes	Yes	No	No
Georgia	Yes	Yes	Yes	No	No
Hawaii	No	Yes	Yes	No	No
Idaho	Yes	Yes	Yes	No	Yes
Illinois	No	Yes	Yes	No	No
Indiana	No	No	Yes	n/a	n/a
Iowa	No	Yes	Yes	No	No
Kansas	No	No	Yes	No	Yes
Kentucky	No	Yes	Yes	No	No
Louisiana	No	Yes	Yes	No	No
Maine	No	No	Yes	No	No
Maryland	Yes	No	Yes	No	No
Massachusetts	n/a	n/a	n/a	Yes	No
Michigan	No	Yes	Yes	No	No
Minnesota	Yes	Yes	Yes	No	No
Mississippi	Yes	Yes	Yes	No	Yes
Missouri	No	Yes	Yes	No	No
Montana	Yes	Yes	Yes	No	No
Nebraska	No	No	No	No	No
Nevada	No	No	Yes	No	Yes
New Hampshire	Yes	Yes	Yes	n/a	n/a
New Jersey	No	Yes	Yes	No	No
New Mexico	No	Yes	Yes	No	No

Table 18, continued

	Definition of Vehicle Could Encompass…			Definition of Pedestrian Could Encompass…	
	Human-Powered PTDs	EPAMDs	Other Motorized PTDs	Human-Powered PTDs	EPAMDs
New York	No	Yes	Yes	No	No
North Carolina	No	No	Yes	n/a	n/a
North Dakota	No	Yes	Yes	No	No
Ohio	Yes	No	Yes	No	No
Oklahoma	Yes	No	Yes	No	No
Oregon	Yes	Yes	Yes	No	No
Pennsylvania	Yes	Yes	Yes	No	No
Rhode Island	Yes	Yes	Yes	No	No
South Carolina	No	Yes	Yes	No	No
South Dakota	No	Yes	Yes	n/a	n/a
Tennessee	No	Yes	Yes	No	No
Texas	Yes	Yes	Yes	No	No
Utah	Yes	Yes	Yes	No	No
Vermont	n/a	n/a	n/a	No	Yes
Virginia	No	Yes	Yes	n/a	n/a
Washington	No	No[a]	Yes	Yes	No
West Virginia	No	Yes	Yes	No	No
Wisconsin	Yes	No	Yes	No	No
Wyoming	No	Yes	Yes	No	No
American Samoa	Yes	Yes	Yes	No	No
Guam	No	No	Yes	n/a	n/a
Northern Mariana Islands	n/a	n/a	n/a	n/a	n/a
Puerto Rico	Yes	Yes	Yes	No	No
U.S. Virgin Islands	No	Yes	Yes	n/a	n/a
YES	20	39	51	3	7

Note: "n/a" indicates that the state did not have a definition for the term "vehicle" or "pedestrian," respectively.

[a] Washington State explicitly states that EPAMDs are not vehicles for the purposes of five sections of the state vehicle code. EPAMDs presumably count as vehicles in other sections.

WHAT BEHAVIORS ARE REGULATED?

When governments write rules about how operators may use PTDs, those rules fall into

four primary categories: user behaviors explicitly required (e.g., users must wear helmets); user behaviors explicitly allowed (e.g., users may ride on streets); user behavior explicitly prohibited (e.g., users may not ride on sidewalks); and user behaviors explicitly exempted (e.g., users need not register their device with the state). While the regulations varied across places and device types (e.g., motorized versus non-motorized), all identified regulations fell into one of these four categories.

The most common user behaviors explicitly required are:

- Helmet use: regulations may require that riders wear a helmet or protective headgear; this requirement may be enforced based on age of user (e.g., all riders under 16 or 18)

- Minimum age: regulations may require users to be of a minimum age (12, 15, or 16); a few states make exceptions that riders under the age limit may ride the PTD if supervised by a parent or guardian

- Braking: definitions may require that PTD is capable of making a complete stop and/or is equipped with braking mechanisms

- Lights and reflectors: definitions and regulations may require that PTDs be equipped with lights, headlamps, and/or reflective gear; regulations usually stipulated the time of day when needed (e.g., 30 min before dusk to 30 minutes after dawn) and the distance of illumination (e.g., 300 feet in front)

- Safety guidelines: regulations may provide guidelines for operating safely (e.g., riding to the right side of the road unless unsafe to do so or making a left-hand turn) and may require that users exercise caution

- Yielding to pedestrians: regulations may require that users yield right-of-way to pedestrians and/or make an audible signal when passing

- Number of riders: regulations or definitions may require that only one user is permitted on a device

- Number abreast: regulations may specify the maximum number of riders abreast (typically two)

- Parking: regulations may provide guidelines for parking (e.g., parked devices must be vertical and cannot block the sidewalk)

- Speed of streets: users may ride only on streets with speed limits below a specified maximum (typically 25 MPH)

- Rights/duties: regulations may define PTD users as having all rights and being subject to all duties of pedestrians, vehicle operators, or bicyclists

- Penalties for not following explicitly required behaviors: regulations often classify non-compliance offenses as either a misdemeanor or traffic violation and may set a maximum fine rate

The most common user behaviors explicitly allowed related to location:

- Riding on streets
- Riding on bicycle facilities (i.e., designated paths and lanes)
- Riding on sidewalks

The most common user behaviors explicitly prohibited related to user conduct:

- Riding on streets
- Riding on bicycle facilities
- Riding on sidewalks
- Making excessive noise or causing disruptions
- Riding on infrastructure not meant for transportation (e.g., benches, ramps, railings, picnic tables, artwork, and/or fountains)
- Performing tricks or acrobatics
- Hitching or attaching oneself to another device or vehicle

The most common user behaviors explicitly exempted from laws and regulations otherwise applicable to that behavior or to that person are:

- License, insurance, and registration: regulations specify that users need not register their device with the state motor vehicle department, use a driver's license, or have insurance
- Persons with disabilities: regulations state that persons with disabilities are exempt from any regulations of use, if using the PTD for purposes of mobility

To illustrate the relative frequency of regulations on different topics, Table 18 and Table 19 show state regulations which were found to apply to electric kick scooters and EPAMDs, the two most commonly-regulated PTD types at the state level. If a state is not included in either table, then that state does not regulate the device.

Table 19. State Motorized Kick Scooter Regulations: Behaviors Explicitly Required, Permitted, Prohibited, or Exempted

	Required													Permitted			Prohibited				Exempted
	Helmet Use	Minimum Age	Braking	Lights & Reflectors	Safety Guidelines	Yield to Pedestrians	Number of Riders	Number Abreast	Parking	Speed Limits	Duties of Vehicle Drivers	Driver's License	Fine or Criminal Charge	Use on Streets	Use on Bicycle Facilities	Use on Sidewalks	Use on Streets	Use on Bicycle Facilities	Use on Sidewalks	Clinging/Towing	License Requirements, Insurance & Registration
California	✓		✓	✓	✓		✓		✓		✓	✓			✓				✓	✓	✓
Delaware[c]		✓			✓								✓				✓	✓	✓		
Maryland			✓	✓	✓			✓			✓			✓	✓						
Massachusetts	✓						✓			✓		✓	✓	✓	✓	✓					
New Jersey[a,d]	✓	✓	✓									✓	✓								
Ohio													✓	✓							
Oklahoma											✓										✓
Oregon	✓	✓			✓	✓		✓		✓	✓				✓				✓		
Minnesota	✓	✓		✓	✓										✓				✓		
Texas															✓	✓					
Utah		✓		✓[b]			✓						✓								✓
Virginia[a]						✓															
Washington															✓						
Northern Mariana Islands								✓													
Puerto Rico																	✓				
US Virgin Islands	✓		✓	✓				✓						✓							
TOTAL	6	5	3	3	5	2	3	4	1	2	4	3	5	4	7	2	2	1	4	1	3

Note: The states and territories not listed in the table have no specific regulations for electric kick scooters.

[a] The state regulations offered guidelines for municipalities to construct local rules, rather than providing strict regulations at the state level.

[b] The state regulation explicitly provides the opposite statement.

[c] In Delaware, motorized scooters are not permitted on any pathway. Motorized scooters are only permitted on any other public or private property if specifically granted permission by the entity in control of that property. Thus, behavioral regulations only apply should that permission be granted.

[d] In New Jersey, only persons with a mobility-related disability may use motorized scooters on public pathways.

Table 20. State EPAMD Regulations: Behaviors Explicitly Required, Permitted, or Exempted

	Required												Permitted			Exempted	
	Helmet Use	Minimum Age	Braking	Lights & Reflectors	Safety Guidelines	Yield to Pedestrians	Number of Riders	Number Abreast	Parking	Speed of Streets	Duties of Pedestrians	Penalty	Use on Streets	Use on Bicycle Facilities	Use on Sidewalks	License, Insurance & Registration	Persons with Disabilities
Alabama				✓						✓			✓	✓	✓	✓	
Arizona																	
California			✓	✓	✓	✓				✓			✓	✓	✓	✓	
Colorado			✓	✓						✓							
Connecticut		✓	✓	✓	✓	✓				✓		✓				✓	✓
Delaware	✓		✓	✓	✓	✓				✓		✓			✓	✓	
Florida	✓					✓				✓	✓		✓	✓	✓	✓	
Georgia	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓		
Idaho											✓						
Illinois											✓						
Indiana																	
Iowa				✓		✓								✓	✓	✓	
Louisiana										✓			✓	✓	✓		
Maine				✓	✓	✓				✓		✓	✓	✓	✓		
Maryland									✓	✓							
Massachusetts																	
Michigan					✓	✓		✓		✓			✓				
Minnesota				✓	✓	✓	✓			✓	✓		✓	✓	✓		
Mississippi						✓							✓	✓	✓		
Missouri		✓		✓	✓					✓	✓		✓	✓	✓		✓
Nebraska				✓		✓						✓	✓	✓	✓	✓	
New Hampshire				✓		✓			✓		✓						
New Jersey	✓	✓											✓	✓	✓	✓	✓
New Mexico			✓	✓		✓					✓		✓	✓	✓		✓
New York	✓	✓	✓	✓	✓	✓		✓				✓	✓	✓			

Table 20, continued

	Required												Permitted			Exempted	
	Helmet Use	Minimum Age	Braking	Lights & Reflectors	Safety Guidelines	Yield to Pedestrians	Number of Riders	Number Abreast	Parking	Speed of Streets	Duties of Pedestrians	Penalty	Use on Streets	Use on Bicycle Facilities	Use on Sidewalks	License, Insurance & Registration	Persons with Disabilities
North Carolina						✓				✓	✓		✓	✓	✓		
Ohio	✓	✓		✓		✓				✓		✓	✓	✓	✓		
Oregon						✓	✓			✓		✓	✓	✓			
Pennsylvania	✓			✓							✓	✓					
Rhode Island					✓	✓					✓	✓		✓	✓		
South Carolina			✓	✓	✓	✓						✓	✓	✓	✓		
Tennessee			✓	✓		✓							✓	✓	✓		
Texas					✓					✓			✓	✓			
Utah		✓		✓	✓	✓	✓		✓	✓		✓	✓	✓		✓	
Vermont			✓	✓							✓	✓					
Virginia		✓			✓	✓		✓		✓	✓	✓			✓		
Washington						✓				✓	✓						
West Virginia			✓	✓		✓					✓	✓	✓	✓	✓	✓	
Wisconsin					✓	✓								✓	✓		
Guam	✓	✓		✓	✓	✓		✓		✓			✓	✓	✓		
TOTAL	*8*	*9*	*11*	*22*	*16*	*26*	*3*	*4*	4	21	13	15	23	24	23	10	4

When governments enact regulations on PTDs, there is notable variance in the number and specificity of the rules they impose. For example, looking at EPAMDs, North Carolina simply states that EPAMD users must yield the right-of-way to pedestrians and other human-powered devices. Conversely, Maine requires EPAMD users to ride on specific transportation facilities, keep within speed limits, give an audible signal while passing, and have safety equipment like lights and reflectors.

Similar examples can be seen in cities. For example, for skateboards, Washington, D.C. has only a single rule requiring minors under 16 to wear helmets, and Seattle has just two conceptual regulations (ride carefully for given conditions and yield to pedestrians). On the other end of the spectrum, Palo Alto, California, has 17 different rules, including some that apply to specific places by name.

WHERE CAN USERS RIDE?

As discussed above, one of the behaviors that governments regulate is where users can or cannot ride a device. Such regulations exist at all three levels but are more prevalent at the city and campus levels.

Regulations by Facility

Regulations governing the types of transportation facilities where users can or cannot ride are relatively common when a device is regulated. For example, out of 16 states with regulations for motorized scooters, ten have language permitting or prohibiting riding on streets, bicycle facilities, or sidewalks (Table 20). For streets and bicycle facilities, motorized scooters were more often permitted than prohibited. That said, in states where devices are permitted, they are not necessarily allowed everywhere. For example, in Ohio, Oregon, and Texas, motorized scooters are permitted on streets—but only those with relatively low speed limits.

Table 21. State Motorized (Kick) Scooter Regulationson Pathways Users May or May Not Ride

	Streets	Bicycle Facilities	Sidewalks
California	Permitted, except when Class II bicycle lane present	Permitted/required (if is a Class II bicycle lane)	Prohibited
Delaware	Prohibited	Prohibited (implied)[a]	Prohibited
Maryland	Permitted	Permitted	~
Massachusetts	Permitted	~	~
Minnesota	~	Permitted	Prohibited
Ohio	Permitted on streets with 45 mph or lower speed limit)	~	~
Oregon	Permitted on streets with 25 mph or lower speed limit)	Permitted	Prohibited
Texas	Permitted on streets with 35 mph or lower speed limit)	Permitted	Permitted
Washington	Permitted	Permitted	Prohibited
Puerto Rico	Prohibited	~	~
TOTAL	7 Permitted, 2 Prohibited	6 Permitted, 1 Prohibited	1 Permitted, 5 Prohibited

Note: "Permitted" indicates that operates may ride on at least some, but not necessarily all, examples of a given facility type. "Prohibited" indicates that operators generally may not ride on a given facility type. "~" indicates a city with no explicit regulations for use on a given facility type.

[a] Delaware does not explicitly prohibit riding on bicycle facilities but bans riding on all public rights-of-way.

Cities also commonly regulated devices by transportation facility. For example, out of 24 cities with regulations on motorized scooters, 19 have language permitting or prohibiting riding on streets, bicycle facilities, or sidewalks (Table 21). In contrast to states, cities more frequently prohibited than permitted motor scooters on all three facilities.

Table 22. City Motorized (Kick) Scooter Regulations on Pathways Users May or May Not Ride

	Streets	Bicycle Facilities	Sidewalks
Arlington, TX	Prohibited	~	Prohibited
Bellevue, WA	Permitted on streets with 25 mph or lower speed limit	~	Prohibited
Charleston, WV	Prohibited	Prohibited (implied)[a]	Prohibited
Chicago, IL	Permitted	~	Prohibited
Eugene, OR	~	Prohibited	Prohibited
Fargo, ND	Prohibited	~	Permitted (except central business district)
Fort Collins, CO	Prohibited	~	Permitted
Honolulu, HI	Prohibited	~	Prohibited
Houston, TX	Prohibited	Prohibited (implied)[a]	Prohibited
Las Vegas, NV	Permitted		Prohibited
Little Elm, TX	Prohibited	Permitted	Permitted
Livermore, CA	~	~	Prohibited
Los Angeles, CA	~	Permitted (except along Pacific beaches)	Permitted (except along Pacific beaches)
Menlo Park, CA	~	Prohibited	~
Milwaukee, MI	Prohibited	Prohibited (implied)[a]	Prohibited
Missouri City, TX	~	~	Prohibited
Pompano Beach, FL	Permitted	~	Prohibited
Seattle, WA.	Permitted	Prohibited	Prohibited
Wilmington, DE	Prohibited	Prohibited (implied)[a]	Prohibited
TOTAL	5 Permitted, 9 Prohibited	2 Permitted, 7 Prohibited	4 Permitted, 13 Prohibited

Note: "Permitted" indicates that operates may ride on at least some, but not necessarily all, examples of a given facility type. "Prohibited" indicates that operators generally may not ride on a given facility type. "~" indicates a city with no explicit regulations for use on a given facility type.
[a] These cities do not explicitly prohibit riding on bicycle facilities, but ban riding on all public rights-of-way.

When permitting users to ride on multiple facilities, governments commonly give riders different rights and responsibilities depending on location. For example, in Virginia, users

of EPAMDs, motorized kick scooters, and motorized skateboards can choose whether to ride on streets or sidewalks. If riding on sidewalks, Virginia riders have the same rights and responsibilities as pedestrians; if riding on roads, PTD users must yield to pedestrians.

Regulations by Land Use or District

In addition to transportation facilities, some prohibitions were based on land use type, particularly at the city level for non-motorized PTDs. For example, at least 18 cities prohibit skateboards, roller/inline skates, and/or kick scooters in business districts.

Rather than by use, cities sometimes prohibited riding in specific geographic zones, bounded through the explicit mention of city blocks and street names. For example, the code for Atchison, Kansas, provides a specific boundary (Commercial Street between Fourth Street and Seventh Street) where no bicycles, roller skates, in-line skates, or skateboards may be used. As another example, Billings, Montana, prohibited skateboard use on any sidewalk or public property in an area bounded by specific streets (i.e., 32nd Street, 24th Street, 6th Avenue N., and 1st Avenue S.). Such block-based prohibitions frequently apply to business districts.

Regulation through Signage

Some cities prohibited use of PTDs through signage indicating that use is not allowed. Basing prohibitions on signs could have varying implications for riders. By requiring signs, it may be more obvious for travelers where riding is prohibited. Conversely, using signs rather than naming specific places in the code means there may not exist any central list specifying all locations where one can or cannot ride.

Unique University Pathway and Public Space Regulations

Campus transportation networks are often very different than in cities. Instead of only streets and sidewalks, campuses have many off-street pedestrian and mixed-use paths, as well as open plazas and other broad swaths of pavement that facilitate circulation. Campuses are also generally busy activity centers, with heavy pedestrian traffic. Reflecting these characteristics, campuses identify many kinds of places where PTDs cannot be ridden or may only be ridden at proscribed times. And, when allowed, regulations often highlight that PTDs are one user among many in shared spaces.

Campuses frequently identify many central and high-traffic areas as “dismount zones” or “walk-only” zones. In many cases, PTD and other non-pedestrian use is always prohibited. However, there are also cases of such prohibitions applying only during peak traffic times (e.g., 7:30 am to 3:30 pm).

Beyond spaces overtly used for transportation, campuses also frequently restrict PTD uses in other kinds of places on university property. For example, some campuses ban PTDs from the inside of buildings, hallways, courtyards, parking garages, tennis courts, stairways, arcades, and residence halls.

HOW ARE REGULATIONS AT DIFFERENT LEVELS OF GOVERNMENT RELATED?

The regulations that exist at different levels of government do not sit in isolation. Riders in a given location are subject to both local and state regulations, should they exist, and regulations at one level can affect or be affected by regulations at another level. In particular, state regulations sit at the top, with city and campus regulations acting in addition to state regulations or filling gaps in the absence of state regulations. Thus, the presence or absence of regulations at the city and campus levels, and their level of detail if applicable, depends on what exists at the state level. For example, EPAMD regulations may be relatively uncommon at the city level because they are prevalent at the state level. Conversely, regulations for human-powered devices may be common at the city level because they are uncommon at the state level.

Some States Specifically Delegate Authority to Local Governments

Several states include language that specifically grants municipalities the authority to implement local policies further restricting use, such as restricting PTD use in locations that pose special safety concerns. For example, California, New Jersey, Oregon, Texas, Virginia, and Washington have such language for motorized scooters. For EPAMDs, 22 states include text about local regulations (Alabama, California, Colorado, Georgia, Illinois, Indiana, Louisiana, Maine, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Oregon, Rhode Island, South Carolina, Tennessee, Vermont, and Washington).

In some cases, states place certain limits when delegating rules to municipalities. For example, for EPAMDs in Washington State, municipalities may restrict device speed. However, they may only do so in “locations with congested pedestrian or nonmotorized traffic and where there is significant speed differential between pedestrians or nonmotorized traffic and EPAMD operators.” To that end, the state also notes that “municipalities shall not restrict the speed of an EPAMD in the entire community or in areas in which there is infrequent pedestrian traffic.” Similarly, North Carolina says local jurisdictions may enact ordinances regulating “the time, place, and manner of the operation of EPAMDs, but shall not prohibit their use.”

Some City/Campus Regulations Repeat State Regulations

In some cases, rules posted at the city and university level were not devised by policymakers at these level of governance; rather, regulations are reiterating those written at a higher level of government. For example, Alliance, Ohio adopts nearly the exact same regulatory language for EPAMDs as the state of Ohio. Other cities (such as Boise, Idaho; Chicago, Illinois; Jackson, Mississippi; and Los Angeles, California), incorporate much of the language presented in their respective state codes, while adding some additional clauses or greater specificity (e.g., establishing city boundaries where use is restricted).

Bridgeport, Connecticut, adds its own regulatory language, but that city also explicitly defers to the state regulation. Less commonly, cities present regulations that differ from

the state code. For example, Key West, Florida, Mountain View, California, and Seattle, Washington, all have their own regulations. In the cases of Mountain View and Key West, the state regulations provide guidelines for safe use, while the city regulations are more restrictive/prohibitive. In the case of Seattle, the city does not repeat Washington's regulatory language, but rather it provides municipal regulations as suggested in the state code (e.g., regulating use on roadways based on a determined speed limit or establishing rules for use in areas designated for recreation).

Campuses Frequently Reference Higher Level Rules

Campuses tended to explicitly note when a regulation did not originate with the university. Perhaps campuses were trying to inoculate themselves from complaints about rules for which they are the messenger rather than the originator. Additionally, when campuses created original rules, they frequently referenced other laws like the federal Americans with Disabilities Act or local and state building and emergency egress ordinances as justification, perhaps trying to add legitimacy to campus rules.

V. INCONSISTENCY IN REGULATIONS

Reflecting the finding that there is no “normal” in PTD regulations, many types of inconsistency show up in the regulations examined for this study. These differences are often not just a matter of degree, with one place writing strict rules and other writing more relaxed rules. Rather, inconsistent rules can be polar opposites of each other. The first section of this chapter describes some of the key inconsistencies in how governments and campuses regulated PTDs. This is followed by a discussion of what some of these inconsistencies might mean for PTD users and what they might say about different jurisdictions.

TYPES OF INCONSISTENCY

Same Device Regulated Differently from Place to Place

One type of inconsistency has to do with the same specific PTD being regulated vastly differently across jurisdictions. For example, absent specific rules on a given PTD, users frequently must follow the same rules as some other mode—however, that other mode differs across places. For instance, in-line skaters riding on roads have the rights and responsibilities of bicyclists in New Jersey but of vehicles in New York; an EPAMD is regulated as a vehicle in Nebraska but as a pedestrian in Idaho.

Codes were very inconsistent across places in terms of where users can ride. There are examples of regulations specifically giving operators permission to ride on a given facility type, prohibiting them from a given facility type, and requiring that they ride on a given facility type. Thus, depending on where they are, PTD operators may, must, or must never ride on roads, bicycle paths, and sidewalks.

Same Places Regulate Devices with Similar Characteristics Differently

Some states regulate specific devices differently, even though those devices have similar capabilities, such as speed. For example, California has different regulations for motorized kick scooters and electric skateboards. Even though both devices are capable of similar speeds, electric skateboards can be ridden on sidewalks, while motorized kick-scooters cannot. Also, a driver’s license is not required to ride an electric skateboard, but a license is required to ride a motorized kick scooter. Finally, electric skateboards are subject to a 15 mph speed limit, while motorized kick scooters are not.

Regulating devices with similar characteristics differently also frequently manifests as one device having regulations and another having none at all. Among motorized PTDs, EPAMDs are more frequently regulated than motorized scooters, which are more frequently regulated than motorized skateboards. Hoverboards and e-unicycles are almost never regulated. Among non-motorized PTDs, skateboards are more frequently regulated than in-line/roller skates, which are more frequently regulated than kick scooters.

Minute differences in device characteristics can lead to devices’ being regulated or unregulated. For example, definitions for various PTDs sometimes include references to a

specific number of wheels. Scooter, motorized scooter, and EPAMD definitions frequently specify that they have two wheels. Such definitions leave out three-wheeled devices that may otherwise be designed like scooters or motorized scooters, or e-unicycles that may otherwise be designed like EPAMDs.

Regulations Inconsistent with Those for Conventional Transportation Modes

A particularly problematic inconsistency in PTD regulations were numerous examples where PTD users were subject to restrictions that are uncommon, if not arguably unfathomable for traditional modes of transportation. Such extra restrictions on PTDs include prohibitions which preclude PTD use entirely in situations in which the users of other modes enjoy the freedom to travel.

For example, in New York City, where automobiles, transit vehicles, pedestrians, and bicycles operate, EPAMDs, motorized scooters, and electric bicycles are all banned. For EPAMDs, this outcome is the result of a state prohibition in cities over one million people—a *de facto* prohibition for New York City, the state's only city meeting that criterion. Such prohibitions have led to complaints over fairness and spurred battles within city government.[34]

Similarly, Delaware effectively bans motorized scooters and motorized skateboards within the state. While not technically prohibited, the devices can only be used if the motor is off, or during a limited-duration special event at which use is permitted. The average American would probably find it unimaginable for a law to similarly permit automobiles, but only if their engines were off or if they were in a parade.

The prohibitions on operating devices in business districts or downtowns also restrict PTDs in large swaths of cities, contrary to the way other modes are regulated. Additionally, sometimes two laws can combine to effectively prohibit PTDs in parts of a city. For example, Bellevue, Washington, prohibits motorized scooters on sidewalks and allows them on streets, but only if the speed limit of a street is 25 mph or below. Thus, if a rider wants to travel between two destinations and the route includes streets with a speed limit greater than 25 mph, a rider cannot legally make that trip, as there is no legal place to ride along a higher-speed arterial.

There are also examples, such as New Jersey, of jurisdictions restricting *who* can ride a device. In New Jersey, only persons with mobility-related disabilities may ride motorized scooters.

Nighttime prohibitions represent a final example of PTD restrictions that are much stricter than those in place for conventional modes. Massachusetts, for example, bars motorized scooters between sunset and sunrise. Bellevue, Washington, similarly bars motorized scooters at night, although riders can ride in twilight conditions (up to 30 minutes after sunset and 30 minutes before sunrise).

[34] J. David Goodman, "Push to Legalize E-Bikes and E-Scooters in New York City Sets Up City Hall Clash," *New York Times*, November 27, 2019, https://www.nytimes.com/2018/11/27/nyregion/e-bikes-nyc-de-blasio.html.

CONSIDERING THE INCONSISTENCY IN PTD REGULATIONS

As discussed in the preceding sections, there are notable inconsistencies in how jurisdictions regulate PTDs when they do. Some of this variability is clearly undesirable, particularly when the same place gives varying rules to different modes for no apparent reason. However, inconsistency is not necessarily always a negative; some variation is to be expected, given that the needs of PTDs and other road users change according to the specifics of the local built environment and transportation systems. Additionally, differences may reflect varying community norms and regulatory philosophies between jurisdictions.

That said, some differences in regulations between cities may not be the result of an actual differences in opinion between them, but rather a result of inconsistency across state regulations. By law, local governments' regulations are affected by their state governments, due to the general supremacy of state regulations over local regulations. Thus, the inconsistency seen in state regulations can promulgate inconsistency in local regulations as well. For example, there could be a scenario in which policymakers in two cities in different states agree on a given regulatory topic, such as using lights and reflectors at night. One city would be permitted to implement a regulation requiring their use, but the second city could not, because its state government has already required different lighting or reflectors or has precluded local regulation on that topic.

VI. FINDINGS UNIQUE TO CERTAIN DEVICES AND LEVELS OF GOVERNMENTS

In addition to the broader themes discussed in previous sections, there were a number of regulations for certain devices and/or in certain places that warrant reflection as potential regulatory choices to mimic—or avoid—for PTDs as a group. The following sections discuss some of these unique situations.

FINDINGS UNIQUE TO CERTAIN DEVICES

EPAMDs Have Relatively Common and Consistent Regulations

Of all PTDs, EPAMDs have the clearest regulatory environment, with 45 states defining and/or regulating them. While not absent of inconsistency, EPAMD regulations are also relatively similar from state to state. To the benefit of EPAMD riders, these regulations are largely permissive. For example, 23 states explicitly allow these devices on streets, 23 allow them on sidewalks, and 24 allow them on bicycle paths. A total of 17 states allow EPAMDs on all three facilities. State regulations also often specify that local government cannot prohibit EPAMDs completely.

The consistency and permissiveness of EPAMD regulations may make these regulations a useful model for other PTD types. However, EPAMD regulations are generally not applicable to other PTDs, despite similar use and operational characteristics, as EPAMDs are very tightly defined. All 45 states define EPAMDs as “self-balancing” and having two, non-tandem wheels. These wheel count and orientation requirements make EPAMD rules inapplicable to most other PTDs. However, hoverboards appear to meet these requirements. Twenty-three states also define EPAMDs based on motor power. Curiously, though, those states universally specify that EPAMDs should have an “average” power of one horsepower (750 watts). Notably, the EPAMD models included in the device inventory in Chapter 2 all had a maximum power greater than that figure, generally closer to two horsepower.

Regulations for EPAMDs may be more consistent and complete due to the lobbying efforts of *Segway, Inc.* (the company representing the inventor of the EPAMD). The company was able to push legislation through in 33 states within the first year of its devices entering the market.[35]

Motorized Scooters Often Grouped with Mopeds and Motorcycles

Motorized scooters are unique among PTDs in that they are sometimes regulated together with larger and heavier devices capable of higher speeds. Thirteen cities apply the same regulations to motorized scooters and motorcycles, and five cities apply the same regulations to motorized scooters and mopeds.

[35] Matt Marshall, “Segway Facing Sidewalk Bans in California,” *Chicago Tribune*, January 26, 2003, https://www.chicagotribune.com/news/ct-xpm-2003-01-26-0301260003-story.html.

The grouping of motorized scooters with larger devices may be a result of the varying meanings attached to the term “scooter.” Chapter 2 describes the motorized version of a “kick scooter” as a PTD for the purposes of this study. However, the term scooter is also used for devices that exceed the size of this report’s definition of PTD. Figure 7 shows a wide variety of devices marketed as scooters. These devices range from human-powered and motorized kick scooters consisting of a simple standing platform and narrow beam, to devices with seats, larger wheels, more powerful engines, more muscular bodies, and aggressive posture and styling.

That devices with a wide range of sizes are regulated together is not necessarily unprecedented. For example, various types of motor vehicles, from subcompact cars to sport utility vehicles to cargo trucks, all have similar rules of the road. However, the common use of the term “scooter” may be problematic as applied to kick scooters and motorized kick scooters. While these might plausibly operate on a sidewalk or bicycle path, most people would likely not say the same for the larger gasoline-powered, motorcycle-like scooters.

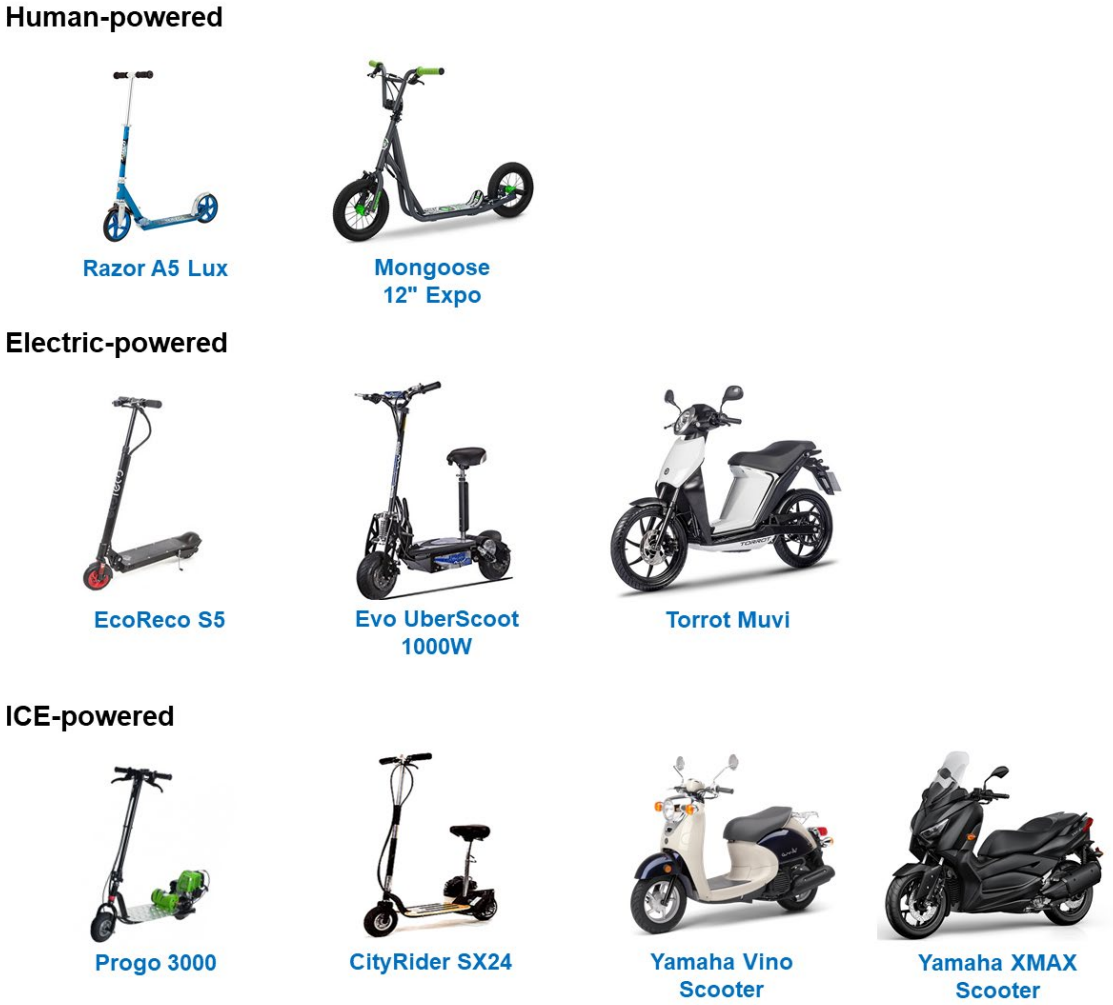

Figure 8. Variation in Devices Marketed as “Scooters”

Sources: See Appendix A.

Fire Concerns Keep Hoverboards Off Campuses

As previously noted, a majority of campuses regulated hoverboards, compared to the near-total absence of hoverboard regulations at the state or city level. Ten of these campus regulations (half the sample) have blanket prohibitions which prohibit hoverboards entirely from campus property (UC Santa Barbara, UC Los Angeles, UC Davis, Arizona State University, Columbia, Portland State University, Florida State University, University of Oregon, San Diego State University, University of Maryland, and University of Missouri).

The restrictions on hoverboards appear to have arisen out of concerns about their flammability rather than concern over how the devices are used. In 2016, the U.S. Consumer Product Safety Commission recalled around 500,000 hoverboards.[36] With precedent set on hoverboards, some campuses have also applied prohibitions on other motorized devices in the name of fire safety. For example, the University of Oregon and the University of Maryland ban the use of electric scooters for this reason.

FINDINGS UNIQUE TO CERTAIN LEVELS OF GOVERNMENT

Cities Describe Penalties in More Detail

City regulations included penalties for non-compliance more often than state regulations. This finding is not particularly surprising, as enforcement is typically left to local agencies. Penalties were typically light, such as fines from $25 to $250 or community service. However, a few local governments imposed riders misdemeanor charges rather than infractions.

Campuses Ban Distracted Riding

Reflecting the idea of shared facilities when PTDs are allowed, campuses tend to regulate user behavior in greater detail than do local governments or states. For example, several campuses specify that PTD riders are not to use headphones or earbuds, listen to music, or talk on the phone. In comparison, while state and municipal codes caution riders to be prudent when navigating shared paths, courteous to pedestrians, and cognizant of surroundings, none explicitly ban use of these technologies.

Campuses Particularly Concerned About Property Damage

As owners of not just pathways, but also buildings and other public spaces, campuses frequently had rules and regulations related to preserving the physical condition of campus property. While these aesthetic concerns are mentioned occasionally in language regulating bicycles (e.g., riding through landscaping), this issue of property damage relates most commonly to skateboards and roller/inline skates. In this vein, campus regulations for use of these PTDs, and especially for skateboards, were framed somewhat differently from

[36] Ritchie King, "Christmas 2015 Was Filled With Hoverboards—And Hoverboard Injuries," *FiveThirtyEight.com*, November 22, 2016, https://fivethirtyeight.com/features/christmas-2015-was-filled-with-hoverboards-and-hoverboard-injuries/.

regulations on other modes, with a focus on prohibiting users from damaging university property. For example, campus policies often mention specific locations where use is prohibited (e.g., buildings, sculptures). In addition, campuses mentioned that skateboard users should not ride recklessly or perform tricks or acrobatics, nor jump off rails or ramps.

VII. MODEL STATE REGULATIONS

In our review of existing regulations, we found that rules of the road for PTD users were frequently nonexistent; furthermore, when regulations on use did exist, their rules were inconsistent within and across public entities. This lack of clear and consistent regulation makes it difficult for PTD users, and users of other modes who interact with them, to determine each other's rights and responsibilities.

The chaotic state of PTD regulations points to a need for new and consistent rules that are simple and easy to understand, emphasize safety, and balance the needs of multiple users. With this in mind, we crafted a proposal for model state legislation for new statutes defining PTDs and outlining the rules of the road users are to follow. (See Appendix C for the full code.)

As a research team, we discussed the implications, strengths, weakness, and challenges of different approaches in crafting regulations for PTDs. After coming up with an initial working draft, we interviewed stakeholders with different professional perspectives to further consider the implications of our proposed regulations. Based on the suggestions, affirmations, critiques, and feedback from our interviewees, we went through many iterations of the proposed legislation before arriving at this final version.

The following sections discuss our general goals for the proposed legislation, walk through the various components of the proposed legislation and explain the rationale behind each section, and finally outline additional actions states may want or need to consider beyond the proposed legislation.

PRINCIPLES UNDERPINNING THE MODEL REGULATIONS

When crafting the specific clauses in the proposed legislation, we aimed to write rules that balance several objectives:

Protect public safety. Regulations should protect other travelers from collisions, especially pedestrians, the most vulnerable road users. At the same time, PTD users are themselves "vulnerable" road users relative to cars, so regulations need to protect their safety as well.

Permit PTD use as a convenient travel option. The "complete streets" paradigm in transportation planning holds that the transportation system should accommodate the needs of all users, regardless of mode. This principle implies that regulators should avoid regulations that make PTD use illegal.

Are easy to understand and remember. Regulations will be much more effective if the general public can easily understand and remember them. Not only do PTD users need to fully understand the rules of the road, but other travelers and traffic enforcement officers also need to know what behaviors to expect from PTD users. For this reason, simple rules will likely be more effective than complex ones.

Allow for new devices without new regulations. As recent experience bears out, new devices can appear at any time and often in large numbers. Given the very high costs of enacting new regulations and educating the public, PTD regulations should be flexible enough to encompass new devices as they appear.

CORE REGULATORY CHOICES

The content in the model code flows from four key choices that underpin the detailed provisions.

States are the appropriate entity to set comprehensive regulations for PTD riders, though local jurisdictions should have flexibility to limit certain uses when necessitated by local conditions. Modes of transportation are typically defined at the state level, so definitions for PTDs would be appropriate in state vehicle codes. Additionally, just as for motor vehicles or bicycles, users will be much more likely to know and understand laws that do not vary from one city to the next. For example, the model code requires the use of lights at night, and it would be unnecessarily complicated to have hundreds of definitions within a state of when night begins and ends.

Additionally, setting some basic rules at the state level will provide users anywhere in a state with guidance on how to operate a PTDs, even if a local government does not create its own rules. Riders are thus not reliant on thousands of local decisions being made before they have clarity on how they may use the devices. Strong state rules also reduce the burden on local governments to enact their own regulations.

Finally, despite the benefits of setting rules at the state level, there will be specific places where stricter rules are appropriate, so the model code includes language explicitly enabling local jurisdictions to add certain types of use restrictions.

Regulate PTDs as a class, not device by device. Some of the most confusing aspects of existing regulations arise from inconsistencies between one device and the next. This variability makes little sense if the different devices have similar operational characteristics. Thus, rather than regulating devices individually, we propose that PTDs be regulated uniformly as a single class of devices.

Regulating the devices as a class has a number of practical benefits. Regulating PTDs as a class would remove the need for states to come up with new definitions and regulations each time a new device type appears in the community. While it is impossible to encompass all future devices, our goal was to define PTDs as a class, using a definition that could accommodate yet-to-be-invented devices that are physically and functionally similar to existing ones.

Additionally, regulating PTDs as a class makes regulation less reactionary. In the current individual regulation system, a device emerges and then must reach sufficiently high consciousness among policymakers before regulations are put in place. With PTDs regulated as a class, even new devices could potentially have clear rights and responsibilities the moment they are invented, so long as they fit in the broader class of devices.

A final key benefit of regulating PTDs as a class is to make the regulations more effective: it will be much simpler for the public (and law enforcement officers) to learn and remember one set of rules than to remember different rules for many different device types.

Where appropriate, craft PTD rules that are comparable to bicycle rules. Applying bicycling rules to PTDs upholds two of the principles above. First, applying bicycling rules to PTDs helps riders learn and remember the PTD rules; riders, law enforcement officers, and the public have one fewer set of specific rules to learn and remember. Second, in cases where PTDs are functionally similar to bicycles, fairness dictates that similar rules apply to both modes.

Permit PTD users to ride on both streets and sidewalks, subject to rules that protect safety and free movement for all travelers. One of the most prominent debates over PTD use, particularly since the emergence of shared electric scooters, is whether and when the devices should be allowed on sidewalks. Reflecting that wider public conversation, the experts interviewed for this project held divergent views, with some of our interviewees opposed to PTDs on the sidewalk at any time or place, but others open to the idea of regulated sidewalk riding.

The question of sidewalk usage is certainly an important issue. Some sidewalks are crowded, narrow, or otherwise unconducive to PTD use. As previously mentioned, pedestrians are the most vulnerable users of the transportation system, and PTDs introduce a faster and bulkier set of users to sidewalks. Not only can PTD users put pedestrians at risk from collisions, but too many or aggressive PTD users could make the sidewalks very uncomfortable places to be, thus discouraging walking.

After considering this question and the various viewpoints shared by the interviewees, we concluded that PTDs should not be prohibited on all sidewalks as a matter of state policy, though such a ban may be appropriate in certain localized cases. The primary reasoning for this position is that street and sidewalk conditions vary greatly within most cities, not to mention from one city to the next.

In the core of a central city, sidewalks may be very crowded and automobile traffic on adjacent roads slow, such as is seen in San Francisco in Figure 8. In this case, moving PTDs entirely off sidewalks and onto streets might make sense, due to the large number of potential conflicts with pedestrians and relatively small speed differential between PTDs and cars.

Figure 9. Narrow and Crowded Sidewalk Lacking Room for PTDs

Source: https://www.flickr.com/photos/bike/7094841707.

Conversely, in more sprawling, automobile-oriented suburban areas, automobiles travel much faster, while pedestrian traffic is nearly non-existent. Figure 9 shows a stretch of Barranca Parkway in Irvine, California. This suburban arterial has five lanes of automobile traffic, no bicycle infrastructure, and a 55-mph speed limit. The automobile-scale land uses adjacent to the corridor result in few pedestrians being present on the sidewalk. In cases like this, which in the U.S. are more common than the crowded sidewalk case, forcing PTD users onto streets is unnecessarily dangerous. Prohibiting PTDs on sidewalks in these sprawling areas criminalizes arguably the only safe place to ride in many of these areas.

Figure 10. Major Arterial Street with 55 MPH Speed Limit: Unsuitable for PTDs

Source: Image from Google Street View of Barranca Parkway in Irvine, California.

Rather than prohibiting PTDs entirely on sidewalks, we instead propose behavioral directives for PTD users on sidewalks that will protect pedestrians. The code also explicitly allows local governments to implement speed limits and mandatory dismount zones where local conditions warrant.

Prohibiting PTDs on sidewalks as a matter of state policy would also be inconsistent with how states regulate bicycles. Out of the 55 states and territories we looked at, 43 do not have language in the state vehicle code prohibiting bicycling on sidewalks. Six states prohibit bicycling on all sidewalks, and six states allow/prohibit bicycling on some sidewalks.

Rather than riding on sidewalks, some have suggested that PTD users should ride on bicycle infrastructure instead. We agree with the sentiment that PTD users are relatively amenable to sharing space with bicycles, and the presence of PTD riders could further justify the provision of more bicycle infrastructure. Studies of skateboarders have found that they are more comfortable on bicycle lanes and paths than on sidewalks and streets, and early research has also found that scooter share users prefer bicycle paths.[37] That said, bicycle infrastructure is much less common than sidewalks. Hence, if the choice is only between a street or a sidewalk, we concluded that states should not force PTDs onto roads in all cases, while users wait for better infrastructure to arrive.

[37] Portland Bureau of Transportation, *2018 E-Scooter Findings Report* (Portland Bureau of Transportation: 2019), 1–36.

DISCUSSION OF THE PROPOSED MODEL CODE FOR "PTD RULES OF THE ROAD"

The proposed model legislation is composed of a preamble and seven sections of statutes:

- Preamble
- Definition
- Lights and Reflectors
- General Operations
- Operation on Roadways and Bicycle Facilities
- Operation on Sidewalks
- Parking
- Penalties

The rest of this chapter presents the specific language recommended in each section of the legislation and explains the reasoning behind each provision. Appendix C presents the complete code, without annotation.

Preamble

Regulatory codes sometimes begin with a preamble that explains the legislators' intent, a choice made in some examples of existing PTD statutes.

> It is the intent of the Legislature in adding this article to allow individuals the freedom to travel by transportation modes that reduce externalities from personal transportation, such as air pollution, climate change, traffic congestion, noise, and public health and safety impacts.

This preamble affirms that the state positively wishes to enable PTD use, rather than simply prohibiting the devices. The text further includes reasons that a state may want to enable PTD use: as a matter of personal freedom of choice and to promote modes of transportation that have relatively fewer negative externalities than motor vehicles.

Definition (Section I)

1) A personal transportation device (PTD) is a device:
    a) designed to transport only one person in a standing or seated position, where the rider is not enclosed,
    b) operated and propelled using human, electric, or motor power,
    c) not greater than 24 inches wide and 42 inches long.

Section I defines what constitutes a PTD, identifying a set of parameters that encompass the myriad individual devices discussed in Chapter 2.

Reflecting existing devices, Section I.1.a. defines PTDs as "personal" transporters carrying just one person, standing or seated, where the rider is not enclosed. Although existing PTDs generally have riders in a standing position, we did not want to preclude PTDs where riders are seated, as not all travelers can stand.

Section I.1.b. specifies that PTDs can be human powered, electric powered, or powered by some other kind of motor such as an internal combustion engine (ICE): all sources of propulsion are currently in use with PTDs. One interviewee suggested we not include ICE-powered devices as PTDs, so as not to encourage their use. However, since such devices exist, it is important to set rights and responsibilities for their users.

Section I.1.c. defines PTDs as fitting inside a footprint of 24 inches wide by 42 inches long. That footprint is large enough to capture most of the devices mentioned in the device inventory. (This maximum width does exclude a few existing devices, such as the Toyota i-real.) We chose to bound the footprint, however, to make it reasonable to operate PTDs on sidewalks. In particular, we set a relatively narrow maximum width in consideration of potential PTD use on narrow sidewalks.

2) Devices designed to move a single person that meet (I.1.a) and (I.1.b) but not (I.1.c) will be regulated as bicycles, in the absence of other regulations specific to that device type.

While the definition of PTDs in section I.1.c does not include devices more than 24 inches wide or 42 inches long, we did not want to leave such devices unregulated. Further, we did not want to encourage gamesmanship in device design, whereby manufacturers could avoid regulation entirely by producing a device slightly larger than a footprint specified in the statute. Thus, Section II states that if a device conforms to II.1.a. and II.1.b. but is larger than the dimensions in II.1.c., then by default such devices should be defined as bicycles, absent any specific regulations on that device type.

3) For the purposes of this section, a PTD does not include:
    a) bicycles or electric bicycles, nor
    b) mobility devices used by persons with mobility-related disabilities.

The final subsection specifies that the statute does not govern bicycles, electric bicycles,

or any mobility device used by persons with mobility-related disabilities (such as wheelchairs and motorized wheelchairs). One reason for these exclusions is that many state codes already regulate those devices. Additionally, persons with mobility disabilities using mobility devices are commonly treated in statute as pedestrians, since the use of those devices replaces walking (rather than providing faster-than-walking travel). Section V of the proposed statute (below) regulates PTDs on sidewalks more strictly than people walking, a scenario that should not apply to people using PTDs to simulate walking. That said, the proposed regulations are likely more permissive for travel *outside* sidewalks than the language in many existing statutes, so applying those proposed PTD regulations to mobility devices used by persons with mobility-related disabilities may improve accessibility for those groups.

Lights and Reflectors (Section II)

From 30 minutes after sunset to 30 minutes before sunrise or at any other time when, due to insufficient light, persons and vehicles are not clearly discernible, the PTD or the rider shall be equipped with:

1) a lamp on the front which shall emit a white light visible from a distance of at least 200 feet to the front,
2) a red reflector or red light attached to the rear that is visible from behind from a distance of 200 feet, and
3) a light or reflector visible from the side at a distance of 200 feet.

This section discusses the use of lights and/or reflectors at night or other times of poor visibility. Lighting is required because PTDs potentially travel faster than pedestrians and also may ride in the roadway, both situations where these devices may pose risks to their riders and others.

We chose to require lighting for visibility instead of prohibiting device use at night. Some existing regulations ban certain PTD types at night, but prohibiting night use would be inconsistent with the regulations on more traditional modes of transportation. Also, such a prohibition would severely limit the value of PTDs for personal transportation.

The opening statement in Section II defines the conditions where light is needed. “Night” is defined as 30 minutes after sunset to 30 minutes before sunrise, a definition found in many state vehicle codes. The language also specifies other circumstances in which poor visibility warrants light and reflector use in the daytime, such as in rain or fog.

Since some PTDs are very short in height, the text states that lights and reflectors can be placed on the device or worn by riders. It may make sense to build lights into the handlebar of an electric scooter, but requiring lights on the device would make little sense for very small and low devices, like in-line skates. For such devices, the lights would be more visible if worn higher on the rider’s body.

Section II.1 and II.2 define the type of lighting equipment required. These specifications are modeled after the language some states use to define lighting on bicycles.

Regulators may be interested in other aspects of how PTDs are equipped, such as brakes or battery standards, but we choose not to include such requirements in these user-focused "rules of the road." Product design and manufacturing requirements fall outside the realm of what users typically control and thus are inappropriate in "rules of the road." Further, we felt that the regulations would better protect public safety if the burden is put on riders themselves to operate the devices safely. However, governments may wish to regulate device lighting features elsewhere in statutes.

General Operations (Section III)

1) PTD operators shall:
    a) yield the right-of-way to pedestrians at all times,
    b) exercise due care to avoid colliding with other persons, vehicles, and transportation devices,
    c) operate the device in a careful and prudent manner and at a rate of speed no greater than is reasonable and proper under the conditions existing at the point of operation, taking into account the surroundings and environment, such as inclement weather, infrastructure conditions, and grade,
    d) abide by regulations for helmet use for bicyclists,
    e) abide by regulations for headsets, earplugs, or earphones for bicyclists, and
    f) abide by regulations for cellphone use for bicyclists

Section III describes what PTD users should or should not do while riding, regardless of *where* they are riding.

Section III.1.a. states that PTD users shall yield the right-of-way to pedestrian at all times. This clause reflects the idea that pedestrians are the most vulnerable users of the transportation system, and thus individuals riding larger, faster PTDs should defer to pedestrians.

The next two subsections include language about riding carefully. Such language is common in existing regulations for PTDs, as well as other travel modes. The code specifies that users should exercise care in terms of avoiding collisions, riding within their abilities, and riding in keeping with conditions in the natural and environment.

Section III.1.d. specifies that helmet use requirements for PTD users (or lack thereof) be the same as rules for bicycles, given that available information indicates that PTD travel speeds cover a range comparable to that of bicycles. Further, setting the rules consistently for bicycles and PTDs makes the requirements easier to remember. In most states, this clause would effectively require that minors, but not adults, must wear helmets. Age requirements for helmet use among bicyclists vary by state.

While this section calls for consistency in helmet rules with bicyclists, the proposed text is not intended to take any particular position on whether or not helmets should be required for either bicyclist or PTD users in the first place.

2) PTD operators shall not:
    a) attach themselves or their PTD to any other moving vehicle, nor
    b) operate a PTD while under the influence of alcohol or any drug to a degree which renders such person a hazard.

Section III.2 outlines two prohibited behaviors for PTD users.

Section III.2.a. states that PTD users should not attach themselves or their device to another moving vehicles, a practice colloquially known as "skitching." This practice is a fairly common factor in bicycle and skateboard injuries,[38] with one study finding skitching to be involved in eight percent of skateboarding fatalities.[39]

Section III.2.b. prohibits operating a PTD under the influence of alcohol or any drugs (including marijuana and prescription drugs that may cause impairment). This language is intended to reflect parallel rules for drivers or bicyclists.

3) PTD operators are not required to hold a driver's license, carry insurance, or register PTDs with the state department of motor vehicles.

Section III.3. specifies that PTD operators need not hold drivers' licenses, carry insurance, or register their devices with state. Some states require driver's licenses for certain PTDs, but those rules raise equity concerns by banning a non-driving alternative for people who are physically and economically unable to drive and/or acquire drivers' licenses. The choice to positively affirm that PTD operators need not carry insurance mimics how states generally treat bicyclists.

Operation on Roadways and Bicycle Facilities (Section IV)

1) PTD operators may ride on roadways where bicycles are permitted and on bicycle facilities.
2) While operating on roadways and bicycle facilities, PTD operators have the rights and duties of a bicyclist.

Section IV addresses the use of PTDs everywhere *other than* pedestrian zones. The proposed text allows PTDs wherever bicycles are allowed on roads, as well as on bicycle-specific infrastructure. Thus, PTD operators could ride on roads without bicycle lanes, in marked bicycle lanes, and on off-street bicycle paths. However, the statute purposefully does not allow PTDs on *all* roadways. For example, PTDs, like bicycles, would not be allowed on limited-access freeways.

Some existing regulations restrict PTDs to low-speed streets (e.g. below 25 or 30 mph). Given that many PTDs can attain speeds comparable to bicycles, and that such restrictions

[38] Jamie Hunter, "The Epidemiology of Injury in Skateboarding," *Epidemiology of Injury in Adventure and Extreme Sports,* 58 (2012): 142–157; Richard Franklin and Jemma King, "Getting a Hold of Skitching," *Safety* 1, no. 1 (2015): 28–43

[39] Kevin Fang and Susan Handy, "Skate and Die? The Safety Performance of Skateboard Travel: A Look at Injury Data, Fatality Data, and Rider Behavior," *Journal of Transport and Health,* 7, part b (2017): 288–297.

are uncommon for bicycles, adding such an extra restriction on PTDs would be modally inconsistent.

Operation on Sidewalks (Section V)

1) PTD operators may ride on sidewalks, but only if such operation does not impede pedestrians or endanger sidewalk users.
2) While operating on sidewalks and in crosswalks, PTD operators shall:
    a) slow when approaching and overtaking pedestrians, PTD operators, and other sidewalk users,
    b) maintain a distance of at least two feet from pedestrians, PTD operators, and other sidewalk users,
    c) make an audible signal before overtaking a pedestrian, PTD user, or other sidewalk user,
    d) slow to a walking speed when approaching and entering intersections, and
    e) dismount if conditions make it impossible to abide by V.2.b or otherwise respect pedestrians' right of way.

As discussed above, the proposed "rules of the road" do not prohibit sidewalk riding at the state-level. However, to protect vulnerable pedestrians, the statute includes several strict behavioral restrictions on sidewalk riding.

Subsections V.2.a to V.2.c cover passing on sidewalks. To protect pedestrians, PTD operators must slow down, maintain a distance of two feet from pedestrians, and audibly signal that they are passing. An audible signal is required, as hand signals and signage alone put sight-impaired pedestrians at an unsafe disadvantage.[40] Further, Subsection V.2.e calls for riders to dismount if they cannot meet the minimum safe passing requirements.

Subsection V.2.d covers PTD riders entering an intersection, requiring them to slow down to a walking speed as they approach and then enter an intersection. The rationale for asking PTD users to slow while approaching intersections is to make it easier for PTD users to be seen by turning motorists.

3) Local governments may set maximum permitted speeds as low as 6 mph where such a speed limit is necessary to protect pedestrians, PTD users, or other road users.

Subsection V.3 explicitly authorizes local governments to set speed limits where such a speed limit is necessary to protect pedestrians, PTD users, or other road users. When discussing a potential speed limit with interviewees, there was a wide range of opinions about what speeds may or may not be appropriate on sidewalks. Some held the opinion that sidewalk riding was unsafe at any speed. Conversely, some thought speeds in the low double digits were acceptable. Currently, no existing research explores how speed impacts safety outcomes—a gap that hopefully will be filled soon.

[40] J. Elliott, et al., *Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities* (U.S. Department of Transportation, 2017).

While we do not propose a maximum speed limit, we propose that local governments avoid setting a speed limit below 6 mph. First, 6 mph is slightly below the average jogging speed of young adults; thus, precedent does exist for sidewalk users moving at that speed. Second, 6 mph is lower than the 15th percentile speed of most PTDs, as found in the limited number of studies of user speed discussed in Chapter 2. Setting a speed limit below 6 mph likely means that the rule will almost never be followed and could thus end up being used mostly as a tool to criminalize existing (reasonable) behavior.

However, there could presumably be conditions where it would be unsafe for PTD users to travel at even 6 mph. In these cases, a local government may be better served with a dismount zone (see below).

While subsection V.3 enables speed limits, local governments are not required to enact them. One interviewee at a local government mentioned that after discussion with public safety officials, the city decided to go with qualitative behavioral rules that officers felt were straightforward to enforce, rather than a quantitative speed limit.

4) Municipalities and other local governments may create mandatory PTD dismount zones where these are necessary to protect pedestrians and other road users.

Section V.4. explicitly authorizes local governments to create dismount zones where safety considerations warrant this measure. As previously discussed, we concluded that it is inappropriate to prohibit PTDs from sidewalks in all places, due to differing sidewalk and roadway conditions. That being said, there will be specific locations where crowding or other conditions justify requiring PTD users to dismount.

Parking (Section VI)

Many PTDs do not need to be “parked” at a destination, as they are small enough to be carried inside by users. However, the advent of dockless, shared, electric scooter systems has made parking a noted point of conflict when it comes to PTDs. The relatively large devices have to be left outside, accessible for the next user, and they can theoretically be left anywhere in a dockless setup.

1) PTD operators shall not park PTDs in ways that are hazardous to other users, interfere with pedestrian traffic or block sidewalks, impede the mobility for persons with disabilities, or obstruct operations of business.

Subsection VI.1. lays out parking restrictions intended to keep sidewalks, streets, and private property freely accessible for pedestrians and other users. First, users should not park devices in such a way that they may be hazardous to other travelers, such as by posing a trip hazard. Additionally, devices should not be left in a way that interferes with pedestrian traffic or blocks sidewalks or building access. PTD users should pay particular attention to not impede mobility for persons with disabilities. For example, users should not park devices on infrastructure provided specifically for persons with disabilities (e.g., a wheelchair ramp) or in such a way that leaves insufficient clearance for persons with

disabilities to pass on a wheelchair or other mobility device.

Note that the proposed statute does not mean that a PTD can *never* be parked on sidewalks. Depending on pedestrian volume and sidewalk width, there may be plenty of room for both parked PTDs and pedestrian flow, such as in a street furniture zone between the travel path and curb.

We considered, but ultimately did not include, a clause requiring devices to be left upright. While it is clear what an upright electric scooter or an EPAMD looks like, that concept is less clear for certain other devices. For example, how would a roller skate, skateboard, or hoverboard have to be "parked" in order to be upright?

> 2) Municipalities and other local governments may impose additional parking restrictions where these are necessary to protect pedestrians and other road users.

Subsection VI.2. explicitly enables local governments to implement additional policies on parking, though limiting such restrictions to cases where local conditions warrant this to protect safety.

Penalties (Section VII)

> 1) Violations of this statute shall be publishable with penalties consistent with laws governing bicyclists, applied mutatis mutandes to PTD users.

The final statute of the proposed code addresses penalties for violations of the preceding sections. To make the rules for PTDs consistent with other modes and therefore easy to remember, the language requires that penalties for improper PTD use be in line with those levied on improper bicycling.

ADDITIONAL IMPLEMENTATION STEPS

The proposed text lays out a comprehensive set of "rules of the road" for PTD users. However, states will likely need to make additional changes in the short or long term, such as the following actions.

Other Code Changes

States adopting the proposed PTD statutes would need to eliminate statutes that overlap with the newly-adopted model regulations. This step would entail eliminating statutes that govern specific device types now regulated as PTDs (e.g., skateboards or EPAMDs). In addition, states may need to revise the definitions of other modes (such as vehicles and pedestrians) to exclude PTDs.

States will likely also need to revise the regulations for other modes, most notably for motor vehicles, to reflect that PTD users would have similar rights as pedestrians or bicyclists,

depending on where the device is operated. For example, if a PTD operated on a sidewalk is treated as a pedestrian as per the model legislation, that would mean that rules requiring drivers to yield to pedestrians should also include yielding to PTDs on sidewalks. Also, states mandating that motor vehicle drivers leave a minimum distance when passing bicyclists would want to apply the same requirement for motorists passing PTDs.

Updating the Code as New Vehicle Technologies Emerge

As technology continues to evolve, states will need to monitor future developments that could have regulatory implications. For example, there has been some discussion in technology circles of autonomously-operated PTDs. Current speculation centers on the idea of PTDs without riders autonomously traveling to charging stations or to rebalance shared PTD systems. If PTDs were moving themselves autonomously, the scenario would be analogous to autonomous delivery robots, so future regulations on unmanned delivery robots could encompass PTDs moving without riders. However, it is also conceivable that in the not-distant future, some PTDs (even those with riders) will operate with partial or full automation.

Another conceivable change in vehicle design is PTDs that enclose the rider with a fairing, similar to the design of some derivations of bicycles and e-bicycles. Currently such devices are not in any kind of common use, so the proposed regulatory code excludes them by definition. If and when such devices appear, states will need to decide whether to define and regulate such vehicles as PTDs or as a new class of device. A new class of vehicle may be necessary, since PTDs with fairings could result in different safety implications as compared to current devices; increased size and mass, or reduced visibility, might raise the risk to pedestrians.

Updating the Code as New Research Arrives

To date, regulators have mostly had to rely on their best guesses about the impact of PTDs. As awareness of PTDs increases, more research that would be of value to regulators will likely be conducted. For example, in early 2019, a study of ER visits at Los Angeles-area university medical centers provided the first-ever examination of injuries from shared electric scooters. However, the authors note that the "geographic and urban planning factors influencing the incidence and severity of these injuries" are still unknown.[41] If and when research arrives to examine these factors, it may indicate that some rules proposed in this report should be revised.

[41] Tarak Trivedi, Charles Liu, and Anna Liza M. Antonio, "Injuries Associated With Standing Electric Scooter Use," *JAMA Network Open* 2, no. 1 (2019), 1–9.

VIII. CONCLUSIONS AND RECOMMENDATIONS

SUMMARY OF FINDINGS FROM EXISTING CODES

Our review of existing regulations in states, cities, and university campuses concludes that PTD users operate in a murky regulatory environment, with poorly-defined and often contradictory rules. Few entities have “rules of the road” that specifically apply to PTDs. Further, sometimes, rules written for other modes are broad enough to encompass PTDs in a counterintuitive fashion, such as treating PTDs either as motor vehicles or pedestrians.

Moreover, even when a jurisdiction does clearly define PTD modes and have regulations, the situation is still confusing for the public. One key issue is that regulatory approaches can vary wildly for the same device in different communities. The lack of consensus can be seen in cases like that of motorized scooters, which in various places across the country are prohibited on sidewalks, allowed on sidewalks, and required to operate only on sidewalks. Community-to-community differences can be confusing to PTD operators who ride in multiple places. For example, transit riders who use PTDs for first-mile, last-mile access may find themselves facing an entirely different set of municipal rules on either end of their transit ride.

Regulatory approaches can also vary wildly in the same place but across different PTDs. Such variation can be seen in cases like California, where motorized scooters and electric skateboards are subject to opposite driver’s license, helmet, sidewalk riding, and speed limit regulations.

When regulations exist for specific PTDs, these statutes frequently cover just one device at a time. Regulations generally only exist for more well-known PTDs, with many lesser-known PTDs never being subject to specific regulations. (Anyone operating a unicycle, for example, will be hard-pressed to find out the rules.[42]) In many cases, there exist very different rules for devices with similar operational characteristics and that are used for similar kinds of trips. One device could have many restrictions, and another could have none, even in the same place.

In rare cases, regulations do group multiple PTD device types together. In particular, many cities and campuses regulate skateboards, kick scooters, and roller/in-line skates together. Motorized scooters were also sometimes found to be grouped with other travel modes, though not with other PTDs as the term is conceptualized in this report. Instead, motorized scooters were sometimes grouped with larger and more powerful mopeds and motorcycles. Arguably, the term “scooter” is problematically broad, particularly for motorized (kick) scooters which are sometimes regulated more similarly to motorcycles than to motorized skateboards or EPAMDs.

Finally, existing rules can also create confusion when PTDs are restricted in ways that are unfathomable for more traditional modes of transportation. For example, New York City

[42] Nikkie Sedaghat, “Unicycling Student Wheels and Deals Against Bicycle Citation,” *The Bottom Line,* February 27, 2013, https://thebottomline.as.ucsb.edu/2013/02/unicycling-student-wheels-and-deals-against-bicycle-citation

prohibits motorized scooters, EPAMDs, and electric bicycles, despite allowing cars, transit vehicles, and human-powered bicycles. Other cities prohibit PTD use in large geographic swaths of a city (such as downtowns or business districts) or on or along high-speed streets. New Jersey restricts the use of motorized scooters only to persons with mobility-related disabilities, and some jurisdictions ban PTD travel at night.

MODEL "RULES OF THE ROAD" LEGISLATION

The second outcome of this research project was proposed model state legislation laying out "rules of the road" for PTD users. This model code was informed by the review of existing state, city, and campus regulations, a review of scholarly literature, and stakeholder interviews. The code contains a preamble and seven sections that cover definitions, lights and reflectors, general operations, operations on roadways and bicycle facilities, operation on sidewalks, parking, and penalties. Readers may refer to Appendix C for the entire model code.

The general philosophy underpinning the model legislation was that PTD rules should:

- Protect public safety
- Permit PTD use as a convenient travel option
- Be easy to understand and remember
- Allow for new devices without new regulations

Working from these principles, we determined four core recommended components of regulations for PTD operators:

- States are the appropriate entity to set comprehensive regulations for PTD riders, though local jurisdictions should have some flexibility to customize the rules in response to local conditions
- Regulate PTDs as a class, not device by device
- Where appropriate, craft PTD rules that mimic bicycle rules
- Permit PTD users to ride in both streets and sidewalks, subject to rules that protect safety and free movement for all travelers

We propose regulating PTDs as a class, rather than as individual devices. This choice should avoid the current situation whereby some devices are regulated and some not, and regulations differ wildly, despite devices having similar characteristics. For the class of PTDs, we then propose a number of behaviors that users should or should not engage in across a variety of topics such as careful riding, yielding to pedestrians, use of lights, and parking.

Overall, we were focused on *how* users should rider rather than *where* users should ride. Notably, we do not propose prohibiting PTDs on sidewalks, at least not as a matter of state policy. While dismount zones in very targeted places may be needed to protect public safety, a blanket ban seems unreasonable, given that sidewalk conditions like pedestrian volumes and facility design vary significantly from place to place. In particular, we felt state regulations should not force PTD riders in sprawling, auto-oriented areas to ride on to dangerous high-speed arterials based on prohibitions motivated by concerns about PTDs on sidewalks in central city downtowns. State sidewalk prohibitions are also inconsistent with how most states treat bicycles.

MOVING FROM PROPOSAL TO POLICY

Whether communities and states ultimately adopt the new regulations discussed here or choose a different approach, there are many steps involved in moving from a discussion draft to legally adopted code. Historical experience with creating regulations for other new modes highlight how such changes could be accomplished for PTDs.

Within the realm of PTDs, EPAMDs provide one example of a way forward. Of the devices examined for this report, EPAMDs have the most consistent existing regulations, with 46 of the 56 states and territories having passed legislation, with fairly permissive and similar rules from state to state. Lobbying from the original Segway manufacturer helped create these regulations.[43] PTD manufacturers and shared mobility companies offering PTD services could engage in similar efforts now. Some may find the idea of industry advocating for regulations problematic. Thus, it may be preferable that regulations be developed by an independent source, following a process that deliberately takes into account the perspectives of multiple stakeholders, including industry representatives. One challenge with industry lobbying is that there are multiple companies building PTDs and providing mobility services, so lobbying efforts could conflict.

The impact of advocacy groups on electric bicycle policy is also instructive. While e-bike regulations are currently less uniform than EPAMD regulations, bicycle user organizations have successfully advocated for the adoption of their proposed legislation in several states. If PTD use increases in popularity such that PTD user groups form, these groups could potentially advocate for a model legislation package similar to the way that cycling groups have done.

FURTHER RESEARCH

As discovered over the course of this project, there is little existing research into PTD regulations. Policymakers to date have had to draft rules of the road without the benefit of solid empirical data on who uses PTDs, in what ways they are used, how people would *like* to use PTDs, and what conflicts and collisions are occurring and where, not to mention research on the safety and travel behavior outcomes resulting from different regulatory approaches. Research on the following topics is sorely needed to inform policymaking.

[43] Todd Litman and Robin Blair, *Managing Personal Mobility Devices (PMDs) on Nonmotorized Facilities* (Victoria Transport Policy Institute: 2017), 1–20; Matt Marshall, “Segway Facing Sidewalk Bans in California,” *Chicago Tribune*, January 26, 2003, https://www.chicagotribune.com/news/ct-xpm-2003-01-26-0301260003-story.html.

PTD regulations in other countries. There are many lessons to be learned from a scan of how other countries approach PTD regulations. Of particular interest would be the regulations adopted in countries that already have pedestrians mixing with large numbers of bicycles or other small vehicles.

Model Local Government and Campus Regulations: This report looked at regulations at three levels of government, but the proposed model legislation is at the state level. Future research should consider appropriate city and campus regulations as well. For example, we took the position that sidewalk riding should not be prohibited at the state level due to variation in sidewalks, but that local governments should be explicitly granted the power to create local dismount areas when appropriate. Research could explore the conditions that would make local dismount zones more or less appropriate.

Assess Effectiveness of Regulations: Future research should examine the outcomes of establishing PTD use regulations. For example, how might they affect, positively or negatively, the attainment of various goals such as public health and safety concerns, or improving accessibility to PTDs, as mobility options? Future researchers may wish to conduct a case-study analysis of cities with different regulatory strategies.

Safety Factors: Protecting public safety is an overarching goal for any PTD regulations. New research tracking numbers of collisions, injuries, and fatalities, and the circumstances around those incidents will help inform such regulations. In particular, research could be designed to determine what situations or behaviors raise serious versus minor safety concerns. Research looking at hospital data, police data, surveys of rider experiences, and surveillance of rider operational behavior could provide useful information in this area.

Sidewalk Conflicts: Arguably the most contentious aspect about PTD use today is sidewalk use, including both device parking and sidewalk riding. Future research could document and characterize the conflicts that occur and explore the contributing factors.

User Behavior and Motivations: Research is needed to collect data about *how* riders use PTDs, as well as how they might *want* to use PTDs. A better understanding of individuals' travel behavior decisions will allow policymakers to craft regulations that thoughtfully account for the ways different types of people currently use—and want to use—PTDs. The diversity of opinions is only gradually coming to light, and often not in forms that are easily accessible to researchers and policymakers. An article in the San José State University student newspaper about how officials had banned electric (kick) scooters on campus for safety reasons illustrates this point. The article reported that some female students interviewed felt safer riding electric (kick) scooters at night, rather than walking, for reasons of personal security.[44]

* * * *

[44] Jaileane Aguilar, "Motorized Scooters Restricted," *Spartan Daily*, February 19, 2019, http://www.sjsunews.com/spartan_daily/news/article_0cc85350-3486-11e9-968c-3f72417da000.html.

Cities world-wide are moving toward a paradigm of reduced automobile vehicle miles traveled and increased use of alternatives. PTDs add to the suite of possible alternatives. As with bicycles and electric bicycles, PTDs can provide mobility at faster-than-walking speeds in a compact, space-efficient manner, typically under human or electric power. Initial studies on electric scooters show that they can replace car trips.[45] Surveys also find interest and positive perceptions from many groups, showing that PTDs are not just toys for teens or "tech bros."[46, 47]

For these reasons, PTDs have the potential to provide incredible value to society when safely integrated into communities. As discussed in this report, there is wide disagreement on how or if this can be done. It is unsurprising that new technologies bring uncertainty about their proper place in a community; likewise, it is natural that there exists concern about possible negative impacts. However, now is the time to take account of the potential of PTDs and to balance user needs with public safety through crafting well-evidenced and thoughtful regulations.

[45] Portland Bureau of Transportation, *2018 E-Scooter Findings Report* (Portland Bureau of Transportation: 2019), 1–36.

[46] Populus Technologies Inc, *The Micro-mobility Revolution: The Introduction and Adoption of Electric Scooters in the United States* (Transportatition Research Information Services: 2018), 1–18

[47] Portland Bureau of Transportation, *2018 E-Scooter Findings Report* (Portland Bureau of Transportation: 2019), 1–36.

APPENDIX A: MISCELLANEOUS SOURCES

Image Sources for Figure 1

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APPENDIX B: PRESENCE OF REGULATIONS IN SAMPLED LOCATIONS

Table 23. Types of PTDS Regulated by States

	Motorized PTDs					Non-Motorized PTDs		
	Electric Personal Assist Mobility Devices (EPAMD)	Motorized Scooters	Motorized Skateboards	Hoverboards	Electric Unicycles	Skateboards	Kick Scooters	Roller/ In-line Skates
TOTAL	38	16	4	0	0	8	5	8
Alabama	✓							
Alaska								
Arizona	✓							
Arkansas								
California	✓	✓	✓					
Colorado	✓							
Connecticut	✓							
Delaware	✓	✓	✓					
Florida	✓							
Georgia	✓							
Hawaii								
Idaho	✓							
Illinois	✓							
Indiana	✓							
Iowa	✓							
Kansas								
Kentucky								
Louisiana	✓							
Maine	✓							
Maryland		✓						
Massachusetts		✓						
Michigan	✓							
Minnesota	✓	✓						

Table 23, continued

	Motorized PTDs					Non-Motorized PTDs		
	Electric Personal Assist Mobility Devices (EPAMD)	Motorized Scooters	Motorized Skateboards	Hoverboards	Electric Unicycles	Skateboards	Kick Scooters	Roller/ In-line Skates
Mississippi	✓							
Missouri								
Montana								
Nebraska	✓							
Nevada								
New Hampshire	✓							
New Jersey	✓	✓	✓					
New Mexico	✓							
New York	✓					✓		✓
North Carolina	✓					✓		✓
North Dakota								
Ohio	✓	✓						
Oklahoma		✓						
Oregon	✓	✓				✓	✓	✓
Pennsylvania	✓							
Rhode Island	✓					✓	✓	✓
South Carolina	✓							
South Dakota	✓							
Tennessee	✓							
Texas	✓	✓						
Utah	✓	✓				✓	✓	✓
Vermont	✓							
Virginia	✓	✓	✓			✓	✓	✓
Washington	✓	✓						
West Virginia	✓							
Wisconsin	✓							
Wyoming								

Table 23, continued

	Motorized PTDs					Non-Motorized PTDs		
	Electric Personal Assist Mobility Devices (EPAMD)	Motorized Scooters	Motorized Skateboards	Hoverboards	Electric Unicycles	Skateboards	Kick Scooters	Roller/ In-line Skates
American Samoa								
Guam	✓					✓	✓	✓
Northern Mariana Islands		✓						
Puerto Rico		✓						
U.S. Virgin Islands		✓				✓		✓

Table 24. Types of PTDs Regulated in Municipal Codes

	Motorized PTDs					Non-Motorized PTDs		
	Electric Personal Assist Mobility Devices (EPAMD)	Motorized Scooters	Motorized Skateboards	Hoverboards	Electric Unicycles	Skateboards	Kick Scooters	Roller/ In-line Skates
TOTAL	13	38	10	0	0	67	46	68
Albuquerque, NM	✓	✓				✓	✓	✓
Alliance, OH								
Anchorage, AK	✓							
Arlington, TX		✓	✓			✓	✓	✓
Atchison, KS						✓		✓
Atlanta, GA							✓	✓
Baltimore, MD								
Beaverton, OR						✓		
Bellevue, WA		✓						✓
Berkeley, CA						✓		✓
Billings, MT						✓	✓	✓
Birmingham, AL						✓	✓	✓
Boise City, ID						✓	✓	✓
Boston, MA	✓							
Boulder, CO		✓				✓	✓	✓
Bowling Green, KY							✓	✓
Brentwood, TN								
Bridgeport, CT		✓				✓	✓	✓
Brockton, MA	✓							
Burlington, VT						✓	✓	✓
Cambridge, MA						✓		
Charleston, SC		✓				✓	✓	✓
Charleston, WV		✓				✓	✓	✓
Charlotte, NC						✓	✓	✓
Cheyenne, WY						✓		✓
Chicago, IL		✓				✓	✓	✓
Clifton, NJ	✓							
Columbus, OH							✓	✓

Table 24, continued

	Motorized PTDs					Non-Motorized PTDs		
	Electric Personal Assist Mobility Devices (EPAMD)	Motorized Scooters	Motorized Skateboards	Hoverboards	Electric Unicycles	Skateboards	Kick Scooters	Roller/ In-line Skates
Corvallis, OR						✓	✓	✓
Davis, CA		✓				✓		
Denver, CO		✓				✓	✓	✓
Des Moines, IA	✓	✓				✓	✓	✓
Detroit, MI		✓				✓		✓
Eugene, OR		✓	✓			✓		
Fargo, ND	✓	✓				✓	✓	✓
Fort Collins, CO		✓	✓			✓	✓	✓
Gainesville, FL								
Hawarden, IA						✓	✓	✓
Honolulu, HI		✓						
Houston, TX		✓				✓	✓	
Hutchinson, MN		✓				✓		✓
Independence, KY		✓						✓
Indianapolis, IN						✓	✓	
Jackson, MS								✓
Jacksonville, FL	✓					✓		✓
Kansas City, MO		✓				✓	✓	✓
Key West, FL						✓		✓
Lake Forest, CA	✓					✓	✓	✓
Las Vegas, NV		✓	✓					
Lincoln, ND						✓		✓
Little Elm, TX		✓						
Little Rock, AK		✓					✓	✓
Livermore, CA		✓	✓			✓	✓	✓
Los Angeles, CA		✓				✓		✓
Lowry Crossing, TX	✓							
Manchester, NH			✓			✓		✓
Memphis, TN						✓	✓	✓

Table 24, continued

	Motorized PTDs					Non-Motorized PTDs		
	Electric Personal Assist Mobility Devices (EPAMD)	Motorized Scooters	Motorized Skateboards	Hoverboards	Electric Unicycles	Skateboards	Kick Scooters	Roller/ In-line Skates
Menlo Park, CA		✓						✓
Milwaukee, MI		✓				✓		✓
Minneapolis, MN	✓					✓		✓
Missouri City, TX		✓						
Monahans, TX								
Mount Morris, MI								
Mountain View, CA		✓	✓			✓	✓	✓
Naperville, IL	✓					✓		✓
New Orleans, LA						✓	✓	✓
New York City, NY		✓				✓	✓	✓
Newark, NJ								
North Miami, FL								
North Ogden, UT								
Norwich, NY						✓		
Oakland, CA.		✓				✓	✓	✓
Oklahoma City, OK		✓				✓	✓	✓
Omaha, NE		✓				✓	✓	✓
Overland Park, KS						✓	✓	✓
Palo Alto, CA		✓				✓	✓	✓
Philadelphia, PA						✓	✓	✓
Phoenix, AZ			✓			✓	✓	✓
Pompano Beach, FL		✓						
Portland, ME						✓		✓
Portland, MI						✓		
Portland, OR						✓	✓	✓
Providence, RI						✓		✓
Rochester Hills, MI						✓		✓
Rockport, TX		✓						
Roswell, GA						✓		✓

Table 24, continued

	Motorized PTDs					Non-Motorized PTDs		
	Electric Personal Assist Mobility Devices (EPAMD)	Motorized Scooters	Motorized Skateboards	Hoverboards	Electric Unicycles	Skateboards	Kick Scooters	Roller/ In-line Skates
Salt Lake City, UT						✓	✓	✓
San Francisco, CA								
San Jose, CA							✓	✓
San Juan Capistrano, CA						✓		
Seattle, WA.		✓				✓		✓
Sioux Center, IA	✓							
Sioux Falls, SD						✓	✓	✓
Somerville, MA							✓	
Texarkana, AR						✓		✓
Tucson, AZ			✓			✓	✓	✓
Virginia Beach, VA								
Washington, DC.						✓	✓	✓
Wichita, KS						✓	✓	✓
Williamsport, PA						✓		✓
Wilmington, DE		✓	✓					✓

[a] This campus had separate regulations explicitly for electric scooters.

[b] This campus had regulations for unicycles (but not specifically electric unicycles).

Table 25. Types of PTDs Regulated by Campuses

	Motorized PTDs					Non-Motorized PTDs		
	Electric Personal Assist Mobility Devices (EPAMD)	Motorized Scooters	Motorized Skateboards	Hoverboards	Electric Unicycles	Skateboards	Kick Scooters	Roller/ In-line Skates
TOTAL	7	12	5	13	1	6	0	68
Arizona State	✓	✓				✓	✓	✓
University	✓	✓		✓		✓	✓	
Columbia University				✓			✓	
Florida State		✓	✓			✓	✓	✓
University	✓	✓		✓			✓	✓
Michigan Institute							✓	✓
of Technology							✓	
Portland State						✓		
University				✓			✓	✓
San Diego State						✓		✓
University		✓		✓			✓	✓
San Jose State						✓	✓	✓
University		✓			✓[b]	✓	✓	✓
Stanford University	✓	✓	✓				✓	
UC at Davis	✓	✓[a]	✓	✓			✓	✓
UC at Los Angeles				✓			✓	✓
UC at Santa Barbara				✓		✓	✓	
University of Colorado	✓	✓					✓	✓
University of Maryland		✓[a]	✓	✓				
University of						✓	✓	✓
Minnesota							✓	
University of Missouri	✓			✓		✓	✓	✓
University of Nevada at Las Vegas			✓	✓			✓	✓
University of Oregon		✓[a]	✓	✓			✓	✓
University of						✓		✓
Southern California		✓				✓	✓	✓
University of Texas at Austin	✓	✓		✓		✓	✓	✓
University of Washington		✓					✓	

APPENDIX C: PROPOSED MODEL STATE "RULES OF THE ROAD" LEGISLATION

Preamble

It is the intent of the Legislature in adding this article to allow individuals the freedom to travel by transportation modes that reduce externalities from personal transportation, such as air pollution, climate change, traffic congestion, noise, and public health and safety impacts.

(I) Definition

1) A personal transportation device (PTD) is a device:
    a) designed to transport only one person in a standing or seated position, where the rider is not enclosed,
    b) operated and propelled using human, electric, or motor power,
    c) not greater than 24 inches wide and 42 inches long.
2) Devices designed to move a single person that meet (I.1.a) and (I.1.b) but not (I.1.c) will be regulated as bicycles, in the absence of other regulations specific to that device type.
3) For the purposes of this section, a PTD does not include:
    a) bicycles or electric bicycles, nor
    b) mobility devices used by persons with mobility-related disabilities.

(II) Lights and Reflectors

1) From 30 minutes after sunset to 30 minutes before sunrise or at any other time when, due to insufficient light, persons and vehicles are not clearly discernible, the PTD or the rider shall be equipped with:
    a) a lamp on the front which shall emit a white light visible from a distance of at least 200 feet to the front,
    b) a red reflector or red light attached to the rear that is visible from behind for a distance of 200 feet, and
    c) a light or reflector visible from the side at a distance of 200 feet.

(III) General Operations

1) PTD operators shall:
    a) yield the right-of-way to pedestrians at all times,

b) exercise due care to avoid colliding with other persons, vehicles, and transportation devices,
c) operate the device in a careful and prudent manner and at a rate of speed no greater than is reasonable and proper under the conditions existing at the point of operation, taking into account the surroundings and environment, such as inclement weather, infrastructure conditions, and grade,
d) abide by regulations for helmet use for bicyclists,
e) abide by regulations for headsets, earplugs, or earphones for bicyclists, and
f) abide by regulations for cellphone use for bicyclists.

2) PTD operators shall not:
   a) attach themselves or their PTD to any other moving vehicle, nor
   b) operate a PTD while under the influence of alcohol or any drug to a degree which renders such person a hazard.
3) PTDs operators are not required to hold a driver’s license, carry insurance, or register PTDs with the state department of motor vehicles.

(IV) Operation on Roadways and Bicycle Facilities

1) PTD operators may ride on roadways where bicycles are permitted and on bicycle facilities.
2) While operating on roadways and bicycle facilities, PTD operators have the rights and duties of a bicyclist.

(V) Operation on Sidewalks

1) PTD operators may ride on sidewalks, but only if such operation does not impede pedestrians or endanger sidewalk users.
2) While operating on sidewalks and in crosswalks, PTD operators shall:
   a. slow when approaching and overtaking pedestrians, PTD operators, and other sidewalk users,
   b. maintain a distance of at least two feet from pedestrians, PTD operators, and other sidewalk users,
   c. make an audible signal before overtaking a pedestrian, PTD user, or other sidewalk user,
   d. slow to a walking speed when approaching and entering intersections, and
   e. dismount if conditions make it impossible to abide by V.2.b or otherwise respect pedestrians’ right of way.
3) Local governments may set maximum permitted speeds as low as 6 mph where

such a speed limit is necessary to protect pedestrians, PTD users, or other road users.

4) Municipalities and other local governments may create mandatory PTD dismount zones where these are necessary to protect pedestrians and other road users.

(VI) Parking

1) PTD operators shall not park PTDs in ways that are hazardous to other users, interfere with pedestrian traffic or block sidewalks, impede the mobility for persons with disabilities, or obstruct operations of business.
2) Municipalities and other local governments may impose additional parking restrictions where these are necessary to protect pedestrians and other road users.

(VII) Penalties

1) Violations of this statute shall be publishable with penalties consistent with laws governing bicyclists, applied mutatis mutandes to PTD users.

ABBREVIATIONS AND ACRONYMS

EPAMD	Electric Personal Assistive Mobility Device
HP	Horse Power
MPH	Miles per Hour
PTD	Personal Transportation Device

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