The Last Mile:
How technology helps and hinders the toughest leg of global commerce

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Introduction

As e-commerce brings global trade to city streets, it pits various interest groups against each other. Residents battle mega-warehouse developers, neighborhood restaurants jostle with micro fulfillment centers, and property owners resent retailers flying drones over them. The explosive growth of e-commerce and consumers’ demand for convenient home delivery have reshaped life and traffic in cities around the world.

On the one hand, the e-commerce boom has catalyzed the creation of last-mile delivery startups and new logistics and fulfillment models, enabling small businesses and individuals to transact directly and promoting new jobs and tax dollars for local governments.

On the other hand, cites wrestle with challenges such as congestion and emissions, competition for curb space, “not in my backyard” issues resulting from massive e-commerce warehouses, and the rise of new liability and privacy challenges posed by autonomous delivery vehicles.

These challenges are more than logistical. As e-commerce brings global trade to city streets, it pits various interest groups against each other. Residents battle mega-warehouse developers, neighborhood restaurants jostle with micro fulfillment centers, and property owners resent retailers flying drones over them. Negotiating among these interest groups, city governments have had to engage in new thinking on technology policies, public-private partnerships, and incentive programs that would fuel innovation without sacrificing competing urban needs.
Boom in on-demand delivery

Unlike 20 years ago when consumers around the world handled the last mile by driving or walking to retail stores and ferrying the goods back home, today’s shoppers expect products to be brought to them.

E-commerce logistics have been a major issue for the world’s biggest cities for more than a decade. For years now, studies have catalogued the mushrooming challenges posed by e-commerce in New York, London, Tokyo, Paris, and many other cities. In 2013, a Columbia University urban studies major John Woodard roamed the streets of New York City to track Amazon, UPS, and FedEx e-commerce deliveries, finding that delivery trucks stayed parked for an average of 21 minutes at a time, and two-thirds of them were double-parked. Woodard’s data suggested delivery trucks occupied street space not designated for parking for seven hours a day.¹ A few years later, another study found that, in 10 of Manhattan’s 43 zip codes, parking for delivery trucks completely overwhelmed street space.²

These trends were propelled by Amazon and other leading providers that have perfected accurate and fast delivery, and the millions of consumers willing to pay for the ease and convenience they have provided. In a 2016 consumer survey in China, Germany, and the United States, almost 25% of consumers said they were willing to pay significant premiums for the privilege of same-day delivery.³

Consumers’ interest in home delivery and shorter delivery windows has only intensified and globalized during Covid-19 lockdowns, including across emerging-market cities (figure 1). The demand for home deliveries has remained even after lockdowns were lifted. For example, in a recent survey, 64% of US consumers say they prefer home delivery of goods and 39% prefer it for groceries, as opposed to curbside and in-store collection. Another survey found that 61% of Americans, especially those with children, prefer shopping with retailers and grocery stores that offer delivery.⁴ Chinese consumers also favor home delivery, especially of groceries. Cost still shapes consumers’ decisions to some degree: more than 60% of shoppers stated that they would choose home delivery over curbside pickup only if it were free, and nearly three-quarters of shoppers prioritized cost over delivery speed.

Unlike 20 years ago when consumers around the world handled the last mile by driving or walking to retail stores and ferrying the goods back home, today’s shoppers expect products to be brought to them. The trend is likely to expand: global e-commerce sales in goods are forecast to grow in some estimates to $39 trillion and the last-mile delivery market to $168 billion by 2025 from $129 billion in 2022.⁵

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Improving the efficiency of last-mile deliveries

The demand for last-mile delivery has been a boon for logistics providers and startups around the world. There are dozens of Uber-ized delivery services such as Postmates and Amazon Flex in the United States. In Colombia, the startup Rappi, which began as a meal delivery service, has evolved into a Latin American superapp enabling more than 200,000 independent couriers to deliver from 250,000 businesses, including groceries, pharmacies, and office supply stores. In Mexico, last-mile delivery leader Cargamos has its own fleet of delivery vehicles and drivers, but also allows third-party drivers to connect to its platform to find customers. In India, Delhivery too manages some 30,000 e-tailer and retailer customers’ deliveries, but has nationalized its service by partnering with more than 6,000 vendors that provide pickup, delivery services, and truckload capacity to retailers and small businesses.
The economics of last-mile deliveries is improving thanks to aggregation and routing technologies that ensure that vehicles never travel empty, and shipments are routed efficiently. For example, Locus, operating in India, Southeast Asia, Europe, and the US, uses big data to help delivery service providers optimize fleet mixes and route plans with data on demand patterns and local traffic conditions.

Digital addressing, a unique identification number for addresses which provides pinpoint accuracy to locate residences and people, reduces expenses in the "final 50 feet" of delivery – the costliest and most time-consuming part of delivery.

To alleviate some of the last-mile delivery challenges and expenses in sprawling cities including traffic congestion and locating drivers, many logistics companies have also built locker and click-and-collect networks that enable shoppers to pick up their products.

Digital addressing, a unique identification number for addresses which provides pinpoint accuracy to locate residences and people, also helps with last-mile deliveries. Digital addresses reduce expenses in the "final 50 feet" of delivery – the costliest and most time-consuming part of delivery, including the cost of searching for parking, moving items from the truck, and navigating routes across traffic, curbs, sidewalks, bike lanes, and building security. Digital address companies such as What3Words that have partnered with Domino’s Pizza and many other brands have created new value even in cities with established and accurate addresses. In a pilot in London, What3words found that the use of digital addresses reduced last-mile delivery times by more than 30% and the volatility of delivery times by 75%.

To alleviate some of the last-mile delivery challenges and expenses in sprawling cities including traffic congestion and locating drivers, many logistics companies have also built locker and click-and-collect networks that enable shoppers to pick up their products. For example, Singapore’s postal company SingPost has rolled out a Last Mile Platform (LaMP), a networked, distributed delivery system that brings together couriers, parcel lockers, and hundreds of brick-and-mortar collection points in Singapore and could connect last-mile partner services across Southeast Asia onto a single platform. LaMP also uses AI to optimize and predict parcel delivery times and improve traceability.

Existing retail infrastructure has been used for last-mile delivery and pickup points, often in creative ways. For example, in Brazil, Mexico, and Chile, logistics platform Kangu has turned thousands of neighborhood corner stores into parcel delivery and pick-up points for some 40,000 customers of online retailers. Sold in 2021 to Latin America’s marketplace Mercado Libre, Kangu delivers eight million orders per month and provides a storekeeper roughly 10 US cents per package stored in a shop. This activity helps drive sales in stores as people tend to buy something at the store when they pick up their packages. Around the world, gyms, parking garages, legacy big-box stores, and small warehouses have been converted into collection and fulfillment hubs.

Demand for last-mile delivery has also revolutionized cities’ warehousing infrastructure. Micro-fulfillment centers and urban micro-warehouses have proliferated around the world, enabling businesses to rent space on demand and fine-tune their delivery capacity. One excellent example is Deliver, which offers micro-warehouses for merchants selling on big online marketplaces such as Walmart, using the same last-mile delivery model perfected by Amazon (see case 1).
In the US, startup Deliverr has worked to assist merchants that are falling behind by warehousing their inventories in markets where their products can be expected to be in demand. This pre-positions goods to reduce the number of miles a product travels to the customer.

Amazon Prime conquered e-commerce logistics by delivering products to consumers within a day at no extra cost. This has put considerable pressure on millions of e-tailers to match Amazon’s delivery speed. In the US, startup Deliverr has worked to assist merchants that are falling behind by warehousing their inventories in markets where their products can be expected to be in demand. This pre-positions goods to reduce the number of miles a product travels to the customer.

The company rents warehouse space around the US and has some 80 warehouses, cross-docks, and sort centers near demand hubs. Cross-docking is the practice of transporting and distributing products to customers using little to no storage facilities. The customers, often third-party sellers on marketplaces such as Shopify, Walmart, Amazon, eBay, and Target, are automatically eligible for Prime-like programs, such as two-day delivery times.

Shopify acquired Deliverr in July 2022 for $2.1 billion, to complement Shopify’s ability to manage merchant inventory from “port to porch.”
“Dark store” was incubated a decade ago by British retailer Tesco. In this model, a retailer has an urban warehouse rather than retail outlets, from which goods are shipped to nearby customers on demand.

In e-commerce, brands and manufactures receive small orders directly from countless customers who expect their delivery quickly often on a specific day. This leads brands and retailers to demand short-term warehouse leases.

Alternative models for last-mile efficiency

A cousin of this model is a “dark store” incubated a decade ago by British retailer Tesco. In this model, a retailer has an urban warehouse rather than retail outlets, from which goods are shipped to nearby customers on demand. Amazon-owned Whole Foods opened its first dark store in Brooklyn in 2020. In Bangladesh, Chaldal, a grocery delivery startup launched in 2013, operates 27 dark store warehouses located in four Bangladeshi cities. The company also enables “Facebook sellers,” or MSMEs that market their goods on Facebook, to drop off their deliveries to available Chaldal warehouses and leverage Chaldal’s distribution and logistics network. In return, Chaldal fills its empty shelves and puts idle logistics capacity to work.

An ecosystem of software providers has emerged to help companies decide where to locate their dark stores. For example, Israeli company Fabric analyzes businesses’ inventory and sales data to determine the demand for specific items in a region or a city and distribute the right amount of inventory across its micro-fulfillment network.

Urban warehouses also use shared economy models to accommodate the varying peaks in demand among e-commerce retailers. In traditional commerce, brands and manufacturers would use historical data to predict order volumes at given times of the year and send larger shipments before seasonal peak traffic to retail outlets. Peaks were typically 20-30% above the usual order volumes. However, in e-commerce, brands and manufactures receive small orders directly from countless customers who expect their delivery quickly often on a specific day like Black Friday; the peaks are less predictable and more volatile, rising 60% or more from the norm. This leads brands and retailers to demand short-term warehouse leases. Startups like Flexe based in Seattle are meeting this demand by allowing...
New modes of delivery such as electric bikes and scooters, as well as autonomous vans, delivery robots, and drones are also enablers of last-mile delivery. These are overhauling delivery speed and reshaping costs.

Dozens of businesses and startups have also sprouted to solve the “first mile” of reverse logistics, meaning declined and returned purchases. Reverse logistics is a hallmark of e-commerce: Consumers worldwide are likelier to return items bought online than offline. Some studies estimate that about a quarter of items bought online are returned, as opposed to fewer than a tenth of items bought in physical stores. In addition, consumers expect to be able to return items they bought online and get full refunds. In Los Angeles, Happy Returns operates 5,000 “Return Bars” that enable shoppers to easily return items without printing or packaging and have refunds or exchanges initiated immediately, all while saving merchants up to 40% on return shipping.

New modes of delivery such as electric bikes and scooters, as well as autonomous vans, delivery robots, and drones are also enablers of last-mile delivery.
The last-mile boom has forced cities to confront a long-standing challenge: how to reduce congestion, noise, and emissions while also ensuring that companies, retailers, and residents are well-supplied.

On the one hand, new e-commerce delivery companies and models have helped optimize delivery, alleviating city congestion. In theory, home delivery should help reduce traffic as one driver can service many households.

On the other hand, the efficiencies created by new delivery models and businesses may have been overwhelmed by the volume of demand for e-commerce delivery, in part because they have promoted impulse purchases, purchases of single items that are individually delivered, and “serial returners” who order too many items and send the less desirable ones back. There are various empirical findings on these dynamics. In one study, the number of freight deliveries per each American grew from 0.12 per day in 2009 to 2.5 in 2017, and is expected to double again by 2023, with no fewer cars on the road. However, another study seeking to get at the impacts of the rise in parcel truck delivery trips found that e-commerce has actually helped reduce shopping-related travel – both vehicle miles traveled and fuel consumption – from what they would have been otherwise.22 Similarly, in a study in Shanghai, e-commerce delivery has helped reduce urban traffic especially during peak hours. To be sure, the frequent returns in e-commerce and repeat deliveries (when no-one is home) may well cancel out the reduction in the miles driven to malls and grocery stores.

In cities of developing economies, infrastructure gaps and lack of addresses produce repeat deliveries and long and variable delivery times and arrests scalability of delivery models.

For years, city governments have sought to respond with mixed results. The following sections will explore logistics innovation hubs, regulatory models, and technology pilots developed by cities to facilitate global commerce at the last mile.
Last-mile sandboxes and slipper distance
Many cities have sought to optimize last-mile delivery models to reduce congestion. For example, Chinese cities facilitate last-mile delivery by using dozens of small service centers located within cities rather than the Western hub-and-spoke model, where trucks are dispatched once daily from one to two large depots on the outskirts of town. This is accomplished with electric bikes making four to five round trips daily. The Chinese system developed organically as the country’s parcel delivery system opened up some 15 years ago to privately held companies, which built low-cost, small (1,000-3,000 square feet) service centers to provide local same-day courier service. This model would later aid the country’s e-commerce boom. Today, China’s leading courier companies have 50-100 service centers in major cities. Shenzhen has spearheaded the creation of an e-commerce-driven urban logistics network with last-mile delivery depots, mainly by converting old industrial sites into modern e-tailing logistics facilities.

London is a European e-commerce logistics pioneer, recently developing a Last Mile Logistics Hub to consolidate deliveries across central London. The initiative transforms 39 parking spaces within the underutilized London Wall Car Park into a hub for Amazon Logistics. The final leg of parcel deliveries will be carried out by e-cargo bikes and people on foot removing many delivery vehicles from city streets.

Some cities have also developed forward-looking master plans, innovation hubs, and test beds for logistics delivery models to incentivize private sector solutions. For example, Seattle’s Neighborhood Delivery Hub acts as a sandbox for innovative sustainable urban logistics strategies and business models that companies can test right in Seattle’s dense uptown neighborhood. The Dublin City Council and Enterprise Ireland incentivize startups to create last-mile technology solutions.

Much of the success of these initiatives typically depends on the business model and how well it incentivizes different last-mile participants to work together. One example of the challenges of findings such a model is European cities’ challenges to operationalize “urban consolidation centers,” or UCCs, where trucks would stop at freight hubs at the edge of cities where parcels would be loaded onto smaller vehicles that then deliver the goods to customers in the city. Freight companies fight these ideas complicating collaboration at centralized transfer locations. Access to land, the unwillingness of freight companies to pay for UCC facilities, and local governments’ reluctance to subsidize them, are also issues. In one study, all 106 catalogued UCCs in Europe had failed after running into these problems. Still, in the city of Nijmegen in the Netherlands, an intrepid entrepreneur made the UCC model finally work, after years of trial and error (see case 2).
CASE STUDY 2

Combining old delivery ideas with a new business model

In the Dutch city of Nijmegen, entrepreneur Birgit Hendriks created the Binnenstadservice hub, a UCC, at an industrial park warehouse that services more than 160 shops. Long-haul trucks park in the hub to unload their shipments, which are picked up by electric bikes and small vans that take the goods into town.

As many UCCs struggled, Binnenstadservice has perfected the business model in three ways:

— Binnenstadservice is a non-profit, which encourages trucking companies to treat it as a partner rather than as a competitor, and for the local government to allow flexibilities in contracting with Binnenstadservice.

— Binnenstadservice’s revenue comes from payments by shops, hotels, and restaurants on the receiving end. This model enables delivery companies to free their trucks for long-haul traffic.

— The hub evolved to offer fee-based services to receivers to send shipments back to the UCC, such as bulky items and clean waste. For example, the electric bikes pick up packaging waste as they make deliveries into the city, then return the waste to the hub.

UCCs are hyper-local and customized for the city. They need to be adapted to larger cities that have much larger delivery needs. For example, the city of Dublin has used so-called Eco Hubs as mini distribution centers to serve a smaller range of service areas.
In developing countries with poor addresses, some cities as well as national postal services have adopted digital addresses that reduce driving and idling on city streets. For example, the Post Office of Dilbar in Katmandu, Nepal, partnered with Google Plus Codes digital addressing system to increase the efficiency of parcel delivery. Plus Codes define locations for areas as small as three by three meters, providing a means to assign addresses based on the latitude and longitude, instead of a traditional method state-assigned street names and numbers. In the state of São Paulo, Google Plus Codes is providing addresses to 340,000 rural properties across 645 towns with two million people who currently have no formal residential address. Plus Codes has also been adopted in locations with extremely dense settings such as slums in Calcutta, helping to unlock many other services such as registration for government services, access to healthcare, and improved policing.31

While efficiency helps decarbonize commerce, consumer surveys around the world call for further action on green e-commerce deliveries. Some three-quarters of 9,000 consumers in six cities in India blame the last mile for pollution and 67% favor investments in the electric vehicle infrastructure to green last mile fleets.32 The State of Maharashtra has called for last-mile delivery companies to ensure that 25% of their fleets consist of electric vehicles by 2025. New Delhi has set similar targets at 100% by April 2030.

Numerous cities have adopted lockers to solve the congestion problem. Chinese cities have long hosted huge spaces for lockers across China, there are more than 300,000 parcel locker locations with 30 million doors shared by courier companies, which as a result pay only a small fee. As the lockers are often located in apartment buildings and office buildings, landlords feel they are an added benefit for tenants.33

Many cities have copied the model. Facing a growing number of delivery accidents among exhausted drivers making more than 4.3 billion e-commerce retail deliveries by truck and 46 billion via other distribution methods, the city of Tokyo partnered with companies Quadient and Yamato Transport in 2019 to establish a dense network of parcel lockers across the city as well as the rest of the country.34 The Singapore Locker Alliance is a particularly interesting solution, as an interoperable, open-access platform with standardized data exchange for locker operators, logistics service providers, marketplaces, and merchants. The Alliance currently hosts hundreds of parcel locker sites covering two residential districts and urban bus and metro stations.35 In Belgium, the city of Mechelen and Belgian Post (BPost) installed parcel lockers at a similar 400-meter radius from key public locations, marketing the locker hubs as serving shoppers at “slipper distance.”

Many cities have also aspired to tap data to manage the last mile. In Europe, the SENATOR Consortium funded by the European Union and coordinated by the Spanish Postal Operator as a demonstration project for sustainable mobility created a “control tower” that uses data and AI to optimize freight delivery services in urban areas and reduce the number and distance of delivery routes by real-time information.36
Cities have worked with ride-hailing and delivery companies to improve urban planning through delivery data. Dozens of cities are using data from Uber to understand traffic patterns and optimize urban planning. In Bangkok, where cars and motorbikes often overwhelm the existing road infrastructure, the city has partnered with delivery and ride-hailing superapp Grab, whose smart mobility platform can enable cities to make better decisions about routes.

**NIMBY challenges of big box warehouses**

Global demand for e-commerce warehousing in cities and nearby regions has soared and warehouse vacancy rates have plunged in the past two years worldwide (figure 2). In the United States, transactions for big-box warehouses of 200,000 square feet or more rose to new highs in 2021, as retailers built buffer stocks against supply chain disruptions and increased inventory in key locations. The trend continued in 2022 pushing demand for warehouses and sending warehouse rents up 19% year-on-year from 2021. Warehouse cost pressures and shortages have coincided with rising costs of building supplies and in many markets with a lack of warehouse workers, which in turn is raising costs for retailers and creating inflationary pressures.

The rise of last-mile delivery has repercussions across the logistics chain, most immediately in the middle mile where massive warehouses have been created to improve proximity to major population centers. While these projects provide jobs and boost local tax revenues, they also undermine quality of life.

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**Figure 2 – Growth of new logistics warehouse completions and vacancy rates in 2010–2021 in the Americas**

<table>
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<th>Year</th>
<th>Completions</th>
<th>Net absorption</th>
<th>Vacancy rate</th>
</tr>
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<td>70</td>
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</tr>
<tr>
<td>2021</td>
<td>270</td>
<td>650</td>
<td>0%</td>
</tr>
</tbody>
</table>

Source: CBRE
In the cities of Fontana and Bloomington, south of one of the world’s largest e-commerce market of Los Angeles, residents, environmental groups, and community organizers say warehouses have added to pollution and traffic, disproportionately impacted the poor, and generated an influx of temporary workers. For example, in the cities of Fontana and Bloomington, south of one of the world’s largest e-commerce market of Los Angeles, residents, environmental groups, and community organizers say warehouses have added to pollution and traffic, disproportionately impacted the poor, and generated an influx of temporary workers. In response, regulators have drawn up rules for operators of warehouses larger than 100,000 square feet to make up for emissions from the trucks entering existing warehouses. Operators can satisfy the requirements through various methods, such as installing solar panels or having air filters installed in local homes, schools, and hospitals.

New Jersey residents are protesting warehouse development plans at town meetings and challenging them in court. Yet one city can only do so much. While local officials may welcome a warehouse project for its various benefits, the negative spillovers may impact other cities and communities. This has led the New Jersey state government to take over and develop guidelines for cities on where and how warehouses should be built. Nearby New York City is similarly taking on negative spillovers by imposing an “indirect source rule” to target emissions from trucks that service warehouses on a planned site of 40 million square feet of industrial buildings (about the size of Central Park).

In some cities south of Los Angeles, residents, environmental groups, and community organizers say warehouses have added to pollution and traffic, disproportionately impacted the poor, and generated an influx of temporary workers.
New business models may offer some alternatives to the big box model. For example, warehouses with only a few SKUs and low product turnover can use high-density storage options, whereby drive-in drive-thru racks reduce the number of aisles needed for walking or packing.

Taxation may also reshape cities’ interest in big box warehouses. In California, cities collect a 1% sales tax from the shipment’s originating municipality. This favors secondary cities on the outskirts of megacities with massive warehouses. Examples are Fresno and Visalia that have scored coveted Amazon Fulfillment Centers. However, bigger cities where consumers make online purchases are now pushing the state to change the law, so that tax dollars can flow to the point of purchase. This of course is a global issue, contested among countries and cities within countries around the US and the world. The solutions may change the dynamics for warehouse developments. For example, California’s cities may strike a compromise where the cities with fulfillment centers and the cities whose residents are making the purchases would receive part of the sales tax distribution.

### 15-minute city vs. 15-minute delivery

Around the world, demand for home delivery has created a rush for urban warehouse space. While rents for warehouses in urban areas are typically two to three times higher than those in peripheral locations, the cost of proximity may pay for itself in reduced transport costs, lead times, and inventory management costs, and improved customer experience. Urban warehouses have also been a boon for retailers who want to convert their retail spaces into storage they can lease out, and for cities that can reap new tax dollars from warehouse projects and sales. Since 2010, in New York City alone, developers have built 21 large warehouses totaling 10.3 million square feet or, in one analysis, 14 LaGuardia airports.

However, city governments are concerned that urban warehouse projects raise real estate costs for small businesses and residents, crowd out other economic activity, and in general make cities less pleasant. To that end, several cities are on a mission to create a “15-minute city,” a concept pioneered by San Francisco resident, Dan Luscher. These are cities where people can stroll around and find all essential services, stores, and restaurants within a 15-minute walking or biking distance unbothered by vehicle traffic. For example, Barcelona has created “superblocks” to decrease traffic and noise in certain neighborhoods. These superblocks have pedestrian and cycle lanes and lower speed limits for local vehicular traffic. This model clashes directly with the idea of a “15-minute delivery” model where city streets are filled with windowless dark stores that employ delivery drivers and robots that deliver goods to customers in their homes. Indeed, while both “15-minute city” and “15-minute delivery” visions are designed to enable consumers to access goods and services with ease, each model makes the city look and feel quite different.

New York City is ground zero in the battle for urban living models. Owners of bodegas claim that dark stores undercut their prices while spoiling community feel. Some are pushing the City Council to prevent dark store owners from
guaranteeing delivery in 15 minutes or less, so as to better protect delivery workers hurrying to bring meals and goods to customers.” In the UK, HM Treasury has similarly sought to stack the deck for Main Street retailers by authoring a consultation paper on a potential online sales tax that would be used to cover brick-and-mortar retailers’ property taxes. Similar battles have been waged in Europe, where Amsterdam and Rotterdam have halted dark store openings for a year.

Some cities have managed to strike a balance between protecting street-level retail and accommodating dark stores. For example, Arlington, Virginia, home to Amazon’s second US headquarters, has taken advantage of the soaring office vacancy rates resulting from growth of remote work and created zoning regulations that permit companies to set up micro-fulfillment centers inside office buildings that are struggling to attract new tenants. This solution is familiar to Asian cities, where the battle for city space has long resulted in multi-story micro-warehouses in such cities as Seoul, Hong Kong, Shanghai, and Singapore. Urban warehouses and Main Street businesses have found interesting symbioses also in other cities. For example, in Minnesota, a redeveloper of warehouse space turned a former boiler room into a brew pub to entice companies to locate near the warehouse.

**Fighting for curb space**

City curbs around the world make up a large share of the “final 50 feet.” As a result, cities have started to actively manage curb use. New York City pioneered a pilot program to turn parking lots into temporary loading zones from 7 a.m. to 7 p.m. on weekdays and created a pilot for some 500 companies such as pharmacies and grocery stores to deliver goods at night from 7 p.m. to 6 a.m. The effort led to more deliveries per hour, lowered emissions, and made daytime parking more available. But it also increased nighttime noise. Paris solved the noise problem with

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“delivery hotels” where freight trucks enter the city at night and deliver packages to micro-warehouses near residential areas. The deliveries are then picked up in the morning by bikes and vans for last-mile delivery.\textsuperscript{54}

Some cities have digitized the curb. The 14,000 miles of streets and curbs of Los Angeles are being digitized in the Los Angeles Code the Curb partnership led by the Los Angeles Department of Transportation. The methodology, which uses cameras mounted on cars, is much faster than traditional surveying. The data can be converted into an interactive parking map for delivery drivers, pick-up/drop-off zones, and electric vehicle charging stations.\textsuperscript{55}

In Dublin, the City Council is piloting curb management with a program called Grid Smarter Cities.\textsuperscript{56} The solution aims to improve curb use in the city center and enables commercial loading vehicles to use the app “Kerb’ to book or extend use of curb space.

**Battle for airspace**

Drones and their delivery robot cousins have raised thorny privacy challenges. For example, they may use cameras to collect consumer data during the delivery process, breaching the law. Residents argue that drones violate property laws that grant residents the right to the low airspace above their properties.\textsuperscript{59}

Growing drone use has also spawned a battle for airspace. Residents argue that drones violate property laws that grant residents the right to the low airspace above their properties. This is not a new issue. Some 75 years ago, the US Supreme Court ruled that usurping property rights in the “immediate reaches” of space directly above a residence is tantamount to “invasions of the surface.”\textsuperscript{62}

The concerns about drones hovering over residents’ homes has led two dozen US cities and towns to advise the federal government on ways to integrate drones into American communities. State governments are being called upon to regain jurisdiction from the federal government over drone operations within 400 feet off the ground. The UK too has drawn up rules on how low to the ground and near a residence drones can fly.\textsuperscript{63}
Delivery robots’ liability

Cities and states around the world are also developing new rules around the kind of autonomous delivery vehicles that are allowed to travel on sidewalks and roads. In the US, state and local governments have created different limits on delivery vehicles’ speed and size. The state of Pennsylvania has classified autonomous delivery robots as pedestrians able to travel on sidewalks, pathways, and roadways at speeds up to 12 miles per hour in pedestrian areas and 25 miles per hour on roads. These robots weigh no more than 550 pounds without cargo. However, densely populated cities such as San Francisco, Ottawa, and New York have banned autonomous delivery vehicles from city streets entirely.

Countries have created rather different models for the deployment and testing of autonomous delivery systems. For example, many EU countries have blanket legislation for delivery vehicles and robots on the one hand and autonomous cars on the other, while the United States has a different regulation for the two – making it easier to test and deploy autonomous delivery solutions. There are further distinctions in the Unites States for road and sidewalk autonomous vehicles.

Autonomous vehicles used for delivery are also creating new questions about liability. For example, could the designer or user of a delivery robot be held liable if the robot hurt a person or property? Should robots only travel on bike lanes? As robots become more autonomous and less controlled by humans, current liability frameworks may not keep up. However, there are precedents in related fields where autonomous capabilities have been used for a long time, such as airlines’ autopilot systems where product manufacturers have avoided responsibility but operators, or airlines, have been held liable. Insurance companies are already racing to create solutions. US startup Koop, for example, sells insurance to the developers and operators of autonomous delivery vehicles to shield them from liability for accidents caused by robots. Korea’s conglomerate Lotte’s insurance arm also has a program for store owners who use service robots.
Conclusion

The e-commerce boom brought billions of packages to city corners, curbs, and airspace, presenting both promise and peril to urban communities. On the one hand, e-commerce catalyzed last-mile delivery startups and new logistics and fulfillment models, streaming local delivery and generating new tax revenues for cities. On the other hand, last-mile delivery has created congestion and pollution as well as competition for curb and airspace, a shortage of logistics employees, and new liability and privacy challenges.

These dynamics have amplified in cities around the world as policies and public-private partnerships fuel innovation.

Among the challenges are the competing demands among city residents for space versus convenience and fast delivery, and battles among businesses responding to these demands. The solution will not rely solely on technology, but by aligning incentives through innovative business models and sound policy decisions on the spatial allocation of economic activities and social life. Cities and regions worldwide are making these choices and developing new solutions and have a great deal to learn from each other.

The solution to challenges of last-mile delivery will not rely solely on technology, but by aligning incentives through innovative business models and sound policy decisions on the spatial allocation of economic activities and social life.
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Other Hinrich Foundation publication by Kati Suominen:

- Fast-tracking blockchain use for interoperable and inclusive trade
- Making digital payments to power 21st century trade
- Eyes on the prize: The race to hone visibility on supply chains
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