

Appendix J. Smart Growth and Urban Freight Considerations

Recent and impending technological advancements stand to revolutionize urban transportation. From autonomous vehicles and intelligent transportation systems to shared- and micro-mobility (i.e., electric scooters, bikeshare), many facets of urban transportation are evolving, and urban goods movement is no exception. The rapid increase of e-commerce as a share of global retail sales has reduced the number of trips that households must make to buy goods, but this reduction in trips has been offset in many metropolitan areas by increases in package delivery trips.³⁹⁷ The wide availability of many commonly demanded products through online retailers like Amazon resulted in large increases in rapid direct-to-consumer package deliveries. Online retailers like Amazon can deliver many products the same day they are ordered by consumers.³⁹⁸ The resulting increase in delivery trips has increased competition for limited curb space in many metropolitan areas, as goods movers must share the curb with Transportation Network Companies (TNCs), transit vehicles, parked automobiles, bicyclists, and pedestrians.³⁹⁹

As the global transportation and goods movement industries evolved over time, cities rapidly grew and are expected to continue this trend in the future. According to the World Bank, 55 percent of the global population lives in urban areas today; by 2050, 68 percent of the global population will be urban.⁴⁰⁰ In California, 95 percent of the population lived in urban areas in 2010, compared to 94 percent in 2000.⁴⁰¹ As the world becomes more urbanized, the demand for commercial activity will continue to increase as people consume more goods and services than ever before, driving up competition for both space and resources.⁴⁰²

From an urban planning perspective, the growth of cities has resulted in many negative consequences, including increases in GHGs from automobile use and industrial activity, and sprawling development patterns that consume large quantities of land. This has led to the adoption of 'smart growth' as a planning philosophy, which aims to promote "compact development (moderate to modestly high density), a mixture of land uses in that development, and a range of feasible transportation options that promote and facilitate the use of modes of travel other than the automobile (e.g., transit, bicycles, and walking)".⁴⁰³

While the achievement of smart growth goals may ultimately serve to make cities more livable for people, it also presents challenges to the urban goods movement industry, which has historically been overlooked in metropolitan planning processes. While the achievement of smart growth goals will undoubtedly supply many benefits to urban populations, urban planners and local governments must be mindful of the needs of the goods movement industry and urban consumers and businesses, which are all central to the urban economy.

Smart Growth

Urban areas in the United States have historically been automobile-centric environments, and the urban planning profession has contributed to this through the development of such policies as minimum parking requirements, minimum lot sizes, and restrictions on development density.⁴⁰⁴

Automobile dominance in the United States has been intensified since the 1950s by the interstate highway network, which served to improve connectivity within and between urban areas, making extensive automobile travel both possible and attractive. However, population density has been increasing in most California cities over the past thirty years as an increasing share of the state's population is choosing to live in urban areas, which is increasing competition for road infrastructure, as the urban goods movement industry must share the road with an increasing number of personal automobile users.

Figure J.1 shows a map of the percent change in urban population density from 1990-2019 (in people per square mile) for California cities with a population of 100,000 or more; 35% of those cities experienced an increase in population density of 1-25%, and 31% experienced an increase of 25-50%. Three cities experienced an increase in population density of 200-500%, and two cities experienced an increase greater than 500%, suggesting that little or no development existed in those areas prior to 1990. The areas with the largest increases in population density are in the Sacramento area and in Southern California between Riverside and Carlsbad.

Expansion of the roadway infrastructure in urban areas has facilitated economic growth, including within the freight industry; however, the widespread adoption of automobile-oriented urban development results in many negative consequences, including increased GHGs and associated reductions in air quality due to automobile dependence, increased quantities of impervious surfaces and associated degradation of water quality due to polluted runoff, and loss of open space due to increased land consumption, to name a few.⁴⁰⁵

As awareness of the impacts of automobile dependency has grown, urban planners and policy makers have increasingly looked to policies under the umbrella of 'smart growth' to enhance the livability of cities and curtail the negative impacts of automobile dependency.⁴⁰⁶ In California, several pieces of legislation (AB 32, SB 375, SB 743, SB 50) have been passed or proposed to advance smart growth priorities. SB 375 requires CARB to set regional targets for GHG reductions and requires metropolitan planning organizations to include a 'Sustainable Communities Strategy' detailing how those reductions will be achieved.⁴⁰⁷ Once fully implemented, SB 743 will change the way transportation impact analysis is conducted in California, shifting the focus from measuring traffic congestion to measuring the impacts of driving using key metrics such as VMT per capita, VMT per employee, and net VMT, which will incentivize denser land use development thus reducing lengths of overall trips⁴⁰⁸ SB 50 seeks to incentivize residential development projects that provide high job accessibility or transit accessibility, both of which would reduce the need for vehicle trips.⁴⁰⁹

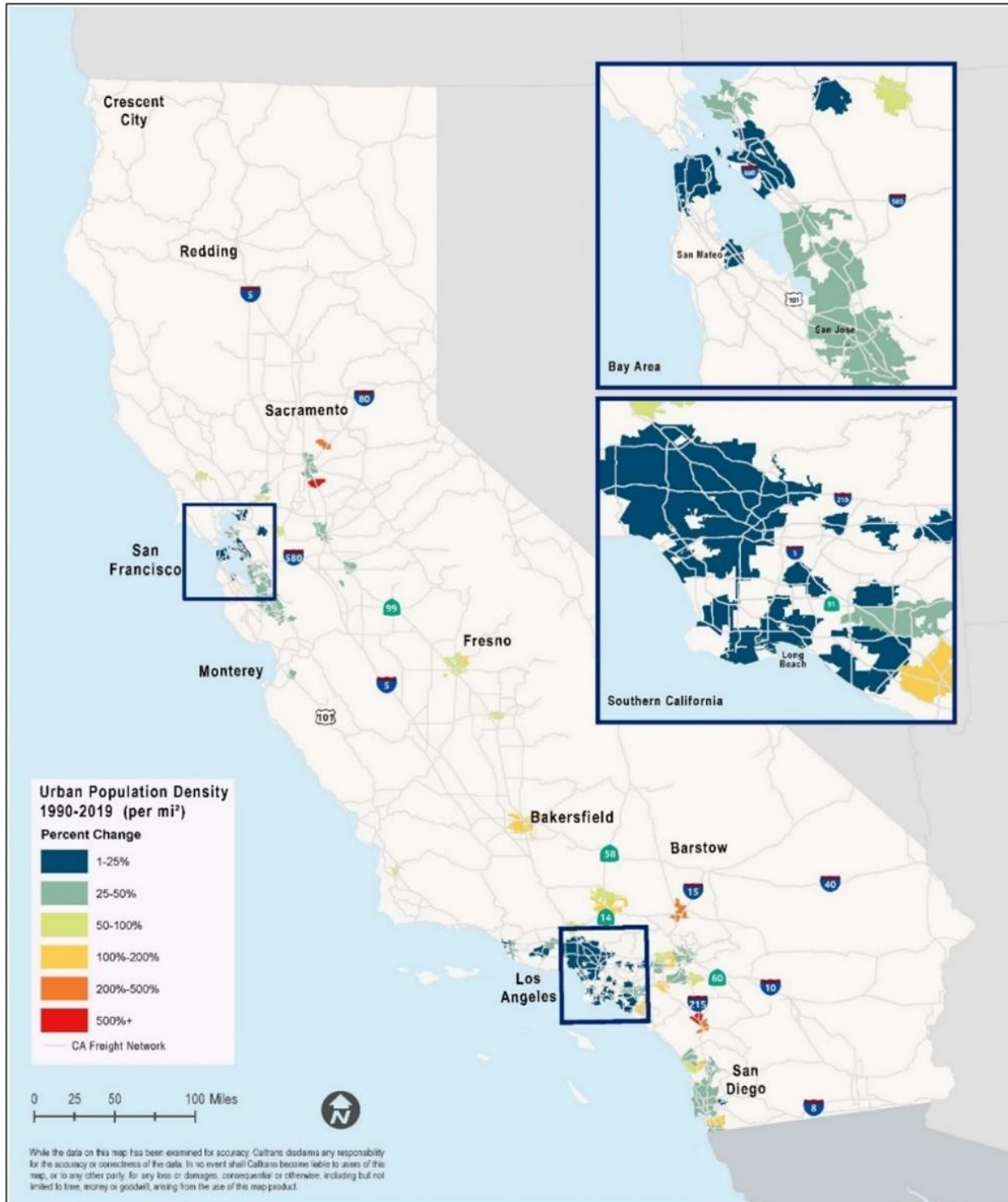


Figure J.1: California Urban Population Density Change in Major Cities, 1990-2019 (Source: Map created by Fehr & Peers, Data from U.S. Census Bureau, 1990-2019)

Historical urban development patterns in the United States have often been characterized as 'sprawling,' which is indicative of an increase in per capita land consumption and an increase in the distance between trip origins and destinations, both of which drive up the cost of providing urban services.⁴¹⁰ In contrast to sprawling development patterns, smart growth policies "result in more compact, multimodal development, reduce per capita land consumption and the distances between common destinations, which reduces the costs of providing public infrastructure and services, and improves accessibility and reduces per capita motor vehicle travel, which in turn provides economic, social and environmental benefits".⁴¹¹ In its 2006 report, *This Is Smart Growth*, the U.S. EPA identified ten fundamental principles of smart growth to guide metropolitan planning and development decisions.

Table J.1: U.S. EPA Smart Growth Principles

U.S. EPA Smart Growth Principles	
1.	Mix land uses
2.	Take advantage of compact building design
3.	Create a range of housing opportunities and choices
4.	Create walkable neighborhoods
5.	Foster distinctive, attractive communities with a strong sense of place
6.	Preserve open space, farmland, natural beauty, and critical environmental areas
7.	Strengthen and direct development towards existing communities
8.	Provide a variety of transportation choices
9.	Make development decisions predictable, fair, and cost effective
10.	Encourage community and stakeholder collaboration in development decisions

Source: *This Is Smart Growth (US EPA 2006)*⁴¹²

Implementation of the Smart Growth principles impacts planning and development decisions by increasing urban building density and reducing car dependency by mixing residential, retail, office, and light manufacturing land uses, reducing street widths, and supplying a wide range of destination types within walking or bicycling distance of residential locations across the socioeconomic spectrum. Although this has far-reaching benefits for livability and quality of life in urban areas, several of the Smart Growth principles present challenges for the urban goods movement industry.

Several studies have attempted to quantify the benefits of smart growth compared to the costs of sprawl. Ewing and Hamidi created an index to measure urban compactness.⁴¹³ The index was constructed using data from the Census and the U.S. Geological Survey's National Land Cover Database and involved principal component analysis of six weighted factors: gross population density in persons per square mile; the percentage of the county population living at low suburban densities of 100 to 150 persons per square mile, corresponding to less than one housing unit per acre; the percentage of the county population living at medium to high urban densities of more than 12,500 persons per square mile, corresponding to roughly eight housing units per

acre; the net population density of urban places within a county; the average block size; and the percentage of blocks with areas less than 1/100 square miles, corresponding to the average size of an urban block. The authors found that nationally, a 10 percent increase in an urban area's compactness score was associated with a 0.6 percent decline in average household vehicle ownership and a 7.8 – 9.5 percent decline in VMT, while walking commute mode share increased by 3.9 percent and public transit commute mode share increased by 11.5 percent.^{414,415} The San Francisco-Oakland, Oxnard, and Los Angeles-Long Beach-Anaheim urbanized areas ranked among the top ten most compact urbanized areas in the nation according to the study.

In a meta review of 300 academic papers studying the impacts of compact urban forms, Ahlfeldt and Pietrostefani (2017) found that 69 percent of the studies reviewed uncovered positive effects associated with increases in compactness, including higher wages, increases in local public spending, pollution and energy use reduction, and increases in non-car mode choice, among others.⁴¹⁶ More than 70 percent of the studies reviewed attributed positive impacts to increased economic density, while 56 percent attributed positive impacts to increased built environment density, and 58 percent attributed positive impacts to an increase in the proportion of mixed land uses.

While a large body of literature has examined the benefits of smart growth for personal travel and livability, relatively little work has been done to examine the impacts of smart growth on urban goods movement. The existing body of knowledge concerning the impacts of smart growth on urban goods movement is presented in detail in later in this chapter.

URBAN GOODS MOVEMENT

Urban goods movement refers broadly to the movement of products, including package delivery and waste management, throughout urban areas.⁴¹⁷ More specifically it is “the complex network of vehicular modes, technological systems and physical structures controlled by people that are responsible for sending and receiving goods.”⁴¹⁸ Given that urban areas are major sources of demand for goods and many freight trips originate or end in an urban area (first mile/last mile), urban goods movement is a major part of the broader freight industry and the economy at large.

Figure J.2 provides a map of urban population density in 2019 for California cities that have a population of 100,000 or more, highlighting the geographic locations throughout the state that support the urban goods movement industry. In California, ninety-five percent of the population lives in urban areas (including outlying suburban areas), and the state's annual gross domestic product (GDP) of more than 2.4 trillion dollars accounts for approximately 14 percent of the nation's GDP; goods production and movement within and between urban areas throughout the state undoubtedly plays a major role in the economic growth of California and the country.⁴¹⁹ Ultimately, goods movement forms the backbone of California's economy, as every California resident and business depends on the prompt delivery of various goods from their place of manufacture to where they are consumed.

Urban goods movement as an industry has undergone rapid change in recent years and is expected to continue at a similar pace as new technologies reach widespread adoption. Within the past decade, e-commerce has exerted a strong influence on urban goods movement, affecting both the quantity and the timing of deliveries. The majority of e-commerce establishments and employees are located in California.⁴²⁰ Additionally, the top five buying

markets in the country in terms of price for industrial commercial real estate are located in California (Los Angeles, San Francisco, Oakland, Sacramento, and San Jose), and this is connected to the increase in demand from big box retailers for fulfillment centers used to ship online orders.⁴²¹

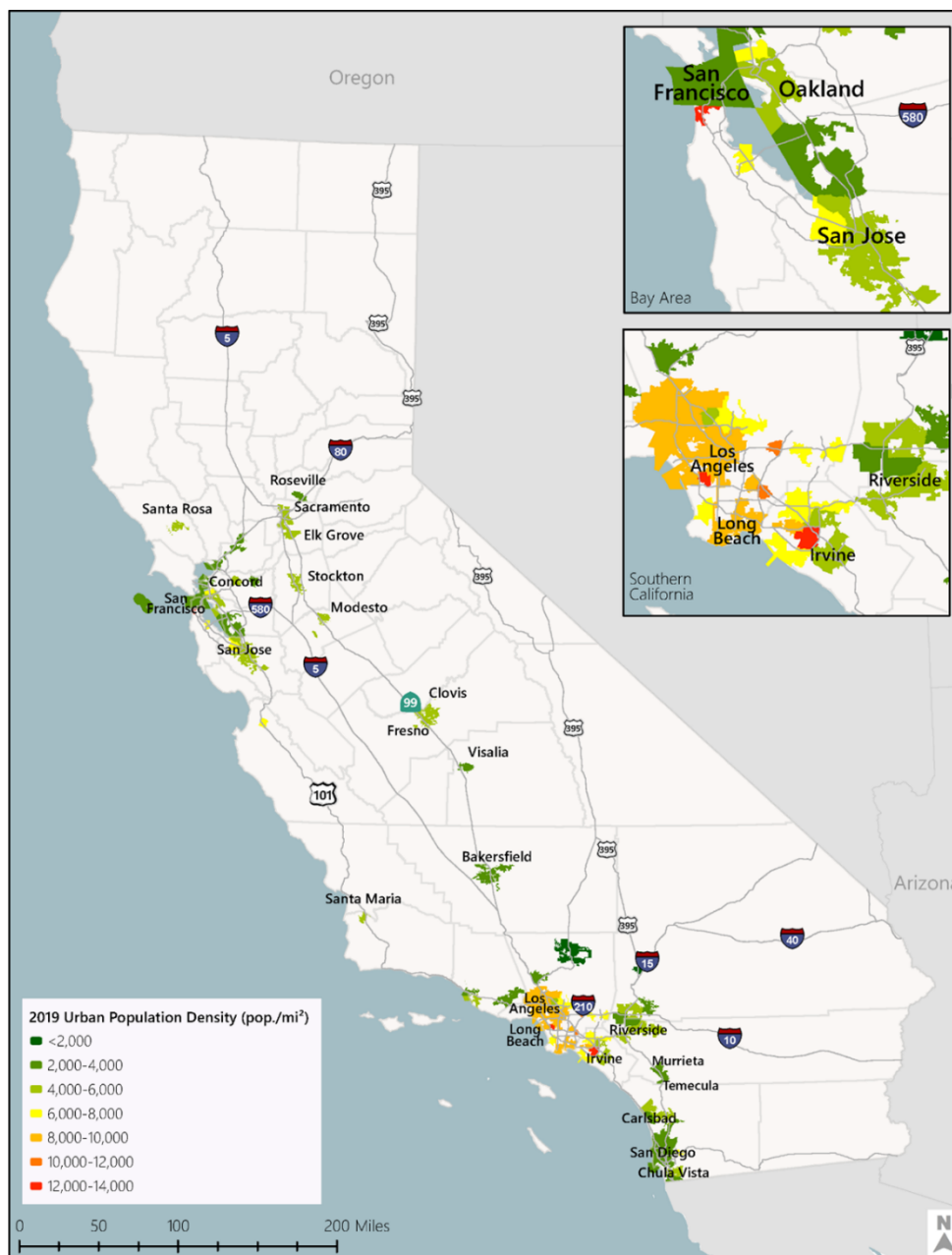


Figure J.2: 2019 California Urban Population Density in Major Cities (Source: Map created by Fehr & Peers, Data from U.S. Census Bureau, 2019)

While the shift toward e-commerce has had a large impact on deliveries to private residences, requiring more frequent deliveries and a greater number of delivery vehicles to meet the demand, commercial businesses have also been affected. According to the Volvo Research and Educational Foundations, “Online sales are growing three times faster than traditional retail sales and companies have shifted to just-in-time deliveries – receiving goods only as they are needed to reduce inventory cost – requiring more frequent and customized deliveries.”⁴²² This has become standard practice for many businesses as they look to maximize revenue in the face of increasing urban rents. Shifting to just-in-time deliveries has also increased the frequency of deliveries and the number of delivery vehicles needed.

A burgeoning technology that stands to radically transform the entire transportation industry – including goods movement – is vehicle automation. While substantial investments have been made in vehicle automation for personal transportation, the goods movement industry will be impacted as well.

Autonomous vehicles (AVs) are projected to supply several benefits: safety improvements, congestion reduction, and greater fuel efficiency. According to Bucsky (2018), “the associated benefits of AV technologies in goods transport can be categorized into three groups: (1) traffic related gains (lower travel time, shrinking costs, less traffic), (2) economic (financial benefits for transport companies, e.g. lower costs, restructuring of market), (3) safety and environment.”⁴²³ Bucsky notes the many potential implications of shifting to AV technology to the goods movement industry, one of which is the displacement of a human driver.

Alternatively, other automation scenarios may be adopted including truck platooning, in which a convoy of several trucks would be operated by a single human driver in the lead truck; highway automation with drone operation, in which a human operator would remotely control trucks on local streets, but allow the truck to operate autonomously on highways; and highway exit-to-exit automation, in which a human driver would navigate a load through local streets and complex driving situations such as congested urban freeways with many on and off ramps and then attach the load to a self-driving truck for long-haul travel on the freeway.^{424, 425}

While much research has focused on the potential benefits of AV technology to the transportation industry and the goods movement industry specifically, widespread adoption of the technology may also create significant challenges for goods movement. According to a report by Viscelli (2018), adoption of autonomous trucks for long-haul deliveries will potentially have major implications for employment in the freight industry, threatening nearly 300,000 trucking jobs. Without policy intervention to protect jobs, “the most likely scenario for widespread adoption involves local human drivers bringing trailers from factories or warehouses to ‘autonomous truck ports’ (ATPs) located on the outskirts of cities next to major interstate exits. Here, they will swap the trailers over to autonomous tractors for long stretches of highway driving. At the other end, the process will happen in reverse: a human driver will pick up the trailer at an ATP and take it to the destination.”⁴²⁶

SMART GROWTH & URBAN GOODS MOVEMENT

Smart growth goals and urban goods movement priorities often appear to be at odds with one another. From a smart growth perspective, the increase in delivery vehicle trips that has resulted from the growth of e-commerce and just-in-time deliveries stands in stark contrast to the goals of reducing vehicle miles travelled, greenhouse gas emissions, and automobile congestion on

urban streets. The mechanics of goods movement is often taken for granted by urban planners, local governments, and consumers alike because goods are expected to be delivered on time and in enough quantities to keep the economy running. However, the process of moving goods where they need to go is often seen as a nuisance.

According to the Guidebook for Understanding Urban Goods Movement (Rhodes et al. 2012), “Cities are quickly becoming the most concentrated, dense consumer market in history. Meanwhile, the capacity of urban transportation infrastructure has increased only modestly. Urban design and regulations affecting how freight moves in modern cities have failed to keep pace with the growing demand for goods and services, and the transportation systems that support modern logistics and supply chain management.”⁴²⁷ Concrete steps must be taken to align smart growth and urban goods movement priorities to ensure that the economic engine of the goods movement industry is able to perform at its peak ability while simultaneously improving the livability of cities and reducing their environmental impacts. Seven key stakeholders will be needed to make this happen⁴²⁸:

- government (including transportation planning agencies),
- communities and residents,
- shippers,
- truckers,
- distribution and warehouse facilities,
- property owners and managers, real estate developers,
- commercial establishments

FREIGHT EFFICIENT LAND USES

Freight Efficient Land Uses (FELU) refers broadly to land-use that minimizes the private and external costs associated with the production, transportation, and consumption of goods, including reverse and waste logistics. As alluded to previously in this chapter, goods movement and land-use connections have been overlooked in the past in terms of supporting the industry while also reducing the negative impacts to communities. The private sector is often only concerned with the private costs associated with selecting a location for facilities without consideration of the external impacts like emissions, noise, aesthetics and congestion. Therefore, it is important for local, regional and state agencies to approach freight land-uses through an efficiency lens that considers everyone as part of the costs of moving goods.

In its 2022 Research Report, *Planning Freight-Efficient Land Uses*, NCHRP identifies 5 FELU principles to guide local land-use practitioners and transportation professionals on how to take action and create an FELU program.

Table J.1: FELU 5 Principles

FELU 5 Principles

1. **Minimize the Private and External Costs of Supply Chains and Their Stages.**
2. **Reduce the Distance Traveled at Supply Chain Stages, Upstream and Downstream.**
3. **Mitigate, or Eliminate, The Externalities at Supply Chain Nodes and Large Traffic Generators.**
4. **Recognize and account for local conditions.**
5. **Engage all Stakeholders**

Source: Planning Freight-Efficient Land Uses (NCHRP Research Report 998 2022)

POLICY AND INFRASTRUCTURE IMPACTS

Delivery trucks contribute to and are affected by congestion in metropolitan areas. This creates significant economic inefficiencies for the urban goods movement industry while also hindering the achievement of smart growth goals by worsening congestion and causing increases in greenhouse gas emissions. According to the report, *Urban Freight for Livable Cities*, urban goods movement – which constitutes the ‘last mile’ of the logistics chain – accounts for more than a quarter of the total cost of freight transport.⁴²⁹ The Texas A&M Transportation Institute states that trucks generate 17 percent of the cost of congestion in the United States but represent only 7 percent of all traffic.⁴³⁰

Because urban roads are narrower than freeways and serve more user types, deliveries within cities typically cannot be made using full-size trucks. Instead, deliveries are made by trucks that are approximately one-third of the size of a full-size truck, which necessitates the use of more delivery vehicles and increases inefficiency in the logistics chain—including additional miles travelled and land use compatibility issues associated with freight transfers from line haul to local trucks. Compounding the problem, many trucks on urban roadway networks are only partially loaded or may be empty. According to the Volvo Research and Educational Foundations, “in the U.S. trucks generate 20 billion miles each year while driving empty”.⁴³¹ Implementation of Principles 2 and 4 of the US EPA Smart Growth principles could present direct challenges for truck movement in urban areas since it may result in the narrowing of urban streets. Considering this, planners and policy makers should consider the turning radius requirements at intersections of urban freight delivery vehicles when evaluating projects that narrow streets by adding pedestrian and bicycle safety infrastructure and amenities. In some cases, alternative goods movement routes can be chosen to ensure that delivery vehicles can access the destinations they need to access, while still improving walkability and compactness in strategically chosen locations.

Many urban road narrowing projects are undertaken to provide ‘complete streets’ that serve all users instead of focusing on maximizing efficiency for motor vehicles at the expense of other travel modes. A growing body of research is now exploring how urban goods movement can be integrated into the complete streets conceptual framework. Alison Conway of the City College of New York recommends conducting corridor studies to identify where urban bicycle and freight networks overlap, as these can be key points of conflict for infrastructure design.⁴³² In addressing specific goods movement needs when designing or changing infrastructure, Conway recommends adhering to seven overarching themes:

- selecting a design and control vehicle;
- supplying adequate space for safe large vehicle turns;
- reducing the frequency of severity of conflicts between large vehicles and vulnerable roadway users;
- reducing speeds without unintended detrimental impacts on operations and safety;
- supplying network connectivity and redundancy;
- supplying adequate space for vehicle parking, loading, and delivery operations; and
- supplying safe access to sidewalks and buildings.

Teran (2015) notes several areas of overlap where urban goods movement and complete streets design can coexist.⁴³³ Implementing road diets, for example, can increase traffic flow while reducing vehicle speeds and providing space for walking, bicycling, transit, and parking. When addressing complete streets design, planners and designers should identify the intersections that are most often used for goods movement and design the curb radius to suit the needs of trucks. Even intersections in locations with less goods movement traffic can be designed with multimodal considerations in mind, ensuring that adequate infrastructure is provided for all users, including trucks. In dense downtown areas, parallel streets can be designed as one-way couplets, with one street serving slower-moving traffic such as bicycles and pedestrians and the other serving trucks and other less vulnerable roadway users. Truck-serving streets would supply better curb access to allow for efficient loading and unloading.⁴³⁴

Four of the US EPA Smart Growth principles pose notable safety challenges when urban goods movement is considered. Implementation of Principles 1 through 4 (Mix land uses; Take advantage of compact design; Create a range of housing opportunities and choices; Create walkable neighborhoods) could result in the closer proximity of pedestrians and bicyclists to delivery trucks. Most bicycle-truck collisions occur in urban areas, suggesting that the higher collision rate is a function of greater exposure of bicyclists to truck activity in urban areas.⁴³⁵ By increasing the density of urban environments, mixing land uses, increasing housing supply, and enhancing walkability and bicycle access through smart growth initiatives, planners and policy makers may ultimately increase the exposure of bicyclists and pedestrians to trucks. Careful consideration must be taken to manage interactions between trucks and the most vulnerable roadway users to maximize safety for everyone. As previously mentioned, designated truck routes may be helpful in achieving this end. **Figure J.3** shows the proximity between bicycles and trucks that can occur in urban areas, even when dedicated bicycle infrastructure is provided.



Figure J.3: Bicycle Truck Proximity on Urban Streets (Source: Transportation Research Procedia)

A major barrier for the urban goods movement industry that contributes to traffic congestion and safety concerns is access to the curb for freight loading and unloading. The demand for curb space has increased in recent years considering the advent of TNCs such as Uber and Lyft and the growing volume of package deliveries spurred by the e-commerce boom. When delivery trucks are unable to access the curb or loading zone at their destination, they often double park and occupy a travel lane, which increases congestion and potentially reduces safety by limiting visibility in the roadway and forcing cars to travel around double-parked trucks. On streets with bicycle lanes, delivery trucks may effectively block these lanes when double-parked or may be required to pass through them to access the curb, posing safety concerns for bicyclists in both cases by increasing collision risk and forcing bicyclists to mix with vehicular traffic **Figure J.4**⁴³⁶

These problems are compounded in the case of destinations with high curbside delivery demand and vehicle turnover, such as multi-tenanted buildings, which typically generate more deliveries than single-tenant buildings. If multi-tenanted buildings do not have internal logistics staff to manage deliveries, drivers must deliver goods to wherever recipients are located within the building. This may add to the expected delivery time while also increasing emissions associated with vehicle idleness, and further blocks lane access.⁴³⁷ Additionally, in situations



Figure J.4: Curbside Bicycle Lane Complicates Truck Access to the Curb (Source: Santa Monica Next)

where double-parking is not possible and the curb or loading zone is occupied, delivery trucks may take unnecessary trips around the block while waiting for delivery access, resulting in an increase in greenhouse gas emissions. According to the Institute of Transportation Engineers (ITE), "it is becoming increasingly important to designate loading zones not only in commercial or industrial areas, but also in residential areas where the frequency of package deliveries may result in blockages for other curbside uses".⁴³⁸

Given the increasing competition for curb space and the negative impacts it has had on urban goods movement, urban planners and policy makers are increasingly looking towards tools under the umbrella of 'curbside management' to reduce these impacts while simultaneously working toward achieving smart growth goals. In the Curbside Management Practitioners Guide, the Institute of Transportation Engineers (ITE) recommends several strategies for ensuring the availability of curb space for urban goods deliveries:

Freight Zone Pricing

Requiring payment for access to freight loading and unloading zones has the dual effect of reducing the duration of loading zone occupancy and increasing the likelihood that loading space will be available when needed.

[Off-peak Delivery and Congestion Pricing](#)

By charging delivery vehicles a fee to deliver goods during peak periods, cities may effectively incentivize delivery during off-peak periods, thus reducing peak-period congestion. Potential benefits to delivery carriers of switching to off-peak delivery include increased parking/loading zone availability, reduced traffic congestion, and faster travel times with attendant reductions in the time needed to complete delivery routes.

[Delivery Vehicle Staging Zones](#)

Providing time-limited on-street queueing areas for delivery trucks at high-demand locations can prevent trucks from blocking travel lanes or driving unnecessarily while waiting for access to the loading/unloading zone.

[Urban Consolidation Centers for Last Mile Delivery](#)

The rapid increase in e-commerce deliveries in recent years has worsened problems related to last-mile deliveries, which increase competition for road space between urban passenger and freight traffic. To address this, Urban Consolidation Centers (UCCs) bring together packages from a multitude of delivery companies and provide last-mile delivery service using relatively smaller, low-emission vehicles that reduce competition for road space. UCCs are often formed through public-private partnerships between local governments and delivery companies.

[Moving Loading and Access Around the Corner](#)

Many delivery drivers are willing to park farther away from their delivery destination if it means they will not have to waste time waiting for loading space to become available. By moving loading and unloading zones at a reasonable distance away from delivery destinations, cities can preserve curb space for high-turnover parking and transit use while reducing goods movement inefficiencies.

Much of the guidance from the Transportation Research Board (TRB) about curbside management overlaps with that of the ITE. However, TRB also recommends allowing delivery vehicles to use off-street parking, setting up appointment- or reservation-based systems for deliveries, and using zoning to increase loading bay sizes to accommodate larger trucks and greater truck volumes.⁴³⁹ Leonardi et al. (2014) recommends using joint procurement and internal logistics operations for large multi-tenanted buildings to reduce delivery vehicle dwell times.⁴⁴⁰

New York City has had remarkable success in using curbside management and other policies to manage urban goods movement and achieve smart growth goals. After forming the New York City Department of Transportation (NYCDOT) Office of Freight Mobility in 2007, the City created a Commercial Vehicle Parking Plan which recommended allocating more curb space for commercial vehicles and using a pricing strategy with an escalating rate structure to maximize turnover of commercial vehicle parking. Combined, these measures have reduced commercial vehicle double-parking and dwell times and have increased parking availability, effectively reducing the need for delivery vehicles to circulate around the block while waiting for loading/unloading space to become available.⁴⁴¹ In addition to curbside management policies, NYCDOT established the 'THRU Streets' program in 2002, which designates certain streets in midtown Manhattan for cross-town travel while other streets are reserved for truck loading and unloading. This is similar to the idea of 'layered networks,' which is based on the recognition that

streets cannot always prioritize all users. Instead, the layered networks concept “envisions streets as systems, each street type designed to create a high-quality experience for its intended users”.⁴⁴² Implementation of the ‘THRU Streets’ program resulted in major improvements to traffic flow in congested Manhattan and has improved safety by reducing conflicts between turning vehicles and pedestrians.⁴⁴³

The City of Portland has implemented truck signal priority along major urban freight corridors to improve safety by reducing the likelihood of trucks running red lights and enhancing the efficiency of freight movement by reducing delay experienced at traffic signals. Additionally, the City collects city-wide freight logistics data that it plans to use to develop a coordinated freight management system to manage deliveries and prevent double-parking of trucks at the curbside.⁴⁴⁴

National Cooperative Highway Research Program (NCHRP) Report 844 presents case studies of the integration of goods and services movement by commercial vehicles in smart growth environments for six metropolitan areas in the United States across six key smart growth classifications: industrial areas transitioning to housing and entertainment districts; working waterfronts transitioning to mixed-use and/or recreation; older commercial and neighborhood areas being revitalized; retrofitting aging commercial corridors; greenfield new communities; and large scale construction.⁴⁴⁵ In the Brady Arts District in Tulsa, Oklahoma, a former rail-served industrial and commercial area transitioned into an arts and entertainment district over a period of 20 years and faced challenges in the form of increased truck traffic during construction, reluctance from residents to retain freight-serving uses in the area, and conflicts between residential and commercial uses. In addressing these challenges, the City found that developing delivery and loading regulations could be useful for managing conflicts at the curbside in the future and innovative funding strategies such as tax increment financing could be used to improve walkability and safety with limited other financial resources. The City also determined that certain industrial uses could be used as buffers between municipal land uses and more intense industrial uses.⁴⁴⁶

In the Ballard neighborhood of Seattle, Washington, what was once a major hub for the maritime industry has recently been a site of major population growth with attendant increases in land and housing prices, which has created challenges for the maritime industry and the working-class neighborhoods that have historically existed in the area. Additionally, the street network is ill-equipped to accommodate freight delivery to new businesses in the neighborhood, creating challenges for shippers. To address these challenges, the City has chosen to prioritize which streets in the neighborhood should be ‘Complete Streets,’ enhancing some streets for industrial and commercial needs and others for multimodal transportation. Additionally, the City is using zoning to ensure that the neighborhood can keep important industries like the maritime industry while barring incompatible uses.⁴⁴⁷

TECHNOLOGICAL IMPACTS

In addition to policy-based tools like curbside management, technological and logistical innovations may also play a role in aligning smart growth goals with urban goods movement priorities. From a logistical perspective, two innovations that promise to reduce delivery vehicle volumes, dwell times, and demand for curb space are: 1) the use of neighborhood pickup points, and 2) automated parcel systems as alternatives to home deliveries. Neighborhood pickup points are typically local shops or other convenient destinations where customers can receive and/or return deliveries.

Automated parcel systems are locker banks that are typically found in shopping centers or large easily accessible public destinations. Carriers leave packages in secured lockers which customers can unlock to receive their delivery using a digital code provided by the carrier. Advantages of neighborhood pickup points and automated parcel systems include eliminating instances of missed deliveries and consolidation of shipments from a carrier to a single location, which maximizes time and financial efficiency.⁴⁴⁸ While the implementation of these logistical innovations could supply multiple benefits to the goods movement industry while advancing smart growth goals, their widespread adoption is not guaranteed.

In addition to neighborhood pickup points and automated parcel systems, several new startup companies have emerged with the goal of optimizing package delivery in large urban developments, especially in multifamily developments where tenants are increasingly demanding secure package delivery. Many of these companies are using the model of partnering with multifamily property owners and managers to install secure lockers within buildings and providing tenants with personal access codes to retrieve their deliveries.^{449, 450} Independently of these companies, many multifamily buildings are installing their own ground floor package rooms or lockers where tenants can pick up their deliveries. Figure J.5 shows an example of an Amazon Hub package locker in a multifamily development.⁴⁵¹



Figure J.5: Amazon Hub Package Locker (Source: The Wall Street Journal)

From a technological perspective, several new innovations hold promise for aligning smart growth and urban goods movement goals:

1. The use of local, alternatively-fueled autonomous vehicles for making deliveries has been promising. A startup called Udelv began testing grocery delivery using autonomous vehicles in San Mateo, California in partnership with Draeger's, a local grocery store chain, in 2018 and will soon deploy autonomous delivery vehicles in Oklahoma City as well.^{452, 453} National grocery store chain Kroger has also been testing unmanned AVs to deliver groceries to customers in Arizona.⁴⁵⁴ By serving multiple customers with a single autonomous delivery vehicle, both traffic congestion and greenhouse gas emissions can be reduced.
2. 3D printing allows certain goods to be effectively manufactured at or near the place where they will be consumed, thus reducing delivery trip length or eliminating the need for delivery altogether. German logistics carrier DHL states that the "future commercial viability of 3D printing and its mainstream adoption will be dependent on critical success factors such as affordability, material versatility, and the speed and quality of the print," but maintains that many companies are showing growing interest in this burgeoning technology as part of their future business models.⁴⁵⁵
3. The use of bicycling to carry cargo in inner cities is being tested. In its European operations, DHL is piloting a model that relies on a DHL van to deliver trailers full of goods to the city-center, where containers with packages can be attached to cargo bicycles for delivery, reducing VMT and associated noise and emissions.
4. Amazon and other companies are testing the use of unmanned aerial vehicles, or drones, for deliveries. The company's first fully autonomous home delivery without the use of a human pilot was conducted in 2017, but the timing of widespread implementation of the service is not yet publicly known.⁴⁵⁶ Amazon's tests have used battery powered drones, which will need frequent battery recharging if the service is deployed on a large scale. If the company switches to using fossil fuels to power its drones, the emissions consequences of the service could outweigh the benefits. Despite the potential negative consequences of drone deliveries, modifications to the building stock to accommodate drone delivery has already begun in some metropolitan areas. In Miami, Florida, for example, a developer is designing a 60-story residential tower to include a rooftop takeoff and landing strip for drones.⁴⁵⁷

RESEARCH GAPS

Several important research gaps exist that merit future exploration. The first pertains to the lack of California-specific information concerning the intersections of smart growth and urban goods movement. Currently, few case studies have been conducted that examine California cities. Future studies that focus on California could inform policy and planning decisions in ways that maximize smart growth and urban goods movement outcomes within the state's unique context.

Another important research gap pertains to the safety implications of new technologies like autonomous vehicles. Existing research and technological development have focused on ensuring that autonomous vehicles can detect other vehicles and key infrastructural features such as traffic signals, signs, and roadway striping. However, comparatively little investment has been made in ensuring that autonomous vehicles can operate safely in truly multimodal environments where pedestrians and bicyclists share the road with motor vehicles. As autonomous vehicle technology is adopted by the urban goods movement industry, safety in

urban environments will become an important consideration, and future research should specifically examine the intersections between technology, urban goods movement, and safety.

Lastly, future research would do well to examine intersections between smart growth, urban goods movement, and disaster resilience and emergency response. The existing literature on the subject offers competing claims about the vulnerability of dense urban areas to natural disasters and emergency response situations. Some studies have concluded that higher density in urban areas leads to greater vulnerability to natural disasters, while others have concluded that increases in infrastructure density reduce vulnerability.^{458, 459} At least one study has concluded that the agglomeration economies found in dense urban areas lead to improved risk management and preparedness for emergency situations.⁴⁶⁰

Importantly, many of California's densest cities are in coastal areas, which increases their vulnerability to sea level rise, and suggests that the location, as well as the form, of cities affects their vulnerability. Additionally, if the frequency and intensity of wildfires in California continue to increase, there may be impacts on urban goods movement including delivery delays and implications for the siting of fulfillment centers and route choices. Research into these impacts could help the urban goods movement industry take a proactive approach in planning for emergency preparedness and reducing negative impacts.

As previously mentioned, NCHRP Report 844 presents case studies of the integration of goods and services movement by commercial vehicles in smart growth environments for six metropolitan areas in the United States.⁴⁶¹

Importantly, none of the case study metropolitan areas are in California. Pilot studies in California cities covering some or all the smart growth classifications presented in NCHRP Report 844 would allow for the preparation of recommendations and guidance that are specific to the California context and would help the urban goods movement industry navigate smart growth challenges in California.

CONCLUSIONS AND RECOMMENDATIONS

As the global trend toward urbanization continues, urban transportation is evolving at a rapid rate, and this has important implications for urban goods movement and the achievement of smart growth goals. The demand for goods in urban areas is greater than ever and shows signs of further growth as e-commerce continues to increase its share of the retail industry. Most e-commerce institutions and employees are in California, underscoring the importance of efficient urban goods movement to the health of the state's economy. However, despite the economic importance of urban goods movement, the aims of the goods movement industry have often been seen by urban planners and policy makers as being at odds with smart growth goals. Recently, with growth of TNCs and their approach to maximize the utilization of vehicles, there are new opportunities to integrate small urban deliveries with passenger transportation services. However, this is still a new concept and require further investigation to evaluate its benefits and impacts.

To this end, the needs of the urban goods movement industry have often been overlooked in planning decisions, and this has the potential to be detrimental to the industry and to the economy. With new technological advancements like autonomous vehicles and other innovations on the horizon, urban transportation and the goods movement industry will both be

transformed in foreseeable and unforeseeable ways, making the alignment of smart growth and urban goods movement goals fundamental to ensuring that California's cities maximize livability and economic health in the future. A summary of issues and associated recommendations for making smart growth and goods movement more compatible, as discussed in this paper is presented in **Table J.2**.

Table J.2: Key Issues and Solutions Associated with Aligning Smart Growth and Urban Good Movement Priorities and Outcomes

Recommendations	Issues Addressed			
	Traffic Congestion	Traffic Safety	Competition for Curb Space	Greenhouse Gas Emissions
Planners and policy makers can take the needs of goods movers into account more explicitly when making infrastructure decisions (i.e., choose alternate freight routes where appropriate, supply adequate space for large vehicle turns and loading/unloading, provide network connectivity and redundancy)	Ü		Ü	
Implement road diets	Ü	Ü		
Prioritize certain intersections for freight movement	Ü	Ü		
Utilize off-peak delivery and congestion pricing	Ü		Ü	Ü
Utilize urban consolidation centers for last mile delivery	Ü		Ü	
Move loading and curbside access around the corner	Ü		Ü	
Allow delivery vehicles to use off-street parking	Ü		Ü	
Develop neighborhood package pickup points, multifamily residential package rooms, and automated parcel systems	Ü		Ü	
Develop neighborhood 3D printing centers	Ü		Ü	Ü
Utilize drone deliveries	Ü	Ü	Ü	Ü
Conduct corridor studies to find places where the urban freight and bicycle networks overlap		Ü		
Implement truck signal priority and/or bicycle signal priority		Ü		

Use low-intensity industrial land uses as buffers between high-intensity industrial land uses and municipal land uses		Ü		
Implement freight zone pricing			Ü	
Develop delivery vehicle staging zones	Ü		Ü	
Implement appointment- or reservation-based systems for deliveries	Ü		Ü	
Utilize joint procurement and internal logistics operations in large multi-tenanted buildings			Ü	
Allocate added curb space for commercial vehicles				Ü
Utilize alternatively-fueled delivery vehicles and/or autonomous delivery vehicles				Ü

Source: Summary Analysis by Fehr and Peers