

Hidden and in Plain Sight: Impacts of E-Commerce in Massachusetts



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► About MAPC and this Report

The Metropolitan Area Planning Council (MAPC) is the regional planning agency for the 101 cities and towns of Greater Boston. Our mission is to promote smart growth and regional collaboration.

Today, the Commonwealth is seeing rising numbers of delivery trucks and vans on the roadway network as people increasingly ordering online for goods, meals, and groceries. For these deliveries to arrive timely each day, a sophisticated logistics network of warehouses, distribution centers, and delivery vehicles needs to be in place. While the effects of this growing form of retail on the roadway network may be noticeable, e-commerce is also having effects on land use, traditional retail, and employment which are not as directly apparent.

MAPC has undertaken *Hidden and in Plain Sight: Impacts of E-Commerce in Massachusetts* to better understand how e-commerce affects the region's communities, and to provide a resource for municipalities and policy makers grappling with the rapid growth and multiplying impacts of this expanding form of retail.

This report concentrates primarily on the transportation and land use effects of increasing online shopping, highlighting key trends both nationally and in Massachusetts. We suggest directions for further research, and we put forward potential policies that could help communities sustainably manage the growth in warehousing and distribution centers and its associated delivery traffic.

MAPC intends to serve as a resource for continued information sharing and findings from e-commerce surveys and pilot programs and conduct research on how municipalities in Massachusetts are currently mitigating and managing the impacts of warehouse and distribution centers. As a follow up to this report, MAPC plans to collaborate with municipalities to develop a playbook on the management of e-commerce warehouse and distribution centers as a resource for other municipalities. Please e-mail ecommerce@mapc.org with relevant information or to be informed of future initiatives.



Executive Summary

E-Commerce Today

E-commerce – the buying and selling of goods or services via the internet, and the transfer of money and data to complete the sale – is a \$600 billion industry in the United States, comprising approximately 14 percent of total retail sales.^{1,2} In 2019, Amazon alone delivered about 2.5 billion packages in the United States, an estimated 20 packages for every household.³ In the first 9 months of 2020, which forced many to remain at home due to the pandemic, e-commerce sales increased 34 percent. The increasing availability and use of next-day and same-day deliveries and the growth in restaurant deliveries via third-party apps such as Uber Eats also fueled this rapid growth.



Despite its impressive growth, e-commerce currently represents less than a fifth of total retail sales. Yet its impacts on traffic, employment, and land development are already apparent across the U.S. In Massachusetts, the impacts of e-commerce can be seen in shifts in employment and in the growth of warehouse and distribution centers. The state's non-store retail employment – which includes online retail occupations – grew 64 percent from 2010 to 2019, while its employment in transportation and warehousing increased 30 percent. During this same period, traditional retail employment numbers in Massachusetts remained relatively flat.

The rapid growth of e-commerce has had widespread effects, especially on transportation networks and land use. These impacts include increased traffic and emissions from delivery vehicles, greater competition for curb space during deliveries, and greater demand for land for warehouse and distribution centers. Amazon, the world's largest retailer, has 34 facilities either operating or proposed in Massachusetts. Once all facilities are operational, the Amazon footprint in Massachusetts will comprise over 12 million square feet of warehouse and distribution space.⁴

A significant component of e-commerce is restaurant delivery and the purchase of prepared meals.⁵ Nationwide, transactions from services such as DoorDash, Grubhub, Uber Eats, and Postmates increased approximately 200 percent between 2015 and 2020, generating an estimated \$26 billion in revenue in 2020.⁶ Online grocery sales for home delivery and pickup reached \$5.9 billion in November 2020, a threefold increase from August 2019. The volume of orders has more than tripled to almost 63 million, and the number of customers has more than doubled to nearly 39 million during this period. There is also an increase in the average amount of spending per order and shopping frequency.⁷ Many industry experts believe that the consumer shift to online grocery delivery and pickup will continue even beyond the COVID-19 pandemic.^{8,9}

There are also equity concerns, including whether low-income neighborhoods and communities of color are disproportionately bearing the traffic, noise, and air pollution from distribution facilities, and whether the shift from traditional retail jobs to warehousing and deliveries is having a greater impact on certain subsets of the population, especially in regard to employment, wages, benefits, and working hours.

Other impacts include reduced spending and associated employment and tax-revenue generation at brick-and-mortar retail stores, and the possible erosion of job security due to a shift toward the use of contractors for deliveries.

Of course, not every effect of e-commerce is negative. The online retail business model and economies of scale have lowered prices for many consumer goods, and have enabled home-bound and carless residents to purchase goods, services, and foods that might otherwise be unavailable to them. Unfortunately, a lack of reliable data makes assessing impacts difficult and complicates the task of managing e-commerce to ensure greater equity and sustainability in the region.

Transportation Impacts

In response to the needs of e-commerce, the supply chain has expanded and evolved. It is now a vast network of interconnected facilities that can terminate not at a store, but at the consumer's home.¹⁰ The resulting increase in delivery-vehicle traffic affects the region's transportation network.

Since 2010, total Vehicle Miles Traveled (VMT) nationwide has grown nine percent overall, with a 13 percent increase in urban areas. In Massachusetts, between 2010 and 2019, total VMT grew 19 percent statewide and 23 percent in urban areas.¹¹ Some of this can be attributed to recovery from the Great Recession, but there is also evidence that e-commerce and the widespread adoption of ride-hailing services are contributing to the growth and its impacts.



It is difficult to determine the extent to which e-commerce deliveries may be replacing vehicle trips for shopping. In theory, a consolidated delivery system of e-commerce could reduce VMT as compared to individual households making their own shopping trips in cars. The reality is more complex. A single online order may arrive in multiple shipments. Thirty percent of online orders are returned, and 15 percent never make it to the correct address on the first delivery attempt.

At least one survey suggests, perhaps counterintuitively, that the more in-store shopping trips a household conducts per week, the more weekly online packages the household receives. Moreover, higher-income households are more likely to pay for expedited or same-day deliveries. These services have relatively greater traffic impacts, since expedited deliveries are typically shipped in a single package and are less likely to be consolidated with other packages for delivery efficiency.^{12, 13}

The growth in e-commerce creates conflicts on local streets. Deliveries compete with bicycle lanes, on-street parking, transit stops and bus lanes, as well as with passenger pickup and drop off. These conflicts are not limited to business districts and commercial areas; they also occur in residential neighborhoods that rely on on-street residential parking. Outdated curb regulations and pricing policies and ineffective enforcement are ill-suited to an era in which commercial demands for curb space are growing so rapidly.¹⁴

E-commerce distribution nodes also strain the transportation system. These facilities are often 24-hour operations, typically generating more than 1,000 vehicle trips each day.¹⁵ They are frequently located in places where access by public transit is limited.¹⁶

Land Use Impacts

The pressure to maintain dependable and ever-quicker delivery times has resulted in e-commerce companies adding warehouse and distribution centers closer to consumers as part of their regional networks.¹⁷ In 2020, Amazon opened more than 175 new fulfillment centers, sortation centers, delivery stations, and regional air hubs in the U.S. and Canada, a trend that shows no signs of slowing.

The competition to add warehouse and distribution centers has resulted in a high demand for industrial real estate, particularly in urban areas. In urban Boston, warehouse rents have increased 42 percent over the last two years.¹⁸ Primarily sited in industrially zoned areas, these facilities require both substantial amounts of land and easy access to the regional highway network.¹⁹

The U.S. has more retail space than any other country. Even in the absence of e-commerce, the nation's retail space is considered to be "overbuilt," and that in-person retail activity is insufficient to support the existing retail footprint. Malls and commercial real estate have been contending with sizable and steady closures, vacancies, and declining profits over the past several years. Nationwide, physical-store closures reached an all-time high in 2017 and again in 2019.²⁰ Approximately 25 percent of all malls nationwide (approximately 1,000) are projected to close over the next five years.²¹ At the same time, online shopping's share of total retail sales is projected to increase to 25 percent by 2026, if not sooner.^{22, 23} These trends, a function of changing consumer behavior and a rise in e-commerce, predated the pandemic; but the social distancing and economic recession associated with the pandemic have accelerated physical retail decline.²⁴




Potential Policy Strategies and Next Steps


E-commerce is changing our economy, consumer practices, and society. It is imperative that state and municipal governments prepare for and manage these disruptions. Land use and transportation policy and planning can ensure that the growth of e-commerce helps the region and the state to achieve its goals related to transportation, equity, economic growth, and sustainability.²⁵ The **five potential policy strategies**, which can be implemented at the state and local levels, identified in this report include:

Advance regional coordination among municipalities. Create a regional strategy for the siting and operations of warehouse and distribution centers to manage impacts such as traffic congestion and emissions. The regional strategy includes developing a transportation and land use design playbook for municipalities, which would include recommendations about zoning, building codes, proposal review, mitigation, tax incentives, and monitoring. A playbook will promote consistency and ensure a level playing field across cities and towns.

Increase transparency in the growing e-commerce industry. Require e-commerce companies to report information and metrics such as the location of warehouse and distribution centers, employment, and transportation impacts of e-commerce logistics and delivery. Data sharing is a critical step to understand and sustainably manage the impacts of e-commerce.



Establish incentives for efficient deliveries. Both the public and private sectors should incentivize more efficient deliveries to reduce traffic and associated greenhouse gas impacts. This can be done by determining a method to assess the impact of e-commerce on congestion and emissions, and then setting a fee structure that incentivizes companies and customers to opt for more sustainable delivery options, such as combining orders into a single delivery and not choosing expedited deliveries.



Implement curb management strategies. After conducting comprehensive curb space inventories, municipalities should use that information to establish curbside management policies that reduce congestion, safety risks, and conflicts. These policies should designate delivery and loading zones, establish dynamic pricing mechanisms to foster efficient utilization of the zones, and authorize rigorous enforcement practices.



Track innovations in e-commerce. Track new technologies and innovations in the e-commerce industry such as package lockers, cargo bikes, air and ground drones, and autonomous vehicles to minimize negative impacts while ensuring public safety and convenience.

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Frequently Used E-Commerce Industry Terms

Frequently used e-commerce industry terms which are also applied throughout this report:

- ▶ **Click and Collect:** Models offered by retailers such as Target, Walmart, and grocery stores. Orders are placed online and picked up by the purchaser curbside at the store or in the store.
- ▶ **Dark Store:** A store that stocks items for fulfillment but is not open to the public.
- ▶ **Delivery Service Provider or DSP:** Independent delivery organizations that help e-commerce providers such as Amazon deliver packages.
- ▶ **Distribution Center (or Fulfillment Center):** A building specifically designed to receive, store and redistribute goods and designed for rapid turnaround for e-commerce and similar “just in time” product deliveries.
- ▶ **Ghost Kitchen:** A single commercial facility that houses multiple restaurant operators who prepare food for takeout or delivery exclusively to fulfill online orders. Also referred to as cloud kitchens, dark kitchens, or virtual food halls.
- ▶ **Package Locker:** Self-service secure containers where customers can pick up packages at their convenience. Also referred to as parcel lockers.
- ▶ **Warehouse:** A large building where raw materials or finished goods are stored, for either a short or longer time. Warehouses can include buildings designed to fulfill e-commerce orders.

Chapter 1: E-Commerce in the US

E-commerce is a \$600 billion industry in the United States,¹ having grown by more than 300 percent since 2010. This shift in how Americans shop is impacting traffic, with millions of daily deliveries to businesses and households. It is changing the built environment by shifting retail activity from traditional retail locations to an increasing number of e-commerce warehouse and distribution centers in both suburban and urban areas. The pandemic has accelerated these changes, with a greater growth of online commerce and more home deliveries of all types of retail, including groceries.

MAPC, the regional planning agency for Greater Boston, has undertaken this study to better understand how the rapid growth in e-commerce impacts the region's communities, and how municipalities and the Commonwealth can meet the streetscape and land use challenges that online retail is creating. MAPC intends to serve as a resource for continued information sharing and findings from e-commerce surveys and pilot programs and conduct research on how municipalities in Massachusetts are currently mitigating and managing the impacts of warehouse and distribution centers.

This study highlights key trends both nationally and in Massachusetts, and concludes with suggestions for further research.



Introduction

E-commerce² is the buying and selling of goods or services via the internet, typically with the online transfer of money and data to complete the sale. It can be business to consumer, direct to consumer, business to business, and consumer to consumer (e.g., on platforms such as eBay).³ Although it's been around since the invention of the modem, e-commerce has grown rapidly over the last ten years, thanks to advances in technology. Leaps in mobile technology, wireless networks, order tracking, online financial transactions, and logistics have all contributed to e-commerce's rise.

The growth in e-commerce is affecting both transportation networks and land uses (zoning, building design, etc.) at both the regional and local levels:

- ▶ **Increasing traffic** with a greater number of vehicles delivering goods to warehouses and distribution centers and vehicles delivering individual orders to consumers. The increase in truck, van, and cars on the road has an impact on both traffic congestion and air quality.
- ▶ **Greater competition for curb space** on local streets. The increased competition can cause conflicts with on-street parking, bicycle lanes, transit lanes/bus stops, and recently expanded pedestrian and outdoor dining space.
- ▶ **Greater demand for warehouse and distribution sites** that require a large footprint, generate truck, van, and car traffic, but also bring jobs, and are increasingly locating in urban locations to meet demand.
- ▶ **Impacts to brick-and-mortar retail**, including retail closures, that may affect local land uses and employment. The extent to which brick-and-mortar retail may be repurposed to warehouse and distribution centers or other land uses remains uncertain.
- ▶ **Impacts on restaurants** with greater take-out and delivery and reduced or eliminated in-person dining.
- ▶ **Equity concerns**, including whether low-income residents and communities of color are disproportionately subject to the traffic, noise, and air pollution from distribution center operations, as well as whether the shift from traditional retail jobs to warehousing and deliveries has greater impacts on certain subsets of the population.

Architects and urban designers are reacting to the changing commerce landscape by designing building lobbies and entries and off-street loading areas for parcel delivery and storage, and by designating places for rooftops and building entrances to accommodate robots and drone deliveries.⁴

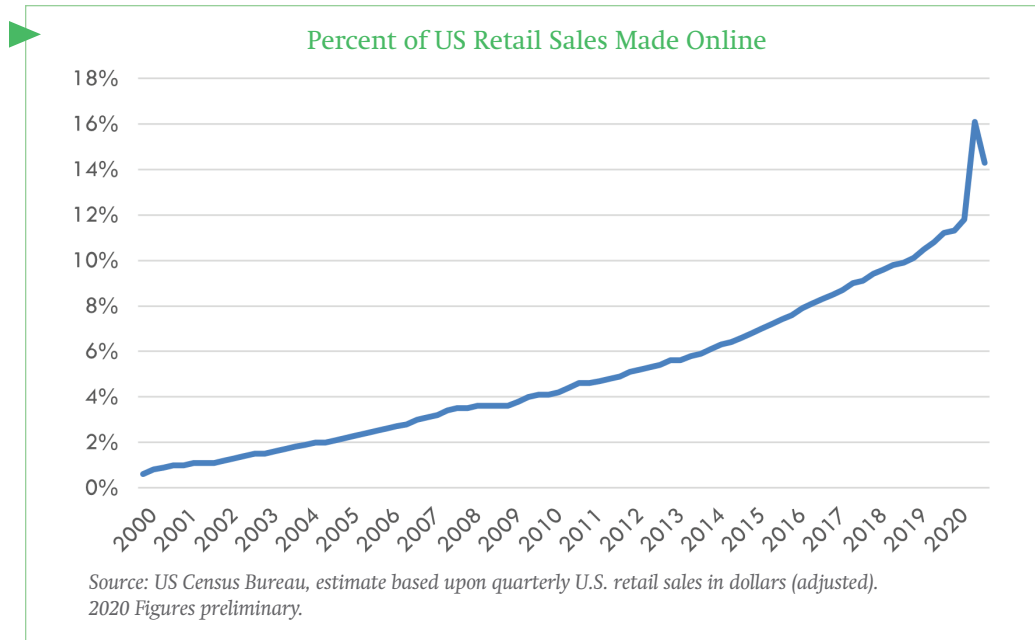
Of course, not every impact is negative: the e-commerce business model and economies of scale have resulted in lower prices for many consumer goods; and e-commerce enables home-bound residents and those without a car to purchase a breadth of goods, services, and foods they might not otherwise be able to access. Unfortunately, the lack of good data about online retail makes assessing the benefits and impacts difficult, which in turn complicates managing the growth of e-commerce to ensure greater equity and sustainability in the region.

E-commerce is projected to grow rapidly over the next few years, and recent surveys of households during the COVID-19 pandemic show that many plan to shop online at higher rates in the future. Therefore, it is imperative that municipalities and state governments better understand and determine ways to manage impacts related to e-commerce.

National Trends and Impacts

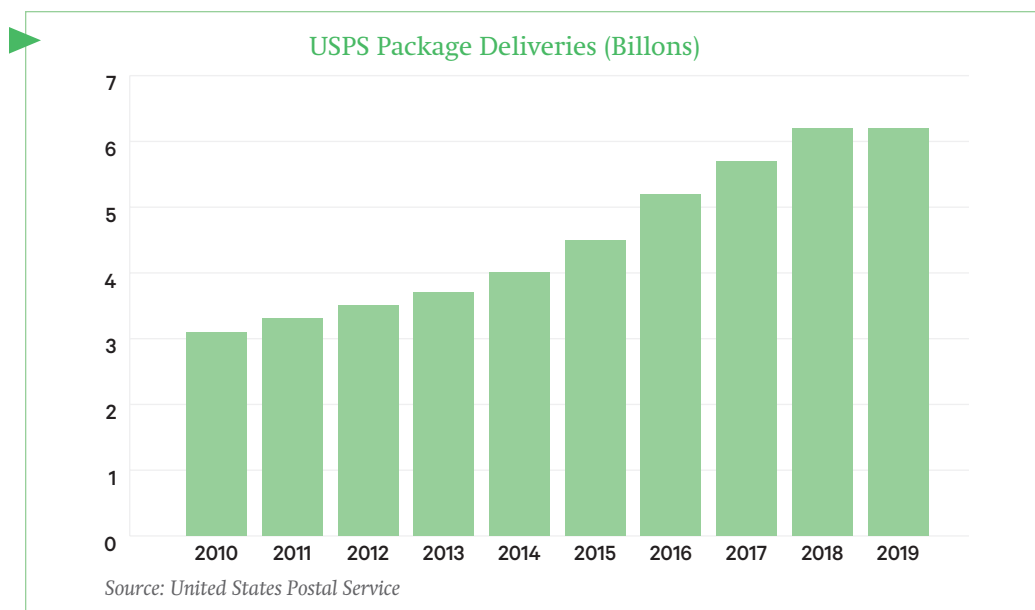
The Census Bureau estimates that as of the third quarter in 2020, e-commerce represented 14.3 percent of total retail sales (Figure 1). While most retail sales are still made in traditional in-person settings, e-commerce has more than doubled in the last five years. Primarily due to the COVID-19 pandemic, which forced many in the United States to stay at home, e-commerce sales increased 30 percent from December 2019 to July 2020, to levels originally forecasted to be reached by late 2022.⁶ Prior to the pandemic, UBS, a global financial services company, projected the share of online retail to rise to 25 percent by 2026 nationwide.⁷

Figure 1. E-commerce as a Percent of Total Retail Sales Nationwide



The National Capital Region Transportation Planning Board estimates that on average, every person nationwide generates demand for roughly 60 tons of freight each year.⁸ In the past ten years, the increase in e-commerce caused U.S. Postal Services (USPS) package deliveries to double (Figure 2). In 2019, Amazon delivered about 2.5 billion packages in the United States, an estimated 20 packages for every household. Due to the pandemic, analysts forecast this number will increase by at least 20 percent.⁹

Figure 2. U.S. Post Office Package Deliveries, 2010-2019



While the impacts of e-commerce are global, urbanized areas are experiencing the greatest effects. New York City alone receives an estimated 1.5 million deliveries per day, more than one for every six residents. While London's congestion pricing program has reduced single occupancy car use from 50 percent to 37 percent since 2003, the number of delivery vehicles has increased by 25 percent over the last ten years.¹⁰

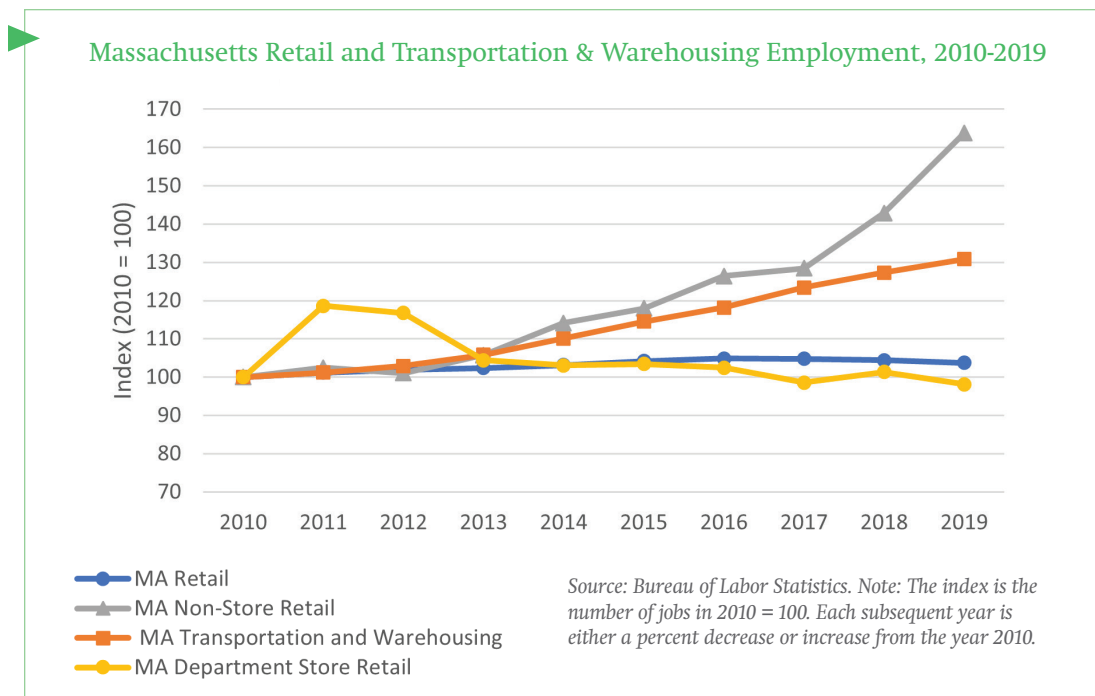
A 2017 survey of households in New York City and Paris revealed that couples with children were more likely to purchase non-food items and groceries online to avoid trips and save time. More than one-third of New York City households surveyed were willing to pay extra for same-day deliveries, nine out of ten had ordered restaurant food online, and 33 percent stated that they began to eat out less frequently once they started using online food ordering apps. The study also found a positive correlation between income and the amount of online shopping.¹¹ A study of millennials – who now make up the largest percent of the workforce nationwide – found that this age group received two to three packages per week, and similarly found a positive correlation between income and the number of packages received each week from online purchases.¹²

Massachusetts E-Commerce Trends

While there are data showing the trends of e-commerce and online retail in the United States, there are almost no e-commerce data collected on the local or state level. The U.S. Census Bureau does not report retail sales by state, and the USPS and other package carriers do not report their data on deliveries at a localized level. Furthermore, while there are limited studies on parking and vehicular traffic impacts in select downtowns such as Manhattan, there have been no comprehensive studies on vehicular traffic generated by e-commerce. Select state and national employment data, however, help show e-commerce trends in the Commonwealth.

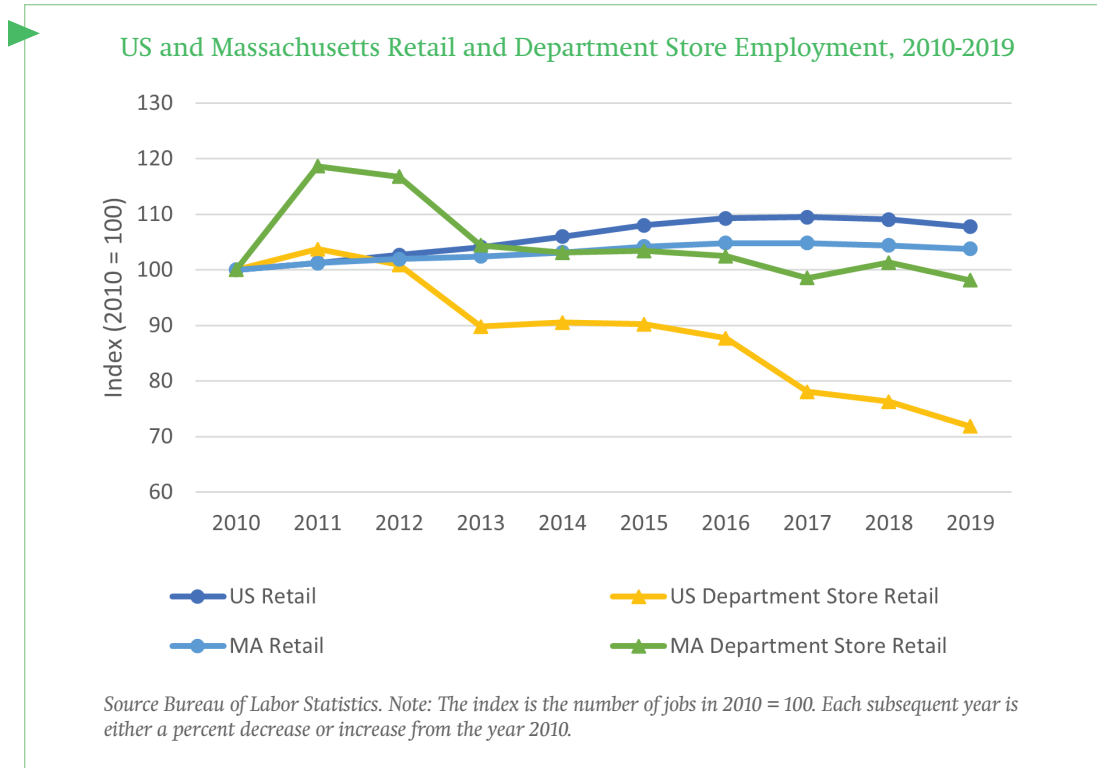
Employment sectors measured by the Bureau of Labor Statistics¹³ that reflect changes from e-commerce include retail, department store retail, non-store retail (which includes online retailers), and transportation and warehousing. According to data from the Bureau of Labor Statistics, Massachusetts retail and department store employment levels have remained relatively steady since 2010 at 330,000 to 350,000 employees (overall retail) and 33,000 to 35,000 employees (department store retail). Non-store retail employment and transportation and warehousing, however, have seen steady increases in the last ten years. Between 2010 and 2019, the state's non-store retail workforce and transportation/warehousing workforce increased by approximately 64 percent (over 19,000 employees) and 31 percent (90,000 employees) respectively (Figure 3).

Figure 3. Massachusetts Retail and Transportation & Warehousing Employment, 2010-2019



By comparison, U.S. employment in both transportation/warehousing and non-store retail employment grew by 39 percent since 2010. Interestingly, both U.S. and Massachusetts retail employment grew slightly from 2010 to 2019, while department store employment in Massachusetts decreased slightly and national employment for department stores saw steady losses (Figure 4).

Figure 4. Massachusetts and U.S. Department Store Employment, 2010-2019



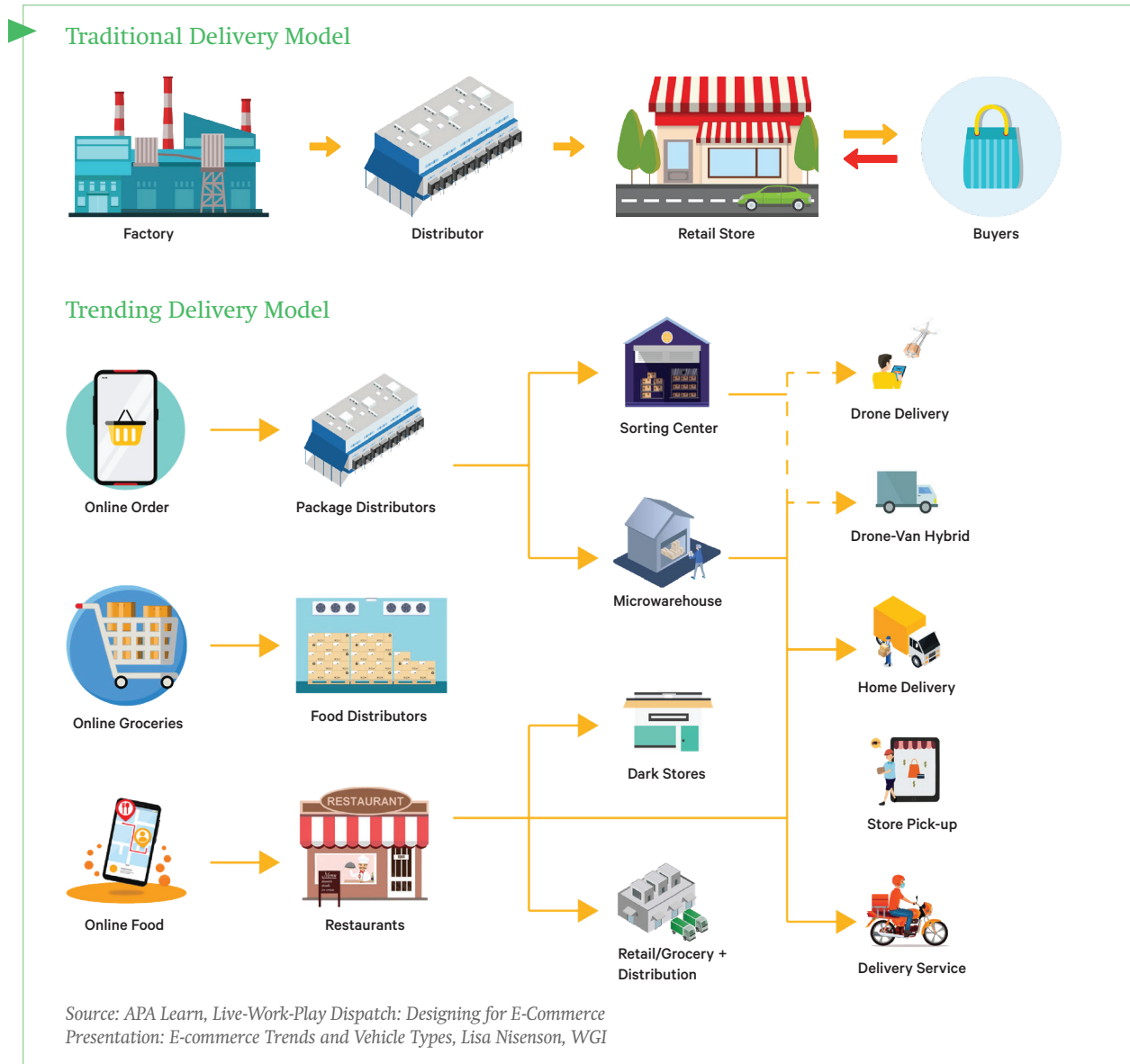
There are equity concerns with this changing retail and e-commerce landscape. The shift from brick-and-mortar to online retail has impacts on gender equity in employment. Currently, brick-and-mortar retail employment in the U.S. is 70 percent staffed by women, while warehousing and package delivery jobs are three-fourths staffed by men.¹⁴ Furthermore, there are concerns about whether the growing number of e-commerce jobs, particularly delivery positions, are filled by independent contractors with limited or no benefits, such as retirement, paid leave, and health insurance. Finally, there may be geographic equity impacts, as the siting of e-commerce warehouse and distribution centers may or may not be accessible by public transportation.¹⁵

► Chapter 2: Transportation and E-Commerce



The transportation impacts of e-commerce are primarily due to what is called “supply chain logistics.” The supply chain consists of the material and informational interchanges in the logistical process stretching from acquisition of raw materials to delivery of finished products to the end user. Distributors, stores, and buyers are some of the links in the supply chain. For e-commerce, supply chain logistics primarily refers to the processes involved in storing and shipping inventory for an online store or marketplace, including inventory management and the picking, packing, and shipping of online orders (Figure 5).¹

Figure 5. Supply Chain Logistics



Centered on a model of same-day delivery and a local approach to distribution, e-commerce has reshaped how supply chains work. In the past, goods moved first from the factory to the distributor, and then to the store where consumers made purchases. Due to e-commerce, the supply chain has evolved into an expanded model that moves goods across a complex network of interconnected facilities. This complex network includes brick-and-mortar stores, multiple warehouse and distribution centers, customer click-and-collect points, and package lockers.²

As a result, e-commerce impacts transportation networks regionally with increased vehicle traffic on roadways and streets, and locally with multiple daily deliveries at workplaces and residences where delivery vehicles compete for use of the curb.

New approaches are being designed to manage and facilitate the reverse logistics of returning items ordered online. For example, in a partnership with Amazon, Kohl's accepts returns of Amazon orders. Kohl's will package and send returned items to Amazon on behalf of customers at no cost. Walmart offers a Mobile Express Returns service which allows Walmart products purchased online to be returned in Walmart's physical stores at no additional cost. By these stores leveraging their physical locations, returns are more convenient for the customer and the retailer benefits from a centralized pick-up point.⁹ However, a shopper making a trip to the retail center to return an online purchase results in additional Vehicle Miles Travelled (VMT) and associated traffic congestion and Greenhouse Gas (GHG) emissions. This again illustrates the difficulty in calculating whether e-commerce has a net positive or negative impact on regional traffic.

A comprehensive study of the online shopping habits of Manhattan residents found that more than a third were willing to pay extra for same-day delivery. Meeting this immediate demand entails the use of more delivery vehicles. The study also found a positive correlation between income and the amount of online shopping. Similar research on shoppers in Texas found that wealthier households (those making more than \$75,000 annually) had an average of three package deliveries per week, compared to two packages per week for households with an annual income of less than \$25,000. This research also found that the more in-store shopping trips a household conducts per week, the more online packages the household receives each week; it found, too, that higher-income households were more likely to pay for expedited or same-day deliveries. These findings all suggest that e-commerce at this time may not be directly replacing in-person shopping trips, but rather providing another way for those with more disposable income to shop more.¹¹

An additional number of households are also embracing the "click and collect" models offered by retailers such as Target, Walmart, and grocery stores. Orders are placed online and picked up by the purchaser curbside at the store or in the store. This does not reduce VMT.¹² It is worth noting that the customer in-store or curbside pickup model is more cost effective for retailers, as they do not handle the last-mile delivery process.¹³

Some researchers have begun to estimate the impacts of e-commerce on both VMT and vehicle emissions, both now and in the future. As of 2018, approximately five percent of e-commerce was same-day delivery. Same-day delivery is forecast to increase to 15 percent within five years. Analysis by UC Davis found that offers for same-day deliveries are estimated to be among the most important determinants in increasing the number of vehicle miles traveled per package delivery. Their research estimates that an expedited one-hour delivery requires an average of 1.3 miles per package delivery, compared to less than 0.2 miles for next-day delivery.¹⁵ A study by the World Economic Forum projected the growth in deliveries using traffic and other data from several cities across the globe. The study concluded that without policy intervention, the number of delivery vehicles will increase 36 percent from 2019 to 2030, along with a 32 percent increase in carbon-dioxide emissions. The study also found that impacts of growth in last-mile deliveries alone could increase average commutes by 21 minutes by 2030. The report recommended various interventions to reduce traffic congestion and associated carbon-dioxide emissions, including mandated electric vehicle fleet adoption, use of drones for deliveries, increased double-parking enforcement, installation of package lockers, and creating more delivery parking zones. Implementing these interventions will require substantive policy changes, monetary investments, along with changes in customer shopping habits.¹⁶

Both the public and private sectors have begun to incentivize more efficient deliveries to reduce traffic and associated GHG impacts. A surcharge on same day deliveries could monetize the traffic impacts created by same-day deliveries and encourage users to select less-expedited delivery options. Amazon at times incentivizes customers (through discounts or reduced fees) to combine purchases into a single delivery. If this option was applied on a more widespread basis, and not just by Amazon, the number of deliveries and packing materials could be reduced. Since the pandemic in early 2020, UPS has added "peak" surcharges for large, high-volume companies such as Amazon, Target, and Best Buy in an effort to manage increasing numbers of shipments. Typically, these extra fees are imposed during the holiday shopping season. The surcharge could impact the volume and sizes of packages these companies ship with UPS.¹⁷

Traffic and Air Quality Impacts

The increased use of e-commerce raises two traffic-related questions: how much added traffic is due to e-commerce deliveries (trucks, vans, and cars), and do e-commerce deliveries replace vehicle trips that used to be made to traditional retail stores.

Since 2010, total Vehicle Miles Travelled (VMT) nationwide has grown nine percent overall but increased 13 percent in urban areas, while VMT in Massachusetts has grown 19 percent statewide and 23 percent in urban areas between 2010 and 2019.³ While some of this growth can be attributed to recovery from the Great Recession, there is also evidence that e-commerce and the widespread adoption of ride-hailing services are contributing to the growth in VMT and associated traffic congestion and vehicle emissions. In 2018, New York City received 1.5 million deliveries each day, a number that has tripled over the last eight years. As of 2018, at least 15 percent of New York City households received at least one package daily. The number of trucks on tolled bridges into New York City rose nine percent from 2014 to 2018.⁴ However, this growth in truck traffic only tells part of the story, as many deliveries are now made by vans and cars. Local data on the number of deliveries and their traffic impacts remains difficult to collect.

There has been almost no research on the extent to which e-commerce deliveries may be replacing vehicle trips for shopping. In theory, a consolidated delivery system of e-commerce orders compared to each individual household driving for their shopping trips should have lowered overall VMT.⁵

► The reality is more complex, indicating that online shopping may not necessarily be directly replacing in-person shopping trips:

- An online order for several items from a single site, such as Amazon or Target, can be shipped from separate warehouse or distribution centers. This can result in multiple deliveries from a single online order.
- Households are now offered more options for same-day or next-day shipping, which requires faster deliveries. This can require more vehicles and less opportunity to optimize distribution and routing.⁶
- Thirty percent of online orders are returned.⁷ This has created the need for what the industry calls “reverse logistics” – the moving of returned orders from the buyer, preferably to a destination that allows for some value recapture. Additionally, due to theft or deliveries to the wrong location, the rate of failed first delivery attempts can be as high as 15 percent in some cities.⁸ Reverse logistics and multiple delivery attempts increases the number of vehicular trips.
- Surveys of shoppers indicate that online deliveries are not wholly replacing in-person shopping trips. Rather, shoppers continue to shop in person on a regular basis *and also* go online primarily to purchase select items they have not bought during their in-person shopping trips.

In some cases, e-commerce may entail both an in-person store visit and a delivery. Some consumers visit a brick-and-mortar store to look at products before comparing prices and purchasing online for delivery. This involves both a car and a delivery trip. Another question is what consumers do with the time saved by making purchases online, and whether they are using any new “free time” for other trips.

A bill was proposed in December 2020 in New York City that would require residents to pay a \$3.00 surcharge on packages they order online, with the exception of medicine and food. The online shopping fee would be used to fund the operating costs of New York's public transit system and is intended to support small businesses and protect the environment.¹⁸ Chicago also proposed in late 2020 a \$1.25 to \$2.50 surcharge on deliveries, with the exception of medicine and restaurants. The purpose of the tax is to help raise revenues for the city.¹⁹ To date, these proposals have not been adopted, in part due to equity concerns about the tax's impacts on lower-income households. While these surcharges could help monetize the traffic impacts created by e-commerce, research suggests they must be done in conjunction with other interventions, such as package lockers and improved delivery parking regulations/enforcement to have the greatest impacts on reducing traffic and air quality impacts.



Photo: FedEx trucks in downtown Boston; Shutterstock

Deliveries and Curb Impacts

The growth in e-commerce also creates conflicts on local streets where delivery vehicles must compete with other uses of the curb, such as bicycle lanes, on-street parking, transit stops and bus lanes, as well as passenger pickups and drop offs for taxis and transportation network companies (TNCs). Parklets and extended outdoor dining areas, which have become more widespread during the COVID-19 pandemic, are also occupying curb space previously dedicated to other uses. Delivery vehicles double parked (particularly in bike and bus lanes) have become a frequent hazard in urban areas. These curb space conflicts are not limited to central business districts, but also are in suburban neighborhoods with a greater prevalence of on-street residential parking.

The first step in tackling the problem with the curb is to understand the delivery-zone supply and demand in downtowns and other dense areas. Since the pandemic, data is suggesting that, nationwide, commercial vehicles comprise nearly 30 percent of parking activity in cities and that more than 50 percent of parking violations in cities are committed by commercial operators.²⁰ Los Angeles, Seattle, San Francisco, New York, and Washington, D.C. have studied the number of deliveries in key locations and developed pilot programs to better manage both the supply of curbside delivery spaces and enforcement.^{21, 22}

Seattle, Toronto, and San Francisco have developed comprehensive framework and policy guides to inform future decision-making about using curb space for a variety of uses. Seattle's [Flex Zone/Curb Use Priorities](#) defines the curb lane as a "flex zone," and allocates ranked curb use priorities (mobility, access for people, access for commerce, activation, greening, and storage) according to street types. Toronto's Curbside Management Strategy and San Francisco's Curb Management Strategy have comprehensive policy approaches and implementation plans that manage curbside space while supporting mobility and access for people and goods. For example, the GoDCgo program in Washington, D.C. allows commercial vehicles to park in loading zones during designated times via a mobile service or smartphone application. DC has found that companies are willing to pay for the reliability, time savings, and reduction in parking violations that result from this program.²³

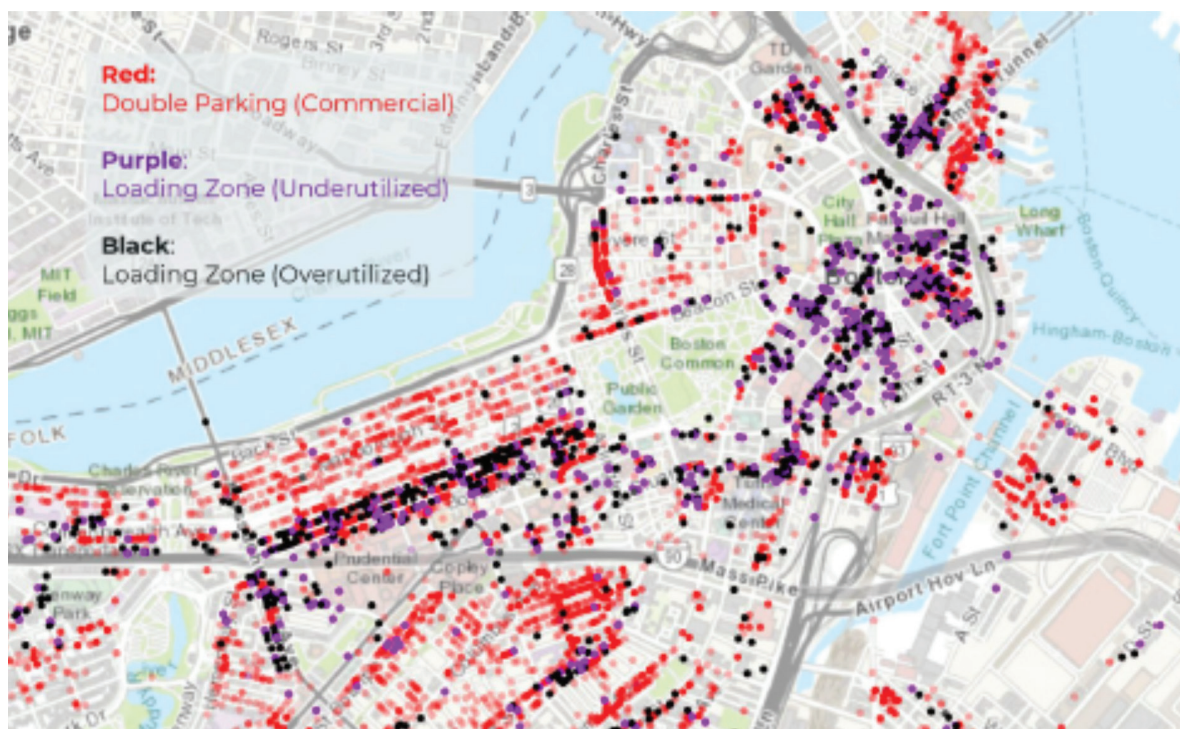
In 2018, the City of Boston began an effort to identify curb lane parking areas that were over- and under-utilized. The city studied its parking violations to determine where delivery vehicles were double-parking in travel lanes, bus lanes, and bicycle lanes and where vehicles were overstaying in loading zones. Boston found substantial variation in curb space utilization within only a few hundred feet throughout the day (7 a.m. – 7 p.m.). As seen in Figure 6, commercial parking/delivery spaces in purple had passenger vehicle violations, indicating they are likely underutilized by commercial vehicles. Red spaces show double-parking violations of commercial vehicles (suggesting too few spaces dedicated for deliveries and commercial vehicles), and black show commercial vehicles that were parked beyond the 30-minute limit for deliveries (indicating spaces are overutilized). In the Back Bay, streets that are primarily residential and closer to the Charles River show higher concentrations of commercial vehicles double parking, suggesting there is not enough parking designated for delivery vehicles. The same applies for Commercial Street in the North End. In comparison, the Financial District has several zones for deliveries that are used by personal vehicles, which may indicate an oversupply of delivery parking spaces.²⁴



Photo (right): UPS truck in Brookline Village in bike/parking lane; MAPC

On the basis of this study, Boston is developing pilot programs to manage deliveries through more dynamic curbside-parking pricing. The City also plans to advance a pilot program for e-cargo bike deliveries.

Figure 6. City of Boston Commercial Parking Violations



Source: City of Boston

The Boston Metropolitan Area Planning Organization (MPO) is undertaking research on the future of the curb. It recommends communities in the Boston area consider pilot programs to better manage curbside use for parking and deliveries.²⁵ Potential strategies include making street parking along entire city blocks for deliveries only, which has reduced double parking and dwell times for delivery vehicles in Washington, DC.

Package Lockers

Package lockers (sometimes called parcel lockers) are self-service secure containers where customers can pick up packages at their convenience. After carriers make deliveries, customers can then retrieve their packages, usually with a personalized access code sent by text or e-mail. Package lockers are typically sited at centralized locations such as apartment buildings, office buildings, grocery stores, and convenience stores. There are various locker services such as the USPS, Gopost, UPS Access Point, DHL Lockers, FedEx Ship & Get, and Amazon Hub.

Delivering to a package locker removes the need for multiple delivery attempts and reduces vehicle dwell times. Enabling drivers to make one delivery trip quickly and efficiently to a centralized location can reduce congestion and emissions. A study by Urban Freight Lab found that package lockers at an apartment complex in Seattle reduced the time UPS trucks were parked in front of the complex by 78 percent.²⁶



Photo: UPS locker at Stop & Shop in Dedham; MAPC

Not surprisingly, an analysis of package deliveries to residential buildings mirrors the tremendous increase in the e-commerce sector. For example, AvalonBay Communities, a real estate investment trust that has an ownership interest in about 80,000 apartments nationwide, reported in 2017 that the average apartment community in the company's portfolio received approximately 1,000 packages a month, up from 650 in the prior year. Over the past several years, the company reported having a 30 percent annual increase in the volume of packages it receives.²⁷

In Massachusetts, AvalonBay has an ownership interest in about 10,530 apartment units in 40 buildings.²⁸ These apartment buildings are in 25 municipalities throughout Eastern Massachusetts.²⁹ Recently, AvalonBay contracted with Amazon to install package lockers at their apartment buildings, which allows data on package deliveries to be collected. Even though the parcel locker system was installed by Amazon, all carriers (e.g., UPS, FedEx, and small regional carriers) can be assigned a carrier code that allows them to deliver to the lockers. The figure below depicts the consolidated data on deliveries across the 10,530 apartment units in the 40 buildings in Massachusetts. Over a 19-month period from January 2019 to July 2020, package deliveries increased by 65 percent. As of July 2020, the average number of monthly package deliveries per apartment unit is 5.3.

Figure 7. Consolidated Deliveries, AvalonBay Communities in Massachusetts



Notes:

- Deliveries include both manually delivered packages and packages delivered to package lockers.
- AvalonBay notes this number is understated as packages are sometimes delivered to the apartment door or left by carriers around the community.
- Package returns are not managed.
- While AvalonBay does not share occupancy data, they utilize an industry benchmark of 95 percent.



Photo (left): Amazon Prime delivery in Revere; Shutterstock



Photo (right): UPS Driver; MAPC

Traffic from Warehouses and Distribution Centers

Warehouses and distribution centers generate three distinct types of trips and associated traffic patterns: 'inbound' traffic from wholesalers, retailers, or other distribution centers (primarily via tractor-trailers); 'inbound' employee traffic via personal vehicles; and 'outbound' delivery traffic via trucks, vans, or smaller vehicles. Each trip, of course, entails a corresponding leg where the vehicle leaves or returns to the facility.

While the traffic generated by e-commerce warehouse and distribution centers vary by size and type of product being delivered, most centers have 24-hour operations.³⁰ The typical cycle of activity consists of the receipt of bulk deliveries from distribution centers late at night from tractor-trailers. The items are sorted and prepped, then loaded into vans overnight for delivery. Delivery vans depart from distribution centers in waves starting in the late morning, make deliveries during the day, and then return in the evening. Employees driving to and from the site are also part of the traffic generated.³¹ A more detailed description of the operations of a distribution center can be found in Chapter 3.

The total volume of traffic to and from warehouse and distribution centers in Massachusetts is currently unknown, as is the extent to which vehicular trips generated by an e-commerce distribution center are replacing other trips that might have been made by shoppers to traditional stores.

Understanding the traffic volume generated by these facilities is further complicated by the number of e-commerce distribution centers repurposed from older warehouses or large buildings. The Amazon distribution center in Dedham, for example, was previously a warehouse used by a Macy's department store and Restoration Hardware. The Amazon facility in Revere occupies an old Necco candy factory. In each location, some of the Amazon activity replaces traffic from previous activities at these sites.



Photo (left): Amazon van entering Milford delivery station on Industrial Road; Neal McNamara, Northborough Patch

Photo (right): Amazon Prime vans departing Milford delivery station on Industrial Road; Central Transportation Planning Staff

Emerging Delivery Models

Emerging delivery models for e-commerce include new technologies such as air and ground drones, autonomous vehicles, as well as using existing technology such as e-bikes in new applications. Several municipalities and the private sector have developed pilots of emerging delivery models to determine their effectiveness. Package lockers (described earlier) started as pilots and are now becoming more widespread in deployment and use. The pilots described below are still early in their development.

► Cargo Bike Deliveries

Whether pedal-operated or electric, cargo bikes can serve as a nimble, carbon-neutral last-mile delivery solution which could reduce delivery times, traffic, emissions, as well as competition for curb space. In Miami, DHL is piloting e-assist cargo bikes, New York City launched an initiative to encourage freight companies to use cargo bikes, and in Seattle, UPS recently conducted a one month e-cargo bike pilot.^{32,33,34}

London implemented a successful pilot in which delivery vans drove to strategically placed meet-up points where the goods were distributed to a team of bicyclists and pedestrians. In turn, the bicyclists and pedestrians delivered the packages while the delivery vans went back to the warehouse, reloaded, and drove to another meet-up point. It was determined that this delivery method allowed for four times as many packages to be delivered during one shift. Following this pilot, the City is considering next steps.³⁵

In the summer of 2020, Boston released a Request for Information (RFI) for Electric Cargo Bikes as a Delivery Solution.³⁶ With a better understanding of existing initiatives in the Boston metro area and elsewhere, the City plans to launch an e-cargo bike delivery pilot program which will identify the potential regulatory, administrative, and operational challenges to e-cargo bike delivery and establish strategies to address those challenges.



Photo: UPS e-assist bike in Seattle, Washington; UPS

► Drones – Air and Ground

Numerous companies are exploring the expansion of aerial and ground drones for deliveries of medical, package, and food deliveries. Walmart and FedEx plan to collaborate on a pilot to send on-demand deliveries of household, and grocery items in North Carolina. Amazon, UPS, and Walgreens all have plans to conduct air drone pilot programs.^{37, 38} CVS and Nuro, a robotics company, have partnered to deliver prescriptions in Houston with ground drones. CVS also has a partnership with UPS to deliver medical supplies via ground drones to retirement communities in Florida.³⁹ Starship Technologies, a delivery robotics company, has new grocery and meal delivery programs at university campuses, including Arizona State University, James Madison University in Virginia, and Georgia Southern University; and in communities such as Mountain View and Modesto in California.⁴⁰

► Autonomous Vehicle Deliveries

Pilots are also underway using autonomous vehicles. In Phoenix, UPS will be undertaking a pilot in which autonomous vehicles will pick up packages dropped off at UPS stores and bring them to a UPS logistics facility.⁴¹ In Bentonville, Arkansas, Walmart and autonomous vehicle startup Gatik have plans for delivering customer orders from a dark store. In Scottsdale, Walmart and GM Cruise have plans to test driverless deliveries using electric vehicles.⁴² Toyota has developed an autonomous delivery service concept called e-Palette, which is a modular store on wheels that could deliver food and packages.⁴³

Although widespread deployment of air and ground drones and autonomous vehicles will take several years to become mainstream, these types of services could dramatically impact personal trips, especially since 45 percent of household trips are for groceries and errands.⁴⁴

► Chapter 3: Land Use and E-Commerce



The dramatic increase of e-commerce is having major effects on land use. The pressure to maintain dependable and quicker delivery times has resulted in e-commerce companies adding smaller warehouse and distribution centers closer to consumers as part of their regional networks, a trend which shows no signs of changing.¹

Consumers are increasingly expecting to receive the goods they purchase promptly and retailers such as Amazon, Walmart, and Target are competing to reduce order-fulfillment times by offering next day and even same-day deliveries. Aimed to compete with Amazon Prime, which has an estimated membership of 112 million,² Walmart launched its own membership service for free deliveries, Walmart Plus, in September 2020. As transportation is the greatest cost as part of e-commerce logistics, the siting of smaller warehouse and distribution centers closer to consumers saves on both delivery times and expenses. Subsequently, the placement of warehouse and distribution centers in urban areas is an integral component of the “last mile” delivery process.

The competition to add warehouse and distribution centers has resulted in a high demand for industrial real estate, particularly in urban areas. According to real estate firm Cushman & Wakefield, the demand for industrial space in North America exceeded supply in 2019 for the first time since before the Great Recession.³ Industry publications report that warehouse rents in the Boston-area market have increased 42 percent over the last two years to an average of just over \$12.00 per square foot.⁴ According to a report by the Industrial Asset Management Council and the Society of Industrial and Office Realtors, “The rise of e-commerce is a primary reason for the growing demand for new warehouse space, strategically located within closer proximity to consumers.”⁵

The push to site warehouse and distribution centers closer to consumers is a significant industry change that impacts both land use and transportation. The increased traffic, emissions, and noise caused by delivery vehicles accessing the warehouse and distribution centers has raised concerns about potential negative health impacts to area residents.⁶ As the distribution centers are located within urbanized areas to meet demand, these centers may be situated in communities of color and lower-income neighborhoods and could create disproportionate impacts.

At the same time, there is significant demand to site large e-commerce warehouse and distribution centers outside of urban areas. Primarily located in industrially-zoned areas, these facilities require both substantial amounts of land and easy access to the regional highway and rail network. It is worth noting that these facilities are frequently located where access by public transit is limited.⁷

While the pandemic has had considerable and immediate negative impacts on businesses and real estate, industrial properties are thriving primarily due to increased e-commerce activity. In 2020, Amazon opened more than 175 new fulfillment centers, distribution centers, sortation centers, delivery stations, and regional air hubs in the U.S. and Canada, a trend which shows no signs of slowing.⁸

As of December 2020, Amazon had 762 active facilities across the country and another 240 in the pipeline that would bring its footprint to over 352 million square feet.⁹

As e-commerce warehouse and distribution facilities are designed to prioritize goods movement and/or short-term goods storage, they require more loading docks, more space for parking, and higher ceiling heights than do traditional warehouses.¹⁰

Amazon Facilities in Massachusetts

Amazon is one of the largest industrial tenants in the greater Boston industrial market and has plans for continued expansion. As of February 2021, 20 Amazon facilities were in operation and 14 facilities were in the pipeline. While the oldest of these facilities became operational in late 2014, ten became operational in 2020 alone. As shown in Table 1 and Figure 8, existing square footage is approximately 4.79 million square feet and planned development is an estimated 7.3 million square feet. If all planned facilities become operational, the total square footage could exceed 12 million square feet.¹¹

Definition of Amazon Facilities

- **Amazon Pantry and Fresh Distribution Center.** Facilities which service dry grocery merchandise (Pantry) or perishables or frozen merchandise (Fresh).
- **Amazon Prime Now.** Facilities that stock a limited line of products that are in high demand and can be delivered within 1-2 hours of order placement.
- **Amazon Whole Foods Retail Distribution Center.** A facility which services Whole Foods grocery products.
- **Delivery Station.** Facilities where packages are sorted and then dispatched directly to the customer. These facilities represent the last leg of the delivery network.
- **Distribution Center (or Fulfillment Center).** A building specifically designed to receive, store and redistribute goods and designed for rapid turnaround for e-commerce and similar “just in time” product deliveries.
- **Sortation Center.** Facilities generally used to sort packages for a geographical region whereby the packages have originated from one or more fulfillment centers within the Amazon network. Packages are usually shipped to delivery stations.

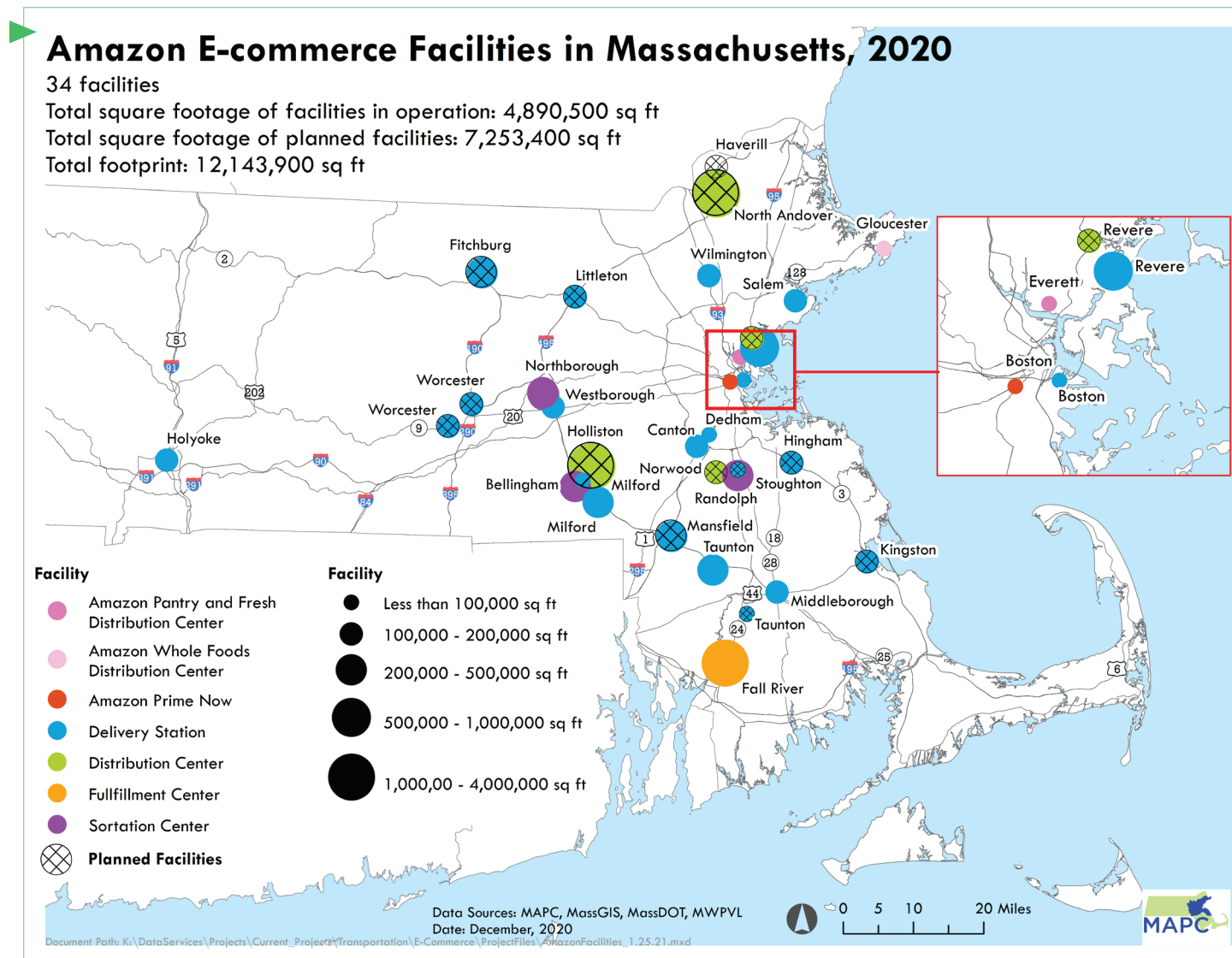
Modified from https://www.mwpyl.com/html/amazon_com.html

Table 1. Operational and Planned Amazon Facilities

Facility Type	Address	Municipality	Square Feet
In Operation			
Fullfillment Center	1180 Innovation Way	Fall River	1,015,700
Delivery Station	135 American Legion Highway	Revere	830,000
Delivery Station	800 John Quincy Adams Road	Taunton	350,300
Sortation Center	1000 Technology Center Drive	Stoughton	332,700
Sortation Center	1 National Street	Milford	332,000
Sortation Center	350 Bartlett Street	Northborough	300,000
Sortation Center	330 Bartlett Street	Northborough	300,000
Delivery Station	351 Maple Street	Bellingham	300,000
Delivery Station	732-750 Everett Street	Norwood	162,700
Delivery Station	4400 Computer Drive	Westborough	156,500
Delivery Station	20 Colonial Road	Salem	147,000
Delivery Station	161 Lower Westfield Road	Holyoke	145,000
Delivery Station	30 Commerce Boulevard	Middleborough	132,300
Delivery Station	110 Fordham Road	Wilmington	100,200
Delivery Station	8 Industrial Road	Milford	81,900
Amazon Prime Now	30 Northampton Street	Boston	72,300
Delivery Station	500 Sprague Street	Dedham	60,500
Amazon Pantry and Fresh Distribution Center	201 Beacham Street	Everett	51,000
Amazon Whole Foods Retail Distribution Center	15 Parker Street	Gloucester	20,400
Delivery Station	415 Summer Street	Boston	n/a
			4,890,500
Planned			
Distribution Center	1600 Osgood Street	North Andover	3,800,000
Distribution Center	555 Hopping Brook Road	Holliston and Medway	1,500,000
Delivery Station	139 Intervale Road	Fitchburg	350,000
Delivery Station	560 West Street	Mansfield	350,000
Delivery Station	125 Goddard Memorial Drive	Worcester	177,000
Delivery Station	100 Industrial Park Road	Hingham	149,000
Delivery Station	39 Presitge Way	Kingston	145,000
Delivery Station	151 Taylor Street	Littleton	143,000
Delivery Station	25 Computer Drive	Haverhill	142,000
Delivery Station	7 Neponset Street	Worcester	121,000
Distribution Center	300 Dan Road	Canton	106,698
Distribution Center	565 Squire Road	Revere	102,000
Delivery Station	100 Mazzeo Drive	Randolph	93,200
Delivery Station	350 Revolutionary Drive	Taunton	74,500
			7,253,400
		Total	12,143,900

As illustrated in Figure 8, current last-mile delivery stations are in Bellingham, Dedham, Everett, Holyoke, Milford, and Revere. Amazon is proposing to expand its network of last-mile delivery stations in Massachusetts with facilities in Boston, Hingham, Kingston, Mansfield, Middleborough, Salem, Taunton, Wilmington, and Worcester.¹² Both existing and planned facilities are heavily concentrated in the southeastern part of the state. This is attributed to the area having proximate access to the regional highway network and a building inventory that meets building specification demands of e-commerce providers (e.g., high ceiling heights and multiple loading docks).¹³

Figure 8. Amazon E-Commerce Facilities in Massachusetts, 2020



Warehousing and Distribution Centers in Eastern Massachusetts

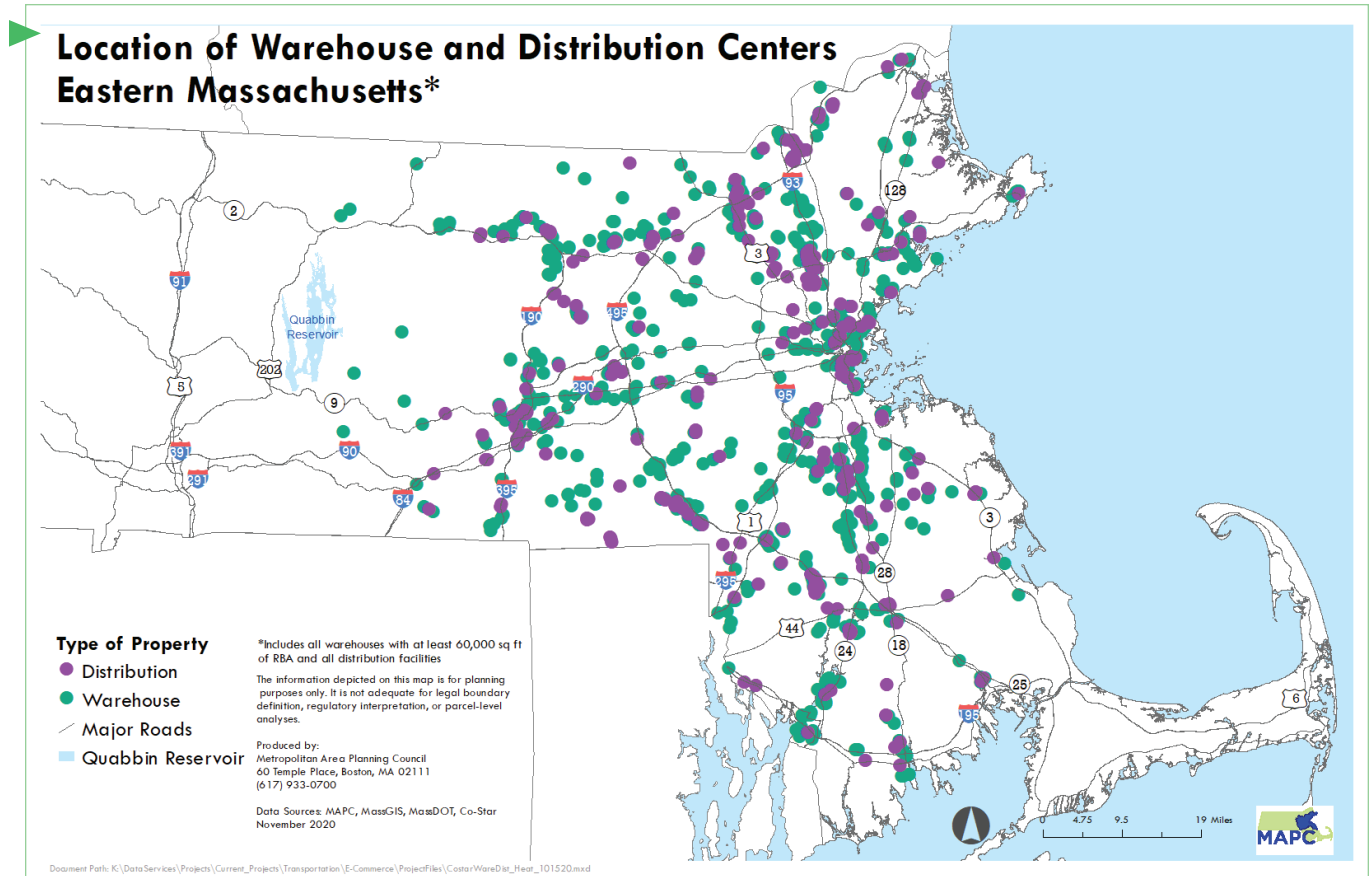
According to Colliers International, the rest of the Greater Boston industrial market (not including Amazon) has slightly under two million square feet in the construction and renovation pipeline.

Colliers has identified the growing importance of two areas in the Commonwealth for the siting of warehousing and distribution: the Route 2 corridor, which provides access to Boston, Worcester, and New Hampshire; and the area south of I-495, which is proximate to the I-95/I-495 interchange.¹⁴ Colliers has also determined that interest in industrial operations has also reached beyond the Boston market.

Consistent with national trends, Greater Boston's industrial market is in demand and growing.¹⁵ Industrial vacancy rates reached a record low of 8.2 percent in Greater Boston at the end of 2020.^{16, 17} According to Colliers, e-commerce is the "major demand driver" in the Greater Boston market.¹⁸

MAPC used CoStar, a commercial vendor that provides information, analytics, and marketing services to the commercial and property industry, to develop an inventory of warehouse and distribution centers. As shown in Figure 9, warehouse and distribution centers are distributed throughout Eastern Massachusetts.¹⁹ The facility types coningle and are generally concentrated along the regional highway network. There are nodal concentrations of both facility types at the major highway interchange areas of I-90/I-190/I-290 (Worcester area), I-90/I-93/I-95 (Boston area), I-495/Route 3 (Lowell area), and I-95 and I-295/I-495 (southwest of Boston).

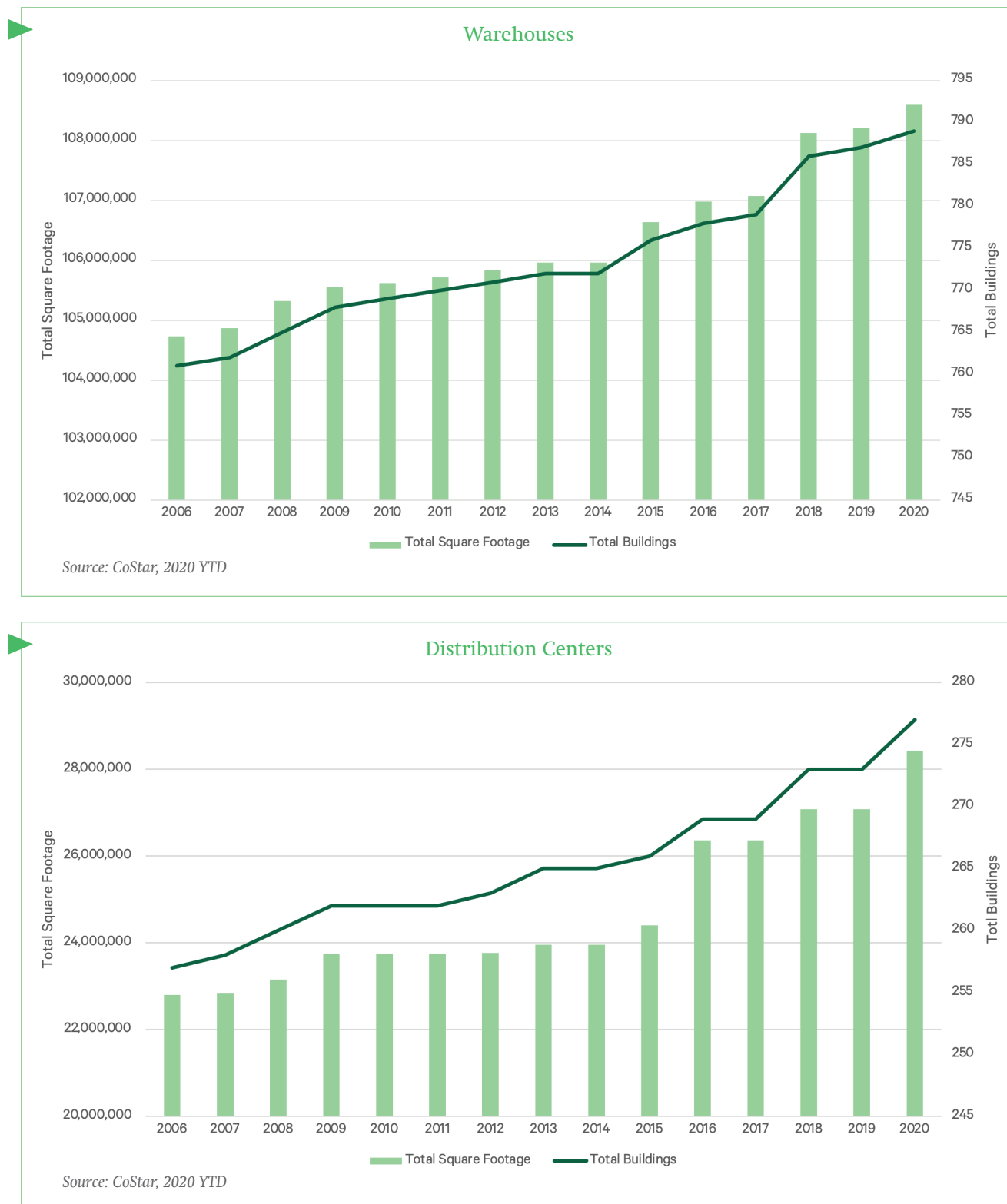
Figure 9. Location of Warehouse and Distribution Centers, Eastern Massachusetts



Note: MAPC's CoStar subscription coverage is for the eastern part of the state extending to the Quabbin Reservoir and does not include Cape Cod.

As shown in Figure 10, the number of warehouses and distribution centers has been steadily climbing since 2006. Currently, warehouse facilities comprise an estimated 790 buildings and total 108.6 million square feet. Distribution centers comprise an estimated 277 buildings, totaling 28.4 million square feet. It should be noted that not all of these facilities operate for e-commerce, but they illustrate the trends of warehousing and distribution centers in Massachusetts.

Figure 10. Warehouses and Distribution Centers in Eastern Massachusetts, 2006-2020



CoStar Definitions

Distribution: Typically large buildings, both single and multi-tenant, used for the warehousing and distribution of inventory. Buildings are typically 200,000 square feet or more, with clear heights 28 feet plus, up to five percent office space and the balance being warehouse/storage space. These buildings typically have one loading door for every 10,000 square feet of Rentable Building Area (RBA) and site coverage up to 40 percent. These buildings are often cross-docked with trailer parking. MAPC included all properties listed as “Existing,” “Under Renovation,” “Proposed,” and “Under Construction” with no square footage minimum.

Warehouses: Typically 25,000 square feet or greater in size, box shape, with one loading dock for every 15,000 square feet of Rentable Building Area (RBA). Up to 20 percent office area with clear heights of 22 feet or greater. Site coverage is typically up to 50 percent. MAPC included all properties listed as “Existing,” “Under Renovation,” “Proposed,” and “Under Construction.” A square footage minimum of 60,000 square feet was applied.

One limitation of CoStar is that the data only represents commercial/rental properties. Accordingly, if a property is owned and operated by the same entity and not leased, the property is likely to not be included in the CoStar database.

Delivery Operations

Frequently, e-commerce companies such as Amazon lease and repurpose space in existing warehouses for distribution centers.²⁰ Distribution centers require large parking lots where employees can park their personal vehicles and the company can stage delivery vans. Distribution centers provide “last mile” package delivery and expedite deliveries to residences and businesses. Their deliveries typically cover a 45-mile radius and serve a market area within an approximate 60-minute driving time of the site.²¹

In general, the daily operations of distribution centers begin with the arrival of tractor trailers that bring packages in bulk from fulfillment centers throughout the night, usually starting after 11 p.m. Customer orders are then sorted, prepped, and loaded into hundreds of delivery vans. Each morning, delivery van drivers travel to the distribution centers, typically by personal vehicle. After arriving, the drivers get into a loaded delivery van, drive out of the site, and make deliveries to customers. Delivery drivers are usually scheduled to enter and leave the site during off-peak morning traffic times. After all deliveries are made, drivers will drive their delivery vans back to the distribution center in the evening and depart from the site.²²

In many cases, the departure of delivery vans is scheduled in waves. As one wave of vans leaves the site, another is loaded. Waves can continue throughout the morning, depending on demand. When there is additional demand, on-call drivers will be used to fulfill customer deliveries. On-call drivers usually arrive in the middle of the day and use their personal vehicle to make deliveries. Once deliveries are completed, the on-call drivers do not return to the site.²³ Including tractor trailers, delivery vans, and on-call drivers, a typical facility can generate more than 1,000 vehicle trips each day.²⁴

Amazon also works with third-party Delivery Service Partners (DSPs) to make deliveries. Independently owned companies, DSPs manage employee benefits, compensation, and address liability issues. Amazon Flex, a program where independent contractors, called delivery partners, deliver Amazon orders to customers, may be used but Amazon will first hire a DSP with their own vans to deliver packages.²⁵ Amazon Flex drivers use their own vehicles and deliver what cannot be accommodated by vans.

The variety of delivery vehicle owners and operators adds to the challenge of managing and regulating transportation impacts such as curb usage. The novelty of this rapidly evolving business/operations model means that traditional trip generation forecasting methods are not applicable.

Sortation systems and robotics automate and streamline orders inside warehouse facilities and increase the speed and intensity of their operations. Such technological innovations are projected to accelerate the e-commerce industry – and of course, could further increase the numbers of vehicles making deliveries.

Impacts of E-Commerce on Retail Infrastructure

The United States has more retail space than any other country. Price Waterhouse Coopers has estimated that there are about 24 square feet of retail floorspace per person in the United States, followed next by 11 square feet in Australia and between two and five square feet in Europe.²⁶ Brick-and-mortar retail real estate is vastly overbuilt in the United States, with some industry experts estimating the amount of overbuild to be about 50 percent.

Many malls and other traditional retail locations have been contending with sizable and steady closures, vacancies, and declining profits over the past several years. Nationwide, physical-store closures reached an all-time high in 2017 and again in 2019.²⁷ According to Coresight Research, approximately 25 percent of all malls nationwide (approximately 1,000) are projected to close over the next five years.²⁸

Despite these significant and steady declines, retail sales are not diminishing. Rather, the retail landscape is transitioning from malls and physical retail locations to warehouses and distribution centers. Online shopping's share of total retail sales has been increasing by approximately one percentage point per year.²⁹ The overbuild of brick-and-mortar retail, coupled with the rise in e-commerce, has accelerated as to what industry professionals refer to as the 'retail apocalypse,' which began during the Great Recession of the late 2000s.³⁰ Both trends – the decline of traditional retail and the dramatic increase in e-commerce – predate the pandemic but have been accelerated by it.³¹



Photo: Example of an Underutilized Strip Mall; MAPC

According to a July 2020 report by CBRE Group, Inc., a commercial real estate firm, an estimated 13.8 million square feet of retail space has been converted to 15.5 million square feet of industrial space over the past three years nationwide.³² Depending on where e-commerce facilities locate and where in-person retail stores close, municipalities could face various land use and fiscal challenges.

Some malls are being converted to warehouse and distribution centers. One well-known example is the Randall Park Mall near Cleveland, Ohio. Touted in the mid-1970's as one of the nation's largest shopping centers, Randall Park Mall was abandoned in 2009 and became an Amazon fulfillment center in 2018.³³ The retrofitting of malls with housing, offices, and other non-retail uses is likely to continue. According to a report issued by Barclay's, turning a closed mall into an e-commerce warehouse or a residential complex could reduce the value of the property between 60 percent to 90 percent.³⁴

Nationwide, Simon Property Group has been exploring with Amazon the possibility of converting some of the property owner's anchor department stores into Amazon distribution hubs. Since many malls are sited near major highways and residential areas, these sites are considered strategic locations for distribution centers. The Simon Property Group owns 14 properties, mostly in eastern Massachusetts.³⁵ Should Amazon and Simon Property Group come to an agreement about utilizing department stores in Massachusetts to warehouse/distribution centers, the land use impacts could be significant.^{36, 37}

State and Municipal Revenues

The effect of e-commerce on state and municipal revenues that come from state sales and income taxes and municipal property taxes is difficult to gauge and not yet fully known. A study by the Economic Policy Institute concluded that Amazon fulfillment centers do not generate broad-based employment growth and that state and local policymakers seeking to maximize long-term benefits should avoid extending tax incentives to lure these businesses. The report argues that investments in public services are more effective than tax incentives at generating long-term economic growth.³⁸

In Massachusetts, North Andover approved an estimated \$27 million in tax incentives to Amazon for a 3.6 million square foot distribution center. This tax increment financing (TIF) agreement will reduce Amazon's property tax bill over a period of ten years. Amazon will not receive a state tax break for this site. North Andover is expected to receive \$18 million in new net tax revenue over the ten-year agreement. In the decade after the agreement expires, the Town anticipates receiving an additional \$45.5 million in property taxes from Amazon.^{39, 40}

Amazon has received tax breaks for other facilities in Massachusetts. In 2015, Amazon received approval for nearly \$16 million in state and local tax incentives for a distribution center in Fall River and an estimated \$3.5 million for a facility in Stoughton. Amazon will also receive up to \$10 million in property tax breaks from the City of Boston for offices in the Seaport District.

Impacts of E-Commerce on the Restaurant and Grocery Industries

The restaurant and grocery industries are undergoing disruption by e-commerce. A significant component of e-commerce includes restaurant delivery and prepared meals.⁴¹ Nationwide, transactions from services such as DoorDash, Grubhub, Uber Eats, and Postmates increased by approximately 200 percent between 2015 and 2020, generating an estimated \$26 billion in revenue in 2020.⁴² The pandemic, due to the attendant closure of restaurants and restrictions to takeout and delivery, has reversed the prolonged trend of declining grocery consumption relative to eating out. Since the pandemic, traditional grocery consumption has grown faster than both restaurant deliveries and eating out.

According to research firm Brick Meets Click, online grocery sales for home delivery and pickup reached \$5.9 billion in November 2020, a threefold increase from August 2019.⁴³ The volume in number of orders has more than tripled to almost 63 million, and the number of customers has more than doubled to nearly 39 million during this period – along with an increase in the average amount of spending per order and shopping frequency.

Despite these increases, grocery delivery comprises an estimated 4.9 percent of the total grocery market. Increases in the grocery market are attributed to a decline in in-store grocery sales, rather than new growth. There is consensus among industry experts that, due to consumer demand, investments in e-commerce technology are accelerating online grocery sales. It is forecasted that online grocery sales are expected to grow

to 20 percent of total grocery retail by 2025. However, the overall growth of the grocery sector will most likely be moderate in the long term.^{44, 45}

To meet current demand and maintain market share, grocers are improving their operational efficiency and enabling online sales with investments in delivery infrastructure and e-commerce technology. Shop & Shop, for example, is adding “warerooms” to their stores. Usually attached to traditional retail stores, warerooms serve as e-commerce distribution/spaces.⁴⁶

In some cases, retail and grocery stores have become places to accommodate various combinations of in-store shopping, curbside pick-up, and distribution center operations. In other instances, retail and grocery stores are being converted to operate as dark stores or micro-fulfillment centers for home delivery or curbside pick-up – the latter of which is preferred by most customers. According to grocery store chain Kroger, for every customer who wants a home delivery, five customers want curbside pick-up.⁴⁷ Municipalities are increasingly faced with the challenge to revise their zoning laws to accommodate for these new land use demands.

Also referred to as cloud kitchens, dark kitchens, or virtual food halls, a ghost kitchen is a single commercial facility that houses multiple restaurant operators who prepare food for takeout or delivery exclusively to fulfill online orders. An emerging model and type of facility, these operations have no storefronts and no dining areas for patrons. Ghost kitchens are comparable to a coworking space for restaurant operators, with the exception that there is no need for front-of-house labor. These types of facilities are typically owned and operated by a third-party company, not a restaurant, and meal delivery companies such as DoorDash, GrubHub, and Uber Eats deliver the food.

Opening a traditional restaurant can be expensive, high-risk, and complex: ghost kitchens are considered to be lower-risk and more affordable. The up-front costs of restaurant space and equipment can be shared and rented under a ghost kitchen model and the costs of front-of-house staff are eliminated. The ghost kitchen model enables existing restaurants to expand their customer base without having to invest in and establish full-service restaurants. It offers a lower cost of entry, and as such can benefit newcomers to the industry. The ghost kitchen model is considered to have a large potential market opportunity and technology is enabling the restaurant industry to rapidly change.^{48, 49} The long-term land use implications of dark stores and ghost kitchens, especially as they pertain to street vitality and local economies are unknown, but should be monitored.



Photo (left): Delivery & Pick Up Prep Room - Dedham Stop & Shop, MAPC

Photo (right): A Curbside Pick Up Sign - Dedham Stop & Shop, MAPC

► Chapter 4: Context of COVID-19 Pandemic



Context of COVID-19 Pandemic

While COVID-19 has accelerated certain consumer patterns and behaviors, many of the trends impacting e-commerce were already underway prior to the pandemic. Although the long-term impacts of the COVID-19 pandemic are less certain, much of the shift to e-commerce will likely remain.

The role of the COVID-19 pandemic in the spike in U.S. online retail sales in 2020 can be broken into **four major areas of impact**:

- ▶ **Growth in non-store shopping and greater downturns in brick-and-mortar retail:** Amazon, the largest online retailer, saw its business increase by 43 percent in 2020.¹ By comparison, industry experts anticipate 15,000 to 25,000 store closures in the U.S. in 2020, mostly in malls; a projection which will shatter the 2019 record of 9,800 closures. The COVID-19 pandemic is accelerating changes in urban and suburban land uses, as malls and shopping centers close and as Amazon and other online retailers increase the number of warehouses and distribution centers.
- ▶ **Increased growth in “click and collect” shopping:** Customers have learned to order online and pick up their orders at larger brick-and-mortar retailers, including Target, Walmart, and Home Depot, either in-store or at the curb. Retailers who have invested in their online presence with same day “touch free pickup” will continue to generate traffic, both online and in-person.³ Stores morphing into both in-person shopping and distribution/fulfillment centers may require the repurposing of parking lots. Parking areas may need less customer parking, but more space for curbside pickup and loading for trucks and vans. Measures to repurpose these facilities could cause increases in car, van, and truck traffic.
- ▶ **More online grocery purchases:** Amazon’s growth in 2020 has been led by their growth in grocery orders via Amazon Fresh and Whole Foods. Since the pandemic started in March 2020, 21 percent of consumers have tried online grocery shopping for the first time. Of that 21 percent, many have continued to shop for groceries online even as they also physically returned to food stores.⁴
- ▶ **Accelerated growth in online restaurant orders:** Over 40 percent of restaurants surveyed added delivery options during the pandemic. Many have stated that they will retain delivery options,⁵ which means increases to curbside traffic and deliveries to households.

The pandemic has prompted more households to try their hand at e-commerce services that they may have not previously attempted. Once shopping habits are developed during the COVID-19 pandemic, these habits may continue. Any long-term shifts will likely mean changes in the physical layout and staffing of local retail facilities, along with increased delivery traffic, as stores and restaurants become both in-person destinations and distribution centers of online orders.

► Chapter 5: Future Trends and Additional Research Areas



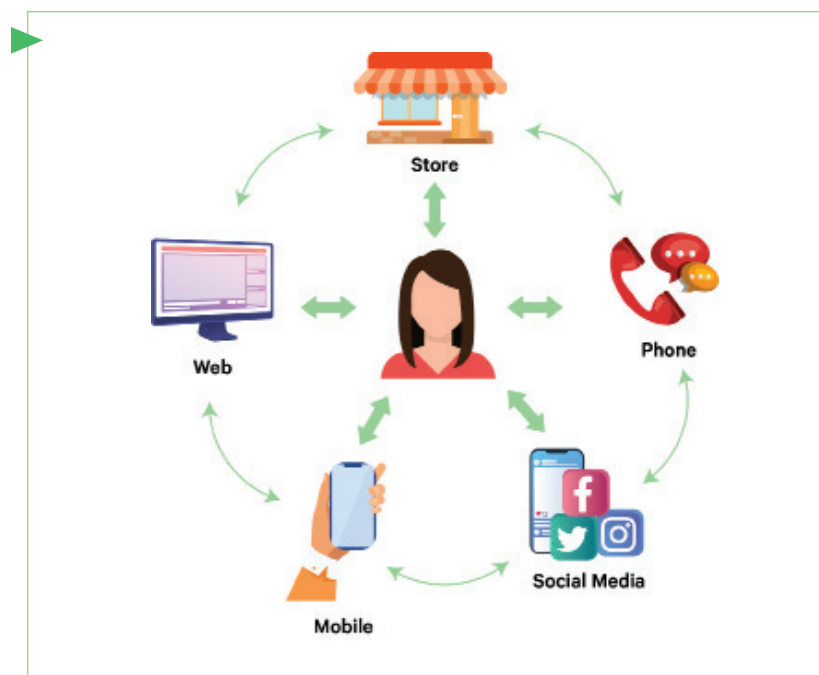
While writing this report, MAPC uncovered several trends and topics that were beyond the scope of this work, but which may be of interest to municipalities, policy analysts, and others. MAPC will continue following these trends and may study them further in the future.

Omni-channel Retail

It is projected that e-commerce by itself will not be the future of retail. Rather, e-commerce will be omni-channel. Omni-channel retail integrates multiple sales channels (e.g., brick-and-mortar store, smart phone, laptop). The goal of the omni-channel retail business model is to provide customers with a seamless and a personalized shopping experience. Due to centralized data management, omni-channel retail simultaneously manages inventories (Figure 11).

Facilitated by technology and based on predicting customer behaviors, the omni-channel business model uses social media and is anticipated to apply emerging technologies such as augmented reality and personalized video soon. Omni-channel retail will successfully leverage and blend the online and in-store shopping experiences. Presently, the leading retailers in this space are Target and Walmart.^{1,2} Further research of omni-channel retail will allow for a better understanding of future e-commerce trends in in-person or online shopping, the siting of warehouse and distribution centers and brick-and-mortar stores, and trip patterns.

Figure 11. Omni-channel Retail



Sustainable Logistics

E-commerce logistics and delivery companies such as Amazon, Walmart, and UPS have announced goals to attain carbon neutrality and are making investments in the electric vehicle market.³

In September 2019, Amazon announced a Climate Pledge. As part of the Climate Pledge, Amazon plans to have 10,000 electric delivery vans on the road by 2022 and 100,000 by 2030.^{4, 5} In June 2020, Amazon launched a \$2 billion fund to help attain carbon neutrality by 2040.

In September 2020, Walmart announced an initiative to reduce its global carbon footprint and is aiming for zero carbon emissions by 2040 for all its global operations. Part of this initiative is to convert to an all-electric vehicle fleet.⁶ Similarly, in January 2020, UPS announced plans to add 10,000 electric trucks to its fleet,⁷ and DHL has launched a GoGreen initiative that aims to perform 70 percent of last-mile deliveries with green vehicles by 2025, and reduce its logistics emissions to zero by 2050.^{8, 9}

Additional research is needed to better understand how these programs are being deployed, the types of vehicles that are being invested in, and how other e-commerce companies can replicate programs by these early adopters.

Waste and Recycling

Increasing e-commerce creates greater demand for cardboard and recycling, as well as packing materials that are not always recyclable. Recently, Amazon has turned to lighter weight plastic envelope mailers, which save both space and fuel, but which are not recyclable in some local single-stream recycling programs.¹⁰ Additional research is needed to understand how the growth and changes in package materials are affecting the production of packaging in Massachusetts as well as waste and recycling.

Shifts in the Warehouse and Distribution Center Marketplace

An increasing number of retailers are incorporating e-commerce, including making more deliveries and offering click-and-collect options. This further amplifies the demand for warehouse and distribution centers. Prologis, an owner, operator, and developer of industrial real estate, estimates that e-commerce retailers need approximately three times the warehouse space to generate revenues comparable to brick-and-mortar sales. In other words, to generate \$1 billion of revenue, a traditional retailer needs about 350,000 to 400,000 square feet of warehouse/distribution space, while an e-commerce retailer needs about 1.2 million square feet.¹¹ More research is needed on how the shift of in-person retail to online business models affect the size and spacing of warehouse and distribution centers and the warehouse real estate marketplace in Massachusetts.

Third-Party Delivery Service Fees

Many consumers use third-party, app-based delivery platforms such as Grubhub, Uber Eats, DoorDash, and Postmates to place orders with restaurants for delivery. These third-party platforms charge restaurants delivery commission fees based on the purchase price. The fees are usually between 20 percent and 30 percent.¹² The Economic Development Bond Bill, which was passed by the Massachusetts General Court and signed to law by Governor Baker in January 2021, approved a 15 percent cap on these fees for the duration of the pandemic state of emergency.^{13, 14} It is expected that this legislation will balance both the business interests of third-party delivery companies and the restaurants serviced by them.

Residential and Commercial Building Design

As noted in Chapter 1, e-commerce and deliveries create a need for more parcel delivery and storage. This can be expected to affect the design of residential and commercial buildings, most of which were not designed for the heavy volumes of packages currently being delivered. For example, residential buildings will increasingly need to be designed with sufficient storage for packages and with refrigerated areas for groceries. The design of single-family houses could include repurposing porches and garages to serve as secure storage areas for deliveries.¹⁵ Research is needed to identify potential design practices. This information can inform updates to zoning and building codes that would enable more efficient deliveries.

► Chapter 6: Potential Policy Responses to E-Commerce



Municipalities have an important role regarding the siting and operation of distribution/ warehousing facilities, and their approaches should align with and advance transportation, economic, and sustainability goals for the region.¹ While many of the following strategies can be implemented on the local level, others should be done regionally through regional planning agencies (RPAs). Some strategies could be implemented via the Commonwealth (agency to be determined) and may require state legislation to implement.

Regional Coordination Among Municipalities

Municipalities must coordinate with one another proactively to understand e-commerce's cumulative impacts and to develop a comprehensive, regionwide strategy that can inform long-range planning and freight planning. The strategy should balance the region's vision and goals for employment, land uses, and traffic management with the needs of the private sector.

A comprehensive strategy can include standards for facility siting and design, transportation demand management policies, equitable employment practices, tax incentive programs, and operations monitoring. It can establish performance metrics, evaluation criteria, and formulas for determining mitigation fees. A comprehensive strategy can also identify specific recommendations for zoning, building codes, and other local regulations that manage the growth and impacts of e-commerce. Drawing from lessons learned in Boston and elsewhere, it can also spell out ways that municipalities can promote low-carbon, low-traffic last-mile delivery services.

The regional strategy should also include the development of an online transportation and land use design playbook for municipalities. This would help municipalities implement development standards and review specific facility proposals through a lens of equity, sustainability, and municipal finance. Standards may include designating truck routes to avoid residential neighborhoods, implementing safety measures to reduce conflicts on roadways, and requiring the use of cleaner vehicles (e.g., compliance with EPA emission standards).² With a common playbook, every municipality will be in a better position to consistently respond to facility proposals.

Increase Transparency into the Growing E-Commerce Industry

The Commonwealth should require e-commerce companies to report information and metrics, such as the location of warehouse and distribution centers; employment (status, occupation, wages, and benefits); and transportation impacts (e.g., truck and other vehicle traffic) of e-commerce logistics and delivery. This data collection is a critical step in understanding and sustainably managing the impacts of e-commerce. New legislation authorizing state agencies to require this data may be needed.

Create Incentives for Efficient Deliveries

Both the public and private sectors should incentivize more efficient deliveries to reduce traffic and associated GHG impacts. This can be done by determining a method to assess the impact of e-commerce on congestion and GHG emissions, and then setting a fee structure that incentivizes both companies and customers to opt for the more sustainable delivery options. These options can include combining orders into a single delivery, using common delivery/pick up areas such as package lockers, and not choosing expedited deliveries.

Track Innovations in E-Commerce

The Commonwealth and regional planning agencies should track new technologies and innovations in the e-commerce industry to ensure that these developments have positive impacts. Amazon, UPS and others have implemented package lockers to make the last-mile delivery process more efficient, and implemented pilot programs with cargo bikes, autonomous vehicles and drones in select areas such as college and medical campuses. RPAs and others should monitor these new developments against public-sector performance standards for traffic congestion, GHG emissions, safety, waste, employment, workers' rights, and equitable service. Where needed, the Commonwealth and municipalities should develop regulations to minimize impacts and sustainably manage these innovations.

Implement Curb Management Strategies

The explosive growth in e-commerce deliveries and ride-hailing is spurring municipal endeavors to control curbside congestion. Controlling curb space serves multiple functions, including providing access for e-commerce. The challenge is to manage this public right-of-way for all users, rather than just for the efficient delivery of goods. The following recommendations manage the curb are anticipated to promote a more efficient use of curb space and to reduce emissions caused by “cruising for parking” and engine idling.³

▶ **Conduct a comprehensive assessment of curb demand and designate spaces for the use of delivery vehicles.** There should be sufficient numbers of these spaces, and they should be distributed appropriately. The designation for deliveries could be both by location and time of day to allow for flexible uses. For example, curb lanes could be reserved for buses in peak commute periods, reserved for deliveries and other short-term uses at mid-day, and then allowed for overnight parking of private vehicles.

▶ **Establish mechanisms for delivery companies and TNCs to reserve those spaces as needed and to pay for the privilege of doing so, using a dynamic pricing model that will maximize efficient utilization of designated spaces.** Examples include providing discounts for TNC riders who walk to designed pick-up zones away from high traffic streets, and peak-period surcharges for deliveries (e.g., a grocery delivery will cost more if delivered at 5:30 pm).

▶ **Establish comprehensive and effective enforcement mechanisms** that can utilize both in-field enforcement and camera- or GPS-based enforcement with penalties and sanctions for violations, especially for violations in transit and active transportation facilities.

▶ **Conduct continuous re-evaluation of curb uses and violations** to determine if the curb management policies should be revised to ensure mobility goals (and other goals) are being met.

► Chapter 7: Next Steps and Areas for Further Research



This report identified trends where data was available to determine the impacts of e-commerce on our Commonwealth, particularly with regard to land use and traffic. As this report makes clear, while there is abundant evidence that e-commerce is a significant and growing part of the Commonwealth's economy, we know little about essential details such as trip generation, GHG emissions, local and regional impacts on brick-and-mortar retail, and on land development needs for warehouse and distribution centers.

Finally, the growing e-commerce sector has impacts in other areas not explored in detail in this report, including the environment (e.g., packaging waste), safety, employee rights and benefits, equity, and shifting employment and tax revenues.

Much more work needs to be done to understand this enormous and rapidly changing industry and its significant social and economic consequences. A deeper understanding will put the public sector in a better position to both manage the growth of the e-commerce sector and ensure the advancement of critical regional and local goals.

To collect information and meet this challenge, MAPC has identified the following steps: Data Collection, Management of Warehouse and Distribution Centers, Data Sharing Legislation, and Information Sharing.

Data Collection

Continue investigating available data sources to better understand the composition of the e-commerce workforce in Commonwealth, the scale of the industry, and its impacts on congestion, emissions, tax revenue, and other topics. The impacts of e-commerce on malls and traditional retail, land use, the transportation network and employment all need to be better understood. MAPC and other RPAs should work with state agencies and municipal officials to identify and gain access to administrative data that can help shed light on these issues.

Additionally, more immediate data collection and analysis needs to be done in the following areas.

► **Research online sales versus traditional retail in Massachusetts.**

This research will uncover the extent to which online retail trends (and their impacts) in Massachusetts compare with the nation. Regional data from brick-and-mortar retail sales can shed light on geographic differences of e-commerce's impacts on traditional retail in the Commonwealth. Understanding the level of e-commerce retail in Massachusetts will help policy makers determine better ways to manage the land development, employment, and tax impacts of the shifting retail landscape.

► **Research the changes in Massachusetts retail and other key employment sectors by income and demographics.**

This research will enable policy makers to better understand the economic and equity impacts of the shift from in-person to online retail in the Commonwealth. Furthermore, this research could uncover the extent to which the growing number of e-commerce jobs, particularly delivery positions, are filled by independent contractors who may have limited or no retirement, paid leave, and health insurance benefits.

► **Research the changes in Massachusetts retail and other key employment sectors by geography.**

Not all e-commerce warehouse and distribution are accessible by public transportation, and their operations could create negative traffic, noise, and air quality impacts. It is important to know if, as distribution centers are increasingly located within urbanized areas to meet demand, these centers are being situated in communities of color and lower-income neighborhoods and creating disproportionate impacts.

► **Research the municipal fiscal impacts of e-commerce.**

More needs to be understood about the tax revenue implications for municipalities that experience mall and other traditional retail closures, and about the economic impacts to municipalities that host more e-commerce warehouses and distribution centers. While tax incentive programs, such as TIFs, encourage growth by lowering taxes in exchange for job creation and private investment, the long-term implications are unclear, and more research is needed.

► **Analyze online delivery vehicle patterns and volumes.**

This information could be obtained by conducting studies of larger scale residential buildings, e-commerce warehouse and distribution centers, and congested urban areas to better understand traffic and delivery trends. Findings from these studies could be used to create pilot programs for new delivery systems (e.g., e-cargo bikes, electric vehicles), to deploy innovative curb management practices, and to implement local options to moderate traffic and other impacts of e-commerce distribution and warehouse centers.

► **Investigate available sources of data about consumer preferences and shopping habits.**

More specific survey data are needed to determine the extent to which online orders may be replacing personal trips. Based upon similar national survey data, MAPC should determine whether a Massachusetts-focused survey of e-commerce consumer patterns is needed. If so, the agency would develop partnerships and solicit funding for a broad-based survey that would provide statistically significant results at the sub-regional level and for specific segments of the population. This information could be used to better estimate vehicular traffic, the number of deliveries per household, and the extent to which the number of deliveries per household varies according to demographic factors such as age, income, and automobile ownership.

Management of Warehouse and Distribution Centers

Collect and distribute actionable steps and example practices for municipalities for the review of warehouse and distribution centers. The integration of warehouse and distribution centers will require deliberate design, mitigation, and management, especially where e-commerce facilities are proximate to higher density residential areas.

MAPC has been conducting research on how municipalities in Massachusetts are currently mitigating and managing the impacts of warehouse and distribution centers, and as an early follow up to this report, will develop a document on the management of e-commerce warehouse and distribution centers as a resource for other municipalities.

Data Sharing Legislation

Based upon the findings from the additional research above, **draft legislation that will authorize state agencies to require e-commerce companies to provide data on impacts of critical public concern where it has been determined that information is not available.** As noted in Chapter 6, this legislation is needed to create visibility in the e-commerce industry and sustainably manage its impacts in employment and workers' rights, safety, traffic, equity, and the environment. The adoption of legislation will require the cultivation of advocacy partners and legislative sponsors.

Information Sharing

Regularly collect, compile, and evaluate permitting and monitoring documents for warehouse and distribution facilities statewide, including information about economic incentive programs and tax revenue collections. The collected information will be publicly available and configured to allow for comparative analysis.

A consistent data collection method will enable a consistent approach to monitoring warehouse and distribution center projects, identifying example policies, and assessing the cumulative siting of warehouse and distribution facilities. This information will also aid in right-sizing mitigation and forecasting trip generation rates.

Create a research clearinghouse on e-commerce, including findings from local pilot programs. As a regional planning agency, MAPC intends to serve as a resource for continued information sharing and findings from surveys and pilot programs. Please e-mail ecommerce@mapc.org with relevant information you would like to contribute as part of this effort as well as to be informed of future initiatives.

► Appendix: Playbook of Actionable Steps to Manage Warehouses and Distribution Centers



The integration of warehouse and distribution centers will require deliberate design, mitigation, and management, especially if they are proximate to higher density residential areas.

Below are actionable steps for municipalities to consider implementing should a warehouse and/or distribution center be proposed for e-commerce related services. It is important to note that there is not one actionable step; rather several steps need to occur simultaneously.

MAPC conducted research on how municipalities in Massachusetts are currently mitigating and managing the impacts of warehouse and distribution centers. Several of the actionable steps contained in this chapter are based on that research. In particular, Everett's site plan approval process and the Traffic Engineering Peer Review recommendations for the Hingham contributed to the development of this chapter.¹ MAPC anticipates this section will be expanded as ongoing work continues and to reflect changes in the industry.

Traffic Impact Studies



At a minimum, traffic impact studies should include the following:

- Projected trips for all vehicular types (e.g., employee vehicles, vans, trucks, and flex drivers).
- Site design (ingress, egress, and circulation).
- Accommodations for pedestrians and bicyclists.
- Amount of parking.

Trip Forecasting

Presently, the Institute of Transportation Engineers (ITE) Trip Generation Manual² does not include a land use type that is directly applicable for warehouse and distribution centers. While ITE Land Use Codes for Industrial Park (140), Warehousing (150), High Cube Fulfillment Center Warehouse (155), and High-Cube Parcel Hub Warehouse (156) are related, they are not an exact match for e-commerce operations. If the ITE Trip Generation Manual does not include data for a similar land use, MAPC recommends the application of empirical trip data. According to ITE, "When practical, the user is encouraged to supplement the data in this document with local data that have been collected at similar sites."³

Since complex logistics facilities such as warehouse and distribution centers are not included in the ITE manual, trip forecasting should be based on proponent's plans for facility activity; and permits should be structured so as to establish clear, enforceable performance metrics for vehicle trips to and from the site.

Site Plan Review

- ▶ A comprehensive site plan review and approval process should address the adequacy of the following:
- Building Design
 - Parking and Loading Facilities
 - Proposed Number and Type of Parking Spaces
 - *Provide a breakdown of the parking demands by functional use (i.e., associates/managers, visitors, Delivery Service Providers (DSPs) vans and drivers, etc.) in order to demonstrate that the proposed number of parking spaces is sufficient to meet the predicted parking demands.*
 - Traffic flow, Circulation, and Traffic Impact
 - *Access points and routes to and from the site to adjoining streets*
 - *Pedestrian and bicycle circulation systems to and from parking areas and structures*
 - External Lighting
 - *Type and amount to be provided*
 - Landscaping and Screening
 - *Type, quality, and quantity to promote an aesthetically pleasing environment and to properly screen the development from adjacent land uses*
 - Stormwater
 - *Method of surface drainage*
 - Utilities
 - *Methods of waste disposal (e.g., sewage and refuse) and water distribution*
 - Snow Removal and Storage
 - Protection and Enhancement of Natural Features
 - Compatibility of Architecture with Surrounding Area

Traffic Mitigation

Negotiate appropriate traffic mitigation agreements.

- ▶ Traffic concerns residents frequently express regarding warehouse and distribution centers are as follows:
- Queuing, traffic, and idling on-site and in the community.
 - Trucks and vans utilizing residential streets and trucks accessing bridges with low underpasses.
 - Vehicles overwhelming gas stations when shifts begin or end.
 - Illegal off-site parking.
 - Vans pulled off to the sides of roads creating hazardous conditions for drivers to pass.
 - Processions of trucks and vans causing traffic at key intersections.

Traffic mitigation agreements can include the installation of traffic signals, intersection improvements, and monetary contributions.

Restriction Zones

Where appropriate, such as where a warehouse is adjacent to a residential area, restrict truck and van access during certain times of the day/or day of week. This measure can reduce congestion and the road impacts of the facility on nearby neighborhoods.⁴

Off-Site Parking

To minimize logistical and traffic issues, it is recommended that parking for all vehicular operations remain on-site. It critical that the on-site circulation plan be designed to reduce potential conflicts with different vehicle types, pedestrians, and bicyclists, and to minimize vehicles queuing in the street.

Traffic Demand Management (TDM) Program

Implement a Traffic Demand Management (TDM) program that will discourage employees from traveling by single occupancy vehicles. TDM components can include discounted MBTA passes, internally secure bike racks, carpooling incentives, and a shuttle service accessing the Commuter Rail and MBTA Stations.

Fueling Operations

It is common practice for e-commerce companies to assign fuel cards to drivers or vehicles. To manage traffic and queuing, municipalities should work with e-commerce companies to determine appropriate times (e.g., on return trips) and locations for refueling. This will help ensure vans don't overwhelm gas stations when shifts begin or end.

Excise Tax

A proposed facility's vans should be required to be registered in the municipality where the facility is sited so the municipality can capture the excise tax.

Vehicular and Roadway Signage

To promote public awareness and safety, ensure that vehicles (e.g., vans) and the site are appropriately signed.

Idling

Do not permit on or off-site idling for all vehicles servicing the facility.

Truck and Van Drivers

Prior to making deliveries, require all Delivery Service Provider (DSP) companies to be properly insured and perform driver background checks.

Be informed of truck and van driver protocols such as training, discipline, and incident (e.g., speeding) procedures.

Project Monitoring Post Occupancy and Corrective Actions

Including a traffic monitoring program is essential. For example, the Traffic Engineering Peer Review for Hingham recommended a monitoring program that will commence within 90 days of the issuance of a Certificate of Occupancy for the Project and be repeated annually.

Any monitoring program should include established thresholds for traffic and/or motor vehicle crash volumes for trucks, vans, and passenger vehicles.

In Hingham, it was also proposed that to the extent measured traffic volumes for the project exceed the projected traffic volumes by more than 10 percent (i.e., 110 percent of the projected traffic volumes) and/or the calculated motor vehicle crash rates exceed the MassDOT average crash rates for similar intersections, corrective actions to reduce the unmitigated impact of the project should be proposed and implemented. Corrective actions should be documented in the traffic monitoring report.

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Chapter 6

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Appendix

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