CENTER OF EXCELLENCE
on New Mobility and Automated Vehicles

Study of Shared Mobility Regulations and Relevance to Automated Vehicles

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About the Center of Excellence on New Mobility and Automated Vehicles

The Center of Excellence on New Mobility and Automated Vehicles ("Mobility COE") focuses on the impacts of new mobility technologies and highly automated vehicles on the evolving transportation system when deployed at scale. Launched in 2023, the center studies the anticipated long-term impacts of increased new mobility technologies and services on land use, real estate and urban design; transportation system optimization; access to mobility and job participation; and municipal budgets and cost-effective allocation of public resources. Established through a cooperative agreement between the Federal Highway Administration and UCLA, the Mobility COE is made up of five core partners and a community of practice from academia and nonprofit organizations. **www.mobilitycoe.org**

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The Mobility Center of Excellence at UCLA acknowledges the Gabrielino/Tongva peoples as the traditional land caretakers of Tovaangar (the Los Angeles basin and So. Channel Islands). As a land grant institution, we pay our respects to the Honuukvetam (Ancestors), 'Ahiihirom (Elders) and 'Eyoohiinkem (our relatives/relations) past, present and emerging.

Disclaimer

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Executive Summary

This report discusses the process by which regulatory frameworks may evolve to fit emerging transportation technologies. It categorizes regulations and describes how recent experiences regulating new shared mobility modes (e.g., micromobility, ride-hail, etc.) may inform regulations for shared automated vehicles (AVs).

Governments issue transportation regulations to address potential negative externalities, among them: public safety, air and noise pollution, collisions, congestion, and wear and tear to the roads. Some of these externalities are immediate (e.g., crash risk), while others develop over a longer time frame (e.g., long-term environmental impacts). Transportation regulations may focus on vehicle technology, individual driver/rider behavior, or the design and pricing of roadways and other transportation infrastructure. Regulations may be outcome-based; for example, a state may establish a cap on the decibel level that an engine can create, which gives automobile firms flexibility to reduce engine noise in the most cost-effective manner. Alternatively, regulations can be prescriptive, specifying particular vehicle requirements. In its best implementations, regulations provide clarity to new markets, thus accelerating innovation by establishing a shared and stable understanding of the rules governing the market. However, if the rules are overly complex, extensive, burdensome, or constantly changing, they can inhibit growth and innovation.

New mobility services operate under multiple systems of regulation. These regulations are set by different levels of government and may carry different compliance and enforcement costs. Regulations intend to balance service availability while mitigating potential negative externalities. Shared mobility operators respond to these requirements in different ways: they may choose to operate in jurisdictions with fewer restrictions, absorb compliance costs, or even benefit from regulation. In some cases, regulatory requirements may make a service economically unfeasible.

There are lessons from existing shared mobility regulations that are extensible to AVs. This report categorizes existing regulations into ten types: safety, data-sharing, vehicles, public right-of-way usage, technology, liability, finance, universal access, public outreach, and hiring requirements. It then identifies six key factors affecting the regulatory environment for shared mobility: policy preference and timing, distributed authorities across different levels of government, modal maturity and similarity to other existing modes, liability/indemnification, compliance, and scaling.

Analysis Methodology

New shared mobility is defined as any transportation service that requires a digital interface to access, and which consumers can access on a per-trip basis, rather than privately owning the vehicle or renting it longer term. The most common deployed services today include micromobility, microtransit, and ride-hail.

Regulations for shared mobility can generally fall into two categories: demand-side user behavior regulations and supply-side operator regulations. While some studies focus on how demand-side regulations affect rider behavior (see for example Lo et al. 2020), this report provides a review and analysis of the ways regulations can affect supply-side operator costs and behaviors. Operator regulations vary widely by place and mode, but the most commonly imposed include permits and operational fees, maximum fleet sizes, minimum service provision, and rebalancing or service geography requirements.

This report documents the multi-layered regulatory environment for new shared mobility, with potential lessons learned for shared autonomous vehicles (AVs). Our study identifies the negative externalities that regulations seek to address and the cost of compliance. Specifically, we analyze:

1. What are the various types of regulations for shared new mobility?
2. What are their intended benefits to operators, public agencies, users, and the public broadly?
3. What are the costs of complying with those regulations, either for operators, public agencies, users, or the general public?
4. To what extent do regulations vary across jurisdictions, and what explains that variance?

This work uses a dual approach. We first examined over 80 Requests for Proposals, regulatory guidance documents, public utilities regulations, and municipal ordinances for micromobility, microtransit, and transportation network companies (TNCs, also known as ride-hail). We also examined over 70 state statutes for micromobility, TNCs and AVs. The sources covered cities and states from across the U.S., including, for example, the states of Arizona, California, Colorado, Florida, Kansas, Maryland, Missouri, Oklahoma, Oregon, Texas, Washington, and Wisconsin, and the cities both large (Los Angeles, Chicago), mid-sized (Kansas City) and small (Tallahassee). The RFP sources and guidance documents are from the years between 2017 and 2025, and the statutes cover the years between 2010 and 2025. Unless otherwise noted as deriving from an interview, the bulk of our analysis stems from document review.

Using these sources, a typology of regulations commonly used across micromobility, microtransit, shared autonomous vehicles, and TNCs is developed. This typology categorizes regulations into ten topic areas, which include requirements for safety, data-sharing, vehicles, public right-of-way usage, technology, liability, finance, universal access, public outreach, and hiring. Interviews are transcribed and coded into these themes; and together with existing

literature on regulation, are synthesized to determine the qualitative costs and benefits of each regulation. Based on the developed typology and interviews conducted, regulations across modes and jurisdictions are compared. We conclude our paper with a discussion of factors affecting shared mobility regulations and explain why they vary across jurisdictions.

Typology of Regulations

Public agencies often issue permits for new shared mobility deployments. These permits are used to define the scope and limitations of the deployment. This section categorizes these scopes and limitations, then discusses how the regulations may vary by mode and the level of government that has the authority to establish the regulation(s).

Safety Requirements

Cities may require operators to provide a safety case (why is the technology safe to deploy) and/or an operational safety plan outlining risk mitigation measures for riders and the public.

In order to assess the operational safety of a deployment, it is necessary to define the scope of the deployment. This may include defining the area of operation, hours of operation, conditions of operation (e.g., weather), maximum fleet size, minimum service provisions, etc. It is also critical to know whether the vehicle is operated by professional drivers (e.g., TNCs and microtransit), by noncommercial private drivers (e.g., car share), by riders who navigate the vehicle but are not required to verify they have a driver's license when they sign up to use the service (e.g., scooters), or by automated systems entirely. If a user is not required to verify having a driver's license, the operator may include more traffic safety instructions in the app or on the vehicle itself. Some cities may limit phone use while operating the vehicle to reduce the risk of impaired riders or distracted driving. See **Table A1** (Appendix) for specific regulations, costs and benefits

Shared mobility programs can be established as a pilot or permanent program, which vary in contract time length, oversight, and renewal process; a government might require operators to acquire a permit to operate, and/or they may require contracts that define regulations for both operators and public agencies. The definition of a 'pilot' varies across contexts and does not always imply a fixed program length. The regulatory locus for shared mobility varies by mode - TNCs and AVs are largely (though not exclusively) governed by state law, while micromobility and microtransit are typically governed by local ordinances and permits. See **Table A1** (Appendix) for detailed definitions, costs and benefits.

Data-sharing Requirements

Public agencies may require operators to disclose data points related to program use, including safety-related data (e.g., crashes, vehicle maintenance, customer-reported issues, etc.) and telematics (e.g., trip speed, trip origin/destination, total number of miles, zero-occupancy miles, etc.). Data sharing requirements vary based on the type of data operators can access, privacy protections, how widely the data can be shared, and how data are stored. Agency access may range from complete ownership over all data produced to limited access to certain data points to minimal to no access to shared mobility data. Unless the program is publicly-owned, agencies typically require some data reporting or access to data but no ownership, and data sharing has become more common over time. Data requirements can pose coordination costs

between agencies and operators but may inform how public agencies incorporate shared mobility services into their existing transportation systems.

Data sharing serves multiple goals: it can provide insight into deployment or travel patterns, forecast congestion, and assist in long-term planning efforts such as locating loading zones or installing dedicated bike lanes. Private companies are, however, often reluctant to provide detailed information regarding ride patterns to public agencies and the broader public, which has led to a range of data-sharing arrangements between regulators and mobility operators. Depending on the mode and arrangement, data is typically provided at either an aggregated level or a more granular, but anonymized level. Practices like this seek to enhance privacy protections but may lose so much spatial resolution that they are no longer meaningful for agencies to draw conclusions or act upon. Data shared with regulatory agencies like city or county planning organizations or state bodies is typically edited and redacted prior to distribution to the public. The locus of data distribution also varies by mode – AV and TNC companies are typically only required to submit data to the state, which may then remit the data to local partners, whereas micromobility and microtransit operators are required to submit data to the local regulating agency (e.g., city, transit agency, department of transportation). Micromobility data regulations tend to be more stringent compared to other modes - many, for example, are required to provide real-time access to location data for vehicles. See **Table A2** (Appendix) for specific regulations, costs and benefits.

Vehicle Requirements

Agencies may specify the types of vehicles and their features that operators can deploy to meet safety, access, or environmental performance requirements. States tend to set vehicle requirements that pertain to various forms of emissions (e.g., electric vehicle requirements for AVs), and the federal government sets safety and accessibility requirements (e.g., paratransit specifics for microtransit). Vehicle requirements vary significantly across jurisdictions for micromobility, which is largely regulated at the local level. Neighboring jurisdictions may require vastly different requirements, such as seats on e-scooters, or specific community outreach events. For AVs, vehicle safety requirements are expected to be set by the National Highway Traffic Safety Administration (NHTSA), whether through the Federal Motor Vehicle Safety Standards (FMVSS) and/or through new rulemaking. See **Table A3** (Appendix) for specific regulations, costs and benefits.

Public Right-of-Way Usage Requirements

Public right-of-way usage requirements for shared mobility define permitted locations for activities such as pick-ups, drop-offs, and riding. They vary across modes and jurisdictions. Some, like speed limits, apply differentially across all modes, whereas others, such as geofencing requirements to restrict sidewalk riding, apply exclusively to micromobility. Spatial requirements are most stringent for micromobility, are highly context dependent, and are generally set by local authorities.

Parking requirements for shared mobility operators, specifically micromobility operators, are intended to prevent users/operators from parking and obstructing the public right of way or in certain areas. These requirements often prohibit parking within a specified distance of transit stops, on private property, or blocking sidewalks. Agencies may create financial incentives for

operators to deploy vehicles in prioritized areas. Operators are typically required to visually display this parking information on the app. Parking requirements can be structured in four ways: operators are sometimes required to lock vehicles to a fixed object, agencies may require users to park vehicles in certain mandatory parking zones, or they may allow for free-floating parking (users can flexibly choose where to end a ride, so long as public right-of-way is not violated). Agencies may also allow for a hybrid approach combining requirements. Contracts typically specify fines for operators when users illegally park vehicles. See **Table A3** (Appendix) for specific regulations, costs and benefits.

Technology Requirements

Technology requirements refer to digital features that users interact with (e.g., apps) and those only visible to operators and public agencies (e.g., software and trip routing). State and local governments may require operators to provide a certain degree of transparency for users in terms of displaying trip logs, as well as how users can book a trip. Public agencies may require operators to use certain software to ensure agencies can access trip data, and specify the type of information that drivers, dispatchers and supervisors can see (e.g., minimizing distractions for drivers).

Liability Requirements

States typically set liability requirements to manage various safety issues, particularly crash risks. The specific insurance types depend on the state and the mode. For services with professional drivers, such as TNCs, states may require that both operators and drivers carry insurance, which may vary based on whether a driver is transporting a passenger or waiting to accept a trip request. To manage crash risks, operators are typically required to carry liability insurance and may be required to indemnify the host jurisdiction against claims or damages. Other types of insurance operators may include cybersecurity and worker's compensation coverage. Operators may also be required to carry a performance bond or letter of credit in the event of a permit or contract breach. See **Table A4** (Appendix) for a list of insurance requirements among states that have passed AV-specific liability requirements.

Financial Requirements

Additional financial requirements levied on shared mobility service providers may take the form of fares, fees, and/or fines.

Fares are paid by users and generally cover operating costs. Agencies may set fare caps or discount zones to meet affordability goals, which the agency may or may not provide subsidies for. Fees are paid by operators and can cover specific services or programs. The money each fee garners may cover an agency's costs to administer a shared mobility program, an operator's cost to provide the service, or generate revenue that can be set aside for specific uses (e.g., dedicated infrastructure, wheelchair accessible vehicles) or go into a general fund. Micromobility operators typically pay higher fees relative to most other modes (particularly TNCs and private driving), though the fees vary greatly in amount and type by city (see Fang and Thigpen, 2024).

Fines serve as a deterrent for violations such as illegal parking, meaning that they are meant to dissuade operators or riders from breaking the rules. See **Table A5** (Appendix) for specific regulations, costs and benefits.

Universal Access Requirements

Some jurisdictions aim to increase mobility and access for those with limited mobility options, whether it be due to abilities (e.g., disabled, elderly, etc.) and/or geographic service coverage (e.g., rural areas, low-income neighborhoods, etc.). About two-thirds of micromobility programs in the US impose at least one requirement aimed to increase accessibility, with about half (46 percent) mandating more than one requirement (Brown and Howell, 2024). Universal access requirements range from process-related requirements (e.g., targeted outreach) to access objectives (e.g., text-to-unlock, cash-based fares). Compliance can be enforced through permit revocation, although it remains unclear if these requirements are effective in practice (Brown and Howell, 2024).

Public Outreach Requirements

Outreach requirements are generally intended to increase public awareness of a shared mobility program to those who might not otherwise be informed about the service, be familiar with its use, or have access in their preferred language. Outreach requirements may include conducting in-person informational events in specific neighborhoods to share information about the service. Operators may be required or volunteer to provide outreach materials, multilingual application interfaces and customer support. Micromobility services are most frequently subject to outreach requirements, while other new mobility services, such as AVs and TNCs, more commonly provide outreach on a voluntary basis.

Hiring Requirements

Public agencies sometimes require operators to comply with certain labor requirements/provisions, which include eligibility requirements for workers, requirements or guidelines related to workforce composition, and incentives to encourage local hiring. Some public agencies may require or recommend hiring categories of staff (e.g., local residents, unionized employees). Some agencies may also rank requests for proposals (RFPs) higher if the operator applicant is owned by socially and economically disadvantaged business owners. Modes that employ drivers, such as TNCs and microtransit, require additional standards such as background checks, training, and minimum ages. States and the federal government set commercial driver requirements. Beyond that, some agencies may establish eligibility for programs supporting disadvantaged business enterprises. Local governments may set preferences for local hiring.

Analysis

The following section discusses the ways that proponents of shared autonomous vehicles can learn from the shared mobility regulatory environment. We describe several factors that shape shared mobility regulations and explain why they vary across jurisdictions:

- policy preference and timing,
- locus of government authority to regulate,
- modal maturity and deviation from existing regulatory regimes,
- liability and indemnification,
- compliance, and
- scaling.

Policy preference and timing

What explains variation in regulatory requirements? Timeline matters. First-mover jurisdictions – areas where services first emerge – may more stringently set requirements than areas that have more time to respond and can learn from early regulatory efforts elsewhere. Policy goals also matter. Regulations may impose greater compliance obligations for operators of services that jurisdictions want to limit, such as electric scooter-share, than for modes that public agencies are actively prioritizing, such as microtransit, or serving areas with limited mobility options. Thus, regulations that add costs to the operator and that limit the scale of the service, such as vehicle-based fees, are more prevalent for micromobility than microtransit. In contrast, agencies may reduce requirements and streamline the process to speed up a program launch, for transportation programs they are eager to adopt.

Locus of government authority affects shared mobility regulations

Governance structure also helps explain the degree of uniformity, or variability, in shared mobility regulations. Regulations are more uniform when states or the federal government set them, such as autonomous vehicles, ridehail services, and microtransit than when local governments set them. Operators generally prefer a more consistent set of regulations and thus may advocate for state-level preemption over local regulatory control, as was the case for TNCs. The federal government (carried out by the National Highway Traffic Safety Administration) is most active in setting vehicle requirements and ensuring compliance with federal accessibility standards. Safety and accessibility requirements are, therefore, generally more uniform, though local governments do sometimes specify that micromobility programs provide a certain proportion of vehicles with “accessible” features (e.g., seats on e-scooters). Micromobility regulations are generally more irregular than those for other modes. Micromobility regulations are typically set by cities and counties, and thus, can vary significantly from one locality to the next. Even within micromobility, however, states may choose to intervene in certain realms of regulation, notably insurance requirements.

Modal maturity

Regulatory differences can reflect how mature a particular technology and/or business model is. The regulatory environment may also evolve over time. Some modes, such as micromobility programs and TNCs, were introduced prior to the development of comprehensive rules, but are now subject to local and state regulation. Generally, public agencies from the local to the federal level have been slow to regulate "disruptive" transportation technologies, whether due to bureaucracy, lack of experience and technical knowledge or data, or to avoid inhibiting market development. This may be especially pronounced with fast-changing technology (Sarewitz, 2011).

Rather than "hard" rules and regulations that may not bend easily to new technology, scholars encourage agencies to adopt "soft" law governance (Hagemann et al., 2018). For example, agencies can choose flexible and dynamic regulations that are outcome-based, or that encourage experimentation in limited areas or for short periods of time (Kaal, 2016).

A pilot program can be a useful way for local governments to test new regulations on a short time scale and with limited physical investment. As part of the procurement process, agencies may initially send a request for information from operators to identify regulations that operators can feasibly comply with. Once a pilot program is underway, they offer public officials protection from potential public outrage; if a new service angers constituents, a city can simply end the pilot, never to renew it again. Pilots also, ideally, provide public officials and private operators with an important learning opportunity; they can test and refine both the service (the vehicles and customer interface), the area it operates in, the number of operators that can be awarded a permit, and the pricing structure.

Over time, RFPs can become more streamlined and standardized. Technology standards have also become more uniform and consistent across RFPs over time. That standardization may, in part, be a result of more tested shared mobility programs. With more completed pilots, cities can look to other cities for best practices and blueprint RFPs.

Deviation from Existing Regulatory Regimes

If a new mode resembles an existing mode, then public agencies may have a better idea of the types of regulations that will be appropriate or useful. Microtransit, though a relatively nascent industry, resembles existing services such as paratransit and TNCs in vehicle type and operating model, and thus regulations show fewer regional differences. In contrast, cities and counties may include a desired list of requirements that operators may or may not be able to comply with, in part because agencies may be unaware of what is and is not feasible.

The less a new technology aligns with the existing regulatory framework, the more differences we may see in how agencies choose to regulate the new mode. A "disruptive" transportation technology is one that may not clearly fit into existing regulatory categories. Biber et al (2022) established a framework for understanding the different types of "disruptions" that innovative businesses may introduce and how policymakers may adapt. Existing regulations may apply to the new technology, may need to be adapted, or must be entirely rewritten to address the new technology. The Biber et al framework then suggests a process for public agencies to react in a way that is agnostic to how a business is organized and instead focuses on how regulations may interact with key policy goals. For example, TNC companies initially leveraged their

ambiguous status as a technology platform to circumvent traditional taxi regulations. In California, TNCs successfully avoided local bans by gaining state preemption. State preemption is common and limits cities' ability to mandate fees or use fees for either financial or policy mechanisms (Lowe et al., 2021). Ride-hail fees can be levied by trip, as a share of the total fare, time of day, and/or if a ride is pooled or solo; rates range widely by city and state (Brown, 2022).

When e-scooters launched, cities had learned from their TNC experiences and tried to prevent a similar regulatory gap. E-scooters were initially in a state of regulatory uncertainty; they did not neatly fit into existing municipal codes. Local governments, who were the first to respond to e-scooter services, reacted in various ways. Most cities created new statutes, whereas others banned e-scooters entirely (Catlin, 2022). In Santa Monica, before the city created statutory definitions for shared micromobility, the city initially categorized e-scooters under vendor laws, which helped the city maintain some regulatory authority over the mode.

Local governments also imposed micromobility parking and docking regulations. Most cities (95 percent) allow e-scooters to park in street furniture/curb zones, but far more ambiguity exists across other locations. 70 percent of cities allow scooters to park against buildings, 62 percent on vegetation or landscaping, and 60 percent against signs (Brown, 2021). The localized nuance creates challenges for operators needing to customize implementations as well as public agency enforcement strategies within each market. It's unclear how effective these regulations are: research suggests that many micromobility regulations, including parking and fleet size, do not bear clear connections to outcomes such as impeded sidewalk access (Brown et al., 2020).

How distinctive AV regulations may be can depend on whether agencies treat the service as legally separate or similar to existing similar transportation services, such as TNCs and micromobility.

Liability and Indemnification

Perhaps the most direct way that states protect the public against the various risks of new mobility is through insurance requirements. With insurance requirements, states have some certainty that a transportation service can afford to make any potential victims whole again.

States may manage risks with a range of liability-related requirements: they may require operators to purchase general liability insurance that covers damages or injuries when users crash their vehicles, cybersecurity insurance for data breaches or other data security threats, worker's compensation for when employees become sick or injured on the job, commercial auto insurance to cover vehicle damages or theft, or uninsured/underinsured motorist insurance when another driver who is uninsured or commits a hit and run causes damage in a crash. Local governments may also require operators to indemnify the city, that is, not to hold the city liable for any claims from users or people who were injured or suffered property damages in a crash. Mobility providers, too, might protect themselves from having to pay for damages by requiring riders to sign an agreement that severely limits the scenarios under which they can claim damages from the operator or technology company that provides the app (Stoeltje et al., 2023). A pedestrian caught in a collision with a scooter, for example, could still claim damages from the scooter rider; if the rider does not have the means to pay them, and the city and scooter company are legally protected, then the pedestrian may have little recourse. Some states carve

out exceptions, however, for incidents beyond "ordinary negligence," such as recklessness, illegal acts, or gross negligence (Stoeltje et al., 2023).

Insurance companies may determine their rates based on a number of factors: risk history (past crashes and theft incidents, and previous claims) and exposure to risk (telematics, such as vehicle miles traveled, speed, braking patterns; neighborhood characteristics, such as dangerous intersections, and denser areas with higher crash rates). Mobility providers in turn may try to reduce their rates by providing safety performance statistics.

Setting insurance requirements for a new transportation mode like shared AVs is a challenge. With limited publicly available data on crash risk, state-set insurance requirements may not reflect actual risk. Furthermore, the different types of AV offerings (fleet owned and operated, privately owned and exclusively privately used, privately owned and occasionally publicly rented) may present different operational risk profiles beyond the inherent safety of the vehicle.

Compliance

How regulations are set can impact compliance. If an industry participates in creating rules and regulations, then they will be more likely to view the regulations as fair and reasonable, and then to follow them (Ayres and Braithwaite, 1992). The size of the firm also matters; larger firms with more resources, such as legal departments, are more likely to comply than a smaller, less-resourced one (Trebbi and Zhang, 2022). When the cost and risk of complying with regulations outweighs the benefits, shared mobility firms may choose to risk ignoring the rules (Becker, 1968). This has been observed with e-scooter services: some jurisdictions require providers to service certain areas but are lax about enforcement. Inspections are an important deterrent (Gray and Scholz, 1991). Fines deter both the sanctioned company from falling out of compliance in the future, as well as other companies in the same industry who see that the regulations have teeth (Shimshack and Ward, 2005). If cities lack resources to consistently inspect mobility programs, then the mobility companies may choose to risk getting fined for falling out of compliance.

Moreover, the regulations must be clear for firms to follow them; regulatory ambiguity gives firms room to interpret requirements in ways that are most advantageous to the firm (Edelman, 1992). Similarly, users may break traffic laws if they are unfamiliar with them or the laws themselves are unclear. For example, when the traffic laws for e-scooter use are unclear or unfamiliar (e.g. where people may ride on sidewalks or roadways), riders may engage in unsafe behavior (Useche et al., 2022).

For new shared AV services, companies are likely to be particularly careful to follow all regulations because they risk losing consumer trust in a revolutionary new technology. This desire to earn public trust incentivizes industry and public sector agreement on precise definitions of regulatory terms. However, this can be a non-trivial feat. For example, how can all parties agree on the definition of something as simple as a stop? Some local traffic regulations define it to include a distance from the stop bar, while others specify the driver must come to a complete halt (e.g. California Vehicle Code §22450 vs California Driver Handbook, Section 7: Laws and Rules of the Road). It becomes even more difficult to define what constitutes a careful and competent driver, much less enforce such a concept.

Scaling

Jurisdictions typically test new mobility regulations under a pilot program prior to enabling full deployment. A pilot program for AVs generally allows operators to operate for a limited time period and within a limited-service area. Under a pilot program, an operator may be required to be physically present in driver's seat of vehicle. If there is not an operator physically in the vehicle, a remote operator is usually required to be able to take control over the vehicle. Pilot program rules may or may not allow for passengers, and the operator usually cannot collect fares for rides. The service hours may be limited depending on weather conditions and time of day. In contrast, once AVs are fully deployed, the operator can generally operate without an operator present in the vehicle. The service is eligible to operate under a longer time frame, and operators are allowed to collected fares.

To scale up, programs benefit from economies of scale (e.g., the fixed infrastructure costs of charging per vehicle decrease as more vehicles use them), as well as from network economies (e.g., shared bikes and scooters become more useful the bigger the network is). Also vital to the scaling process is that organizations learn from the successes and missteps of any pilot and early deployments.

Two regulatory challenges can inhibit scaling. First, pilot programs may operate in a “protected niche” where public agencies have temporarily simplified or reduced existing regulations to enable a pilot program to deploy more quickly or cheaply (Van Winden and Den Buuse, 2017). When pilot programs evolve into permanent ones, scaling up may be difficult because these protections have gone away or there is a more competitive procurement process.

Second, policies, subsidies, and regulations may be volatile, particularly when it comes to an emerging transportation mode. That instability and uncertainty may cause operators to abandon a program or move to a more certain regulatory context. This was observed when GM Cruise and its robotaxi service was dissolved following an October 2023 safety incident, and GM subsequently decided instead to focus on development of personally owned L2+ vehicles (Korosec and O’Kane, 2024).

Conclusion and Future Work

This report covers a subset of shared mobility regulations, ones that exemplify the types of requirements that public agencies may require of operators. In part, the volume of regulations mirrors the multiple policy goals that public agencies seek to address with regulation (Pinski et al., 2025). Agencies want to protect public safety, reduce air pollution, promote local employment, and various other policy goals. Some outcomes may be out of an operator's control, such as city-wide air pollution reduction goals for bikeshare programs, and some policy goals are more costly to effectively address than others. The operators interviewed were willing to pursue these public policy goals but emphasized the need for stronger public-private partnerships to ensure requirements were cost-effective and designed to support long-term benefits.

A number of other factors explain the broad variation in regulations across modes and jurisdictions. One key factor is public agency demand: if an agency wants a mobility program, they may ask for fewer or more lenient requirements and may streamline the permitting process. If public agencies try to use regulation to address policy goals outside of expanding mobility, however, they may increase costs for operators and users that ultimately reduce the transportation benefits of a service (Pinski et al., 2025). For example, public agencies may require union or local hiring, or specify additional vehicle features, which can affect costs and ridership outcomes.

A second key factor that determines regulatory variation is the locus of government. The higher the level of regulation (e.g., state rather than city), the more uniform the regulations are across space and programs. By contrast, more localized regulatory control yields more varied requirements across jurisdictions. Shared mobility operators often advocate for state-level regulation or preemption to achieve regulatory consistency.

A third factor in the shared mobility regulatory landscape is service model maturity. This may encompass technology and/or business model maturity. Often, the more mature a model, the more that cities and states can mimic the already-tested regulations other agencies have adopted, then adjust it as needed to fit their local context. Some of these adjustments may increase or decrease operator costs, e.g., jurisdictions may issue permits that have particularly expensive additional requirements for operators, such as a particular form of insurance.

The degree of perceived risk guides a significant area of shared mobility regulation: that of liability. States typically set liability requirements to manage various safety issues, particularly crash risks. Some liability costs are not specific insurance requirements themselves, but other mobility program requirements that expose an operator to higher risk. For example, indemnification requirements essentially enable cities to legally protect themselves as much as possible from any potential damages and resulting lawsuits in the case of a crash. From the perspective of a public agency, new shared mobility services represent new reasons for people to sue the city and drain its budget. Without sufficient data on crash risk in different environments, however, liability requirements may not accurately reflect actual risk. On top of actual risk varying across environments (e.g., sunny versus snowy), jurisdictions may estimate risk differently, resulting in substantially different requirements across different places.

Regulations may change over time. Early on, public agencies often experiment with regulations for a new mobility service via pilot programs. Pilot programs provide operators with formal permission to operate and offer local governments the opportunity to see which requirements are beneficial and which are burdensome, and whether the service model can meet their public goals. Agencies may learn which regulations are more or less costly to comply with, and which are easiest to enforce. However, even pilot regulations can quickly become permanent. We found that state statutes such as insurance requirements rarely change once passed, and when local governments changed regulations for a shared mobility program, they often removed certain requirements only to add new ones. Once scaled up to full deployment, shared mobility program requirements are stickier to change.

Future Work in the Study of Autonomous Transportation Regulations

This report documents the types of regulations that commonly pertain to new shared mobility services, and the typical level of government that sets them. The regulatory framework for mobility services is generally understudied, in part because regulations, particularly local ones, are so wide-ranging and change over time. Some areas that could benefit from greater understanding of new shared mobility regulations include:

- More comprehensively cataloguing Requests for Proposals, as well as service contracts, to measure exactly how requirements change across jurisdictions, by service model, and over time.
- Quantifying the compliance cost of each regulation for operators and public agencies, although these values may be both business-sensitive and challenging to estimate.
- Measuring the extent to which operators comply with regulations.
- Understanding autonomous vehicle goods delivery, including delivery robots.
- Understanding how regulations relate to land use for autonomous mobility, and the ways the operators may navigate complex requirements such as dynamic use of the public right-of-way, parking requirements and restrictions, and electric charging infrastructure at centralized depots or dispersed across a jurisdiction.

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Appendix

Table A1. Driver and Operations Safety Requirements for Autonomous Vehicles

Term	Law Enforcement Interaction Plan	Map of Operational Design Domain (ODD)	Passenger Safety Plan
General Definition	Requires AV operators to submit a plan that offers guidance and information to help law enforcement effectively interact with AVs.	Requires AV operators to submit a map showing the boundaries of the operation of the vehicle. May also require conditions and operational limitations placed on vehicles.	Outlines how AV operators will ensure the safety, accessibility, and well-being of passengers. It may address risk prevention, incident response, passenger communication, safe boarding and exiting, and protections for shared rides.
Costs	Added financial costs to operators; Potential increased costs to riders	Added financial costs to operators; increased compliance requirements; Potential increased costs to riders.	Added financial costs to operators; increased compliance requirements; Potential increased costs to riders.
Benefits	Increased public safety; Enhanced transparency for responders	Increased public safety, enhanced transparency	Increased rider safety, Accountability.

Table A2: Data Requirements for Autonomous Vehicles

Term	Passenger receipt	Record Retention	Crash Reporting Requirements
General Definition	This category includes regulations related to the content and format of electronic receipts issued to passengers for shared AV services. Requirements might include providing key trip details such as the point of origin and destination, total duration and distance of the ride, and a clear itemization of any fares or charges applied.	Specifies how long various records must be stored including: trip records, records of complaints and resolutions, accident records, etc.	Specifies that AV operators must submit detailed reports on crashes occurring within specific timeframes. Reports might include data on the number of incidents or amounts paid for bodily injury, fatalities, and property damage resulting from those crashes.
Costs	Added financial costs to operators; Potential increased costs to riders	Added financial costs to operators; potential increased costs to riders.	Added financial costs to operators; Potential increased costs to riders.
Benefits	Added financial costs to operators; Potential increased costs to riders	Enhanced transparency for regulators and auditors	Enhanced transparency for riders
Benefits	Added financial costs to operators; Potential increased costs to riders	Enhanced transparency for regulators and auditors	Enhanced transparency for riders

Table A3. Vehicle and Spatial Public Right of Way Usage Requirements for Autonomous Vehicles

Term	Trade markings	Solicitation
General Definition	Requires that AVs need to have a symbol or marking that makes it clear that the vehicle is an AV.	Specifies areas where shared AV operators cannot solicit passengers.
Costs	Added financial costs to operators; Potential increased costs to riders.	Limits flexibility for operators and riders.
Benefits	Increased visibility and identification for first responders.	Adds protections for competing transportation types, potentially increases safety.

Table A4. State Insurance Requirements for Shared Autonomous Vehicles

State	Code Section	Year passed	Insurance requirements	Liability Limit (Relative to conventional)	Non-commercial passenger limits
Alabama	Code of Ala. § 32-9C-4	2024	$1,000,000 per accident for death, bodily injury, and property damage to a third party.	10x	25/50/25 k
Arizona	A.R.S. § 28-9702	2021	25/50/15 k	1x	25/50/15 k
Arkansas	A.C.A. § 27-51-2002	2021	$750,000	7.5x	25/50/25 k
California	Cal Veh Code § 38750 & Cal. Code Regs. tit. 13, § 227.08	2012	$5,000,000	47x	30/60/15 k
Colorado	C.R.S. 42-4-242	2017	25/50/15 k	1x	25/50/15 k
Florida	Fla. Stat. § 627.749	2019	$1,000,000 for death, bodily injury, and property damage	50x	10/0/10 k
Georgia	O.C.G.A. § 40-8-11	2017	100/300/50 k	4.5x	25/50/25 k
Iowa	Iowa Code § 321.516	2019	20/40/15 k	1x	20/40/15 k
Kansas	K.S.A. § 8-2903	2022	25/50/25 k	1x	25/50/25 k
Kentucky	KRS § 186.766	2024	$1,000,000	11x	25/50/10 k

State	Code Section	Year passed	Insurance requirements	Liability Limit (Relative to conventional)	Non-commercial passenger limits
Michigan	MCLS § 257.665	2013	20/40/10 k	1x	20/40/10 k
Mississippi	Miss. Code Ann. § 63-35-11	2023	25/50/25 k	1x	25/50/25 k
Nebraska	R.R.S. Neb. § 60-3304	2018	25/50/25 k	1x	25/50/25 k
Nevada	Nev. Rev. Stat. Ann. § 482A.060	2013	$1,000,000	10.5x	25/50/20 k
North Carolina	N.C. Gen. Stat. § 20-401	2017	30/60/25 k	1x	30/60/25 k
North Dakota	N.D. Cent. Code, § 39-01-01.2	2019	25/50/25 k	1x	25/50/25 k
Oklahoma	47 Okl. St. § 1704	2022	$1,000,000	10x	25/50/25 k
Pennsylvania	75 Pa.C.S. § 8508	2022	$1,000,000	20x	15/30/5 k
South Dakota	S.D. Codified Laws § 32-41-4	2024	25/50/25 k	1x	25/50/25 k
Tennessee	Tenn. Code Ann. § 55-54-102	2017	$5,000,000	50x	25/50/25 k

State	Code Section	Year passed	Insurance requirements	Liability Limit (Relative to conventional)	Non-commercial passenger limits
Texas	Tex. Transp. Code § 545.454	2017	30/60/25 k	1x	30/60/25 k
Utah	Utah Code Ann. § 41-26-107	2019	30/65/25 k	1x	30/65/25 k

Table A5: Financial Requirements

Term	Fees	Fares	Insurance Requirements
General Definition	Taxes and fees on shared AVs. Examples include application fees and annual assessment fees.	Cost to use the shared AV service. Specific requirements may include that the fare rate be posted online or through an app. May also require that customers can access the total estimated fare amount.	Specifies what amount of insurance is required for shared AVs.
Costs	Added financial costs to operators; Potential increased costs to riders.	Added financial costs to operators; Added operational costs to operators; Potential increased costs to riders.	Added financial costs to operators; Potential increased costs to riders.
Benefits	Revenue generation for governments.	Enhanced transparency for riders.	Added potential financial payments for shared AV crash victims.

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