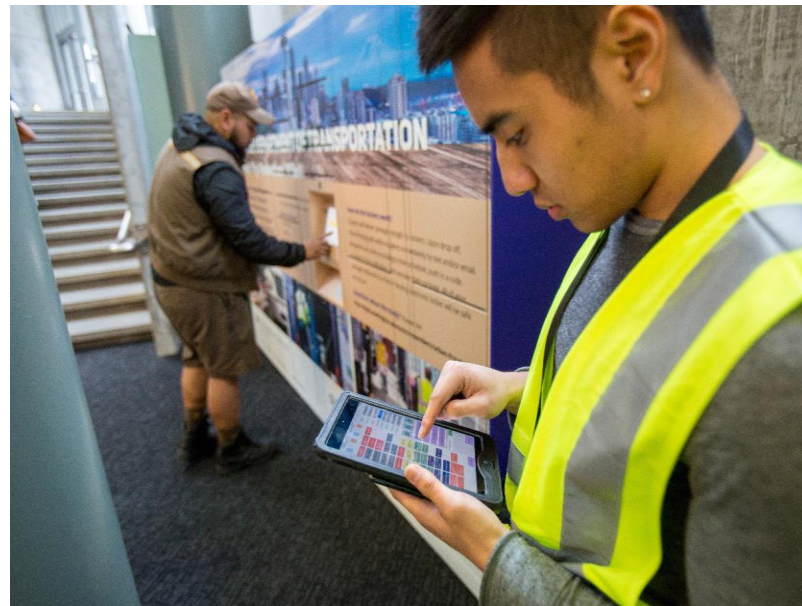


E-Commerce and Emerging Logistics Technology Research Report



*Freight Master Plan
Update*

December 2019

Freight Master Plan Update: E-Commerce and Emerging Logistics Technology Research Report

Final Report

December 2019

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Preface

The City of Portland's Bureau of Transportation is interested in understanding how e-commerce retail sales, and in particular, the delivery of retail products via e-commerce methods to residences, is changing freight demand and the handling, storage, packaging, logistics and delivery traffic that accompany it. The exceptionally high growth of e-commerce retail sales since the first recorded e-commerce transaction in 1994 and the associated demand for quick delivery and hassle-free returns, has dramatically changed logistics strategies, speeded construction of close-in fulfillment centers and warehouses, and created innovations in who makes final deliveries and when, where and how those deliveries occur.

To many, delivery of e-commerce products is synonymous with new technologies that are highly efficient and environmentally sustainable and may result in fewer large trucks on the road. To others, it's simply growth in traffic from a wider variety of vehicles making deliveries.

There are questions about whether e-commerce deliveries have implications on streets that may already be congested, on residential streets where they may bring unwanted traffic, and to and from distribution centers and industrial areas. Moreover, do these changes warrant corresponding adjustments to the functional classification and design of some City streets, including on-street loading and parking spaces.

Business-to-business e-commerce has been in place for a longer period of time than e-commerce transactions between businesses and consumers, and much of their logistics were in place when the Portland Freight Master Plan was adopted in 2006. One new and important phenomenon since the 2006 Plan has been the rapidly changing trends associated with business-to-consumer e-commerce of retail products.

The City of Portland is seeking to gain an understanding of the changes to supply chains and delivery patterns resulting from the on-demand economy in order to know how they may affect traffic conditions, use of on-street loading areas, and changing uses of commercial buildings and land. While e-commerce industries develop fulfillment centers and distribution facilities, and last-mile carriers create new logistics and operating strategies to handle the demands, cities must ensure these economic transitions occur smoothly.

One important finding of this research is that, just as with more conventional deliveries, there are no perfect solutions to resolving many of the adverse traffic, safety and curbside impacts of e-commerce. There are, however, a number of reasonable and practical strategies that will reduce the number of deliveries and their combined vehicle miles of travel which will support the City of Portland's efforts in achieving many of its other transportation and climate-related goals. Other promising strategies will require additional data collection, analysis and testing ideas in collaboration with industry.

This report is a first step toward examination of this dynamic and wide-ranging topic. It focuses on the types of deliveries being made, how they're being accomplished, their future growth, and provides profiles of some e-commerce sectors. As readers will note, the report not only touches on transportation effects, but the accompanying new distribution centers and logistics management practices that allow them to conduct deliveries quickly and at a relative low cost. Further, interviews were held with shippers, carriers, academics, and freight experts from other cities to assist in validating the completed research.

In addition to this review, the Portland Bureau of Planning and Sustainability and the Portland Bureau of Transportation are assessing how warehouses, distribution centers and like facilities are adapting to the demand for e-commerce products. There has been a significant increase in these developments including the two regional Amazon facilities, and a large number of other logistics warehouses located nearer to population centers in order to meet requirements for rapid delivery.

Together these efforts are supporting the incremental update of the Portland Freight Master Plan.

Other documents completed for the E-Commerce and Emerging Logistics Technology Research Project are:

- *Technical Memorandum No. 1: Expected Growth in E-Commerce Delivery*
- *Technical Memorandum No. 2: Summary of Interviews with Freight Service Providers*

This study is funded by the City of Portland.

Executive Summary

E-Commerce Orders and Shipping is Growing at a Significant Clip

As we see in other major cities throughout the world, City of Portland residents, businesses and institutions are benefitting from the convenience of shopping on-line, also known as e-commerce¹. While e-commerce retail sales represent just 10% of the total retail sales made in Oregon in 2018, on-line sales jumped 50% from just three years earlier². The global e-commerce market for all goods surpassed \$2 trillion in 2017 and is expected to nearly double by 2021³ as more products are only sold on-line, deliveries are made quickly, often at minimal cost and sometimes free, and merchandise returns are a hassle-free process.

According to recent data compiled for the National Household Transportation Survey, the average number of monthly online deliveries made per household more than doubled from 2.4 in 2009 to 4.9 in 2017⁴. Looked at another way, according to a March 2018 survey by Periscope, nearly 70% of all Americans have made online purchases, which was consistent among all age groups, but highest in the 18-29 years old cohort (with 66% stating that they “only” or “mostly” shop on-line) and lowest in the 60-69 years old cohort (with 20% stating that they “only” or “mostly” shop on-line)⁵. The U.S. Department of Commerce which tracks retail sales reported that e-commerce retail sales grew from \$165 billion in 2010 to \$452 billion in 2017, a 175% increase, while total retail sales grew by only 29% during the same period.⁶ To place this in context, the number of e-commerce packages delivered annually in the U.S. was estimated at 11 billion⁷. Another way to appreciate this volume is that if 11 billion standard-sized books (a common e-commerce purchase) were placed end-to-end they would circle the earth 84 times.

Much of the growth in e-commerce sales has come during an exceptionally strong period of economic expansion nationally as well as in the Portland region, but it’s hard to imagine that even in a weak economy that consumers would not continue to purchase a significant share of their retail goods on-line.

How E-Commerce Deliveries are being Accomplished

To accomplish the rapid rise and requirements for quick deliveries, several fulfillment centers, warehouses, and distribution centers have located from ex-urban locations to sites within or adjacent to the Central City, and supply chains and their corresponding logistics strategies have been modified to accomplish the onslaught of same day and next day deliveries. Further, last-mile carriers have increased their workforces⁸,

¹ Ecommerce (electronic commerce) is the buying or selling of goods and services over an electronic network, primarily the internet. Principal products purchased on-line include clothing, computer hardware and software, electronics, and others.

² Oregon Office of Economic Analysis, Oregon Economic News, Analysis and Outlook: posted by Josh Lehner, 11/28/2018 <https://oregoneconomicanalysis.com/2018/11/20/thanksgiving-and-holiday-shopping/>

³ Retail e-commerce sales worldwide amounted to \$2.3 trillion in 2017 and are projected to grow to \$4.88 trillion by 2021. statista, 2018, <https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/>

⁴ National Household Travel Survey (NHTS), Federal Highway Administration, Washington, DC 2019, <https://www.fhwa.dot.gov/policyinformation/nhts.cfm>

⁵ CPG Goes Omnichannel Shoppers Grasp the Digital Opportunity, Periscope by McKenzie, March 2018, <https://www.periscope-solutions.com/download.aspx?fileID=3456>

⁶ Estimated Quarterly U.S. Retail Sales: Total and E-commerce, U.S. Department of Commerce, <https://www2.census.gov/retail/releases/historical/ecommm/17q4.pdf>

⁷ The Rise of the Last-Mile Exchange, Tim Laseter, Andrew Tipping, and Fred Duiven, strategy+business magazine, July 2018, <https://www.strategy-business.com/article/The-Rise-of-the-Last-Mile-Exchange?gko=7cf43>

⁸ Regional courier and messenger jobs grew by +36% since 2011, Oregon Employment Department, Publications, Oregon Industry Employment Forecast, 2017-2027, <https://www.qualityinfo.org/ed>

expanded hours of operation and fleets, and employ not just trucks, but also vans, automobiles, and bicycles, to fulfill customer requirements.

While there are no reliable data yet for how much traffic is being generated by delivery of e-commerce products (or all deliveries for that matter) in the Central City or in other Portland neighborhoods, the Portland Office of Transportation is concerned that this added traffic may be producing increased delays in mobility, creating potential safety conflicts, and leading to longer circulation travel times to find available curb space.

How Other Cities are Addressing E-Commerce Delivery Growth

Other cities have begun collecting data and monitoring conditions specifically associated with all deliveries (including package, parcel, grocery and restaurant deliveries), and have partnered with industry to consider, and in some cases establish, several innovations before these deliveries lead to increased congestion in the roadways and at the curb. For example:

- Several cities have introduced code changes to encourage more off-street loading bays in downtown buildings and other form-based ordinances for warehouse and distribution center developments.
- Seattle plans to install sensors at the curb spaces in its central business district to assist in understanding how much time it takes to accomplish a delivery in the downtown in order to establish more realistic fee schedules and dynamic pricing for use of curb space.
- New York City established an off-hours delivery program which has over 400 subscribers.
- The City of Chicago converted a floor of a downtown municipal parking garage into a fulfillment center allowing for deliveries to be accomplished by bicycle and foot.
- Singapore and several European cities have established Delivery Micro-hubs which are consolidation centers with a smaller footprint where goods are delivered from warehouses and distribution centers via truck and picked up by the customer or delivered by cargo bike or bicycle to their destination. (Similar to The Redd distribution center only at a larger scale.)
- The City Council of Paris, France invited developers to create central city logistics centers (five of which are operational) and mandated that 50% of final-kilometer deliveries be carried out by non-diesel vehicles by 2017, followed by the total phase-out of diesel-fueled deliveries by 2020.
- The City of London, England established an Ultra-Low Emission Zone (ULEZ) within the central London congestion charge area. Vehicles, including trucks, cars and vans, need to meet the ULEZ emissions standards or their drivers must pay a daily charge to drive within the zone. To encourage use of electric vehicles, the City began installing rapid charge electric charging hubs throughout the zone in 2019.
- In Germany, DHL has installed 3,000 “Packstations” (satellite parcel lockers) which they claim are within ten minutes of about 90 percent of the German population⁹.
- And, there are multiple ongoing experiments with drones, robots and autonomous vehicles in confined areas for making deliveries. This consists of Amazon testing six delivery robots during daylight hours in Snohomish County, WA, Kroger grocery delivery by autonomous vehicle pilot projects in Scottsdale, AZ and Houston, TX, and Google’s drone delivery pilot program of Walgreens and FedEx products in Christiansburg, VA.

⁹ DHL Packstation – success story continues., Deutsche Post DHL Group, May 06, 2014, www.dpdhl.com

Recommendations for the City of Portland¹⁰

Each of the ideas and programs above addressed problems experienced by cities, shippers and carriers alike, and in some cases were advanced where industry and cities both benefitted; while others progressed due to their attention to meeting policy goals. Given the City of Portland's policies related to climate, safety, mobility and economic development, and their direct relevance to shipper and carrier goals for improving operational efficiency, the time may be ripe for introducing strategies which accommodate e-commerce delivery growth in a sustainable and least impactful manner.

This is an opportune time for the City and industry to collaborate. For example, we know that with our growing population will come significant growth in the number of deliveries. We also have limited options for accommodating rapid delivery requirements as our traffic congestion levels and curb demands are growing. And both the City and industry have a common interest in increasing the efficiency of the delivery vehicle fleet – through reduced travel time and vehicle miles of travel (vmt), expanded use of emission-free delivery vehicles, and consolidating deliveries.

It's important to note that none of the recommendations provided below are perfect remedies. In fact, we don't yet know what the right answers are because we don't have comprehensive data to understand all of the changing delivery patterns and because these activities are expected to continue to evolve. However, we can't wait to act until we do have that complete understanding. We should test ideas now so that we can know what can work without adverse consequences and can then place the City in a better position to tell the market what we want them to do.

Given this caution, and with our goals identified in the City's Climate Action Plan, its focus on Smart City PDX technology solutions, and interest in maximizing our ability to share the roadway, it is recommended that the City of Portland consider the following goods movement related innovations:

Recommendations that can be accomplished in the short-term (generally those that can be accomplished without new resources, programs, regulatory changes, or formal adoption):

- **Completing Analyses of the Problem** - collecting detailed traffic volume and curb utilization data of deliveries (including package, parcel, groceries, and restaurant deliveries, many of which may be ordered via e-commerce methods) by truck, van, automobile, and bicycle – being careful to distinguish trips by automobiles that are making deliveries – is key to determining which direction the City should take. Armed with this type of data, cities can identify where and when e-commerce deliveries are creating conflicts and begin to assess feasible solutions to overcome them. In concert with the data collection effort and associated analyses, it is recommended that the City of Portland convene an Expert Panel of city officials, shippers and carriers, and academics to define their common ground objectives (such as reducing trips through consolidation of deliveries, hand-offs to smaller and non-polluting vehicles, and others).
- **Pricing Usage of Delivery Zones** – as curb usage is more intense during certain periods of the day, graduated fee schedules may help shift their use to other less active times of day.
- **Increase Number of Parcel Lockers** – these are in use at Amazon storefronts and in several grocery and convenience stores to allow for consolidation of deliveries and pickup by consumer.

¹⁰ Though some of the ideas and actions implicit in these recommendations are being carried out or considered by PBOT in some manner, none of them have been officially endorsed by the City of Portland at this time. They are the author's suggestions and will be considered for implementation by PBOT staff accordingly.

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- Creating Incentives for Alternative Fueled Vehicles – like the state’s diesel retrofit program that was discontinued in 2011 or providing rapid electric charging facilities for delivery vehicles and allowing emission-free delivery vehicles to use dedicated bus lanes.
 - Improved In-Building Management of Deliveries – many commercial and residential buildings have been overwhelmed with the number of deliveries they’re receiving which has increased the time needed to complete the delivery. Property owners or business associations could provide guidance on best practices for receiving deliveries and informing their tenants that they’ve arrived; or facilities could be required under development review or zoning code rewrite.

Longer term Recommendations (where more substantial research and possibly partnerships are necessary):

- Shifting Deliveries to Non-peak Periods – this was suggested as part of PBOT’s Sustainable Freight Strategy and while challenging to implement (e.g., having staff shifts at the receiving end that can handle goods delivery during late night/early morning hours), may be feasible for a wide range of companies. In New York City, over 400 companies subscribe to its off-hour delivery program in four business districts during the hours of 7pm to 6am. Company labor and operational costs were offset in the first year with a \$1,500 payment, with funding (which has now expired) provided by the U.S. Department of Transportation.
- Encourage Crowd Sourcing for Deliveries – also called a Last-Mile Exchange, where trucks with available capacity and destined for nearby locations can fill each other up.
- Establishing Central City Logistics Centers – also called Micro-Hubs where goods can be consolidated from trucks and transferred to smaller trucks, vans and bicycles for the last-mile delivery.
- Directing Trucks to Reserved Delivery Zone Space – with an App that will allow check-in/check-out and parking payments and curb sensors that detect the presence of a vehicle in the loading/unloading bay and informs the control center; this could reduce circulation by delivery vehicles.
- Shared Off-Street Loading Facilities - work with property developers and owners to develop off-street loading facilities that can be used by multiple properties. This could include development of a single facility that could be used by adjacent properties who share its capital and operating costs, or for an independent facility (from a logistics center to a micro-hub to free-standing secure lockers) that could be available to multiple properties who again share its cost.
- Develop Form-based Ordinances/Codes for Warehouse/Distribution Center Developments – may improve land use efficiencies and allow for introduction of state-of-the-art logistics practices

(A more detailed description of these recommendations, including a summary of their feasibility, advantages and disadvantages, consistency with City plans and programs, etc., is found in Chapter VII.)

While some of these improvements are typically initiated and operated by industry, there are many instances where the public and private sectors share costs and operational responsibilities to achieve a strategic public goal. Working together, the City and shippers and carriers can improve the efficiency of e-commerce deliveries and realize associated operating cost savings in many areas where they would mutually benefit.

Each of these ideas can be further explored during the City of Portland's Freight Master Plan update which is expected to be underway in the fourth quarter of 2019. Moreover, they can be independently explored by PBOT's Smart City PDX staff, Portland State University's Transportation and Technology Lab, or the University of Oregon's Urbanism Next Center.

I. How E-Commerce Works

While e-commerce transactions occur between businesses, from businesses to consumers, and from consumers to consumers, it is most commonly associated with online shopping of retail products - the specific subject of this report - primarily clothing/apparel, consumer electronics/technology, and beauty products. These transactions are growing at a very significant rate which has led to reduced in-store sales, and in some instances even displacement of brick-and-mortar stores¹¹.

Shopping online is very convenient and provides nearly the entire assortment of goods that can be purchased in stores. It also allows consumers to research similar products from other vendors with different price structures, and typically simplifies any returns of ordered products (which can run as high as 30% of all purchases)¹².

One of the more remarkable phenomena about e-commerce is that fast delivery at low cost and in some instances no-cost is common among most retailers. In fact, Amazon PrimeNow subscribers in Portland – the service is not yet universally available – can now get free two-hour delivery on more than 25,000 items or within an hour for an additional \$7.99.¹³ Other stores including Albertsons, Fred Meyer, New Seasons, Safeway, Target, and more offer same day and in many cases one-hour delivery throughout the City of Portland. Elsewhere, Macy's, Walmart, Sam's Club, CVS, Office Depot offer same day delivery. And restaurant deliveries, which used to be limited to pizza and Chinese food establishments, is now more the standard than the exception.



Source: Fred Meyer website 9/16/2019. Fred Meyer offers one-hour delivery for as little as \$9.95 without any required purchase amount.

¹¹ In most instances, retailers use on-line and brick-and-mortar stores interchangeably, as they provide multiple options for customers to shop, compare and purchase.

¹² *Riding the Returns Wave: Reverse Logistics and the U.S. Postal Service*, Office of the Inspector General of the US Post Office, Report Number RARC-WP-18-008, April 30, 2018 <https://www.uspsaig.gov/sites/default/files/document-library-files/2018/RARC-WP-18-008.pdf>

¹³ *Prime Now*, <https://primenow.amazon.com/>

These services are most successful when high delivery volumes can be consolidated and thereby reduce mileage and fuel consumption by delivery vehicles, and maximize the efficiency of labor forces to complete the highest number of deliveries at the least cost. Doing so is the goal of the logistics strategies that are employed to maximize vehicle loads, assign deliveries to appropriate vehicles, and keep marketed inventory in close-in warehouses.

E-commerce transactions – where the consumer makes a retail transaction from their phone or computer - alters our traditional supply chains and distribution systems from building inventories in warehouses based on market predictions and shipping goods to physical stores to “pulling” purchases to their ultimate desired location including homes, nearby stores, lockers, or other convenient locations (see Figure 1).

Fulfillment Centers and Warehouses

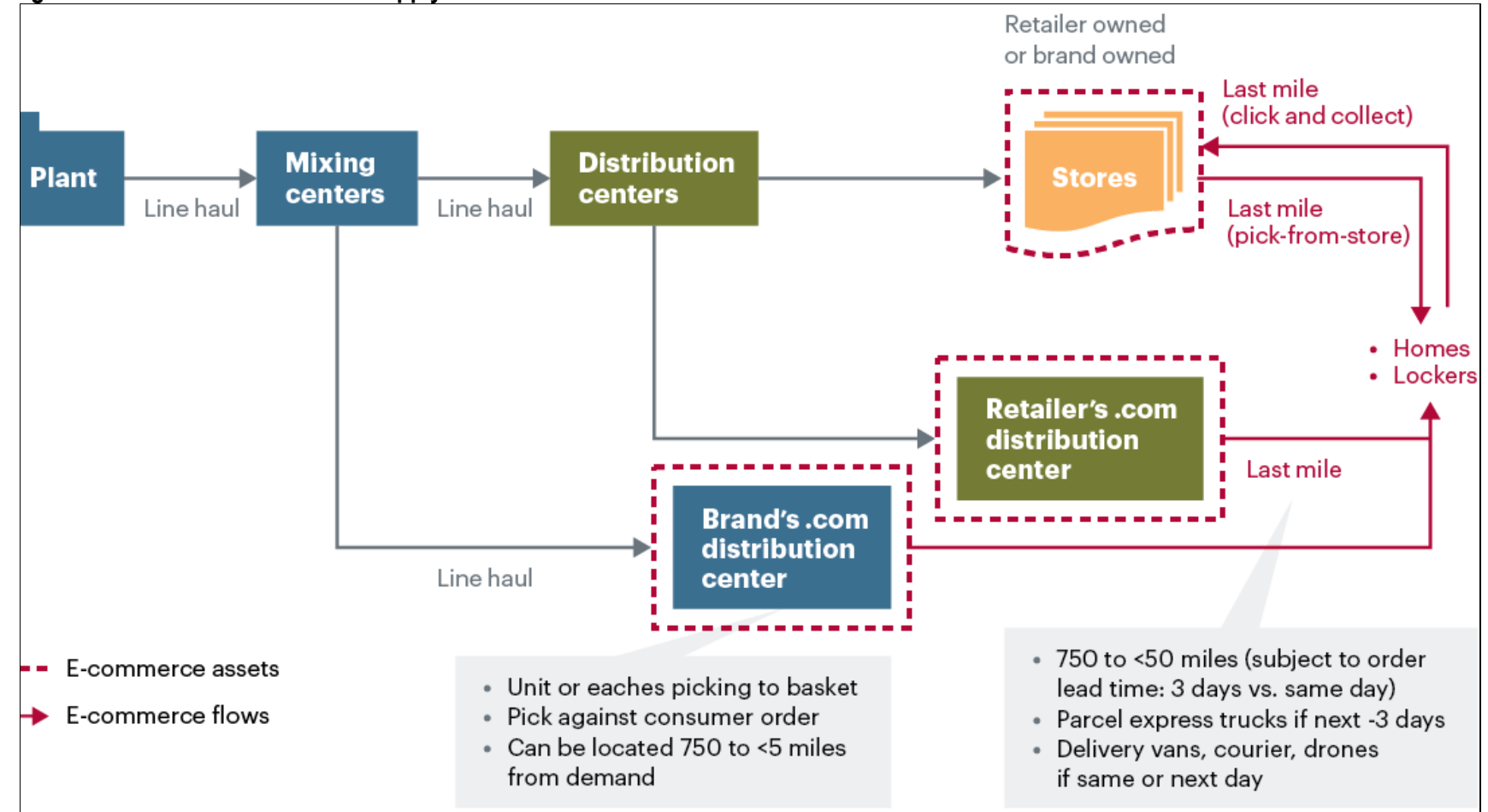
The ability of businesses to meet consumer delivery demands – i.e., fast delivery with free shipping - starts with their “Fulfillment Centers, which are a new kind of distribution facility stocking a wide range of finished goods for short periods of time and are located within or adjacent to urban areas. This enables same day or next day delivery – including handling, packaging, and labeling the shipment and delivering it directly to the customer. In addition to these outsourced functions, fulfillment centers are also charged with inventory management, negotiating rates with carriers, and managing returns. They act as the middleman for all activities that occur between the manufacturer and the customer.

Fulfillment centers don’t replace the conventional distribution centers which consolidate the full assortment of a retailer’s goods at regional facilities for delivery to stores. Delivery of retail products to stores is based on an order of items that the store expects to sell and are delivered at either prescribed times or otherwise when the retailer can receive the goods. Their supply chains and schedules are predictable. In contrast, delivery of e-commerce retail items is based on the individual customer’s order requirements, and is accordingly, highly unpredictable.



Inside a typical Amazon Fulfillment Center

Figure 1. The E-commerce “Pull” Supply Chain



Source: A.T. Kearney analytics

Fulfillment centers are larger than the warehouses of the past. Their ceiling heights have risen from yesterday's 24- to 26-foot ceiling height to the 36- to 40-foot range¹⁴ because new robotics have enabled picking and placing packages within just a few feet of clearance from ceilings. They require a great deal of space for storage racks, conveyors, and other sophisticated equipment to quickly break down bulk shipments and prepare goods for distribution. Fulfillment center properties need to accommodate scores of truck bays and large truck turning radii as well as ample parking areas for the large numbers of employees.

The Amazon Fulfillment Center in Troutdale, which is a robotics multi-floor (4 floors) facility, sits on 51 acres, contains 2.24 million square feet, 64 truck bays, 276 truck trailer parking spaces, and its 1,500 employees have 2,500 parking spaces and 40 bicycle spaces¹⁵.

The Amazon regional distribution facility in Rivergate, scheduled to open in early 2019, contains 880,000 square feet, approximately 1,000 parking spaces, and will employ 1,000 individuals¹⁶.



Amazon Fulfillment Center in Troutdale opened in October 2018

Delivery Vehicles and Strategies

Deliveries are being achieved by a larger fleet of U.S. Postal Service (USPS), UPS and FedEx light and medium trucks with expanded hours of operation to homes and businesses as well as to neighborhood mailbox facilities. Amazon recently ordered 100,000 electric delivery vans which will hit the streets between 2021 and 2024¹⁷. Further, in the case of the “Amazon Key” service, directly to your doorstep and inside your home via a smart lock fitted to a customer’s door. In other instances, packages are being delivered to

¹⁴ *Five Things You Need To Know About Industrial Real Estate*, by Champaign Williams, Forbes Magazine, 4/25/2017, <https://www.forbes.com/sites/bisnow/2017/04/25/5-things-you-need-to-know-about-industrial-real-estate/#599cff141c5e>

¹⁵ Site Plans for “Project Piper Warehouse”, produced for City of Troutdale, OR by Langan International LLC, 9/17/2018

¹⁶ Ibid.

¹⁷ *Amazon will order 100,000 Electric Delivery Vans from EVE Startup Rivian*, Jeff Bezos says, by Andrew Hawkins for The Verge 9/19/2019, <https://www.theverge.com/2019/9/19/20873947/amazon-electric-delivery-van-rivian-jeff-bezos-order>

storefront establishments including Whole Foods, Amazon, and 7-Eleven stores, and to locker facilities separate from post office boxes at apartment buildings.

The big three national carriers (UPS, FedEx, and the USPS) with their well-developed hub-and-spoke delivery networks and extensive fleets account for 85% of the last-mile market in the U.S. today¹⁸. In addition, regional short-haul shippers (such as [Ontrac](#) and [XPO Logistics](#), both of whom operate in Oregon) move about 12% of all last-mile deliveries¹⁹, and the balance is composed of all carriers including local operators via crowdsourced platforms (including [Deliv](#) and Uber).



Amazon Key incorporates a smart lock fitted to a customer's door, and a security camera to record the movements of the delivery person.

Vans, automobiles and bicycles are also completing a large percentage of deliveries, including delivery of e-commerce items. In Portland, the three largest cargo bike companies – Portland Pedalworks, B-Line, and Portland Pedal Power, which can carry up to 600 lbs of goods on electric-assist²⁰ - are a common sight in the Downtown, Lloyd Center, South Waterfront and Central Eastside districts and represent an appropriate solution for many last-mile deliveries.

In addition, shippers utilize shared use mobility systems similar to Uber and Lyft where registered drivers in passenger cars or a company's employees can be contacted about their ability to make a delivery. In many instances, individuals with cars are competing against trucking companies. Other innovations include systems created by [Nimber](#) and [Roadie](#) which put drivers in touch with companies to conduct deliveries when they have available capacity and/or have a similar origin and/or destination as the cargo in their truck.

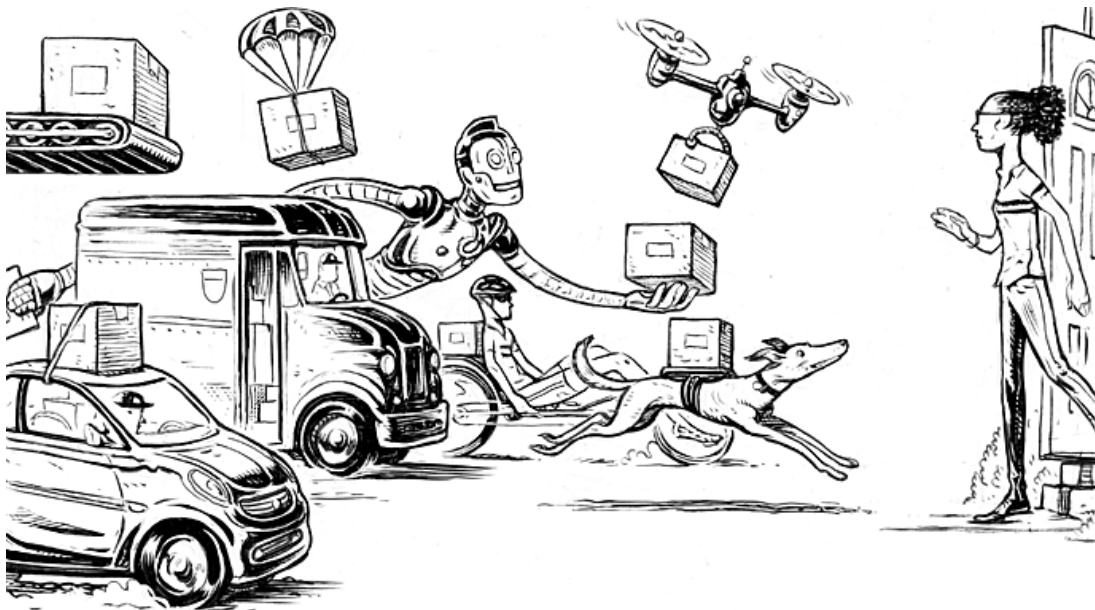


Illustration by Lars Leetaru. Courtesy of strategic + business magazine.

¹⁸ *US E-Commerce Trends and the Impact on Logistics*, AT Kearney, April 2017, https://www.atkearney.es/operaciones/ideas-perspectivas/articulo/-/asset_publisher/LCcgOeS4t85g/content/us-e-commerce-trends-and-the-impact-on-logistics/10192

¹⁹ Ibid.

²⁰ Cargo bikes in use elsewhere are reported to be able to handle up to 750 lbs of cargo.

While many of these strategies have increased the productivity of carrier fleets, many carriers also face challenges employing the necessary number of truck drivers (particularly with regard to long-haul travel) to complete all of these deliveries. This has led many industry experts to predict that there will be a significant increase in the use of bicycles and tricycles (motorized and non-motorized) for local deliveries, and that in the next few years many more deliveries will be made by autonomous vehicles, robots, and even drones.

II. Growth in E-Commerce

According to an article in the New York Times, the first official e-commerce transaction occurred on August 12, 1994:

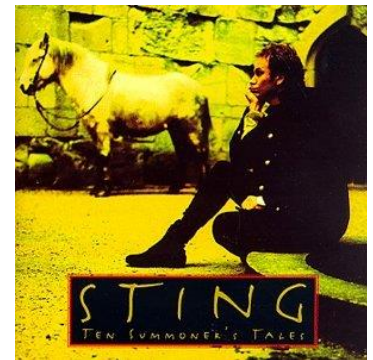
“At noon yesterday, Phil Brandenberger of Philadelphia went shopping for a compact audio disk, paid for it with his credit card and made history.

“Moments later, the champagne corks were popping in a small two-story frame house in Nashua, N.H. There, a team of young cyberspace entrepreneurs celebrated what was apparently the first retail transaction on the Internet using a readily available version of powerful data encryption software designed to guarantee privacy.

“Experts have long seen such iron-clad security as a necessary first step before commercial transactions can become common on the Internet, the global computer network.

“From his workstation in Philadelphia, Mr. Brandenburger logged onto the computer in Nashua, and used a secret code to send his Visa credit card number to pay \$12.48, plus shipping costs, for the compact disk “Ten Summoners’ Tales” by the rock musician Sting.

“Even if the N.S.A. was listening in, they couldn’t get his credit card number,” said Daniel M. Kohn, the 21-year-old chief executive of the Net Market Company of Nashua, N.H., a new venture that is the equivalent of a shopping mall in cyberspace. Mr. Kohn was referring to the National Security Agency, the arm of the Pentagon that develops and breaks the complex algorithms that are used to keep the most secret electronic secrets secret.”²¹



Since that remarkable event, e-commerce sales have grown as a percentage of total retail sales. The global e-commerce market for all goods surpassed \$2 trillion in 2017 and is expected to nearly double by 2021²². Business-to-business sales have represented a larger share of e-commerce but that share is expected to decline by 50% (or \$1.1 trillion²³) by 2020 as retail business-to-consumer e-commerce grows. In Oregon,

²¹ *Attention Shoppers: Internet is Open*, Peter Lewis, New York Times, 8/12/1994, <https://www.nytimes.com/1994/08/12/business/attention-shoppers-internet-is-open.html>

²² *Retail e-commerce sales worldwide amounted to \$2.3 trillion in 2017 and are projected to grow to \$4.88 trillion by 2021*. statista, 2018, <https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/>

²³ *US B2B eCommerce To Reach \$1.1 Trillion By 2020*, Andy Hoar, Apr 2, 2015 Forrester, <https://go.forrester.com/blogs/15-04-02-us-b2b-ecommerce-to-reach-11-trillion-by-2020/>

retail sales represented approximately 10% of the state's total Gross Domestic Product (GDP) in 2017, and e-commerce retail employment is just 11% of total retail employment in the Portland metro region²⁴.

According to recent data compiled for the National Household Transportation Survey, the average number of monthly online deliveries made per household more than doubled from 2.4 in 2009 to 4.9 in 2017²⁵. Looked at another way, according to a March 2018 survey by Periscope, nearly 70% of all Americans have made online purchases, which was consistent among all age groups, but highest in the 30-39 years old cohort (85%) and lowest in the 60-69 years old cohort (77%)²⁶. The U.S. Department of Commerce which tracks retail sales reported that e-commerce retail sales grew from \$165 billion in 2010 to \$452 billion in 2017, a 175% increase, while total retail sales grew by 29% during the same period.²⁷ E-commerce now represents about 10% of all retail sales revenue in the U.S. To place this in context, the number of e-commerce packages delivered annually in the U.S. was estimated at 11 billion²⁸. Another way to appreciate this volume is that if 11 billion standard-sized books (a common e-commerce purchase) were placed end-to-end they would circle the earth 84 times.

Researchers in New York City surveyed deliveries made to eight residential buildings in 2016²⁹ and found a variety of interesting phenomena that could also be relevant to City of Portland conditions:

- The number of deliveries of packages/parcels and food (groceries as well as prepared foods from restaurants) are nearly equal though the vehicles use, and delivery time periods are very different.
- All delivery types were relatively equal throughout the 9am-9pm day, but parcel delivery peaks in the afternoon followed by the morning periods, while peak delivery times for prepared foods are the evening peak and evening off-peak periods. Grocery delivery was relatively constant throughout the day except for a deep decline during the evening peak period.
- Nearly 60% of all package/parcel deliveries are made by step vans and cargo vans, 12% by foot, 10% are made by single-unit trucks, 10% by passenger cars, and 9% by bicycle.
- Bicycles delivered 72% of all prepared foods, 17% of groceries, and approximately one percent of packages/parcels.
- 47% of all truck/van/passenger car deliveries were parked illegally; of the 53% that parked legally, 39% were double-parked.³⁰

²⁴ *Retail and E-Commerce (Graph of the Week)*, Josh Lehner, Oregon Employment Department, March 16, 2018, <https://oregoneconomicanalysis.com/2018/03/16/retail-and-e-commerce-graph-of-the-week/>

²⁵ *National Household Travel Survey (NHTS)*, Federal Highway Administration, Washington, DC 2019, <https://www.fhwa.dot.gov/policyinformation/nhts.cfm>

²⁶ *CPG Goes Omnichannel Shoppers Grasp the Digital Opportunity*, Periscope by McKenzie, March 2018, <https://www.periscope-solutions.com/download.aspx?fileID=3456>

²⁷ *Estimated Quarterly U.S. Retail Sales: Total and E-commerce*, U.S. Department of Commerce, <https://www2.census.gov/retail/releases/historical/ecommm/17q4.pdf>

²⁸ *The Rise of the Last-Mile Exchange*, Tim Laseter, Andrew Tipping, and Fred Duiven, strategy+business magazine, July 2018, <https://www.strategy-business.com/article/The-Rise-of-the-Last-Mile-Exchange?gko=7cf43>

²⁹ *Freight Activity at High-Density Residences in New York City*, Alison Conway, PhD, City College of New York, at TRB International Urban Freight Conference, October 20, 2017

³⁰ *Parking Conditions for Residential Delivery in New York City: A Case Study Analysis*, Pierre Escand, Quanquan Chen, Alison Conway, TRB Volume: 2672 issue: 9, December 1, 2018 <https://doi.org/10.1177%2F0361198118783161>

A similar data collection effort³¹ was completed in the Center City district of Seattle in the fall of 2017 which focused on curb usage and found that:

- 40% of commercial vehicles parked in “unauthorized locations”, including in “parking loading zones” (which are designate for drop off and pickup of passengers), metered spaces bus lanes, tow away zones, and other restricted areas.
- Passenger vehicles made up 52% of the vehicles parked in commercial vehicle loading zones.
- 54% of all commercial vehicles were parked for 15 minute or less, 28% were parked between 15 and 30 minutes, and 16% were parked for periods longer than 30 minutes.
- Service vehicles (i.e., those providing maintenance for heating, ventilation, air conditioning, plumbing, electrical and other systems) constituted 36% of all commercial vehicles parked at the curb.

The effect of this phenomenal growth of deliveries has resulted in changes to motor carrier and local pickup and delivery operations. According to the American Transportation Research Institute, the average distance traveled by a typical truck box trailer (the most common truck cargo) in the U.S. decreased by 296 miles, or 37%, between 2000 and 2018³². Despite the reduced mileage of an average haul, truck vehicle miles of travel (vmt), particularly in urban areas, increased by 17.7% between 2011 and 2016³³; primarily due to the significant growth in short-haul and last-mile trips. Moreover, employment grew by 85,000 new employees at courier and messenger services establishments between 2007 and 2017³⁴, and single-unit truck registrations grew by 7.8% while combination truck registrations grew by just 4.4% during the same period³⁵.

Amazon’s role in this transformation cannot be overstated. The company accounted for 5% of all retail sales in the U.S. in 2017, and as shown in Table 1, was responsible for 49% of all online retail sales in 2017³⁶.

Another growth indicator is the absorption of industrial warehouse space which has increased at unprecedented rates in the City since 2015, with vacancy rates dropping from 7.2% citywide in the 4th quarter of 2011 to 3.5% in the 4th quarter of 2018 (see Table 2). Industrial space vacancy rates in the Portland region – which directly serves the City commercial, retail, restaurant and residential sectors - dropped to a low of 3.2% in 2018 from 7.5% in 2011.

Another indicator of local growth in e-commerce is employment in the transportation and warehousing category which is where a great number of e-commerce delivery jobs are found. As shown in Table 3, employment in this sector grew by 12% in the Portland region and 12.5% statewide between 2005 and 2018. Employment in truck transportation dropped

Table 1. Top 10 U.S. E-commerce Companies

	% of E-Commerce Sales in U.S. 2017
Amazon	49.1%
eBay	6.6%
Apple	3.9%
Walmart	3.7%
Home Depot	1.5%
Best Buy	1.3%
QVC Group	1.2%
Macys	1.2%
Costco	1.2%
Wayfair	1.1%

Source: emarketer, July 2018

³¹ *Commercial Vehicle Parking in Downtown Seattle: Insights on the Battle for the Curb*, Gabriela del Carmen Giron-Valderrama, Jose’ Luis Machado-Leon, and Anne Goodchild, TRB Conference 2019, <https://mail.google.com/mail/u/0/#inbox/FFNDWMZxHpgNCffmSjvtcKQVxRnZPML?projector=1&messagePartId=0.1>

³² *E-Commerce Impacts on the Trucking Industry*, American Transportation Research Institute, page 21, February 2019, <https://truckingresearch.org/wp-content/uploads/2019/02/ATRI-Impacts-of-E-Commerce-on-Trucking-02-2019.pdf>

³³ Ibid, page 22

³⁴ Ibid, page 23

³⁵ Ibid, page 24

³⁶ *Amazon’s Share of U.S. E-Commerce is now 49% or 5% of Retail Sales*, Ingrid Lunden, Tech Crunch magazine July 2018, <https://techcrunch.com/2018/07/13/amazons-share-of-the-us-e-commerce-market-is-now-49-or-5-of-all-retail-spend/>

during the period, but courier and messenger jobs grew by +31%, and warehouse and storage jobs grew by 21% in the region and nearly 24% statewide.

Table 2 . Industrial Space Vacancy Rates for City of Portland and Portland Region 2011-2018

	Q4 2011	Q4 2012	Q4 2013	Q4 2014	Q4 2015	Q4 2016	Q4 2017	Q4 2018
Central City	4.2%	4.1%	2.5%	2.0%	1.9%	Na	2.9%	3.4%
NW/Guilds Lake	7.4%	5.4%	5.7%	4.6%	4.7%	Na	2.7%	2.3%
N/NE	7.8%	7.4%	6.6%	6.0%	5.2%	Na	5.1%	3.8%
Total City of Portland	7.2%	6.6%	5.9%	5.3%	4.7%	Na	4.5%	3.5%
Region	7.5%	6.8%	5.9%	5.0%	4.7%	Na	3.7%	3.2%

Source: Portland: The Knowledge Report 2011 through 2018, Colliers International, <https://www2.colliers.com/en/United-States/Cities/Portland>

Table 3. Transportation and Warehouse Sector Employment Trends in the Portland Region and Oregon Statewide

<i>Portland 7-County Region</i>	2005	2011	2018	% Change 2005-2018
Truck transportation	11,100	9,700	10,700	-3.7%
Couriers and messengers	4,800	4,500	7,000	31.4%
Warehousing and storage	4,400	3,300	5,600	21.4%
Total	22,305	19,511	25,318	11.9%

<i>Statewide</i>	2005	2011	2018	% Change 2005-2018
Truck transportation	19,178	17,097	18,778	-2.1%
Couriers and messengers	6,597	6,242	9,648	31.6%
Warehousing and storage	7,524	6,699	9,886	23.9%
Total	35,304	32,049	40,330	12.5%

Source: Oregon Employment Department, Publications, Oregon Industry Employment by Geography, 2000-2018, <https://www.qualityinfo.org/ed>

According to the Oregon Employment Department these jobs are expected to increase by 21% in the next decade (see Table 4), with warehousing and storage jobs increasing by 60%.

Table 4 . Oregon Statewide Employment Forecast Growth in Transportation and Warehouse Sector Employment 2007-2027

	2017	2027	Change	% Change
Truck transportation	18,700	19,600	900	5%
Couriers and messengers	9,100	11,000	1,900	21%
Warehousing and storage	8,600	13,800	5,200	60%
Totals	36,400	44,400	8,000	21%

Source: Oregon Employment Department, Publications, Oregon Industry Employment Forecast, 2017-2027, <https://www.qualityinfo.org/ed>

Also, cargo flights (i.e., flights with 100% cargo) to PDX International increased by more than 34% between 2016 and 2019³⁷. Further, according to Scott Drumm cargo flights at PDX increased by twelve/day in the past year³⁸. All goods delivered to and from air cargo facilities at PDX are completed by trucks and other motor vehicles.

As our abilities to make purchases electronically become even more accessible through smartphone and other internet connectivity, we will likely see continued high growth rates in e-commerce sales and their corresponding delivery traffic. It's important to note, however, that most shopping still takes place in retail stores.

III. Consumer Trends and Delivery Demands

While we don't yet understand whether the growth in e-commerce delivery is creating traffic congestion, safety conflicts and/or impedance at the curb, we do have reliable data from the U.S. Department of Commerce about retail sales at stores and via e-commerce, and from marketing organizations about consumer preferences.

Which Products are Being Purchased Online?

Retail consumers are primarily purchasing clothing, electronics, computer equipment, and furniture online, which hasn't fluctuated in the past five years. As shown in Figure 2 and Table 5, of the major retail products being purchased online, most exceed the sales generated at stores.³⁹

Delivery of groceries and other food items via e-commerce is growing at a very significant rate (the offering to consumers is so new that there isn't reliable data to document the phenomenon). These deliveries are truly revolutionary in that they involve perishable, short-lived items that require refrigeration and has led to an entirely new set of equipment, facilities, delivery mechanisms, and refrigerated warehouse space⁴⁰. Sparked by the on-line restaurant delivery service [Grubhub](#) and Amazon's purchase of Whole Foods and their delivery service to Amazon Prime members, grocery and restaurant delivery have become commonplace overnight.

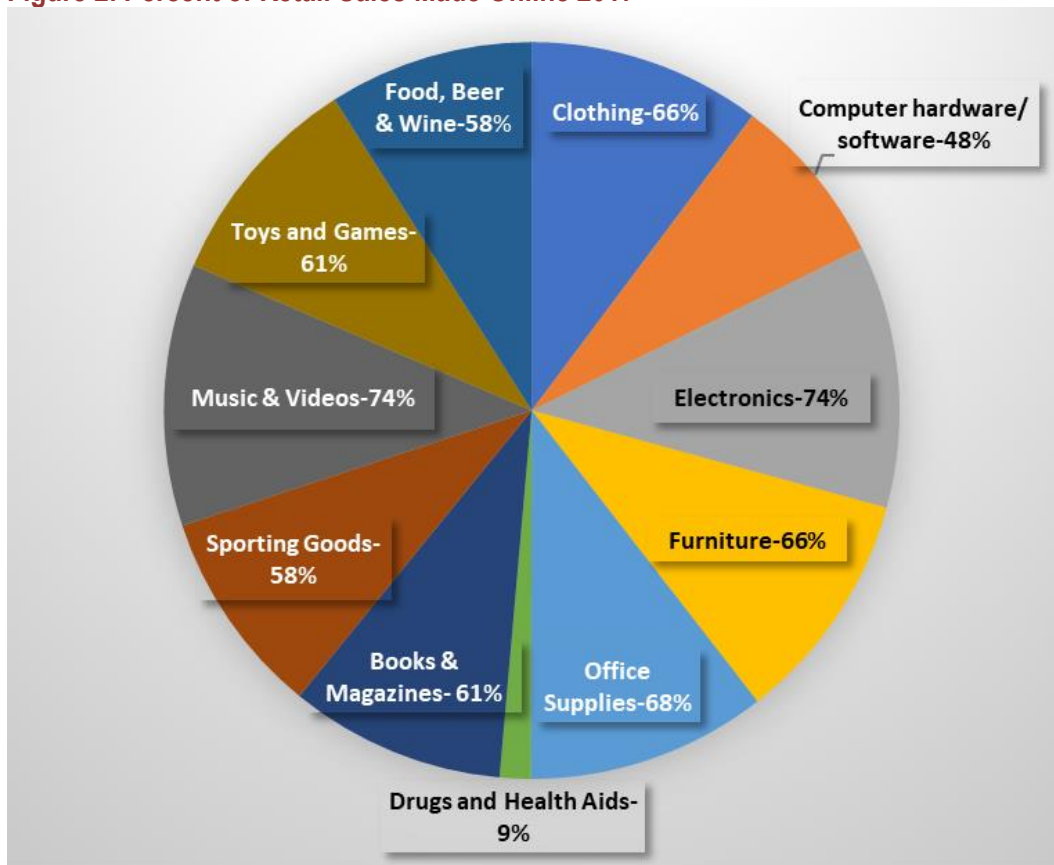
³⁷ PDX Aviation Statistics, <https://www.portofportland.com/FinanceAndStatistics>

³⁸ Reported by Scott Drumm, Port of Portland, at City of Portland E-Commerce Peer Review Meeting 1 on 4/12/2019.

³⁹ *Consumers Are Changing E-Commerce Preferences*, [Material, Handling and Logistics News](https://www.mhlnews.com/technology-automation/consumers-are-changing-e-commerce-preferences), September 13, 2018 <https://www.mhlnews.com/technology-automation/consumers-are-changing-e-commerce-preferences>

⁴⁰ *Millennials, Ecommerce Cause Cold Storage Business to Surge*, by Nelie Day, Western Real Estate Business. Page 1, July 2018, <https://westernrealestatebusiness.epubxp.com/i/1001516-jul-2018/30>

Figure 2. Percent of Retail Sales Made Online 2017



Source: U.S. Department of Commerce

Table 5. Online and Store Purchases by Type and \$ in 2017

		Sales (in billions\$)		
		Online	Store	% Online
1	Clothing	\$13.6	\$7.0	65.9%
2	Computer hardware/software	\$11.1	\$11.9	48.1%
3	Electronics	\$8.4	\$2.9	74.1%
4	Furniture	\$7.8	\$4.1	65.8%
5	Office Supplies	\$5.7	\$2.7	67.8%
6	Drugs and health aids	\$4.8	\$50.0	8.8%
7	Books and Magazines	\$4.2	\$2.7	61.0%
8	Sporting Goods	\$3.0	\$2.2	58.2%
9	Music and Videos	\$2.8	\$1.0	74.0%
10	Toys and Games	\$2.7	\$1.7	61.4%
11	Food, Beer and Wine	\$2.3	\$1.7	57.9%
12	Other merchandise	\$12.5	\$16.5	43.2%
13	Non-merchandise	\$6.8	\$3.6	65.5%
		\$85.7	\$108.0	44.2%

Source: U.S. Department of Commerce

Consumers' Shipping Requirements are Changing

It wasn't long ago that shipping and handling charges were part of every online or telephone purchase and customers would expect to receive their purchase "within 4-6 weeks for delivery." One could then opt to pay extra for faster shipping and track the progress of shipments. Soon after came free shipping within a week's time, followed by delivery within one day, and even within one or two hours. In this highly competitive market, suppliers are continually testing and evaluating customer's preferences.

According to the annual eCommerce study conducted by 3PL provider Dotcom Distribution:⁴¹

- 90% of those surveyed "highly value free returns when making online purchases; 91% say free shipping influences future purchases. Giveaways also positively influence consumers' future purchases. These factors outranked faster delivery times."
- "62% would buy again from a brand offering free returns/exchanges"
- "67% are likely to add items to cart to receive free shipping"



[Courtesy of Material, Handling and Logistics News](#), September 13, 2018

Interestingly, consumers stated that free shipping and on-time delivery is more important than faster shipping:

- "Only 25% of 2018 respondents would pay extra for faster shipping — in sharp contrast to the 47% who'd have paid up to \$9 more for faster delivery in 2016"
- "93% are greatly or somewhat impacted by shipping cost"
- "77% said delayed order arrival would influence future purchase decisions with a retailer"

Finally, age is an indicator of delivery preferences. For example, younger consumers value convenience and faster delivery, while older buyers are more likely to seek low-cost or free shipping, and free returns.

- "Gen Z" (individuals born between the mid-1990s and mid-2000s): 36% named same-day delivery a top influence in future purchase decisions — highest of all groups; 87% are more likely to make

⁴¹ *Consumers Are Changing E-Commerce Preferences*, [Material, Handling and Logistics News](https://www.mhlnews.com/technology-automation/consumers-are-changing-e-commerce-preferences), September 13, 2018
<https://www.mhlnews.com/technology-automation/consumers-are-changing-e-commerce-preferences>

online purchases if they can return in-store; 75% are more likely to purchase from retailer again if online order came with free giveaway”

- “Millennials” (those born between 1981 and 1996): 76% would add items to online carts to qualify for free shipping; 36% prefer buying online — both highest of all groups; 79% are less likely to buy from e-tailer (i.e., an e-commerce retailer) again if delivery is delayed; 60% are more likely to purchase from e-tailer again if online order came with free giveaway”
- “Baby Boomers” (born between 1946 and 1965): <1% expect one-day delivery — lowest of all groups; 95% of purchase decisions are “somewhat” or “greatly” influenced by shipping costs — highest of all groups”

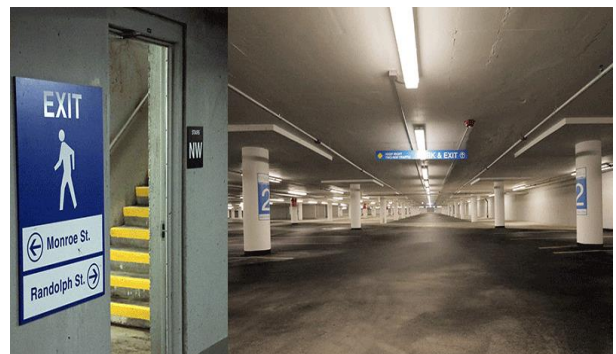
Another study found that the “Gen X” (individuals born between 1966 and 1980) age group made more online purchases in 2016 than any other group, with an average of 18.6 purchases/year across the world⁴².

IV. Innovations for Improving Last-Mile Deliveries

Delivering merchandise in the last-mile portion of the trip in a cost-effective manner has been a challenge for e-commerce vendors since its inception. The fundamental economics continue to be dependent on 1) route density — how many packages can be delivered on a given delivery run; and, 2) concentrated package volume — how many packages or items are delivered at each stop. As package volume has grown, carriers have been able to increase the number of deliveries per stop and/or per mile, although these efficiencies cannot always be guaranteed.

Beginning with the point of origin, industrial land to construct new fulfillment centers and warehouses is often unavailable and/or very costly. Some developers are repurposing older industrial buildings, including use of dying shopping malls. Under construction in Chicago is the Millennium Chicago last-mile facility which is conversion of a portion of a city-owned underground parking garage in the city’s central business district and within 15-minutes of nearly 230,000 residents.

In Seattle where industrial space is very limited, [Prologis](#) is building a three-story, 590,000-square-foot fulfillment center⁴³, the first multi-story warehouse in the U.S. though they are commonplace in other countries. The facility will accommodate both e-commerce and smaller light-industrial tenants. (Prologis recently purchased the 115-acre Portland Meadows horse racing facility which they reportedly will redevelop as an urban logistics facility with up to ten buildings for warehouse, distribution or light manufacturing use.⁴⁴)



Courtesy of JLL Millennium Chicago

⁴² *The truth about online consumers: 2017 Global Online Consumer Report*, KPMG International, 2017, <file:///C:/Projects/ECommerce%20for%20PBOT/TM%201/the-truth-about-online-consumers.pdf>

⁴³ Brochure - Prologis Georgetown Crossroads 6050 East Marginal Way South Seattle, WA <https://www.prologis.com/industrial-logistics-warehouse-space/united-states/seattle/prologis-georgetown-crossroads>

⁴⁴ *Prologis Purchases Portland Meadows Property*, by Stephanie Basalyga for the Portland Tribune, 9/11/2019, <https://pamplinmedia.com/but/239-news/438247-350376-prologis-purchases-portland-meadows-property>

Secondary Logistics Centers

Micro-hubs. Also referred to as micro-hubs or micro depots, micro-hubs are consolidation centers for last-mile deliveries in dense urban districts. Goods are delivered from warehouses and distribution centers via truck to the micro-hub facility where they are either picked up by the customer or delivered by cargo bike or bicycle to their destination. The Redd in the Central Eastside is a micro-hub providing dry goods and refrigerated warehouse space, handling, packaging and last-mile delivery by cargo bike.

Micro-hubs can be:

- Urban Consolidation Centers - larger, permanent facilities located in urban areas that allow businesses to consolidate and coordinate between freight carriers;
- Delivery micro-hubs - are urban consolidation centers with a smaller physical footprint; and
- Neighborhood Lockers - are small storage units located close to the final delivery point which can be conveniently accessed by customers. In Portland lockers are found at Amazon retail storefronts, 7-Eleven stores, apartment buildings, and other locations.



Rendering of ProLogis Georgetown Crossroads, Seattle

As of August 2018, there were seven micro-hubs operating in Amsterdam⁴⁵ serving the postal system and other logistics providers where vans unload packages to be delivered by “freight bikes” for the last-mile delivery.

⁴⁵ City deliveries using micro-hubs and innovative freight bikes, 2020 Civitas Conference, Amsterdam, The Netherlands, 8/3/2018, <https://civitas.eu/event/city-deliveries-using-micro-hubs-and-innovative-freight-bikes>

In Frankfurt and Utrecht, DHL delivers standardized containers (which can load up to 275 lbs.) by van to designated “City Hub” locations for transfer to their “cubicycle” cargo bicycles specially equipped to handle the containers. DHL expects that “each City Hub can replace up to two standard delivery vehicles, with an equivalent CO2 saving of over sixteen tons per year and a significant reduction in other emissions.”⁴⁶

Neighborhood Lockers reduce the time that a delivery person spends in a building⁴⁷ and consequently reduces the time that curb space is utilized for active deliveries.

As of November 2018, Amazon has developed 21 storefront locations in Portland where packages are delivered to a storage locker for pickup⁴⁸. Customers are notified of their arrival and provided with a locker number and code to open the locker. Returns can also be transacted at these facilities. Most of their locker facilities are located in other commercial establishments including Fred Meyer and Whole Food groceries, and some are independent Amazon stores that are staffed. In addition, some high rise office and residential buildings have Amazon locker facilities. These satellite facilities can reduce delivery trips by concentrating deliveries, and may offer convenience to customers who don’t have a means of directly receiving parcels, as well as providing additional security over deliveries made to unoccupied homes or businesses. While they won’t significantly reduce vehicle miles of travel, they can be a means of making other non-vehicular delivery services feasible.



Amazon Locker



Amazon Storefront at 1131 SW Jefferson Street

⁴⁶ DHL expands green urban delivery with City Hub for cargo bicycles, DHL Press Release, 3/1/2017, https://www.dhl.com/en/press/releases/releases_2017/all/express/dhl_expands_green_urban_delivery_with_city_hub_for_cargo_bicycles.html

⁴⁷ According to Barb Ivanov, University of Washington Urban Freight Lab, “nearly 80% of the time a delivery person is in this building is spent getting through security (12%) and riding elevators to different floors and going door-to-door to tenants 67%.” 3/14/2018, <https://depts.washington.edu/sctlctr/news-events/in-the-news/nextgen-supply-chain-interview-barbara-ivanov>

⁴⁸ Calculated from *Find an Amazon Locker in Your Area*, November 2018, https://www.amazon.com/gp/help/customer/display.html/ref=hp_200689010_findlocker?nodeId=201117850

Logistics Strategies

Logistics managers who dispatch fleets strive to combine a variety of packages with similar locations into each delivery. For example, Amazon is leveraging its acquisition of Whole Foods to combine grocery with other e-commerce package offerings in order to increase route density. This year, [Walmart](#) is completing the construction of “pickup towers” at 500 of its U.S. stores to concentrate demand into a single delivery point⁴⁹.

Some carriers may be under contract to provide on-call delivery according to a contract or on a per trip basis. As discussed earlier, crowdsourcing (or “crowd shipping”) and shared mobility strategies are also a commonly used means of scheduling deliveries (Table 6 presents a sample of crowdsourcing delivery systems in operation in Portland). Much like the transportation network company apps used by Uber and Lyft, conventional trucking companies as well as other registered delivery services or individuals can be contacted about their ability to make a delivery. Company employees are also used for these purposes, and there are systems such as those created by Nimber and Roadie which put drivers in touch with companies to conduct deliveries when they have available capacity in their trucks and / or have a similar origin and/or destination as the cargo in their truck.

Table 6. Crowd Sourced-Use Mobility Firms in the Express and Parcel Delivery Business Operating in Portland

	Start Year	Company Fee	Modes: Package Size	Insurance	Operation
Nimber	2016	20%	Walk, bike, car or van	Up to 500 pounds	Price negotiated between deliverers and users. “On-the-way”
Rickshaw	2013	From \$5.50	Package delivery		Broker. Cooperate with carriers
Roadie	2015		Up to pick-up truck or 500 lb.	\$500 free, up to \$10,000	Price negotiated between deliverers and users. Price set based on mileage and package size

*This is a selected list and is current as of 11/2018. This industry has been generating many start-ups, many of which are unable to stay in business for the long-term.

Many experts don’t believe these options are sustainable over the long run and have been discussing the idea of a “[Last-Mile Exchange](#).”⁵⁰ As shown in Figure 3, rather than responding to a customer order (or predictions about orders), “transportation companies and retailers could engineer demand earlier in the sales process and dynamically balance supply and demand, much as Uber uses surge pricing to encourage more drivers to work during times of peak needs in peak locations.”⁵¹

In other words, if retailers and last-mile transportation providers share data in real time, carriers could determine whether they could complete such a delivery – by combining it with other deliveries already scheduled – and what they should bid for the assignment. Those with deliveries to the same location or nearer to that location could offer a discounted price. The exchange would likely require a shared data-

⁴⁹ *Hundreds More High-Tech Pickup Towers are Headed Your Way*, by Justin Rushing, Walmart Communications. April 5, 2018, <https://blog.walmart.com/innovation/20180405/hundreds-more-high-tech-pickup-towers-are-headed-your-way>

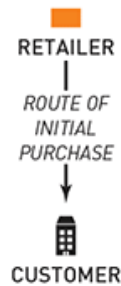
⁵⁰ *Shifting Patterns: The Future of the Logistics Industry*, PwC Network, November 2016, <https://www.pwc.com/gx/en/transportation-logistics/pdf/the-future-of-the-logistics-industry.pdf>

⁵¹ *The Rise of the Last-Mile Exchange*, Tim Laseter, Andrew Tipping, and Fred Duiven, strategy + business, July 2018, <https://www.strategy-business.com/article/The-Rise-of-the-Last-Mile-Exchange>

Figure 3. Last-Mile Exchange Flow Chart

How a Last-Mile Exchange Might Work

The current system of delivering packages from an online retailer to the customer's home could expand and evolve into a complex network informed by data that would yield improved convenience, transparency, efficiency, and cost savings.



When a customer orders an item online for delivery, the "from" and "to" addresses, which are traditionally instructions for a carrier, are also valuable data points.



The carrier, knowing that a delivery is being made to a certain customer, can offer the retailer a better price for delivery of another item to the same address. A retailer can then encourage additional simultaneous purchases with special offers or discounts.



The carrier can also offer the same retailer a great price for an additional package to be delivered next door. The retailer can encourage the neighbors accordingly.



The retailer or its warehouse might have neighbors as well. The carrier can offer nearby sellers better delivery rates for delivering to the initial customer.



Ultimately, a last-mile exchange will allow a dynamic pricing model open to multiple retailers, targeting a host of consumers, bid on by a host of carriers. Collectively, the "invisible hand" of the marketplace will drive greater efficiency and a win for retailers, carriers, and consumers.

Source: Strategy&

based system to pool package data, resource availability data, and analytics to dynamically optimize pickup and delivery routes.

Innovations for Accomplishing the Last-Mile Delivery

The conventional method for last-mile deliveries involves a dedicated employee of a carrier picking up parcels at a consolidation point before delivering them directly to the recipients. In addition to the logistics strategies and crowdsourcing approaches described above, the following innovative delivery systems are being tested or are in development today and would provide direct benefits to ecommerce delivery:

Autonomous Trucks. Self-driving long-haul heavy-duty trucks, last-mile delivery vans and other commercial delivery trucks are being tested throughout the world; in many instances on public roadways. They carry standard-sized containers and are generally of the same weight as today's truck fleets. The economic benefits of self-driving trucks are numerous, including the cost savings of phasing out truck drivers, and the ability for trucks to operate 24 hours/day since there wouldn't be driver restricted hours issues to contend with.

Like autonomous passenger vehicles, autonomous trucks come with several issues of concern to the City of Portland including safety regulations and the potential for increased vehicle miles of travel and congestion.



"Vera", a driverless, all-electric truck cab from Volvo currently operates in confined areas at the Port of Gothenberg, Sweden where it travels repetitive routes over short distances

Autonomous Cars. Nuro, an autonomous vehicle startup focused on the last mile delivery of local goods and services, has teamed with Kroger to delivery groceries using autonomous vehicles (which can travel up to 25 mph) in two pilot grocery delivery programs: the first ran from August 2018 to March 2019 operating out of one store in Scottsdale, AZ. The other began in March 2019 and serves two stores in Houston, Tx⁵². For a cost of \$5.95/delivery, customers place delivery orders using Kroger's online system and Nuro's app and are advised when the battery-powered vehicle shows up at their residence⁵³.



Nuro's R-1 vehicle can carry twelve grocery bags stored in refrigerated compartments and opened using an app.

Other grocery chains have attempted to license autonomous vehicle delivery services and are expected to have these services available soon. Stop & Shop, a northeastern U.S. chain of grocery stores, intends to kick-off an autonomous vehicle delivery service in the Boston area sometime in 2019⁵⁴. The battery powered "Robomart" vehicle will restock its quarters at nearby Stop & Shop stores.



Robomart autonomous vehicle delivery will supplement Stop & Shop's standard delivery services using drivers

Even though smaller than conventional delivery trucks, these autonomous delivery vehicles will utilize on-street curb space, increasing competition for vehicles seeking parking or loading and unloading, as well as the occasional blockage of bike lanes, fire hydrants and crosswalks.

Robot Deliveries. Another autonomous vehicle making last-mile deliveries are self-driving robots that travel only on sidewalks and crosswalks and can carry orders as heavy as 50 pounds for as far as 30 miles⁵⁵. They travel at slow speeds using a global positioning system and 360-degree camera sensors to allow autonomous navigation⁵⁶. They need to be supervised by humans, but that can be done remotely for several operating at any one time.

Amazon has been testing its own "Scout" vehicles with six bots since January 2019 in Snohomish County, WA. For now, Amazon says, it will limit its testing to daylight hours Monday through Friday.

⁵² Kroger and Nuro Launch Autonomous Delivery Service in Houston, Kroger Press Release, March 14, 2019, <https://www.prnewswire.com/news-releases/kroger-and-nuro-launch-autonomous-delivery-service-in-houston-300812183.html>

⁵³ Ibid.

⁵⁴ Stop & Shop is planning to roll out small 'driverless grocery stores' in the Boston area, Boston Globe, January 19, 2019, <https://www.boston.com/news/business/2019/01/16/stop-shop-robomart-driverless-grocery-stores>

⁵⁵ Postmates' new rover, Serve, is adorable by design, by Michael Grothaus Fast Company magazine, December 14, 2018, <https://www.fastcompany.com/90281867/postmates-new-rover-serve-is-adorable-by-design>

⁵⁶ <https://www.starship.xyz/>

Scout will also have a human chaperone to make sure the bot can “safely and efficiently navigate around pets, pedestrians, and anything else in their path.”⁵⁷ Robot delivery vehicles are being tested by Starship Technologies throughout Europe and recently begun tests at George Mason University. With online retail sales in the U.S. increasing by 16 percent just between 2016 and 2017⁵⁸, as many as eight sidewalk bot delivery vehicles have entered the marketplace including: Loomo Delivery, Anymal, Serve, Marvel, Box Bot, Kiwibot, Scout, and Starship Robots.

A combination delivery system featuring an autonomous car that includes an autonomous bot inside has been developed by Anybotics and Continental, to accomplish the full roadway to sidewalk delivery by unmanned devices⁵⁹.

Cities have been struggling with how to regulate this new kind of vehicle creating confusion and congestion on sidewalks. San Francisco severely restricted the machines at the end of 2017, requiring permits and mandating that startups test their delivery robots in quieter, more industrial neighborhoods.



Scout Bot by Amazon



Serve Bot by Postmates

Drones. Deliveries by drones are being used in limited environments and for selective delivery types in a few countries including the UK, France, Japan and China. Their use for delivering relief and medical supplies to remote or difficult to reach areas is growing. Hotels are experimenting with drone delivery of food and beverages to guests. In addition, its widespread use for other types of deliveries – in particular, food and packages - has been delayed by additional tests, development of regulations, and for shippers to resolve several logistical challenges. The cost savings to shippers, and the benefits to commerce, as well as ,reduced truck traffic and corresponding fuel consumption and emissions, would be enormous if drones replaced many deliveries completed by more conventional means.

⁵⁷ *Out of the Way, Human! Delivery Robots Want a Share of Your Sidewalk*, by Jeremy Hsu for Scientific American, February 19, 2019, <https://www.scientificamerican.com/article/out-of-the-way-human-delivery-robots-want-a-share-of-your-sidewalk/>

⁵⁸ *The Last Mile Delivery Market in the United States - Growth Opportunities to 2023: E-commerce is the Biggest Driver*, Business Wire Magazine, February 4, 2019, <https://www.businesswire.com/news/home/20190204005673/en/>

⁵⁹ *Robotic Package Delivery with ANYmal 31*, January 2019/5 Comments/in News /by Péter Fankhauser, <https://www.anybotics.com/2019/01/31/robotic-package-delivery-with-anymal/>

In September 2019, the FAA approved testing drone delivery of FedEx and Walgreens products by Wing, a subsidiary of Google, in Christiansburg, Virginia⁶⁰. The license was issued after the company tested drone deliveries at Virginia Tech University and then on-demand items to homes near campus.

There's consideration about the ability of local jurisdictions to regulate commercial drone operations. In general, the FAA has authority over the air space while local jurisdictions have authority over landing sites. However, operations in the airspace can impact citizens' privacy, noise levels⁶¹, safety, and land use, all of which fall under the purview of local jurisdictions.

After receiving an order from a mobile app, one of the company's (i.e., Google) fleet of drones can pick up a package from a business or home, fly to a designated destination, hover about 20 feet over the delivery area, and use a tether to lower the package to a precise location such as a backyard or a doorstep, according to its exemption application. Wing uses its own unmanned traffic management (UTM) system to manage the drone's flight path from take-off to landing to ensure safe operations around obstacles such as buildings, trees, and other drones.⁶²



Wing's drone lifts from the ground vertically, flies horizontally, and carries packages in its belly. One drone "pilot" can remotely fly up to five machines at one time, though that number may increase.

⁶⁰ Drone Deliveries Coming Soon, as Wing Unveils Plans for First-of-its-Kind Trial with FedEx and Walgreens, FedEx press release, September 19, 2019, <https://about.van.fedex.com/newsroom/drone-deliveries-coming-soon-as-wing-unveils-plans-for-first-of-its-kind-trial-with-fedex-and-walgreen/>

⁶¹ However, Portland's noise ordinance does not include noise from vehicles. <https://www.portlandoregon.gov/civic/63268>

⁶² Google drones may soon fly commercially over Virginia, by John Gallagher, Freight Waves Magazine, 4/19/2019, <https://www.freightwaves.com/news/technology/google-drones-may-soon-fly-commercially-over-virginia>

Cargo bikes. Portlanders are familiar with cargo bikes through the common appearance of B-Line, Portland Pedal Power, Soup Cycle, and other delivery companies. Most cargo bikes are electrically powered, or electric power assisted, and some can carry up to 750 lbs. of cargo⁶³. They are an ideal substitute for many deliveries by van, particularly since they don't require much – if any - parking area. In addition, they can be loaded and unloaded in lesser time, and can move more quickly in congested urban areas that have a bicycle route network. They also don't require as much roadway capacity as trucks and are an important means of delivering goods when roadways are unavailable during emergencies or other incidents. In 2016, UPS began operating its electrically assisted e-bike tricycle in Portland, and in early 2019, UPS will start a licensed pilot program for e-bike operations on sidewalks and bicycle lanes in the downtown Seattle area including the Pike Place Market⁶⁴.

Given their wider wheelbases and longer length, cargo bikes cannot always comfortably navigate bicycle lanes as well as bicycles can, yet they are not permitted in travel lanes reserved for passenger cars, trucks and buses. In addition, in some instances they are not permitted to use on-street truck loading zones, and they can reduce access for pedestrians if they park on sidewalks. Finally, the economics of the cargo bike delivery business is very challenging. For example, they can't carry a great many packages/delivery, they aren't practical for most longer trips, and they often don't have the benefits of back-haul delivery that deliveries by truck, van, or passenger cars do.



Photo courtesy of bikeportland.org

⁶³ *Cargo bikes Not Drones Are The Future For Urban Deliveries*, by Carlton Reid for Forbes Magazine, October 15, 2018, <https://www.forbes.com/sites/carltonreid/2018/10/15/cargobikes-not-drones-are-the-future-for-urban-deliveries/#151b4abde790>

⁶⁴ *UPS To Launch First-Of-Its-Kind U.S. Urban Delivery Solution in Seattle*, UPS Press Release, October 25, 2018, <https://www.pressroom.ups.com/pressroom/ContentDetailsViewer.page?ConceptType=PressReleases&id=1540482965617-103>

Bike Couriers. Bike couriers are of course common today, but their usage for last-mile delivery is expected to grow significantly as does the point-to-point delivery market, especially for business-to-business documents and prepared food. According to a 2016 McKinsey report:

“Ultimately, the best solution to a glut of delivery vehicles could be less high-tech....old-fashioned bicycles remain the most cost-competitive choice for many last-mile deliveries. “If droids do not become significantly cheaper,” the analysts wrote, “bike couriers are likely to be the best delivery form for instant delivery in urban areas.”⁶⁵

Amazon’s Delivery Service Partner Program. In June 2018, Amazon introduced this program to train individuals to operate a delivery business moving Amazon packages. For a minimum investment of \$10,000, individuals will also get access to Amazon-branded vehicles, uniforms, and discounts on fuel, insurance, and more, but they will not be Amazon employees. The program is available at 75 delivery stations throughout the U.S. - including Portland - and the company expects to contract with “hundreds of small business owners who would hire tens of thousands of delivery drivers.”⁶⁶



Applicants accepted into Amazon’s new start-up delivery program will get access to Amazon-branded vehicles and uniforms like these.

⁶⁵ *Out of the Way, Human! Delivery Robots Want a Share of Your Sidewalk*, by Jeremy Hsu for Scientific American, February 19, 2019, <https://www.scientificamerican.com/article/out-of-the-way-human-delivery-robots-want-a-share-of-your-sidewalk/>

⁶⁶ <https://logistics.amazon.com/>

V. Findings from Stakeholder Interviews

In addition to the research about e-commerce demand, delivery practices, logistics strategies, and future trends, interviews were held with nine individuals between April 2019 and August 2019 to help validate many of the research claims.

The interviews contained six questions for carriers, shippers and the academics, and seven questions for city agencies. Most of the interviews were conducted by telephone, though some were completed independently and submitted by email. After receipt of the surveys, follow-up questions were asked in order to clarify responses and to try to ensure some level of consistency among the responses.

The interviewees fall into three categories: carriers delivering e-commerce products in the City of Portland; peer cities that are addressing e-commerce delivery issues; and, academia involved in national research current research about e-commerce. They were selected based on their experience in delivering products ordered via e-commerce methods, or in the case of the city agencies and the academic professionals, have been evaluating the effects and trends associated with e-commerce deliveries. The study team also considered reaching out to several of Portland's peer cities including Austin, Denver, Minneapolis, Sacramento, Salt Lake City and San Diego, but found they hadn't yet engaged in extensive e-commerce analyses nor had they completed detailed freight planning.

Insights Gained from Interviews

In large part, the information collected via the questionnaires was consistent with the research findings. For example, there's universal agreement that: congestion and conflicts that occur within on-street delivery zones is a major impediment to meeting delivery schedules; that highly automated distribution/warehouse/fulfillment centers are simplifying the supply chains; and that smaller electric powered vehicles are making up a growing percentage of the last mile delivery vehicle fleet. In addition, while e-commerce deliveries are growing at unprecedented rates, cities are not providing capacity for accommodating them, and in many instances were eliminating loading zones.

And while each of the cities are excited about the use of e-bikes and other smaller nonpolluting vehicles to make last-mile deliveries, industry representatives indicated that 90% of all e-commerce deliveries are still made by truck. All agree that developing partnerships between cities and other roadway authorities and shippers and carriers is critical to developing solutions.

While some cities are hopeful that encouraging off-hours deliveries will help overcome congestion at the curb and along roadways, and shippers and carriers would like to be able to transfer more of their loads to off-hour periods, their ability to do so is restricted by neighborhood noise ordinances and complaints from residential neighbors near distribution centers and delivery warehouses⁶⁷.

In addition, carriers and shippers expect to see an increase in handoffs from one mode to another either at distribution centers or informally on roadways and/or parking lots.

E-commerce packages and deliveries are a relatively low margin enterprise compared to delivery of business-to-business packages. The profit margins tend to be higher with business-to-business deliveries and the volume is more stable. According to the FedEx representative, that was the primary reason for the company no longer serving Amazon.

⁶⁷ The City of Portland's noise ordinance covers noise from amplified music, events and parades, construction, animals from legal animal facilities, but not from vehicles. <https://www.portlandoregon.gov/civic/63268>

The interviews also demonstrate that shippers and carriers are extremely flexible and open to the manner in which last-mile deliveries are made, and that there's a heavy reliance on third party vendors to complete last-mile deliveries.

VI. Potential Adverse Impacts of E-Commerce on City Policies, Projects and Programs

There are at least five general areas where E-Commerce deliveries may produce some adverse impacts to the function and performance of the local transportation system and conflicts with other PBOT priorities:

- **Contribution to traffic congestion.** While there are no accurate counts of the added trips made by deliveries of e-commerce items, there is much evidence to support the assumption that e-commerce delivery vehicles are adding to our traffic congestion. As discussed earlier, vacancy rates for warehouses in the City of Portland dropped from 7.2% in 2011 to 3.2% in 2018; transportation and warehouse employment grew by 30% between 2011 and 2018; and cargo plane traffic at PDX grew by twelve flights/day just in the past year. Each of these local phenomena generate delivery trips.

Traffic delays on City streets are receiving increasingly greater attention and it would be useful to know what the contribution of e-commerce vehicle delivery traffic is to those levels.

- **Competition for curb space** between vehicles needing curb space to complete their deliveries and the needs of buses, bicycles, and automobiles seeking parking for the same on-street curb areas is very high and leads to a significant amount of circulation to find available curb space. Moreover, some of the curb space is already dedicated for bus lanes, bus stops, bicycle lanes, public parking, and parking reserved for handicapped motorists as well as governmental organizations (e.g., Portland Police vehicles and PBOT Parking Enforcement vehicles). With the expected growth in e-commerce deliveries and the programmed City initiatives for dedicated bus lanes and bicycle lanes also designated for curb areas, this competition will grow much worse.
- **Additional greenhouse gas emissions** produced by the growth in e-commerce delivery vehicles is not as simple as the added delivery traffic that we're experiencing, but also because customer demands for one day or two-day delivery requires carriers to make special trips rather than consolidate them. Driven by Amazon's same-day delivery as well as one-hour delivery, companies are being pushed like never before to offer their products at a delivery speed that was not previously an industry standard. Walmart, Target, and Costco now provide same-day delivery, and groceries are delivered in one to two hours by Kroger and Whole Foods.

In 2017, UPS disclosed that e-commerce trends had decreased the number of packages it dropped off per vehicle. Further, UPS' Director of Global Sustainability Patrick Browne stated:

*"The time in transit has a direct relationship to the environmental impact. I don't think the average consumer understands the environmental impact of having something tomorrow vs. two days from now. The more time you give me, the more efficient I can be."*⁶⁸

⁶⁸ America's addiction to absurdly fast shipping has a hidden cost, Lynda DePillis, CNN Business, 7/15/2019, <https://www.cnn.com/2019/07/15/business/fast-shipping-environmental-impact/index.html>

Further, a University of Washington study found that grocery delivery can cut between 80% and 90% of carbon emissions compared to individuals driving to grocery stores on their own. However, Professor Anne Goodchild, the study's author warns:

*"The efficiency and these benefits of delivery came from consolidation and sharing a big vehicle. And as we move away from that, if we move towards basically paying someone to make a trip for us, those benefits are eroded."*⁶⁹

This is consistent with research from the Sustainable Freight Research Center at the University of California at Davis which found that "if a delivery van makes less than six stops on a trip, the emission advantage disappears."⁷⁰

- **Creates sidewalk impediments** is a common impact of e-commerce delivery, particularly where delivery space (either on-street or off-street) is unavailable, and where buildings aren't equipped to accommodate large volumes of package deliveries. These impediments block pedestrian travel for disabled and abled individuals and create safety hazards for pedestrians.



- **Reduced revenue for retail stores** is a byproduct of e-commerce. Since 2014, e-commerce retail sales have grown from 9.5% of total retail sales to 14.3% of total retail, sales in 2018. This growth has led to store closings resulting in unemployment, reduced tax revenues, and less activity in our commercial districts. This is a national problem notably with well-known stores such as Sears, Payless Shoes, Toys r Us, Brookstone and JC Penny filing for bankruptcy in 2018 and 2019, and many other retailers closing stores including Nordstrom, Macys, Lowes and Walgreens. The problem is very evident at several shopping malls such as the Lloyd Center Mall which has multiple long-term vacancies.

Portland has weathered this storm better than other cities due to the large growth in our population, but the e-commerce phenomenon is also creating disruption locally in our retail landscape.

- **Impacts to neighborhood circulation.** Though there is no quantitative evidence citywide, there may be some disruption to traffic and parking conditions in residential neighborhoods due to the increased e-commerce delivery traffic directly to resident's homes. Further, these deliveries have become commonplace in these neighborhoods during weekends, late night periods, and even during holidays. They may result in some safety conflicts and noise complaints as well and may generally impact the quality of life desired by many City residents.

⁶⁹ Ibid.

⁷⁰ Ibid.

VII. Recommendations for the City of Portland

The initial goals of this project were to complete research to understand how much or whether e-commerce delivery impacts traffic flow and curb usage in the City, and to determine if the subject deserved a significant amount of attention in the City's upcoming Freight Master Plan Update. As the research was unfolding, the Study's Peer Review Committee and PBOT staff urged that the study result in recommendations and actions, which is what is described in this chapter.

These recommendations and "next steps" have not been endorsed by the City of Portland. Rather they are suggestions by the author, who further recommends that they be more fully evaluated in PBOT's upcoming Freight Master Plan Update or under an independent process. Some of the recommendations can also be discussed under ongoing PBOT and Bureau of Planning and Sustainability activities. Prior to reviewing these recommendations there may need to be development of work plans, assessments of the resources required to organize and coordinate the work, as well as to document and program the appropriate materials. In total, the efforts to initiate development of these recommendations will ultimately require the allocation of additional professional staff resources.

Committee members and PBOT staff were encouraged, in part, by the efforts of cities that are being proactive in accommodating e-commerce delivery before it becomes a problem that they must react to. In addition, they noticed that many of the strategies that could assist in reducing the impact of e-commerce delivery were consistent with the Portland's Smart City PDX initiatives to utilize technological and operational strategies to solve traffic problems.

While we don't have reliable information about where and whether deliveries (including not only e-commerce deliveries, but package, parcel, grocery and restaurant deliveries as well) are creating new congestion and curbside conflicts, we do know that it is a growing fact of daily life that is only going to increase. In that regard, these recommendations are more programmatic than they are site-or issue-specific. They require data, more analysis, and collaborative discussion among City officials and shipper and carrier and related business stakeholders. In fact, many of the recommended strategies that have been employed elsewhere have benefitted from those kinds of collaborations.

Several of the recommendations are organized as "short-term" actions because they can be implemented without significant resources, do not require official actions, and are consistent with City policies and practices. Others require a great deal more analysis, code changes, and land use actions.

Given this caution, and with our goals identified in the City's Climate Action Plan, it's focus on Smart City PDX technology solutions, and interest in maximizing our ability to share the roadway, it is recommended that the City of Portland consider the following goods movement related innovations:

The recommendations – which are described below and summarized in Table 7 – are presented in the author's preferred order of importance; however, given City policies and program and logistics strategies, there may be reason to consider them in a different order.

Recommendations that can be accomplished in the short-term (generally those that can be accomplished without new resources, programs, regulatory changes, or formal adoption):

Recommendation 1 – Analyze Curbside Usage in the Central City by Delivery Vehicles.

Prepare a budget request for PBOT to begin collecting data and completing analyses of all delivery patterns (package, parcel, e-commerce, groceries, restaurants) by all delivery vehicles) – including on-street usage, travel time to complete deliveries, origin and destination, etc. on a regular basis such as every five to ten years - in all Central City districts (in particular, the Downtown, Central Eastside, Lloyd, Northwest and South Waterfront districts) including volume, by vehicle type, time to conduct delivery, etc., at curb locations. The potential outcomes of these analyses could include determining whether curb regulations meet the needs of deliveries, and whether and where delivery vehicles must circulate for available curb space. This data could also be the foundation for consideration of variable pricing of delivery zones as is done in San Francisco.

PBOT currently provides on-street loading and unloading spaces based on requests from property owners or businesses along with a review of the proximity of other truck loading spaces. Under PBOT's recent Parking Management Manual, loading zone occupancy, turnover, violation rates and peak hour of usage will be reviewed every two years to ensure that the location of the on-street truck loading spaces is appropriate and that they are being effectively served for both loading and customer/ visitor demand⁷¹.

Prior to jumping into these data collection and analysis efforts, it's essential that PBOT identify what they are trying to measure, what the goals of the analyses are, and the methodologies that will be employed for the evaluations.



Analyze Curbside Usage in the Central City by Delivery Vehicles

- **Short Term Action**
- **Relevance to City Policy:** TSP, Smart City PDX
- **Benefits:** Maximize curb usage, reduce circulation time
- **Challenges:** Complex data collection effort
- **Next Steps:**
 - Work with the PBOT Parking Division staff to create a work plan and budget and establish a stakeholder working group to include city staff, business interests, and delivery companies.
 - Prepare a budget request for data collection and PBOT staff time.

⁷¹ Performance Based Parking Management Manual, Portland Bureau of Transportation, April 2018, <https://www.portlandoregon.gov/Transportation/article/686017>

Recommendation 2 - Variable Pricing of Central City Curb Space.

This is a subject that will soon be analyzed under PBOT's Pricing for Equitable Mobility Community Task Force and by Metro in its Regional Congestion Pricing Study. As with congestion pricing on freeways, bridges and tunnels in the Bay area, Southern California, Seattle, Miami, Dallas, and elsewhere, delivery vehicles would be charged a variable rate to load and unload goods at the curb based on the time of day. For example, if the 8am-Noon period is the peak usage period for deliveries, then the rate would be highest during that period, and may have the effect of moving deliveries to time periods where curb usage and corresponding rates are lower.



This type of program – called *SFpark* - has been implemented in San Francisco at all of its 28,000 on-street parking metered spaces and at City-owned metered parking lots and garages. *SFpark* uses sensors to identify where spaces are available and the length of time that a vehicle has been parked. Charges range from \$0.50 to \$7.00 per hour depending on length of time parked and, most importantly, the availability of other nearby spaces (i.e., peak periods). Rates can also be reduced if there is an ample number of available spaces in the vicinity of a parking space. After five years, the program has found that average parking rates are lower than they were prior to the program, parking availability has improved, and vmt and associated GHG emission have been reduced.

Variable Pricing of Central City Curb Space

- **Short Term Action**
- **Relevance to City Policy:** TSP, Smart City PDX, Parking Management Manual
- **Benefits:** Maximize curb usage, balance traffic and curb peak usage
- **Challenges:** Compliance/Enforcement, extensive outreach, review of possible exemptions, code changes
- **Next Steps:**
 - More fully evaluate the operational and administrative requirements for this work through discussion with appropriate *SFpark* personnel at the SFMTA and develop a work plan to complete initial feasibility studies.
 - Conduct initial feasibility studies as part of PBOT's Pricing for Equitable Mobility Community Task Force project or Metro's Regional Congestion Pricing Study.

Recommendation 3 – Drop-offs to Parcel Lockers.

At last count, Amazon had developed 21 storefront locations in Portland where packages are delivered to a storage locker for pickup. These are essentially Micro-hubs. With the partnership of cities throughout Germany, DHL has been able to deploy 3,000 “Packstations” or parcel locker satellite facilities within “10 minutes of 90 percent of the population”, many of whom collect their packages on foot or by bicycle. And the packages themselves are consolidated for delivery to each “Packstation”.

To further consolidate deliveries to these parcel lockers, residents could have their packages sent to their places of employment. A “pilot” project could involve encouraging employees of City of Portland agencies to have their personal deliveries sent to their places of employment where these lockers may be in place.

The City of Portland may find that their participation could lead to an expansion of satellite parcel lockers.



Drop-offs to Parcel Lockers.

- **Short Term Action**
- **Relevance to City Policy:** NA
- **Benefits:** Consolidate deliveries, reduce delivery vehicle vmt
- **Challenges:** Siting them, maintenance, providing adequate parking/circulation space adjacent to them
- **Next Steps:**
 - Develop a work plan outline and budget for conducting research into how off-site lockers have been installed at retail outlets, commercial and residential buildings, and the operational requirements and costs to develop them.
 - Reach out to possibly interested parties including the USPO, UPS, FedEx, Amazon, and others, to determine if there is interest in developing a pilot project.
 - Work with central city business groups and the PBA to determine market feasibility and need.
 - Work with Bureau of Planning and Sustainability and Development Services staff and property managers to identify regulatory impediments and building code constraints for installing locker stations and opportunity areas.

Recommendation 4 – Incentives for Emission-Free Delivery Vehicles

Similar to providing preferential parking to carpool vehicles and electric vehicles, the City of Portland could encourage the use of cargo bikes, and other emission-free vehicles (i.e., electric or other non-fossil fueled vehicles) with various incentives. There are currently 141 free electric vehicle charging stations throughout the Central City (534 in the City overall), many of which are available for public use. Many electric delivery vehicles can accomplish a day's work with one daily charge.⁷² The City could install rapid charge battery chargers for electric delivery vehicles, dedicate curb spaces for cargo bike deliveries, and possibly even assist in the purchase of emission-free vehicles (e.g., subsidies or business tax deductions). With the cost of replacing fossil-fueled fleets so high, strategic incentives might help carriers make the business case to purchase electric vehicles.



Incentives for Emission-Free Delivery Vehicles

- **Short Term Action**
- **Relevance to City Policy:** Climate Action Plan
- **Benefits:** Reduce GHG and other emissions
- **Challenges:** Cost, siting them, maintenance, meeting needs, may not be feasible for trucks/vans/cars, difficult economics for cargo bike services
- **Next Steps:**
 - PBOT staff develop Low Emission Zone options and share with stakeholders.
 - Similarly, update the work completed for PBOT's Sustainable Freight Strategy through establishment of an expert stakeholder committee.

⁷² The USPO's electric step vans can travel 85 miles between charges and their electric cargo vans can travel up to 200 miles on one charge. UPS' electric cargo bikes can go for 10-12 hours/day on one charge. There is no reliable data just yet on the distance and time an electric powered single-unit or larger truck can travel on one charge.

Recommendation 5 - Improved In-Building Management of Deliveries

In many instances the time lost between arriving at the delivery destination and completing the delivery can be very lengthy when there isn't building staff to accept package or a storage area to deliver them to. According to a study by the University of Washington Urban Freight Lab of downtown Seattle deliveries, as much as 80% of total delivery time is lost when buildings are not set up to efficiently receive and catalogue deliveries.⁷³ Requirements for providing adequate facilities could be provided in zoning code based on the number of residential units or amount of commercial square footage. Alternately, property owners could be advised about best practices in handling delivery packages through their professional associations.



Improved In-Building Management of Deliveries

- **Short Term Action**
- **Relevance to City Policy:** NA
- **Benefits:** Reduce time at curb
- **Challenges:** None
- **Next Steps:** Coordinate a meeting (or more) between PBOT, Bureau of Planning and Sustainability and Development Services staff and property managers, building owners, business representatives and others about their challenges and issues with handling package delivery volume in order to resolve problems associated with use of the right-of-way for delivery operations, and possibly develop best practices for use in development review and zoning updates.

⁷³ According to Barb Ivanov, University of Washington Urban Freight Lab, “nearly 80% of the time a delivery person is in the building is spent getting through security (12%), riding elevators to different floors and going door-to-door to tenants (67%).” 3/14/2018, <https://depts.washington.edu/sctlctr/news-events/in-the-news/nextgen-supply-chain-interview-barbara-ivanov>

Table 7. Last-mile Delivery Strategies Implemented or Being Planned

Strategy	Where it's implemented	Potential Benefits		Initial Step(s)
		<u>City</u> <i>Reduce # of delivery vehicles; and related vmt, emissions, congestion - and...</i>	<u>Industry</u> <i>Consolidation of deliveries; and related reduced operating costs - and...</i>	
1. Monitoring and analyzing use of curb – monitor usage	Seattle, Washington, DC, NYC, Houston	<ul style="list-style-type: none"> • Efficient use of curb for all users • Potential to price usage based on peak and off-peak demand 	<ul style="list-style-type: none"> • Improved curb availability • Reduced circulation time 	<ul style="list-style-type: none"> i. Establish technical team and work program ii. Convene a work group to review above findings
2. Variable pricing use of curb space	San Francisco	<ul style="list-style-type: none"> • Efficient use of curb for all users • Revenue source for trans needs 	<ul style="list-style-type: none"> • Improved curb availability • Reduced circulation time* 	<ul style="list-style-type: none"> i. Review findings from Metro Pricing Study / SF program i. Collect data – see above
3. Parcel Lockers	In Portland stores; Germany and England satellite lockers	<ul style="list-style-type: none"> • Reduce competition for curb space 	<ul style="list-style-type: none"> • Reduced travel time 	<ul style="list-style-type: none"> i. Discuss with carriers – USPO, UPS, Amazon
4. Incentives for emission-free last-mile delivery**	Rotterdam, Stockholm, Gothenburg	<ul style="list-style-type: none"> • Reduce number of fossil-fueled delivery vehicles 	<ul style="list-style-type: none"> • May defray some capital / operating costs 	<ul style="list-style-type: none"> i. Consider pilot at The Redd; or elsewhere
5. Improved Building Management of Deliveries	In Portland and elsewhere	<ul style="list-style-type: none"> • Reduce time at curb 	<ul style="list-style-type: none"> • Reduce delivery time 	<ul style="list-style-type: none"> i. Interview property owners; ii. Establish guidelines
6. Off-hours deliveries	NYC, Ports of LB/LA, Sao Paulo, Bogota, Barcelona	<ul style="list-style-type: none"> • Efficient use of curb for all users 	<ul style="list-style-type: none"> • Improved curb availability • Reduced circulation time 	<ul style="list-style-type: none"> i. Pick up where Sustainable Freight Strategy left off
7. City support of development of crowd-sourced strategies	None found	<ul style="list-style-type: none"> • Ensure access to all carriers 	<ul style="list-style-type: none"> • Operational option • Utility for all carriers 	<ul style="list-style-type: none"> i. Review “Last-mile Exchange” concept
8. Central city logistics centers	Paris, London, Amsterdam, Utrecht, Berlin, Portland	<ul style="list-style-type: none"> • Increased last-mile delivery by bicycle, foot, smaller vehicles 	<ul style="list-style-type: none"> • Operational option • Reduced travel time 	<ul style="list-style-type: none"> i. Pick up where Sustainable Freight Strategy left off
9. Direct truckers to where there's available curb space	Lisbon, Washington, DC	<ul style="list-style-type: none"> • Efficient use of curb for all users 	<ul style="list-style-type: none"> • Improved curb availability • Reduced circulation time 	<ul style="list-style-type: none"> i. Review Lisbon and Washington, DC programs
10. Increase Reqs for Off-Street Loading	Portland and elsewhere	<ul style="list-style-type: none"> • Efficient use of curb for all users 	<ul style="list-style-type: none"> • Reduced delivery time 	<ul style="list-style-type: none"> i. Review Japan and Australia program for integrating off-street facilities into new developments
11. Form-based ordinances/ codes for warehouse/ distribution centers	Albany, NY, Japan, Australia	<ul style="list-style-type: none"> • Maximize loading facility and curb usage efficiency 	<ul style="list-style-type: none"> • Reduced travel time 	<ul style="list-style-type: none"> i. Review Albany ordinance ii. Review consistency with Comp Plan

*May result in higher or lower operating costs depending on carrier's patterns

**Paris only allows emission-free delivery vehicles access to their delivery hub centers; London will charge fossil-fueled delivery vehicles to access their congestion charge zone

Longer term Recommendations (where more substantial research and possibly partnerships are necessary):

Recommendation 6 – Develop an Off-Hour Delivery Program for Central City Deliveries.

This was one of the primary recommendations in PBOT's Sustainable Freight Strategy and has achieved success in New York City where over 400 companies deliver between the hours of 7pm and 6am in the city's most congested districts. New York's program got a boost with a federal grant that allowed the City to subsidize companies up to \$1,500 for the extra expense that off-hour delivery entails. However, as those subsidies are about to expire, several companies have found that their cost savings have been so great that they plan to continue operating during off-hour periods. We have an opportunity to find carriers and shippers who are curious about whether such changes would result in decreased operating costs to volunteer in a pilot program.

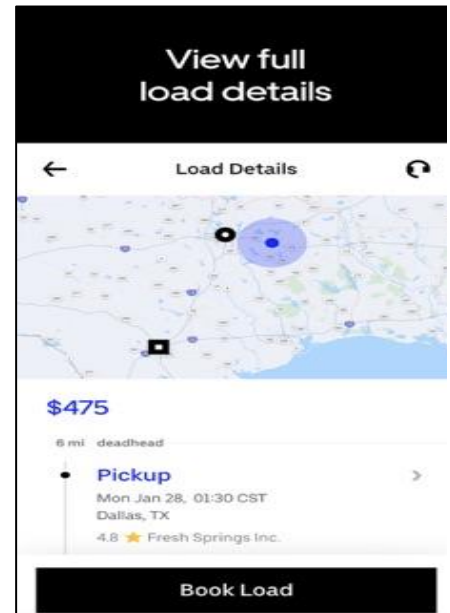


Develop an Off-Hour Delivery Program for Central City Deliveries.

- **Long Term Action**
- **Relevance to City Policy:** TSP, Climate Action Plan
- **Benefits:** Reduce peak period travel and curb usage; could be a useful operation for deliveries to parcel lockers and logistics centers
- **Challenges:** May require subsidy to offset shipper and carrier costs; may not be feasible for grocery or restaurant items which may require heat and/or cold storage, or those instances where there is no one to receive goods
- **Next Steps:**
 - Prepare a one-page description of how these programs work, including reduced operating costs for industry for review with relevant stakeholder groups such as the Portland Business Alliance, Central Eastside Industrial Council, Portland Freight Committee, Lloyd TMA, retail associations, and others.
 - Prepare a brief survey to those participants and others to gauge interest and ideas for pilot programs, etc.

Recommendation 7 – Develop a “Last-Mile Exchange” or Crowd-Sourced Strategies to Provide Delivery Options for Shippers and Carriers.

These are already in place in the private sector; most notably through [Nimber](#), [Roadie](#) and [Uber Freight](#). However, these services are for the completion of deliveries that have already been ordered and therefore don't reduce any volume during the surge periods, and more importantly, don't allow for more efficient means of delivery. If retailers and last-mile transportation providers shared data in real time, carriers could determine whether they could complete such a delivery – by combining it with other deliveries already scheduled – and what they should bid for the assignment. Those with deliveries to the same location or nearer to that location could offer a discounted price. The exchange would likely require a shared data-based system to pool package data, resource availability data, and analytics to dynamically optimize pickup and delivery routes. As with developing an off-hour delivery program, there needs to be a leader for this initiative and the City of Portland may be a good candidate for that role. However, this could be initiated as a pilot project



Develop a “Last-Mile Exchange”

- **Long Term Action**
- **Relevance to City Policy:** Smart City PDX, Climate Action Plan
- **Benefits:** Reduced vmt and emissions
- **Challenges:** Finding an organization to set up and managing the program
- **Next Steps:**
 - Organize a meeting of a small group of dispatchers from Portland area logistics providers, local carriers and small shippers to determine if there's any interest or need for a universal exchange.
 - Consider developing a pilot exchange with support from Portland State University. E.g., as a class project for students in the Supply and Logistics Management, Information Technology or Business Administration programs.

Recommendation 8 – Develop Central City Logistics Centers.

Portland has a Central City logistics center at The Redd where goods are delivered to the facility by truck and repackaged, stored, and delivered to Central City locations by cargo bike (in this case B-Line and SoupCycle). This is a highly successful operation that has grown to include food warehousing, packaging and food processing. This kind of operation could be expanded at The Redd, but also employed elsewhere throughout the Central City to increase the volume of last-mile deliveries by bicycle (i.e., bicycles can carry a maximum of 650 lbs. of cargo, while city delivery parcel vans as much as 7,500-10,000 lbs., and medium-sized trucks can carry up to 26,000 lbs.). In other words, we'd need a great many more cargo bikes to divert a large portion of cargo from trucks). The City of Paris has developed multiple urban logistics centers as part of mixed-use projects, and the City of Chicago developed one in an existing downtown multi-level parking garage. Here too, the City of Portland could develop such centers in City-owned buildings or permit them on City-owned land.



Freight Depot Central Tokyo

Develop Central City Logistics Centers

- **Long Term Action**
- **Relevance to City Policy:** NA
- **Benefits:** Consolidate deliveries that can be transferred to smaller vehicles or delivered by bike or foot, reduced vmt and curb usage
- **Challenges:** Cost and making a business case for development and ongoing management and maintenance.
- **Next Steps:** Consult EcoTrust, Prosper Portland and the Bureau of Planning and Sustainability about whether they're considering (or previously considered) other logistics centers, and develop an understanding of how to determine their feasibility., etc., for possible creation of another urban logistics center.

Recommendation 9 – Direct Trucks to Available Curb Delivery Spaces

SmartPark. This kind of program is in place in Lisbon, Portugal where Sidewalk Labs (part of the Google Alphabet group of companies) has developed the Coord platform which collects information about several mobility services as well as curb usage. The data collected is being used for navigation services, mobility service apps real-time bidding and reservations for freight loading zones. curbFlow, a mobility company that coordinates commercial operator pickup and drop-off activity to available curb space in real time, worked on a pilot project in Washington, DC where parking spaces were replaced with commercial loading zones for online food delivery service or other online delivery platforms. After registering with the program, delivery drivers used a free app to reserve space free of charge. “Ambassadors” who signed drivers up, put up cones to reserve spaces, and collected usage data in and around these zones. curbFlow is also working on similar projects in West Hollywood, CA and Columbus, OH.



The City of Portland provides information on variable message signs about the number of available parking spaces at its Downtown and Lloyd District parking garages. Washington, DC’s “ParkDC” app communicates information about available off-street and *on-street* spaces; and navigation to available loading spaces is also provided by San Francisco’s “SFpark” program.



Direct Trucks to Available Curb Delivery Spaces

- **Long Term Action**
- **Relevance to City Policy:** Parking Management Manual
- **Benefits:** Reduced vmt, travel time, and curb usage
- **Challenges:** Cost and cost recovery, removal of spaces that may be needed for parking or other uses.
- **Next Steps:**
 - Request that PBOT Parking Division staff consult with personnel working on these projects in San Francisco, Washington, DC and Seattle to understand their operating and capital requirements, etc., and conduct a preliminary initial feasibility assessment, costs, challenges, etc., of introducing these systems to Portland.
 - Consider partnering the above assessments with PBOT staff that will be involved in the Pricing for Equitable Mobility Community Task Force project or with Metro staff directing the Regional Congestion Pricing Study.

Recommendation 10 – Increase Requirements for Off-street Loading Facilities.

While providing off-street loading facilities is challenging because it dedicates such large amounts of leasable area to a non-revenue producing function, it would significantly reduce on-street congestion due to truck deliveries as well as significantly reduce the time needed to complete deliveries. In ordinance development the City can continue to seek ways to make the development of off-street loading facilities more financially feasible, and in development review City staff could continue to encourage their construction. Another strategy which has been employed in Japan and Australia is the development of off-street loading and unloading facilities that can be used by multiple buildings who then share the capital and operating costs for the facility.

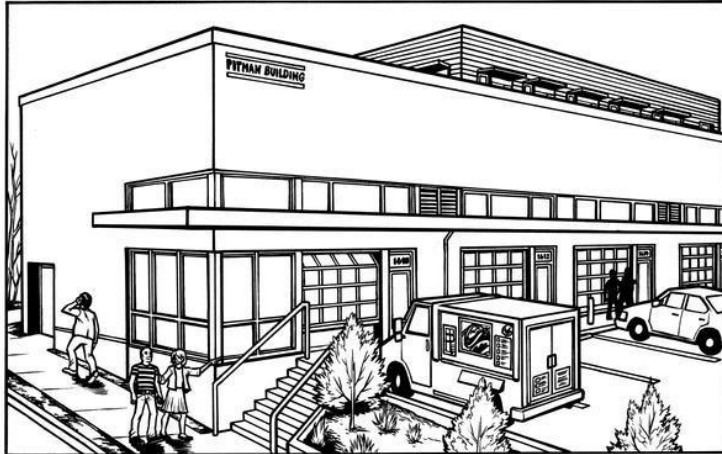


Increase Requirements for Off-street Loading Facilities

- **Long Term Action**
- **Relevance to City Policy:** Parking Management Manual
- **Benefits:** Reduced curb usage, improved safety and traffic flow
- **Challenges:** Added cost and reduced revenue to developers/property owners; also introduces a new sidewalk blockage issue
- **Next Steps:**
 - Convene staff from PBOT, Bureau of Planning and Sustainability, and Development Services to review current regulations, guidelines, etc., and outcomes for requesting off-street loading facilities.
 - Determine whether additional guidance or criteria is needed when requesting off-street loading facilities such as evaluating whether there is or isn't adequate adjacent on-street loading area, or whether there should be a threshold variable for when off-street loading should be required (e.g., 30 dwelling units or more).
 - Also, consider whether mitigation of expected delivery volume is necessary if off-street loading facilities are not being provided.

Recommendation 11 – Form-based Ordinances / Codes for Freight Facilities.

There can be a disconnect between the land use and zoning requirements for freight facilities and how those facilities function; particularly with the dynamic evolution of goods movement with e-commerce. As with other form-based codes, the City of Portland could complete due diligence of warehouse and distribution developments including reviews with the adjacent communities which could reduce the time for public review and allow the City to get in return the kinds of facilities that could reduce delivery traffic. This may be very meaningful in rapidly evolving areas like the Central Eastside and Northwest districts where industry, office, retail and residential uses mix.



Form-based Ordinances / Codes for Freight Facilities

- **Long Term Action**
- **Relevance to City Policy:**
- **Benefits:** Accelerates permit approvals, addresses neighborhood needs, and can reduce vmt and emissions
- **Challenges:** Requires code rewrite and official review and approval processes; will only be effective with each new development?
- **Next Steps:**
 - Convene staff from PBOT and Bureau of Planning and Sustainability to review whether current regulations, guidelines, etc., address the increased level of delivery traffic.
 - If it is determined that the current regulations are inadequate, begin the analyses and steps necessary for code and ordinance development.



VIII. Conclusions

As with other successful consumer driven businesses, e-commerce is generating activity throughout the City of Portland's economy, including increased development (and redevelopment) of industrial properties, growing warehousing and distribution jobs, and likely, added traffic volume. We don't yet have an accurate grasp about how much vehicular traffic is being generated by e-commerce deliveries, whether or not it's causing traffic delays or safety conflicts, and whether deliveries could be accomplished in a more efficient manner, including through drop-off locations in business districts, use of non-polluting vehicles, dedicated delivery zones, off-hours deliveries, etc.

Some cities are collecting data and completing analyses to find methods for accommodating delivery traffic. For example, New York City's off-hours delivery program was established after a rigorous and comprehensive data collection effort found that peak hour deliveries took 150% to 180% longer than deliveries during off peak periods (i.e., 7am-6pm period). The City of Seattle in partnership with the University of Washington's Urban Freight Laboratory will be installing sensors in curb spaces throughout the downtown to measure and monitor curb usage by all vehicle types in order to develop solutions that efficiently accommodate delivery and other vehicles.

Other cities are testing and/or developing solutions such as Washington, DC with its robot delivery pilot program which may reduce the number of delivery vehicles in the roadway and at the curb. The City of Seattle requires that any on-street delivery spaces that are removed for parking, or bus and bicycle lanes must be replaced at an adjacent location. And the City of Chicago an urban logistics center has been created in a floor of one of its downtown municipal parking garages.

There are also numerous examples where industry has developed and implemented solutions for last-mile deliveries including those generated by e-commerce. In Portland, B-Line has established a warehouse/distribution center at The Redd in the Central Eastside where trucks drop off packages for delivery by B-Line cargo bikes. UPS is experimenting with cargo bikes to complete urban deliveries throughout the U.S. (including a proposal to Portland), and Amazon has installed neighborhood lockers in multiple grocery and convenience stores as well as at staffed storefronts where packages can also be received and returned.

Interestingly, shippers, carriers and the City of Portland have common goals when it comes to e-commerce. They all want the business to succeed and they all want to have the most efficient operations. For industry that means to reduce the added labor and fuel consumption costs associated with traffic congestion and extended circulation seeking available curb delivery space. For the City of Portland, it means reduced carbon emissions from fossil-fueled delivery vehicles.

These goals could be met in part or in whole incrementally over time without any actions by the City of Portland, but given City policies and deadlines for meeting mobility, safety, and climate goals, it may be appropriate and the right time for the groups to begin to collaborate on projects and programs that may accelerate accomplishment of these goals.

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Appendices

Freight Master Plan Update: E-Commerce and Emerging
Logistics Technology Research Report

Technical Memorandum No. 1
Expected Growth in E-Commerce Delivery

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Preface

The City of Portland's Bureau of Transportation is interested in understanding how e-commerce retail sales, and in particular, the delivery of retail products via e-commerce methods to residences, is changing freight demand and the handling, storage, packaging, logistics and delivery traffic that accompany it. The exceptionally high growth of e-commerce retail sales since the first recorded e-commerce transaction (of a Sting CD) in 1994 and the associated demand for quick delivery and hassle-free returns has dramatically changed logistics strategies, speeded construction of close-in fulfillment centers and warehouses, and created innovations in who makes final deliveries and when and where those deliveries occur.

To many, delivery of e-commerce products is synonymous with new technologies that are highly efficient and environmentally sustainable and may result in fewer large trucks on the road. To others, it's simply growth in traffic from a wider variety of vehicles delivering packages.

There are questions about whether e-commerce deliveries have implications on streets that may already be congested, on residential streets where they may bring unwanted traffic, and to and from distribution centers and industrial areas. Moreover, do these changes warrant corresponding adjustments to the functional classification and design of some City streets, including on-street loading and parking spaces.

Business-to-business e-commerce has been in place for a longer period of time than e-commerce transactions between businesses and consumers, and much of their logistics were in place when the Portland Freight Master Plan was adopted in 2006. One new and important phenomenon since the 2006 Plan has been the rapidly changing trends associated with business-to-consumer e-commerce of retail products.

The City of Portland is now seeking to gain an understanding of the changes to supply chains and delivery patterns resulting from the on-demand economy in order to know how they may affect traffic conditions, use of on-street loading areas, and changing uses of commercial buildings and land. While e-commerce industries develop fulfillment centers and distribution facilities, and last-mile carriers create new logistics and operating strategies to handle the demands, cities must ensure these economic transitions occur smoothly.

This memorandum is a first step toward examination of this very dynamic and wide-ranging topic. It focuses on the types of deliveries being made, how they're being accomplished, their future growth, and provides profiles of some e-commerce sectors. As readers will note, the memorandum not only touches on transportation effects, but the accompanying new distribution centers and logistics management practices that allow them to conduct deliveries so quickly and at a relative low cost.

Some of the major findings of this research include:

- *Nearly 70% of all Americans have made on-line purchases.*
 - *On-line purchases represent 44% of total retail sales, with on-line sales of many products exceeding sales made of those same products at stores.*
 - *Between 2010 and 2017, e-commerce retail sales grew by 175% while total retail sales grew by 29% during the same period. Amazon transacts 49% of all e-commerce sales.*
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- *To accomplish this increase in deliveries, the three largest carriers – USPS, UPS and FedEx - began delivering on weekends and during late evening hours, and significantly increased their vehicle fleets.*
 - *Many e-tailers offer same day delivery with minimum purchase amount, and some even provide delivery within one or two hours.*
 - *Meeting these demands has led to the development of close-in “fulfillment centers” such as the two Amazon Fulfillment and Distribution Centers in the Portland region built in the past year.*
 - *In addition, cargobikes, delivery crowd-sourcing, shared mobility and use of transportation network companies are all now commonplace in Portland.*
 - *The number of local delivery service providers is growing, and future delivery methods will likely include autonomous vehicles, drones, and robots.*

In addition to this review, the Portland Bureau of Planning and Sustainability and the Portland Bureau of Transportation are assessing how warehouses, distribution centers and like facilities are adapting to the demand for e-commerce products. There has been a significant increase in these developments including the three regional Amazon facilities (in Troutdale, Rivergate and Hillsboro), and a large number of other logistics warehouses located nearer to population centers in order to meet the requirements that many consumers have for rapid delivery.

Together these efforts are supporting the incremental update of the Portland Freight Master Plan.

Other documents being completed for the E-Commerce and Emerging Logistics Technology Research Project are:

- *Technical Memorandum No. 2 – Summary of Interviews with Freight Service Providers*
- *Final Summary Report*

This study is funded by the City of Portland.

Background

E-commerce, or electronic commerce, is the buying or selling of goods and services over an electronic network, primarily the internet. While e-commerce transactions occur between businesses, from businesses to consumers, and from consumers to consumers, it is most commonly associated with online shopping of retail products (i.e., the specific subject of this memorandum), primarily clothing/apparel, consumer electronics/technology, and beauty products. These transactions are growing at a very significant rate which has led to reduced in-store sales, and in some instances even displacement of brick-and-mortar stores⁷⁴.

Shopping online is very convenient and provides nearly the entire assortment of goods that can be purchased in stores. It also allows consumers to research similar products from other vendors with different price structures, and typically simplifies any returns of ordered products (which can run as high as 30% of all purchases)⁷⁵

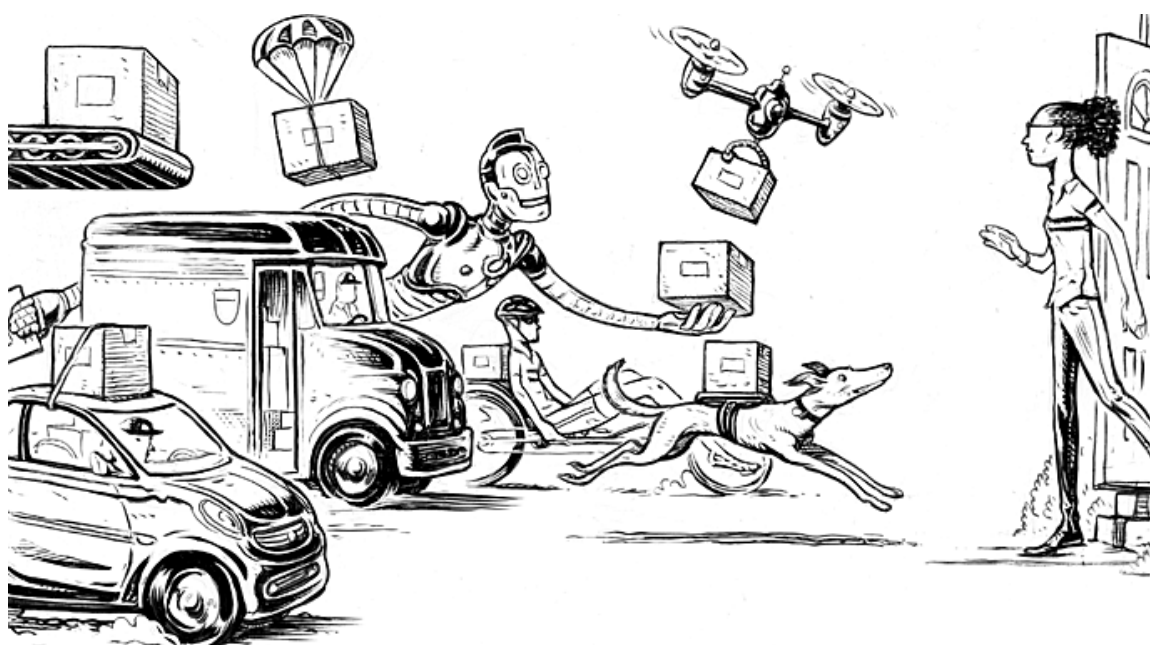


Illustration by Lars Leetaru. Courtesy of strategic + business magazine

One of the more remarkable phenomena about e-commerce is how shippers and carriers are responding to consumer demand for fast delivery (within a day in many instances) of specialized products without paying extra for shipping. This means that shippers must provide faster service at lower cost. (In fact, Amazon Prime subscribers in Portland – the service is not yet universally available – can now get free two-hour delivery on more than 25,000 items or within an hour for an additional \$7.99.⁷⁶)

⁷⁴ In most instances, retailers use on-line and brick-and-mortar stores interchangeably, as they provide multiple options for customers to shop, compare and purchase.

⁷⁵ *Riding the Returns Wave: Reverse Logistics and the U.S. Postal Service*, Office of the Inspector General of the US Post Office, Report Number RARC-WP-18-008, April 30, 2018 <https://www.uspsaig.gov/sites/default/files/document-library-files/2018/RARC-WP-18-008.pdf>

⁷⁶ Prime Now, <https://primenow.amazon.com/>

The ability of businesses to meet these demands starts with their distribution centers (also called “Fulfillment Centers”) which provide warehousing, handling, packaging and delivery logistics, and are now being developed nearer to consumer demand. Deliveries are being achieved by a larger fleet of U.S. Postal Service (USPS), UPS and FedEx light and medium trucks with expanded hours of operation to homes and businesses as well as to neighborhood mailbox facilities. Further, in the case of the “Amazon Key” service, directly to your doorstep and inside your home via a smart lock fitted to a customer’s door.

In addition, shippers utilize shared use mobility systems similar to Uber and Lyft where registered drivers in passenger cars or a company’s employees can be contacted about their ability to make a delivery. In many instances, individuals with cars are competing against trucking companies. Other innovations include systems created by [Nimber](#) and [Roadie](#) which put drivers in touch with companies to conduct deliveries when they have available capacity and/ or have a similar origin and/or destination as the cargo in their truck.

While many of these strategies have increased the productivity of carrier fleets, there is a shortage of truck drivers for all of these deliveries. This has led many industry experts to predict that there will be a significant increase in the use of bicycles and tricycles (motorized and non-motorized) for local deliveries, and that in the next few years deliveries will be made by autonomous vehicles, robots, and even drones.

As our abilities to make purchases electronically become even more accessible through smartphone and other internet connectivity, we will likely see continued high growth rates in e-commerce sales and their corresponding delivery traffic. It’s important to note, however, that most shopping still takes place in retail stores.

In many ways e-commerce delivery doesn’t differ much from conventional parcel or retail product delivery. They both use the same types of vehicles and vendors for deliveries. What is different is that e-commerce often involves same day, or one- or two-day delivery of a very wide assortment of items, which has required the construction of fulfillment centers and new warehouses within or on the edges of the urban areas, which has provided more stress to the last-mile delivery and supply chains.

In addition, deliveries of retail products to stores is based on an order of items that the store expects to sell and are delivered at either prescribed times or otherwise when the retailer can receive the goods. Their supply chains and schedules are predictable. In contrast, delivery of e-commerce retail items is based on the individual customer’s order requirements, and is accordingly, highly unpredictable.

In comparison to the freight that’s typically carried on our highways, railroads, river and pipeline systems (such as, heavy bulk products, containers, and heavy equipment), e-commerce deliveries of retail products is a relatively minor percentage of the freight moved in the Portland region. In the Central City and in some of our other dense neighborhoods, however, the vehicles completing e-commerce deliveries are smaller, more efficient, and generally less disruptive to local traffic operations than the truck fleets of the past. Their volume and unique characteristics may require that we examine our street design, regulations and future plans for accommodating deliveries.

Table 1 below illustrates the various logistics supply chains utilized for different business models.

Table 1. Logistics Strategies Utilized by Different Business Models

Segment	Business Model	Carriers	Customer
Business-to-Business	Logistics Service Providers	Freight forwarders, 3rd and 4th party logistics service providers	Manufacturers, wholesalers, and retailers
	Carriers	Trucking, rail, sea, and air freight companies	Logistics Service Providers
	Courier/Express/Parcel	Courier/Express/Parcel companies	Retailers, manufacturers, and retailers
Business-to-Consumer	Courier/Express/Parcel	Courier/Express/Parcel companies	Private consumers

The U.S. Postal Service's operations is a component of both business models, and customer-to-customer transactions such as those completed through eBay may also utilize these same strategies

Growth in E-Commerce

According to an article in the New York Times, the first official e-commerce transaction occurred on August 12, 1994:

“At noon yesterday, Phil Brandenberger of Philadelphia went shopping for a compact audio disk, paid for it with his credit card and made history.

“Moments later, the champagne corks were popping in a small two-story frame house in Nashua, N.H. There, a team of young cyberspace entrepreneurs celebrated what was apparently the first retail transaction on the Internet using a readily available version of powerful data encryption software designed to guarantee privacy.

“Experts have long seen such iron-clad security as a necessary first step before commercial transactions can become common on the Internet, the global computer network.

“From his workstation in Philadelphia, Mr. Brandenberger logged onto the computer in Nashua, and used a secret code to send his Visa credit card number to pay \$12.48, plus shipping costs, for the compact disk “Ten Summoners' Tales” by the rock musician Sting.

““Even if the N.S.A. was listening in, they couldn't get his credit card number,” said Daniel M. Kohn, the 21-year-old chief executive of the Net Market Company of Nashua, N.H., a new venture that is the equivalent of a shopping mall in cyberspace. Mr. Kohn was referring to the National Security Agency, the arm of the Pentagon that develops and breaks the complex algorithms that are used to keep the most secret electronic secrets secret.”⁷⁷

Since that remarkable event, e-commerce sales have become a significant percentage of total retail sales. The global e-commerce market for all goods surpassed \$2 trillion in 2017 and is expected to nearly double by 2021⁷⁸. Business-to-business sales have represented a larger share of e-commerce but that share is expected to decline by 50% — \$1.1 trillion⁷⁹ — by 2020 as retail business-to-consumer e-commerce grows.

⁷⁷ *Attention Shoppers: Internet is Open*, Peter Lewis, New York Times, 8/12/1994, <https://www.nytimes.com/1994/08/12/business/attention-shoppers-internet-is-open.html>

⁷⁸ *Retail e-commerce sales worldwide amounted to \$2.3 trillion in 2017 and are projected to grow to \$4.88 trillion by 2021*. statista, 2018, <https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/>

⁷⁹ *US B2B eCommerce To Reach \$1.1 Trillion By 2020*, Andy Hoar, Apr 2, 2015 Forrester, https://go.forrester.com/blogs/15-04-02-us_b2b_ecommerce_to_reach_11_trillion_by_2020/

In Oregon, retail represented approximately 10% of the state's total Gross Domestic Product (GDP) in 2017, and e-commerce retail employment is just 11% of total retail employment in the Portland metro region⁸⁰.

According to recent data compiled for the National Household Transportation Survey, the average number of monthly online deliveries made per household more than doubled from 2.4 in 2009 to 4.9 in 2017⁸¹. Looked at another way, according to a March 2018 survey by Periscope, nearly 70% of all Americans have made online purchases, which was consistent among all age groups, but highest in the 18-29 years old cohort (with 66% stating that they "only" or "mostly" shop on-line) and lowest in the 60-69 years old cohort (with 20% stating that they "only" or "mostly" shop on-line)⁸². The U.S. Department of Commerce which tracks retail sales reported that e-commerce retail sales grew from \$165 billion in 2010 to \$452 billion in 2017, a 175% increase, while total retail sales grew by 29% during the same period.⁸³ E-commerce now represents about 10% of all retail sales revenue in the U.S. To place this in context, the number of e-commerce packages delivered annually in the U.S. was estimated at 11 billion⁸⁴. Another way to appreciate this volume is that if 11 billion standard-sized books (a common e-commerce purchase) were placed end-to-end they would circle the earth 84 times.

The effect of this phenomenal growth of deliveries has resulted in changes to motor carrier and local pickup and delivery operations. According to the American Transportation Research Institute, the average length of a typical truck box trailer (the most common truck cargo) has decreased by 296 miles, or 37%, between 2000 and 2018⁸⁵. Despite the reduced mileage of an average haul, truck vehicle miles of travel (vmt), particularly in urban areas, has increased by 17.7% between 2011 and 2016⁸⁶; primarily due to the significant growth in short-haul and last-mile trips. Moreover, employment grew by 85,000 new employees at courier and messenger services establishments between 2007 and 2017⁸⁷, and single-unit truck registrations grew by 7.8% while combination truck registrations grew by just 4.4% during the same period⁸⁸.

Amazon's role in this transformation cannot be overstated. The company accounted for 5% of all retail sales in the U.S. in 2017 and as shown in Table 2 was responsible for 49% of all online retail sales in 2017⁸⁹, up from 44% in 2016.

⁸⁰ *Retail and E-Commerce (Graph of the Week)*, Josh Lehner, Oregon Employment Department, March 16, 2018, <https://oregoneconomicanalysis.com/2018/03/16/retail-and-e-commerce-graph-of-the-week/>

⁸¹ *National Household Travel Survey (NHTS)*, Federal Highway Administration, Washington, DC 2019, <https://www.fhwa.dot.gov/policyinformation/nhts.cfm>

⁸² *CPG Goes Omnichannel Shoppers Grasp the Digital Opportunity*, Periscope by McKenzie, March 2018, <https://www.periscope-solutions.com/download.aspx?fileID=3456>

⁸³ *Estimated Quarterly U.S. Retail Sales: Total and E-commerce*, U.S. Department of Commerce, <https://www2.census.gov/retail/releases/historical/ecommm/17q4.pdf>

⁸⁴ *The Rise of the Last-Mile Exchange*, Tim Laseter, Andrew Tipping, and Fred Duiven, strategy+business magazine, July 2018, <https://www.strategy-business.com/article/The-Rise-of-the-Last-Mile-Exchange?gko=7cf43>

⁸⁵ *E-Commerce Impacts on the Trucking Industry*, American Transportation Research Institute, page 21, February 2019, <https://truckingresearch.org/wp-content/uploads/2019/02/ATRI-Impacts-of-E-Commerce-on-Trucking-02-2019.pdf>

⁸⁶ *Ibid*, page 22

⁸⁷ *Ibid*, page 23

⁸⁸ *Ibid*, page 24

⁸⁹ *Amazon's Share of U.S. E-Commerce is now 49% or 5% of Retail Sales*, Ingrid Lunden, Tech Crunch magazine July 2018, <https://techcrunch.com/2018/07/13/amazons-share-of-the-us-e-commerce-market-is-now-49-or-5-of-all-retail-spend/>

*Table 2. Top 10 U.S.
E-commerce Companies*

	% of E-Commerce Sales in U.S. 2017
Amazon	49.1%
eBay	6.6%
Apple	3.9%
Walmart	3.7%
Home Depot	1.5%
Best Buy	1.3%
QVC Group	1.2%
Macys	1.2%
Costco	1.2%
Wayfair	1.1%

Source: emarketer, July 2018



Amazon Key incorporates a smart lock fitted to a customer's door, and a security camera to record the movements of the delivery person.

There aren't any reliable estimates for how many deliveries the reported growth in sales is generating in Portland - or any other city or region for that matter - and no field surveys of these activities were made for this project. From the explosion in local fulfillment center construction (which is intended to serve local area demands) and the number of new delivery bays they incorporate, we can surmise that delivery traffic is growing. Other data sources were consulted, such as the [Portland Region Commodity Flow Forecast](#), origin-destination data collected by ODOT Region 1, and the vehicle classification data collected by ODOT's numerous permanent traffic recorder machines in the Portland region. None of those data sources provide specific enough information about truck types that could be correlated to the range of smaller delivery trucks used in e-commerce, and the Commodity Flow Forecast only reports on generalized commodity types (e.g., the closest category in the forecast for say books are "Newsprint/paper", "Paper articles", and "Printed products", which cover a much larger group of commodities than books).

Also considered was whether there was any increase in the number of vehicles typically used to deliver packages to homes and businesses. For example, in 2018:

- The USPS has 215,000 mail trucks in operation in the U.S.⁹⁰
- UPS international utilizes about 119,000 package cars, vans, tractors, motorcycles⁹¹
- FedEx has "185,000 motorized vehicles"⁹²

Information about the number of e-commerce deliveries to residences, or the types and number of vehicles used for these deliveries in the Portland area was considered proprietary by UPS and FedEx, and unavailable by the USPS.

⁹⁰ *Postal Facts - U.S. Postal Service*, 2019 <https://facts.usps.com/>

⁹¹ *About United Parcel Service Co.* 9/2018, <http://www.vault.com/company-profiles/airlines/united-parcel-service-co/company-overview.aspx>

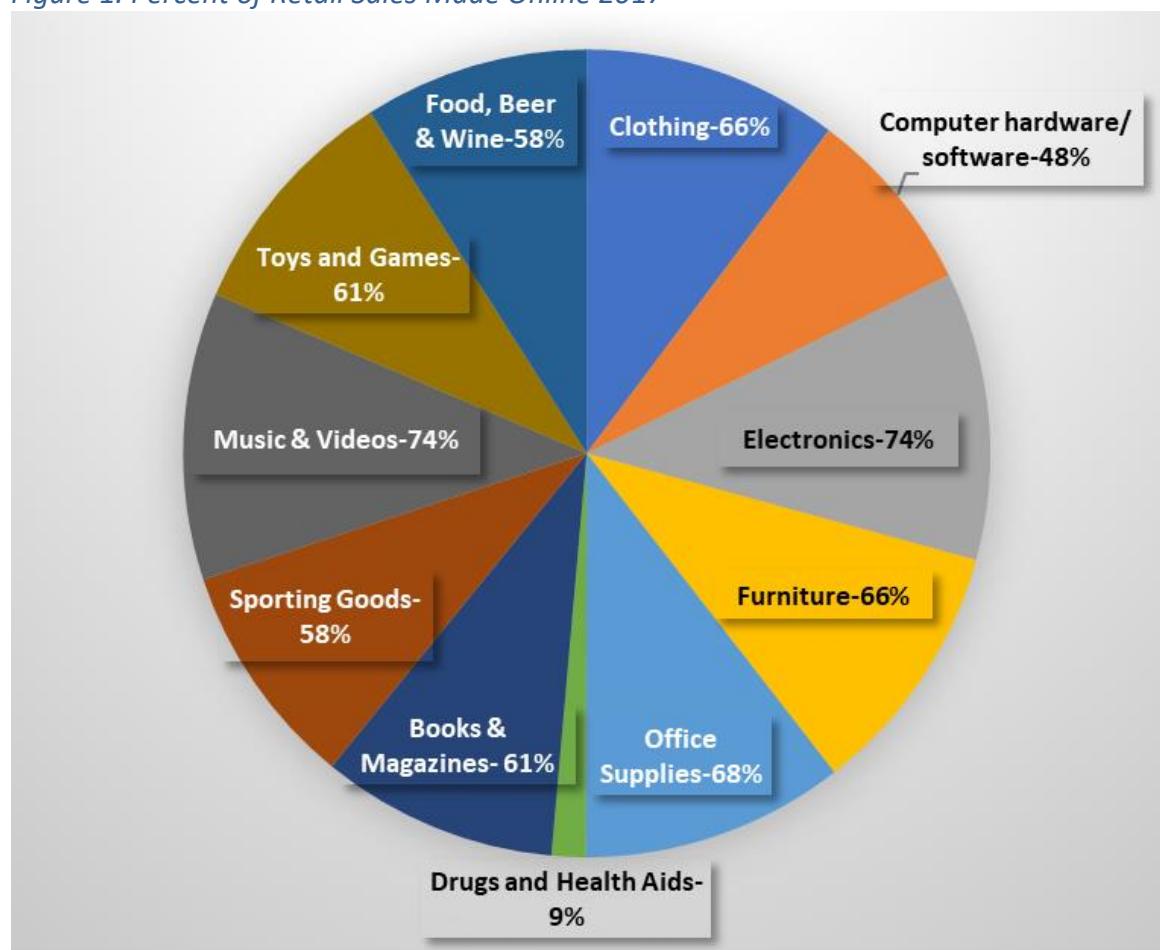
⁹² *About FedEx Express Fact Sheet*, 2/28/2019, <https://about.van.fedex.com/our-story/company-structure/express-fact-sheet/>

Which Products are Being Purchased Online?

Retail consumers are primarily purchasing clothing, electronics, computer equipment, and furniture online, which hasn't fluctuated in the past five years. As shown in Figure 1 and Table 3, of the major retail products being purchased online, most exceed the sales generated at stores.⁹³

Delivery of groceries and other food items via e-commerce is growing at a very significant rate (the offering to consumers is so new that there isn't reliable data to document the phenomenon). These deliveries are truly revolutionary in that it involves perishable, short-lived items that require refrigeration (and an expected demand for a 20% increase in refrigerated warehouse space⁹⁴) has led to an entirely new set of equipment, facilities, and delivery mechanisms. Sparked by the on-line restaurant deliver service [Grubhub](#) and Amazon's purchase of Whole Foods and their delivery service to Amazon Prime members, grocery and restaurant delivery have become commonplace overnight.

Figure 1. Percent of Retail Sales Made Online 2017



Source: U.S. Department of Commerce

⁹³ *Consumers Are Changing E-Commerce Preferences*, Material, Handling and Logistics News, September 13, 2018

<https://www.mhlnews.com/technology-automation/consumers-are-changing-e-commerce-preferences>

⁹⁴ *Millennials, Ecommerce Cause Cold Storage Business to Surge*, by Nelie Day, Western Real Estate Business. Page 1, July 2018, <https://westernrealestatebusiness.epubxp.com/i/1001516-jul-2018/30>

		Sales (in billions\$)		
		Online	Store	% Online
1	Clothing	\$13.6	\$7.0	65.9%
2	Computer hardware/software	\$11.1	\$11.9	48.1%
3	Electronics	\$8.4	\$2.9	74.1%
4	Furniture	\$7.8	\$4.1	65.8%
5	Office Supplies	\$5.7	\$2.7	67.8%
6	Drugs and health aids	\$4.8	\$50.0	8.8%
7	Books and Magazines	\$4.2	\$2.7	61.0%
8	Sporting Goods	\$3.0	\$2.2	58.2%
9	Music and Videos	\$2.8	\$1.0	74.0%
10	Toys and Games	\$2.7	\$1.7	61.4%
11	Food, Beer and Wine	\$2.3	\$1.7	57.9%
12	Other merchandise	\$12.5	\$16.5	43.2%
13	Non-merchandise	\$6.8	\$3.6	65.5%
		\$85.7	\$108.0	44.2%

Consumers' Shipping Requirements are Changing

[illegible]

According to the annual eCommerce study conducted by 3PL provider Dotcom Distribution:⁹⁵

- 90% of those surveyed “highly value free returns when making online purchases; 91% say free shipping influences future purchases. Giveaways also positively influence consumers’ future purchases. These factors outranked faster delivery times.”
- “62% would buy again from a brand offering free returns/exchanges”
- “67% are likely to add items to cart to receive free shipping”

Interestingly, consumers stated that free shipping and on-time delivery is more important than faster shipping:

- “Only 25% of 2018 respondents would pay extra for faster shipping — in sharp contrast to the 47% who’d have paid up to \$9 more for faster delivery in 2016”
- “93% are greatly or somewhat impacted by shipping cost”
- “77% said delayed order arrival would influence future purchase decisions with a retailer”

Finally, age is an indicator of delivery preferences. For example, younger consumers value convenience and faster delivery, while older buyers are more likely to seek low-cost or free shipping, and free returns.

- “Gen Z” (individuals born between the mid-1990s and mid-2000s): 36% named same-day delivery a top influence in future purchase decisions — highest of all groups; 87% are more likely to make online purchases if they can return in-store; 75% are more likely to purchase from retailer again if online order came with free giveaway”
- “Millennials” (those born between 1982 and 2001): 76% would add items to online carts to qualify for free shipping; 36% prefer buying online — both highest of all groups; 79% are less likely to buy from e-tailer (i.e., an e-commerce retailer) again if delivery is delayed; 60% are more likely to purchase from e-tailer again if online order came with free giveaway”
- “Baby Boomers” (born between 1946 and 1965): <1% expect one-day delivery — lowest of all groups; 95% of purchase decisions are “somewhat” or “greatly” influenced by shipping costs — highest of all groups”

Another study found that the “Gen X” (individuals born between 1966 and 1992) age group made more online purchases in 2016 than any other group, with an average of 18.6 purchases across the world⁹⁶.

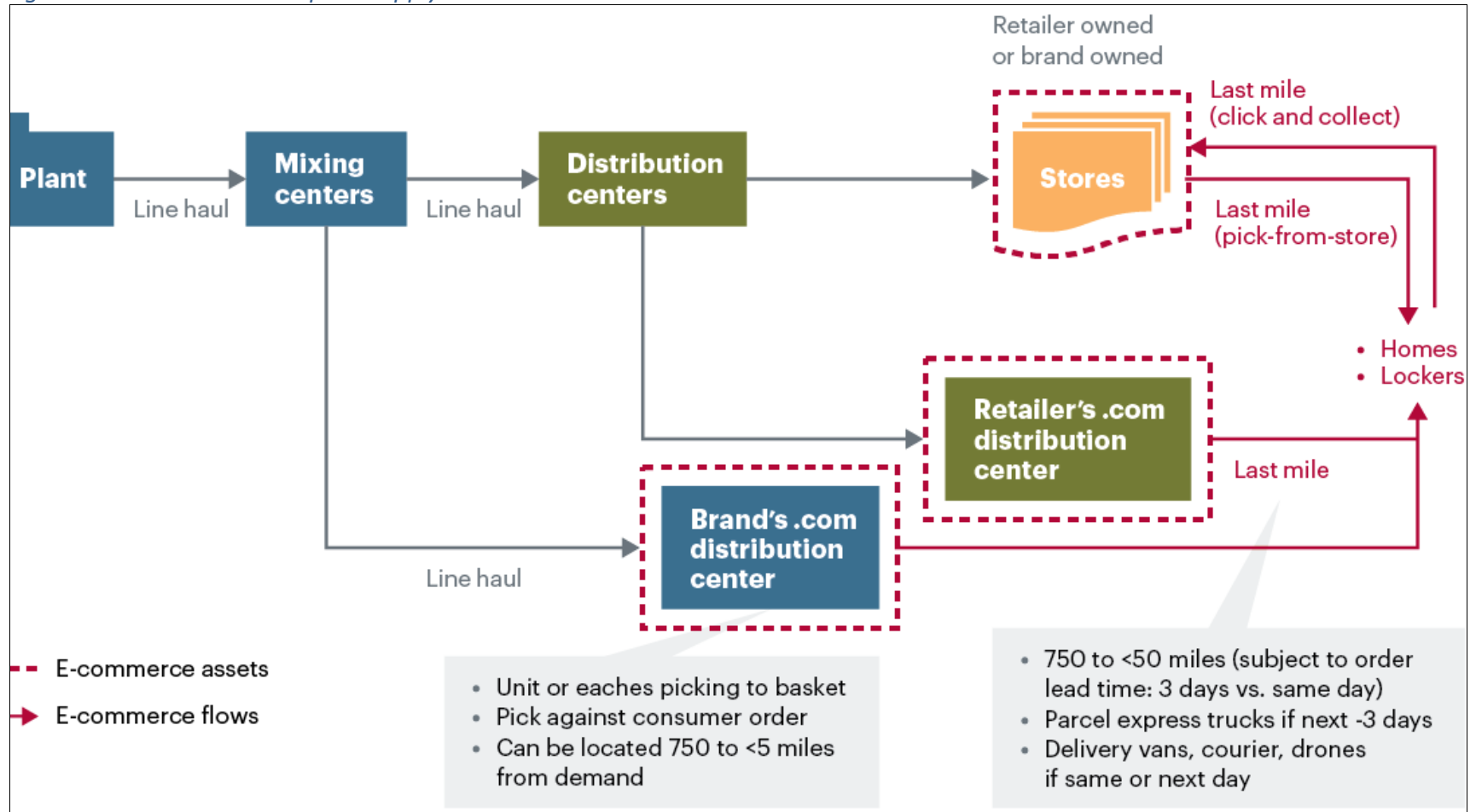
Methods used to Deliver E-commerce Goods

In fact, meeting these customer preferences has altered our traditional supply chains from creating inventories in warehouses and shipping to physical stores to “pulling” purchases to their ultimate desired location including homes, nearby stores, lockers, or other convenient locations (see Figure 2). The ability to meet these requirements – fast delivery with free shipping - has required a significant investment in new facilities (“Fulfillment Centers”) that are nearer to consumers, logistics strategies that consolidate and increase the number of deliveries to smaller geographic areas, and a wider range and number of carriers.

⁹⁵ *Consumers Are Changing E-Commerce Preferences*, Material, Handling and Logistics News, September 13, 2018
<https://www.mhlnews.com/technology-automation/consumers-are-changing-e-commerce-preferences>

⁹⁶ *The truth about online consumers: 2017 Global Online Consumer Report*, KPMG International, 2017,
<file:///C:/Projects/ECommerce%20for%20PBOT/TM%201/the-truth-about-online-consumers.pdf>

Figure 2. The E-commerce “pull” Supply Chain



Source: A.T. Kearney analytics



Inside a typical Amazon Fulfillment Center

Fulfillment Centers. In contrast to warehouses which store inventory in bulk on a long-term basis in generally ex-urban areas, fulfillment centers are located at the edge of urban areas – and in some instances in the middle of central business districts - and stock a wide range of finished goods for short periods of time. This enables same day or next day delivery – including handling, packaging, and labeling the shipment and delivering it directly to the customer. In addition to these outsourced functions, fulfillment centers are also charged with inventory management, negotiating rates with carriers, and managing returns. They act as the middleman for all activities that occur between the manufacturer and the customer.

Fulfillment centers are larger than the warehouses of the past. Their ceiling heights have risen from yesterday's 24- to 26-foot ceiling height to the 36- to 40-foot range⁹⁷ because new robotics have enabled picking and placing packages within just a few feet of clearance from ceilings. They require a great deal of space for storage racks, conveyors, and other sophisticated equipment to quickly break down bulk shipments and prepare goods for distribution. Fulfillment center properties need to accommodate scores of truck bays and large truck turning radii as well as ample parking areas for the large numbers of employees.

The Amazon Fulfillment Center in Troutdale, which is a robotics multi-floor (4 floors) facility, sits on 51 acres, contains 2.24 million square feet, 64 truck bays, 276 truck trailer parking spaces, and its 1,500 employees have 2,500 parking spaces and 40 bicycle spaces⁹⁸.

The Amazon regional distribution facility in Rivergate, scheduled to open in early 2019, contains 880,000 square feet, approximately 1,000 parking spaces, and will employ 1,000 individuals⁹⁹.

⁹⁷ *Five Things You Need To Know About Industrial Real Estate*, by Champaign Williams, Forbes Magazine, 4/25/2017, <https://www.forbes.com/sites/bisnow/2017/04/25/5-things-you-need-to-know-about-industrial-real-estate/#599cff141c5e>

⁹⁸ Site Plans for "Project Piper Warehouse", produced for City of Troutdale, OR by Langan International LLC, 9/17/2018

⁹⁹ Ibid.

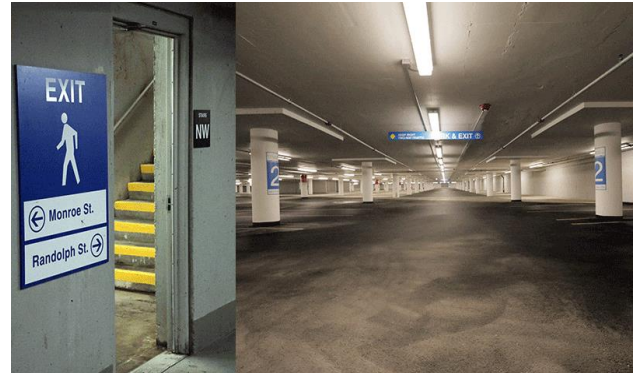


Amazon Fulfillment Center in Troutdale opened in October 2018



Amazon Regional Distribution Center in Rivergate will employ approximately 1,000 when it opens in early 2019

Where industrial land to construct these centers is unavailable some developers have repurposed older industrial buildings, and some are considering using dying shopping malls. Under construction in Chicago is the Millennium Chicago last-mile facility which is a conversion from a portion of a city-owned underground parking garage located at Michigan Avenue and Randolph Street in the city's central business district and within 15-minutes of nearly 230,000 residents.



Courtesy of JLL Millennium Chicago

In Seattle where industrial space is very limited, [Prologis](#) is building a three-story, 590,000-square-foot fulfillment center¹⁰⁰, the first multistory warehouse in the United States, though they are commonplace in other countries. The facility will be able to accommodate both e-commerce and smaller light-industrial tenants and is in the mixed-use South Seattle neighborhood.



Rendering of ProLogis Georgetown Crossroads, Seattle

Logistics Management Strategies. Delivering merchandise in the last-mile portion of the trip in a cost-effective manner has been a challenge for e-commerce vendors since its inception. The fundamental economics continue to be dependent on 1) route density — how many packages can be delivered on a given delivery run; and, 2) concentrated package volume — how many packages or items are delivered at

¹⁰⁰ Brochure - Prologis Georgetown Crossroads 6050 East Marginal Way South Seattle, WA
<https://www.prologis.com/industrial-logistics-warehouse-space/united-states/seattle/prologis-georgetown-crossroads>

each stop. As package volume has grown, carriers have been able to increase the number of deliveries per stop and/or per mile, although these efficiencies cannot always be guaranteed.

Fulfillment Centers are hyper-connected facilities utilizing artificial intelligence in the form of new software, automated guided vehicles, and robotics. These are essential for the interdependent processes of managing inventory, sorting and inspecting packages, operating equipment, predicting pricing, monitoring delivery schedules, communicating shipping schedule, and other means of streamlining operations. With these technologies and equipment in place, logistics managers can quickly make and execute decisions.

On the road, logistics managers who dispatch their own fleets strive to combine a variety of packages with similar locations into each delivery. For example, Amazon is leveraging its acquisition of Whole Foods to combine grocery with other e-commerce package offerings in order to increase route density. This year, [Walmart](#) is completing the construction of “pickup towers” at 500 of its U.S. stores to concentrate demand into a single delivery point¹⁰¹. In Germany, DHL has 3,000 “[Packstations](#)” which they claim are within 10 minutes of about 90 percent of the German population¹⁰².

As discussed in the next section, the entire range of vehicle assets (including trucks, vans, passenger cars, taxis, and bicycles) are contracted to complete last-mile deliveries as well. Some carriers may be under contract to provide on-call delivery according to a contract or on a per trip basis. Crowdsourcing (or “crowd shipping”) and shared mobility strategies are also a commonly used means of scheduling deliveries (Table 4 presents a sample of crowdsourcing delivery systems in operation in Portland). Much like transportation network company apps used by Uber and Lyft, conventional trucking companies as well as other registered delivery services or individuals can be contacted about their ability to make a delivery. Company employees are also used for these purposes, and there are systems such as those created by Nimber and Roadie which put drivers in touch with companies to conduct deliveries when they have available capacity in their trucks and / or have a similar origin and/or destination as the cargo in their truck.

Table 4. Shared-Use Mobility Firms in the Express and Parcel Delivery Business Operating in Portland

	Start Year	Company Fee	Modes: Package Size	Insurance	Operation
Nimber	2016	20%	Walk, bike, car or van	Up to 500 pounds	Price negotiated between deliverers and users. “On-the-way”
Rickshaw	2013	From \$5.50	Package delivery		Broker. Cooperate with carriers
Roadie	2015		Up to pick-up truck or 500 lb.	\$500 free, up to \$10,000	Price negotiated between deliverers and users. Price set based on mileage and package size

*This is a selected list and is current as of 11/2018. This industry has been lately generating many start-ups, many of which are unable to stay in business for the long-term.

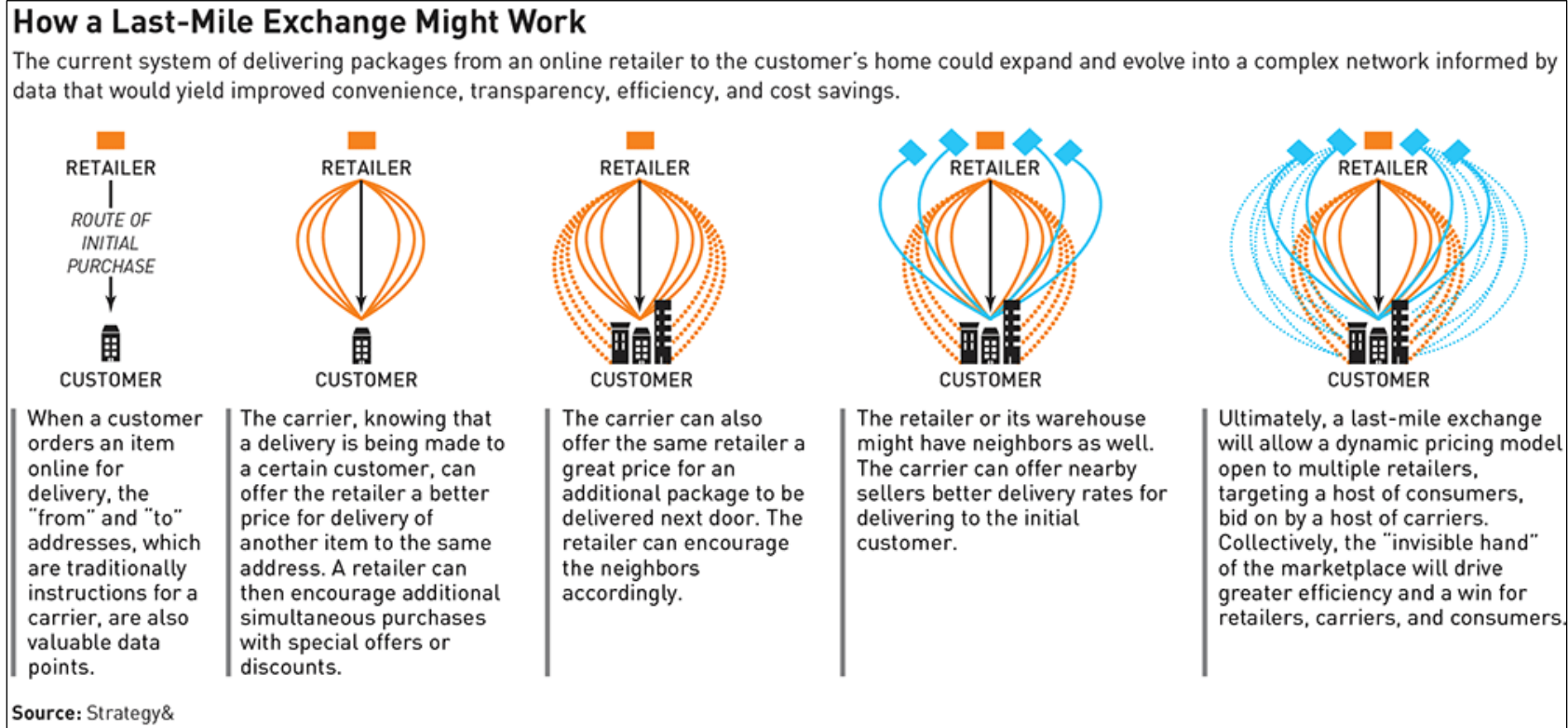
Many experts don’t believe these options are sustainable over the long run and have been discussing the idea of a “[Last-Mile Exchange](#).”¹⁰³ As shown in the flow chart below (Figure 3), rather than responding to a customer order (or predictions about orders), “transportation companies and retailers could engineer

¹⁰¹ *Hundreds More High-Tech Pickup Towers are Headed Your Way*, by Justin Rushing, Walmart Communications. April 5, 2018, <https://blog.walmart.com/innovation/20180405/hundreds-more-high-tech-pickup-towers-are-headed-your-way>

¹⁰² Packstation-Wikipedia, 3/30/2019, <https://en.wikipedia.org/wiki/Packstation>

¹⁰³ *Shifting Patterns: The Future of the Logistics Industry*, PwC Network, November 2016, <https://www.pwc.com/gx/en/transportation-logistics/pdf/the-future-of-the-logistics-industry.pdf>

Figure 3. Last-Mile Exchange Flow Chart



demand earlier in the sales process and dynamically balance supply and demand, much as Uber uses surge pricing to encourage more drivers to work during times of peak needs in peak locations."¹⁰⁴

In other words, if retailers and last-mile transportation providers could dynamically share data in real time among all the players, carriers could determine whether they could complete such a delivery – by combining it with other deliveries already scheduled – and what they should bid for the

¹⁰⁴ *The Rise of the Last-Mile Exchange*, Tim Laseter, Andrew Tipping, and Fred Duiven, strategy + business, July 2018, <https://www.strategy-business.com/article/The-Rise-of-the-Last-Mile-Exchange>

assignment. Those with deliveries to the same location or nearer to that location could offer a discounted price. The exchange would likely require a shared data-based system to pool package data, resource availability data, and analytics to dynamically optimize pickup and delivery routes.

Innovations for Accomplishing the Last-Mile Delivery. The big three national carriers (UPS, FedEx, and the USPS) with their well-developed hub-and-spoke delivery networks and extensive fleets account for 85% of the last-mile market in the U.S. today¹⁰⁵. In addition, regional short-haul shippers (such as [Ontrac](#) and [XPO Logistics](#) – both of whom operate in Oregon) move about 12% of all last-mile deliveries¹⁰⁶, and the balance is composed of all carriers including local operators via crowdsourced platforms (including [Deliv](#) and Uber).

The conventional method for completing last-mile deliveries involves a dedicated delivery employee of a parcel delivery service provider who picks up the parcels at a consolidation point and delivers them directly to the recipients. Large vans are typically used as delivery vehicles. However, many companies are exploring a range of new technologies and practices. In addition to the logistics strategies and crowdsourcing approaches described above, the following innovative delivery systems are being tested or are in development today and would provide direct benefits to e-commerce delivery:

Autonomous Trucks. Self-driving long-haul heavy-duty trucks, last-mile delivery vans and other commercial delivery trucks are being tested throughout the world; in many instances on public roadways. They carry standard-sized containers and are generally of the same weight as today's truck fleets and are often powered by fully electric or hybrid-electric motors. The economic benefits of self-driving trucks are numerous. For example, phasing out the 900,000 truck drivers in the U.S, would save hundreds of billions of dollars in labor costs, and the trucks could operate 24 hours/day since there wouldn't be driver restricted hours issues to contend with. Those drivers could be redeployed to monitor, manage, or otherwise assist in autonomous delivery operations.

"Vera", a driverless, all-electric truck cab from Volvo is not yet available for purchase and is intended to be operated in confined areas, such as ports or transit hubs, where it would be able to travel repetitive routes over short distances.

¹⁰⁵ *US E-Commerce Trends and the Impact on Logistics*, AT Kearney, April 2017, https://www.atkearney.es/operaciones/ideas-perspectivas/article/-/asset_publisher/LCcgOeS4t85g/content/us-e-commerce-trends-and-the-impact-on-logistics/10192

¹⁰⁶ Ibid.



As with autonomous passenger vehicles, they aren't yet permitted on public roadways except where official testing is occurring and with a driver in the cab to take over driving if necessary. In April 2016, trucks from major manufacturers including Volvo and the Daimler Company completed a week of autonomous driving across Europe¹⁰⁷. Since October 2017, autonomous trucks have been hauling Frigidaire refrigerators along the I-10 freeway, from a warehouse in El Paso, Texas, to a distribution center in Palm Springs, California¹⁰⁸. The 650-mile trip includes a human driver to monitor the operations, be available to take over driving if necessary, and to drive the truck when it leaves the interstate freeway. Once in Palm Springs, a driver unhitches the trailer, and passes the load to another driver who takes it the last few miles to Frigidaire's southern California distribution center.

Uber's autonomous truck began hauling cases of Budweiser along 120 miles of I-25 between Ft. Collins and Colorado Springs in 2016¹⁰⁹. The driver sat in the back of the cab, while the truck navigated the highway itself — albeit with a police escort. As of March 2018, Uber said its autonomous trucks had driven a collective two million miles, and that they had begun regularly transporting freight in Arizona. Uber, however, suspended all their autonomous trials in the U.S. and Canada after one of the company's autonomous test cars struck and killed a pedestrian in Tempe, Arizona.

Like autonomous passenger vehicles, autonomous trucks come with several issues of concern to the City of Portland including safety regulations and the potential for increased vehicle miles of travel and congestion.

¹⁰⁷ *Fleet of self-driving trucks completes journey across Europe*, Business Insider Intelligence, Apr. 11, 2016, 10:00 PM, <https://www.businessinsider.com/fleet-of-self-driving-trucks-completes-journey-across-europe-2016-4>

¹⁰⁸ *Self-Driving Trucks are now Delivering Refrigerators*, by Alex Davies for Wired Magazine, 11/12/17, [HTTPS://WWW.WIRED.COM/STORY/EMBARK-SELF-DRIVING-TRUCK-DELIVERIES/](https://www.wired.com/story/embark-self-driving-truck-deliveries/)

¹⁰⁹ *Self-Driving Truck's First Mission: A 120-Mile Beer Run*, by Mike Isaac, New York Times, Oct. 25, 2016, <https://www.nytimes.com/2016/10/26/technology/self-driving-trucks-first-mission-a-beer-run.html>

Autonomous Cars. Nuro, an autonomous vehicle startup focused on the last mile delivery of local goods and services, has teamed with Kroeger to delivery groceries using autonomous vehicles in two pilot grocery delivery programs: the first ran from August 2018 to March 2019 operating out of one store and covered one zip code in Scottsdale, AZ, and the other began in March 2019 and serves two stores and covers four zip code areas in Houston, Tx¹¹⁰. For a cost of \$5.95/delivery, customers place same-day delivery orders using Kroger's online system and Nuro's app and are advised when the battery-powered vehicle shows up at the curb of their residence¹¹¹. The delivery vehicles travel up to 25 mph on local roads.



Nuro's R-1 vehicle can carry twelve grocery bags stored in refrigerated compartments and opened using an app

Other grocery chains have attempted to license autonomous vehicle delivery services and are expected to have these services available soon. Stop & Shop, a northeastern U.S. chain of grocery stores, intends to kick-off an autonomous vehicle delivery service in the Boston area sometime in 2011¹¹². The battery powered "Robomart" vehicle will restock its quarters at nearby Stop & Shop stores.



Robomart autonomous vehicle delivery will supplement Stop & Shop's standard delivery services using drivers

As stated earlier, even though smaller than conventional delivery trucks, these autonomous delivery vehicles will utilize on-street curb space, increasing competition for vehicles seeking parking or loading and unloading, as well as the occasional blockage of bike lanes, fire hydrants and crosswalks.

Robot Deliveries. Another autonomous vehicle making last-mile deliveries are self-driving robots that travel only on sidewalks and crosswalks and can carry orders as heavy as 50 pounds for as far as 30 miles¹¹³. They travel at slow speeds using a global positioning system and 360-degree camera sensors to allow autonomous navigation¹¹⁴. They need to be supervised by humans, but that can be done remotely for several operating at any one time.

Amazon has been testing its own "Scout" vehicles with six bots since January 2019 in Snohomish County, WA. For now, Amazon says, it will limit its testing to daylight hours Monday through Friday,

¹¹⁰ Kroger and Nuro Launch Autonomous Delivery Service in Houston, Kroeger Press Release, March 14, 2019, <https://www.prnewswire.com/news-releases/kroger-and-nuro-launch-autonomous-delivery-service-in-houston-300812183.html>

¹¹¹ Ibid.

¹¹² Stop & Shop is planning to roll out small 'driverless grocery stores' in the Boston area, Boston Globe, January 19, 2019, <https://www.boston.com/news/business/2019/01/16/stop-shop-robomart-driverless-grocery-stores>

¹¹³ Postmates' new rover, Serve, is adorable by design, by Michael Grothaus Fast Company magazine, December 14, 2018, <https://www.fastcompany.com/90281867/postmates-new-rover-serve-is-adorable-by-design>

¹¹⁴ <https://www.starship.xyz/>

when sidewalk traffic is lowest. Scout will also have a human chaperone to make sure the bot can “safely and efficiently navigate around pets, pedestrians, and anything else in their path.”¹¹⁵ Robot delivery vehicles are being tested by *Starship Technologies* throughout Europe and recently begun tests at George Mason University. With online retail sales in the U.S. increasing by 16 percent just between 2016 and 2017¹¹⁶, as many as eight sidewalk bot delivery vehicles have entered the marketplace including: Loomo Delivery, Anymal, Serve, Marvel, Box Bot, Kiwibot, Scout, and Starship Robots.

A combination delivery system featuring an autonomous car that includes an autonomous bot inside has been developed by Anybotics and Continental, to accomplish the full roadway to sidewalk delivery by unmanned devices¹¹⁷.

Cities have been struggling with how to regulate this new kind of vehicle creating confusion and congestion on sidewalks. San Francisco severely restricted the machines at the end of 2017, requiring permits and mandating that startups test their delivery robots in quieter, more industrial neighborhoods.



Scout Bot by Amazon



Serve Bot by Postmates

Drones. Deliveries by drones are being used in limited environments and for selective delivery types in a few countries including the UK, France, Japan and China. Their use for delivering relief and medical supplies to remote or difficult to reach areas is growing, and hotels are experimenting with drone delivery of food and beverages to guests. In addition, its widespread use for other types of deliveries – in particular, food and packages - has been delayed by additional tests, development of regulations, and for shippers to resolve several logistical challenges. The cost savings to shippers, and the benefits to commerce, as well as reduced truck traffic and corresponding fuel consumption and emissions, would be enormous if drones replaced many deliveries completed by more conventional means.

After successfully using drones to deliver medical equipment to hospitals throughout the world including the U.S., UPS received FAA certification (in October 2019) to operate as a “drone airline”. UPS plans to add drone delivery to markets outside the health care industry and is constructing a centralized operations control center for drone deliveries.

The Federal Aviation Administration (FAA) enacted rules governing the commercial use of drones – e.g., they must weigh less than 55 lbs., fly no higher than 400 feet, at speeds less than 100 mph,

¹¹⁵ *Out of the Way, Human! Delivery Robots Want a Share of Your Sidewalk*, by Jeremy Hsu for Scientific American, February 19, 2019, <https://www.scientificamerican.com/article/out-of-the-way-human-delivery-robots-want-a-share-of-your-sidewalk/>

¹¹⁶ *The Last Mile Delivery Market in the United States - Growth Opportunities to 2023: E-commerce is the Biggest Driver*, Business Wire Magazine, February 4, 2019, <https://www.businesswire.com/news/home/20190204005673/en/>

¹¹⁷ *Robotic Package Delivery with ANYmal 31*, January 2019/5 Comments/in News /by Péter Fankhauser, <https://www.anybotics.com/2019/01/31/robotic-package-delivery-with-anymal/>

operated only during daytime hours, and that drone operators qualify for flying certificates and be at least 16-years old¹¹⁸. In 2017, a presidential directive was issued that called on the FAA and the U.S. Department of Transportation (USDOT) to create initiatives that would enable American companies to eventually use drones for delivery purposes. In March 2018, the USDOT announced that ten state and local governments had been selected for a pilot program which would include parcel delivery over a period of 2 ½ years¹¹⁹. At the conclusion of the pilot the USDOT may elect to propose new regulations.

In April 2019, the FAA approved a license for commercial drone deliveries to Wing, a subsidiary of Google, in two rural counties in Virginia. The license was issued after the company tested drone deliveries to students at Virginia Tech University and then on-demand items to homes near campus.

After receiving an order from a mobile app, one of the company's fleet of drones can pick up a package from a business or home, fly to a designated destination, hover about 20 feet over the delivery area, and use a tether to lower the package to a precise location such as a backyard or a doorstep, according to its exemption application. Wing uses its own unmanned traffic management (UTM) system to manage the drone's flight path from take-off to landing to ensure safe operations around obstacles such as buildings, trees, and other drones.¹²⁰



Wing's drone lifts from the ground vertically, flies horizontally, and carries packages in its belly. One drone "pilot" can remotely fly up to five machines at one time, though that number may increase.

¹¹⁸ Fact Sheet—Small Unmanned Aircraft Regulations (Part 107), Federal Aviation Administration, July 23, 2018, https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=22615

¹¹⁹ U.S. Transportation Secretary Elaine L. Chao Announces Unmanned Aircraft Systems Integration Pilot Program Selectees, US Department of Transportation, May 9, 2018 <https://www.transportation.gov/briefing-room/dot3419>

¹²⁰ Google drones may soon fly commercially over Virginia, by John Gallagher, Freight Waves Magazine, 4/19/2019, <https://www.freightwaves.com/news/technology/google-drones-may-soon-fly-commercially-over-virginia>

There's consideration in the courts and FAA's evolving regulations about the ability of local jurisdictions to regulate commercial drone operations. In general, the FAA has authority over the air space while local jurisdictions have authority over landing sites; however, operations in the airspace can impact citizens' privacy, safety, and land use, all of which fall under the purview of local jurisdictions. Recently a federal judge struck down a few prohibitions adopted by the city of Newton, MA. The judge wrote:

"This (the ordinance restriction on drone flights under 400.0') thwarts not only the FAA's objectives, but also those of Congress for the FAA to integrate drones into the national airspace. Although Congress and the FAA may have contemplated co-regulation of drones to a certain extent, see 81 Fed. Reg. 42063 § (III)(K)(6), this hardly permits an interpretation that essentially constitutes a wholesale ban on drone use in Newton." ¹²¹

The judge, however, did allow other sections of the ordinance that had to do with privacy, noise, and safety to remain in force.

At this time, the City of Portland has an ordinance prohibiting drones to fly in or over any city park, except in places that have been designated for such use.

Cargo bikes. Portlanders are familiar with cargo bikes through the common appearance of B-Line, Portland Pedal Power, Soup Cycle, and other delivery companies. Most cargo bikes are electrically powered, or electric power assisted, and some can carry up to 750 lbs. of cargo¹²². They are an ideal substitute for many deliveries by van, particularly since they don't require much – if any - parking area, can be loaded and unloaded in lesser time, and can move more quickly in dense and congested urban areas that have a bicycle route network. They also don't require as much roadway capacity as trucks and are an important means of delivering goods when roadways are unavailable during emergencies or other incidents. According to the NYC Department of Transportation, "2 bikes can replace one delivery vehicle with CO2 savings of approx. 16 tons/year"¹²³. In 2016, UPS began operating its electrically assisted e-bike tricycle in Portland, and in early 2019, UPS will start a licensed pilot program for e-bike operations on sidewalks and bicycle lanes in the downtown Seattle area including the Pike Place Market¹²⁴.

Given their wider wheelbases and longer length, cargo bikes cannot always comfortably navigate bicycle lanes as well as bicycles can, yet they are not permitted in travel lanes reserved for passenger cars, trucks and buses. In addition, in some instances they are not permitted to use on-street truck loading zones, and they can reduce access for pedestrians if they park on sidewalks.

¹²¹ Singer vs. City of Newton, U.S. District Court District of Massachusetts, 9/21/2017

<https://www.documentcloud.org/documents/4058344-Singer-v-Newton-Decision.html#document/p13/a376954>

¹²² *Cargo bikes Not Drones Are The Future For Urban Deliveries*, by Carlton Reid for Forbes Magazine, October 15, 2018, <https://www.forbes.com/sites/carltonreid/2018/10/15/cargobikes-not-drones-are-the-future-for-urban-deliveries/#151b4abde790>

¹²³ *Freight Can't Wait – Opportunities to Improve Efficiency of Last Mile Delivery in NYC*, Diniece Peters Mendes, NYCDOT, TRB 2019 Annual Meeting, <http://amonline.trb.org/68387-trb-1.4353651/t0005-1.4505752/1090-1.4507308/p19-21971-1.4495977/p19-21971-1.4507316>

¹²⁴ *UPS To Launch First-Of-Its-Kind U.S. Urban Delivery Solution in Seattle*, UPS Press Release, October 25, 2018, <https://www.pressroom.ups.com/pressroom/ContentDetailsViewer.page?ConceptType=PressReleases&id=1540482965617-103>



Photo courtesy of bikeportland.org

Microhubs. Also referred to as micro-hubs or micro depots, microhubs are consolidation centers for last-mile deliveries in dense urban districts. Goods are delivered from warehouses and distribution centers via truck to the microhub facility where they are either picked up by the customer or delivered by cargo bike or bicycle (or even robot or drone) to their destination.

Microhubs can be:

- Urban Consolidation Centers - larger, permanent facilities located in urban areas that allow businesses to consolidate and coordinate between freight carriers;
- Delivery microhubs, such as DHL's Packstations throughout Germany, are urban consolidation centers with a smaller physical footprint; and
- Lockers (see below) are small storage units located close to the final delivery point which can be conveniently accessed by customers. In Portland lockers are found at Amazon retail storefronts, 7-Eleven stores, apartment buildings, and other locations.

As of August 2018, there were seven microhubs operating in Amsterdam¹²⁵ serving the postal system and other logistics providers where vans unload packages to be delivered by “freight bikes” for the last-mile delivery.

In Frankfurt and Utrecht, DHL delivers standardized containers (which can load up to 275 lbs.) by van to designated “City Hub” locations for transfer to their “cubicycle” cargo bicycles specially equipped to handle the containers. DHL expects that “each City Hub can replace up to two standard delivery vehicles, with an equivalent CO2 saving of over sixteen tons per year and a significant reduction in other emissions.”¹²⁶



DHL Cubicycle

Neighborhood Lockers. Smart lockers reduce the time that a delivery person spends in a building¹²⁷ and consequently reduces the time that curb space is utilized for active deliveries.

As of November 2018, Amazon has developed 21 storefront locations in Portland where packages are delivered to a storage locker for pickup¹²⁸. Customers are notified of their arrival and provided with a locker number and code to open the locker. Returns can also be transacted at these facilities. Most of the locker facilities are located in other commercial establishments including Fred Meyer and Whole Food groceries, and some are independent Amazon stores that are staffed. In addition, some high rise office and residential buildings have Amazon locker facilities. These satellite facilities can reduce delivery trips by concentrating deliveries, and may offer convenience to customers who don’t have a means of directly receiving parcels, as well as providing additional security over deliveries made to unoccupied homes or businesses. While they won’t significantly reduce vehicle miles of travel, they can be a means of making other non-vehicular delivery services feasible.



Amazon Storefront at 1131 SW Jefferson Street



Amazon Locker

¹²⁵ City deliveries using micro-hubs and innovative freight bikes, 2020 Civitas Conference, Amsterdam, The Netherlands, 8/3/2018, <https://civitas.eu/event/city-deliveries-using-micro-hubs-and-innovative-freight-bikes>

¹²⁶ DHL expands green urban delivery with City Hub for cargo bicycles, DHL Press Release, 3/1/2017, https://www.dhl.com/en/press/releases/releases_2017/all/express/dhl_expands_green_urban_delivery_with_city_hub_for_cargo_bicycles.html

¹²⁷ According to Barb Ivanov, University of Washington Urban Freight Lab, “nearly 80% of the time a delivery person is in this building is spent getting through security (12%), riding elevators to different floors and going door-to-door to tenants (67%).” 3/14/2018, <https://depts.washington.edu/sctict/news-events/in-the-news/nextgen-supply-chain-interview-barbara-ivanov>

¹²⁸ Calculated from Find an Amazon Locker in Your Area, November 2018, https://www.amazon.com/gp/help/customer/display.html/ref=hp_200689010_findlocker?nodeId=201117850

Bike Couriers. Bike couriers are of course common today, but their usage for last-mile delivery is expected to grow significantly as does the point-to-point delivery market, especially for business-to-business documents and prepared food. According to a 2016 McKinsey report:

“Ultimately, the best solution to a glut of delivery vehicles could be less high-tech....old-fashioned bicycles remain the most cost-competitive choice for many last-mile deliveries. “If droids do not become significantly cheaper,” the analysts wrote, “bike couriers are likely to be the best delivery form for instant delivery in urban areas.”¹²⁹

Amazon’s Delivery Service Partner Program. In June 2018, Amazon introduced this program to train individuals to operate a delivery business moving Amazon packages. For a minimum investment of \$10,000, individuals will also get access to Amazon-branded vehicles, uniforms, and discounts on fuel, insurance, and more, but they will not be Amazon employees. The program is available at 75 delivery stations throughout the U.S. - including Portland - and the company expects to contract with “hundreds of small business owners who would hire tens of thousands of delivery drivers.”¹³⁰



Applicants accepted into Amazon’s new start-up delivery program will get access to Amazon-branded vehicles and uniforms like these.

¹²⁹ Out of the Way, Human! Delivery Robots Want a Share of Your Sidewalk, by Jeremy Hsu for Scientific American, February 19, 2019, <https://www.scientificamerican.com/article/out-of-the-way-human-delivery-robots-want-a-share-of-your-sidewalk/>

¹³⁰ <https://logistics.amazon.com/>

E-Commerce Transportation Profiles

In order to provide some context for e-commerce delivery phenomena, profile descriptions of the ordering and delivery processes were prepared for three types of transactions: international packages, clothing, and locally delivered groceries. These descriptions are summaries of the complex logistics that control these flows for ordinary types of transactions that are often made by Portland residents and businesses. Information about the package volume of these transactions and their specific travel characteristics of their deliveries is either unavailable or is proprietary data kept by the companies.

Profile I - International Express Mail

Over the course of an average day, tens of millions of packages and mail are sent between the USA and foreign countries and involve multiple modes including air, sea, truck, and rail for portions of the trip. This profile involves the delivery of documents weighing less than 1 lb. shipped door-to-door between a downtown location in Portland, OR to a downtown location in London, UK through FedEx.



began its international delivery service in 1984 and today is the largest courier of international packages serving 220 countries and territories. On an average day the company moves six million packages internationally. FedEx offers International Next Flight, International First, and International Priority services with different rates and schedules. Packages from the U.S. to London are initially shipped overnight to the Memphis, TN central facility and then flown the following morning to Stanstead Airport in London, sorted and delivered by truck to the addressee.

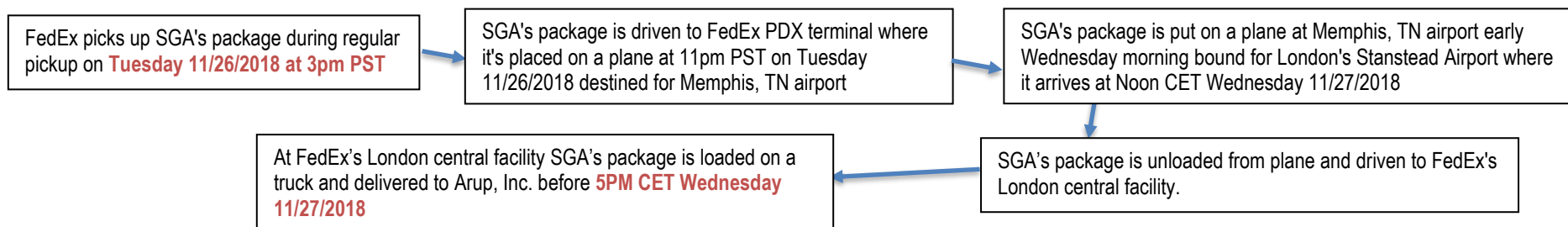
Sample Shipment – originating on Tuesday between 8am-6pm:

From: SGA, 1120 SW 11th Avenue, Suite 500, Portland, OR 97205

To: Arup, Inc. 13 Fitzroy Street, London W1T 4BQ, United Kingdom


Shipping Options:

	Fees	Arrival
FedEx International Next Flight	\$241.00	By 5pm Wednesday
FedEx International First	\$118.57	By 9am Thursday
FedEx International Priority	\$66.63	By 12pm Thursday



Profile II - Clothing

In 2017, nearly two-thirds of all clothing sales were made online, with domestic sales of \$13.6 billion. It is the number one retail item – in terms of sales revenue – purchased online. This profile involves the purchase of a woman's coat weighing 12 oz. delivered directly from the manufacturer in Portland, OR to a Portland, OR customer's home. Shipping rates and delivery schedules are the same for deliveries to all other continental U.S. locations.

 **cotopaxi** is a Salt Lake City-based maker of women's and men's outdoor clothing and gear which opened its business in April 2014. Their apparel is manufactured in Tianjin, China and Portland, OR and has two retail stores in Utah. Their goods can also be purchased at the three REI stores in the Portland region, and at a wide variety of retail stores throughout the U.S.

Manufacturers like Cotopaxi can sell through wholesalers, marketplaces such as Amazon and eBay, or through its own shipping department.



Cotopaxi Pacaya -Women's Insulated Hooded Jacket

Shipping Options

	Cotopaxi	Amazon Prime*	Amazon
Free Shipping	7-11 days, orders + \$99	Same day, 1 day, 2 day	7-10 days
Standard Shipping	4 days, \$7.33	2 days, Free	5-7 days, \$5.00
Expedited shipping	2 days, \$12.78	1 day, Free	3 days, \$25.00
Same day, One day/Overnight	"One-day", \$20.58	Same day, Free	"Overnight", \$40.00
Interest-free payment plan?	Three payments of \$67	For purchases + \$149	For purchases + \$149
Free Returns	Within 90 days	Within 30 days	Within 30 days

* Amazon prime membership costs \$119/year

Profile III – Local Groceries

Food has been delivered since the first grocery stores were opened. Dairy, beverages, meats, bread, and produce were often delivered to your door or sold by a vendor from the street. However, in the past 50 years those deliveries began to fade away, and when conducted, were very expensive. That is, until recently. While 78% of all shoppers still buy their groceries at stores, online purchases of groceries was a \$48.7 billion business in 2017, which was a 2.3% growth from 2016 sales. In addition, sales of health care products grew 3.2% from 2016 for a total of \$43.5 billion.



purchased Whole Foods in 2017 and began delivering the store's groceries and other items in selected cities in February 2018 and expanded to Portland area stores in August 2018. Amazon Prime members get free deliveries for orders over \$35 within two hours and can pay \$7.99 if they request delivery within one hour. Even if you're some distance away from a Whole Foods store – e.g., the nearest Whole Foods store to downtown Gresham is in the Hollywood neighborhood at 4301 NE Sandy Blvd, Portland, OR, or about 12 miles away – other services like Envoy will complete the delivery. Whole Foods accounts for about 2.5% of the U.S. on-line grocery market, but Walmart, Kroger, and Target have expanded online delivery and in-store pickup, poured money into supply chains and technology improvements, and kept prices low, even in the face of higher costs, to prevent customer defections. Just one year after Whole Foods began providing free delivery through Prime Now service, more than 1,800 Walmart stores now offer free grocery pickup, Target has same-day delivery choice for household essentials for a \$99 membership fee, and Kroger now has 1,250 curbside pickup stores and offers delivery.

When ordering for a delivery from Whole Foods which can be made through an app or Amazon's website, a list of restaurants and other stores which also deliver in or near your zip code is just another click away on the same screen.

Selected Grocery Store Delivery Options

	Whole Foods	Walmart	Kroger	Target
U.S. Stores providing delivery	446	800	1,250	1,100
Free Shipping	Within two hours	Not available	For orders over \$35	For orders over \$35
Expedited shipping	Within one hour, \$7.99	\$9.95 for orders over \$30	\$4.99 for orders under \$35	\$7.00 for orders under \$35
Delivery Service Area	Limited – as per location	Limited – as per location	Limited – as per location	Limited – as per location
Membership Required?	Yes, Prime Now, \$199/year	No	No	Yes, Shipt, \$99/year
Curb side pickup?	Yes, for Prime Now members	Yes, free for orders over \$30	Yes, \$4.95/order	Yes, \$4.95/order

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Technical Memorandum No. 2
*Summary of Interviews with E-Commerce Delivery
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Preface

The City of Portland's Bureau of Transportation is interested in understanding how e-commerce retail sales, and in particular, the delivery of retail products via e-commerce methods to residences, is changing freight demand and the handling, storage, packaging, logistics and delivery traffic that accompany it. The exceptionally high growth of e-commerce retail sales since the first recorded e-commerce transaction in 1994 and the associated demand for quick delivery and hassle-free returns, has dramatically changed logistics strategies, speeded construction of close-in fulfillment centers and warehouses, and created innovations in who makes final deliveries and when, where and how those deliveries occur.

This technical memorandum documents interviews held with representatives of nine organizations that are directly involved in e-commerce delivery in Portland and other cities to help validate the research on e-commerce deliveries conducted for Technical Memorandum No. 1 - Expected Growth in E-Commerce Delivery. In addition, these individuals provided insights and details about how they've changed their delivery practices to adapt to the enormous demands generated by e-commerce sales for quick delivery and consumer-friendly returns, particularly deliveries in the "last-mile".

The interviewees agreed with the earlier research that delivery of e-commerce items will continue to grow at significant rates, and that carriers and shippers will not only exhaust all current remedies from crowd-sourcing to fulfillment centers to using a range of delivery modes and facilities to accommodate them, but will be developing new ones. Moreover, many of the current innovations have been developed in partnership between cities and the freight industry.

Some of the major insights gained from these interviews include:

- Partnerships between cities and carriers, shippers and logistics providers is key to resolving delivery issues.*
- Cities can manage curb parking and loading spaces through real-time monitoring sensors.*
- Warehouses and fulfillment centers are moving closer to city centers to help expedite last-mile delivery demand.*
- Technology, smaller vehicles, extended delivery hours, and increased carrier staffing are all part of the range of solutions to addressing last-mile delivery requirements.*
- Crowd sourcing and "hand-offs" between modes are other growing trends in accomplishing e-commerce delivery.*

In addition to this review, the Portland Bureau of Planning and Sustainability and the Portland Bureau of Transportation are assessing how warehouses, distribution centers and like facilities are adapting to the demand for e-commerce products. There has been a significant increase in these developments including the three regional Amazon facilities (i.e., Troutdale, Rivergate and Hillsboro), and a large number of other logistics warehouses located nearer to population centers in order to meet the requirements that many consumers have for rapid delivery.

Together these efforts are supporting the incremental update of the Portland Freight Master Plan.

Other documents being completed for the E-Commerce and Emerging Logistics Technology Research Project are:

- *Technical Memorandum No. 1 – Expected Growth in E-Commerce Delivery*
- *Final Summary Report*

This study is funded by the City of Portland.

Introduction

In addition to the research about e-commerce demand, delivery practices, logistics strategies, and future trends completed for *Technical Memorandum No. 1: Expected Growth in E-Commerce Delivery*, interviews were held with nine individuals between April 2019 and August 2019 to help validate many of the research claims.

The interviews contained six questions for carriers, shippers and the academic participants, and seven questions for city agencies. Most of the interviews were conducted by telephone, though some were completed independently and submitted by email. In some cases, after receipt of the surveys, follow-up questions were asked in order to clarify responses and to try to ensure some level of consistency among the responses.

The interviewees, shown in Table 1 below, fall into three categories: carriers delivering e-commerce products in the City of Portland; peer cities developing programs to address e-commerce delivery issues; and, academia involved in national research current research about e-commerce.

Table 1. Organizations interviewed for E-Commerce Research Report

Organization	Organization Type	Interviewee
FedEx	Carrier	Name withheld
Postmates	Carrier	Vignesh Ganapathy, Sr Government Relations
Fred Meyer	Shipper/Carrier	Rob Freeman, Supply Chain Logistics
Seattle Department of Transportation	City	Mary Catherine Snyder, Parking Strategist
San Francisco Municipal Transportation Agency	City	Becca Homa, Senior Transportation Planner
Washington, DC Department of Transportation	City	Name withheld
New York City Department of Transportation	City	Diniece Mendes, Director, Freight Mobility
SUNY Albany Department of Geography and Planning	Academia	Catherine Lawson, PhD, Associate Professor
USC Center for Global Supply Chain Management	Academia	Nick Vyas, Assistant Professor of Clinical Data Sciences and Operations

The interviewees were selected based on their experience in delivering products ordered via e-commerce methods, or in the case of the city agencies and the academic professionals, have been evaluating the effects and trends associated with e-commerce deliveries. The study team also considered reaching out to several of Portland's peer cities including Austin, Denver, Minneapolis, Sacramento, Salt Lake City and San Diego, but found that they hadn't yet engaged in extensive e-commerce analyses nor had they completed detailed freight planning.

Stakeholder Interview Questions

The following six questions were asked of the five industry (i.e., carriers, shippers and logistics providers) representatives and the two academic professionals:

1. What are your companies' top challenges and concerns in respect to serving your customers and moving freight? What keeps you up at night?
2. What are some logistic industry trends and innovations you expect with regard to:
 - Warehousing and Fulfillment Centers
 - Use of different delivery vehicles types and modes (cargo vans, electric trikes, drones, autonomous vehicles)
 - Federal, state and local regulations
 - Other?
3. What changes, if any are you making to your business practices in response to growing e-commerce delivery demand?
 - extending delivery hours
 - adding more fleet vehicles and drivers
 - change in delivery vehicle type (cargo vans, passenger cars, delivery bike/trike, hand carts, etc.)
 - technological improvements (routing and tracking software)
 - use of centrally located fulfillment centers/warehouses
4. What adverse impacts, if any, do you see e-commerce having on the Portland economy?
 - Reduction in labor force?
 - Higher level of workforce training needs?
 - Reduction in traditional "brick and mortar" stores?
 - Greater traffic generation from increased deliveries?
5. In your view what can the City of Portland do to help facilitate efficient freight movement. What are your greatest "last mile" transportation challenges:
 - Allocating curbside loading and parking space
 - Improved truck wayfinding signage
 - Require dedicated loading space in central city buildings ("last 50 feet")
 - New infrastructure projects
 - Land use changes
 - Other?
6. Is there anything else that you want to add to help the City of Portland and other policy makers understand concerns and challenges in e-commerce logistics and how it is changing?

The seven questions below were asked of the four peer city representatives which differ slightly from the questionnaire issued to the industry representatives:

1. What are your City's top challenges and concerns with respect to accommodating freight deliveries?
2. What are some logistic industry trends and innovations you expect with regard to:
 - Warehousing and Fulfillment Centers
 - Use of different delivery vehicles types and modes (cargo vans, electric trikes, drones, autonomous vehicles)

-
- Federal, state and local regulations
 - Other?
3. What changes, if any, are you seeing from carriers and shippers in response to growing e-commerce delivery demand?
 - extending delivery hours
 - adding more fleet vehicles and drivers
 - change in delivery vehicle type (cargo vans, passenger cars, delivery bike/trike, hand carts, etc.)
 - technological improvements (routing and tracking software)
 - use of centrally located fulfillment centers/warehouses
 4. Does your City have any pilot projects, plans, etc., underway that are associated with accommodating e-commerce delivery?
 5. Has your City collected data focused on the volume et al of e-commerce delivery trips,?
 6. In your view what can the City of Portland do to help facilitate efficient freight movement. What are your greatest “last mile” transportation challenges:
 - Allocating curbside loading and parking space
 - Improved truck wayfinding signage
 - Require dedicated loading space in central city buildings (“last 50 feet”)
 - New infrastructure projects
 - Land use changes
 - Other?
 7. Is there anything else that you want to add to help the City of Portland and other policy makers understand concerns and challenges in e-commerce logistics and how it is changing?

Stakeholder Interview Findings

The industry and City representatives as well as the national researcher had very similar takes on trends and business practices in e-commerce delivery, but their answers about how to improve conditions for delivery efficiencies varied.

Industry Responses

1. **Top Challenges:** The shippers and carriers have similar concerns with accomplishing e-commerce deliveries, such as:
 - Addressing the rising demands of e-commerce.
 - Attracting the necessary personnel at both dockside and for deliveries to meet demand.
 - Congestion and lack of available curb space to complete last-mile deliveries on-schedule. One of the interviewees stated: “The first and last mile environment requires different strategies, and we need to be thinking of tailored options and strategies and understand the challenges.”
 - It’s important that we collect data about the utilization of curb space by all users before eliminating its use by delivery vehicles.
 - Safety and the potential for serious accidents, particularly between trucks and bicyclists.

2. Logistics Industry Trends and Innovations

- Warehousing and Fulfillment Center
 - Expect to see more siting of fulfillment centers, distribution centers and warehouses closer to central business districts and other locations with a high density of last mile delivery destinations.
 - Functions and activities at new warehouses and fulfillment centers will be increasingly automated with improved inventory management and fewer on-site employees.
- Use of different delivery vehicles types and modes (cargo vans, electric trikes, drones, autonomous vehicles)
 - Smaller personal-sized vehicles and drones will become a regular part of last mile delivery.
 - There'll be an increase in in-store pick-up and home delivery.
 - We will also see many more electrically powered trucks, and while autonomous delivery vehicles are a certainty, they will not be a major player in the delivery market anytime soon.
- Federal, state and local regulations
 - There is concern about the potential for cap-and-trade legislation to increase operating costs (i.e., fuel costs).
- Other?
 - Each of the industry interviewees mentioned that we will increasingly see different forms of transportation that are most appropriate to the delivery type and its destination. Shippers will consider trucks, vans, bicycles, etc., for every type of delivery.
 - Moreover, interviewees believe that we'll see more last-mile deliveries completed using a hub and spoke model where there'll be handoffs between environments; e.g., truck to a terminal to a car to a bicycle.
 - One of the academic researchers stated that some technologies like AI, machine learning, blockchain, and robotic automation are driving logistics strategies and supply chains. Along with this is also the uberization and Air Bnb of warehouses such as Warehouse Exchange are emerging and becoming critical components of e-commerce logistics.

3. Changes to business practices

- extending delivery hours
 - Most carriers have already expanded their delivery services to seven days/week, and with extended hours.
 - While shippers and carriers would like to conduct more nighttime deliveries or during off peak traffic hours because of the improved efficiencies they would gain, neighborhood noise ordinances can restrict their ability to do so¹³¹.
- adding more fleet vehicles and drivers
 - Some shipper/carrier industries are adding drivers to gain more control and limit the expense of hiring 3rd party carriers.
- change in delivery vehicle type (cargo vans, passenger cars, delivery bike/trike, hand carts, etc.)
 - As described above, shippers and carriers are using a much wider range of delivery vehicle types, particularly for last-mile deliveries. Fred Meyer is focusing on customer in-store pick up and home delivery through a 3rd party. Kroger outside of the Pacific Northwest is building

¹³¹ The City of Portland's noise ordinance does not cover noise vey vehicles. <https://www.portlandoregon.gov/civic/63268>

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-
- distribution centers specific for home delivery and using Sprinter vans and copying the Ocado model from Europe¹³².
 - technological improvements (routing and tracking software)
 - Shippers and carriers have updated their logistics software ability to route and track deliveries.
 - use of centrally located fulfillment centers/warehouses
 - FedEx operates from its airport facilities, and Postmates doesn't own or operate warehouses. Fred Meyer is not adding any new distribution centers or warehouses in the Pacific Northwest, but its parent company, Kroger, is building distribution centers in other regions specifically for home delivery.
 - Many companies are struggling not just with staffing needs to meet the rising demands of e-commerce, but with meeting their speed and accuracy requirements especially for mid-size and small companies.

4. Adverse Impacts

- Higher level of workforce training needs?
 - Focus of training is on achieving very high efficiencies due to the high expectations for meeting delivery requirements.
- Reduction in traditional “brick and mortar” stores?
 - Industry interviewees all agree that fewer new stores are opening, but it's also important to understand that e-commerce packages and delivery have a very low margin compared to levels achieved with business to business packages.
- Greater traffic generation from increased deliveries?
 - No answers provided.
- Other?
 - The Postmates interviewee stated that is unknown whether e-commerce is contributing to any adverse economic impacts because it is satisfying a workforce need. That is, their workforce is made up of individuals who can work as many hours as they want without committing to a longer or permanent position. They have employees who are college students who need to work while on vacation, or new parents who need a flexible schedule, or seniors who want to work just a few hours, etc. Their model “creates employment opportunities for a disaggregated workforce.”; i.e., for those who cannot or do not desire a conventional work week.

5. What can the City of Portland do help industry overcome “last mile” transportation challenges

- Allocating curbside loading and parking space
 - Each of the interviewees said that this is needed. Further, at some locations, the location of on-street parking spaces impacts the ability for trucks to access off-street loading facilities.

¹³² “Ocado Retail Ltd is a joint venture between Marks & Spencer Group and Ocado Group. It is responsible for ocado.com and our two other retail brands: Fetch, our online pet store, and Ocado Zoom, our new one-hour grocery service.

“Ocado is the world's largest dedicated online supermarket. It has a quarter-of-a-million active customers, and a 15% share of the UK online grocery market.

“Ocado Zoom is our new one-hour grocery service. Customers can have a wide range of groceries delivered in under 60 minutes, or in a same-day slot of their choice.

“Fetch is our rapidly-growing petcare destination website, offering a curated range of specialist pet foods and accessories for discerning ‘Pet Parents’.” <https://ocado.com/who-we-are/>

- Improved truck wayfinding signage
 - No answers provided.
- Require dedicated loading space in central city buildings
 - No answers provided.
- New infrastructure projects
 - Recommend that large commercial vehicle access be part of all new construction projects, and that major arterials be widened.
- Land use changes
 - No answers provided.
- Other?
 - Modernizing curb allocation and usage. That is, we need data about curb usage in order to have a better idea for maximizing use of it. As an example, restaurant deliveries probably don't need as many long-term spaces as they've had in the past because deliveries are growing and not as many customers drive to restaurants, or restaurant delivery business may be growing so much that they need additional curb space for their delivery vehicles. A restaurant may be able to expand their reach with more pickup and loading zones.¹³³
 - Educational effort/campaign to improve the sharing of roadways with trucks
 - Eliminate neighborhood noise delivery restrictions¹³⁴.

6. Other

- According to the FedEx interviewee, the most lucrative part of parcel delivery companies is business-to-business transactions. The margins tend to be better and the volume is more stable. This is why FedEx recently ended its relationship with Amazon for domestic express service, precisely because the margins are so low.
- It's important not to group business to business deliveries with e-commerce deliveries. While both delivery types may utilize the same curb spaces, any data collection efforts regarding deliveries should try to disaggregate them.
- All of the shippers are willing and happy to work with the City of Portland on this subject.

City Responses

1. **Top Challenges.** With respect to their top challenges, the cities listed four main categories:

- Managing Curbside Demand – each of the four cities indicated this as a top challenge – including issues such as

¹³³ PBOT currently provides on-street loading and unloading spaces based on requests from property owners or businesses along with a review of the proximity of other truck loading spaces and the ability to consolidate those spaces. PBOT's recent Parking Management Manual, however, uses a data driven process to maximize usage of on-street truck loading space in conjunction with its new "combination zone" designation. These zones, which are prioritized on certain types of streets and encourage turnover with 30-minute loading time limits during designated time periods, can be used as timed zones for visitor or residential uses at other times of the day. The City will review loading zones at least once every two years to ensure that the location of the on-street truck loading spaces is appropriate and that they are being effectively served for both loading and customer/ visitor demand. Key metrics to collect as part of the review should include TLZ occupancy, turnover, duration of stay, violation rates, and peak hour of use. *Performance Based Parking Management Manual*, Portland Bureau of Transportation, April 2018, <https://www.portlandoregon.gov/Transportation/article/686017>

¹³⁴ Not applicable in Portland where there is no ordinance related to noise produced from vehicles.

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- Double parking by trucks, and trucks parked in bicycle lanes¹³⁵ and bus lanes.
 - Accommodating multiple modes at curbside; balancing the multiple users who seek limited number of curb spaces.
 - Enforcement of on-street/curbside loading zones to keep them free for loading purposes as well as to encourage delivery drivers to use them when available.
 - Emerging priorities and needs such as transit lanes and bicycle lanes often replace loading zones.
 - Lack of off-street loading capacity exacerbates our system which has high density and relatively low off-street loading and parking availability.
 - Growth Management
 - Goods movement is growing even faster than population and 90% of it is by truck.
 - Congestion impacts travel time reliability and increases business costs.
 - Freight conditions – demands and logistics – are continuously changing and it's challenging to develop long term solutions.
 - The representative from San Francisco described the City's ambitious goals for lowering greenhouse gas emissions including those produced by delivery vehicles.
 - Safety
 - There are conflicts between trucks and vulnerable road users: while trucks are involved in a relatively low number of crashes citywide, they make up a higher percentage of crashes that involved someone being killed or severely injured.
 - These conflicts will grow more challenging with our expected increases in the volume of truck, pedestrian and bicycle traffic.
 - Other
 - There aren't any available areas for overnight truck parking, and drivers making in-city deliveries need a place to rest to comply with their hours of service limitations.

2. **What kinds of logistics industry trends and innovations is your City experiencing or expecting?**

The four cities are seeing similar innovations from carriers and shippers.

- Warehousing and Fulfillment Center
 - Large fulfillment centers are being located closer to consumers (reverse sprawl effect for logistics), though in some cases, high land prices in central business districts are limiting their location to just outside city limits.
 - Carriers are experimenting with satellite lockers, and package consolidation at storefront locations has become commonplace.
- Use of different delivery vehicles types and modes (cargo vans, electric trikes, drones, autonomous vehicles)
 - Cargo-bikes and E-trikes are being used in each of the four cities.
 - One city representative mentioned that they've seen a slow decline in large tractor trailers and an increase in more single unit trucks and vans.
 - One of the city representatives stated that they expect cities to incentivize and regulate for smaller, cleaner vehicle; while another said that the adoption of electric trucks is limited because there's not yet enough infrastructure available for them to operate efficiently.

¹³⁵ According to one interviewee, "which is expected since we didn't plan for replacement loading areas (when installing curbside bicycle lanes) in the vicinity of the previous spaces."

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- While one city has a pilot program using a small personal delivery robot program with Starship Enterprises, another City believes that some high-density cities will outlaw drones or have very strict limits on their usage.
 - Federal, state and local regulations
 - One City representative believes that future regulations will lead to improved safety and efficiency in fleet truck design, larger adoption and incentivizing of commercial electric vehicles.

3. Are you witnessing any changes to business practices by the delivery companies?

City representatives mentioned that they're seeing more crowd sourcing of deliveries and that typical freight vehicles are now becoming more ambiguous as passenger cars are making last mile deliveries as well.

- extending delivery hours
 - Yes.
 - adding more fleet vehicles and drivers
 - Yes, as well as augmenting them with independent contractors making deliveries in their vehicles.
 - change in delivery vehicle type (cargo vans, passenger cars, delivery bike/trike, hand carts, etc.)
 - Cargo vans, e-trikes, hand carts, personal cars are all completing freight and food deliveries.
 - technological improvements (routing and tracking software)
 - No answers provided.
 - use of centrally located fulfillment centers/warehouses
 - See above responses to question 2.

4. Have you tested or introduced any pilot projects to manage e-commerce deliveries?

Each of the four cities are piloting curb management programs involving data collection about curb usage and type of usage, such as Washington DC's *CurbFlow Pilot* <https://ddot.dc.gov/release/ddot-announces-next-innovation-curb-side-management-program> and its *PUDO Pilot* <https://ddot.dc.gov/release/mayor-bowser-and-ddot-announce-pick-up-drop-zone-pilot-program-expansion>. In addition, the cities are testing:

- Residential loading zone pilot – designating / expanding No Parking curbside, and its regulations to accommodate package deliveries in select residential areas – typically in front of apartment complexes, at hydrants, and at corners
- Ongoing personal delivery robot program (with Starship Enterprises)
- Off Hour Deliveries Program expansion
- Installing sensor equipment in load zones to monitor usage and to direct drivers to free curb space.

One city cautioned that because there so many different types of deliveries, that cities should not expect that one single solution or program such as flex hours, adding smaller vehicles, etc., will resolve issues with E-Commerce deliveries. Further, a relatively large number of deliveries are now being made by passenger cars, and cities should be mindful that e-commerce delivery is a multi-modal enterprise.

5. Have you collected data regarding e-commerce delivery activity?

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- NYC DOT conducts a robust annual travel survey called the Citywide Mobility Survey (CMS) which assess the travel behavior, preferences, and attitudes of residents of the city, including finding that 41% of New Yorkers receive deliveries at least several times a week.
 - Seattle DOT's internal processes require a review of the impact to curb space when it's removed for bicycle lanes, transit lanes, or other reasons, and requires that any commercial space that's eliminated must be replaced elsewhere.
 - Seattle DOT collects data about usage, and they have included questions about delivery activity in the travel diary survey issued to City residents.
6. **What are your greatest “last mile” transportation challenges?** There was much agreement among the cities about curb management, wayfinding, off-street loading, and partnerships with the freight community.
- Allocating / enforcing curbside loading and parking space
 - Yes, allocating the correct amount of loading space (making sure that zones are long enough to accommodate all the types of trucks that are regularly delivering) is provided.
 - Improved truck communication of truck routes and restrictions, via digital maps, GPS routing systems and wayfinding signage
 - Yes; ensuring compliance with MUTCD critical.
 - Require dedicated loading space in central city buildings (“last 50 feet”)
 - Washington, DC requires off-street loading docks via PUD zoning process, but exceptions or hardships are often granted.
 - Yes. dense vertical markets demand longer dwell time, need to consider consolidation initiatives.
 - Yes, updating building codes to require off-street loading as well as a designated package drop location can increase efficiency.
 - New infrastructure projects
 - Suggestion that when creating a dedicated use zone (e.g., for a protected bicycle lane, transit-only lane, etc.) make sure to accommodate truck loading and freight or work with businesses to reschedule to off hours.
 - Land use changes
 - No answers provided.
 - Other?
 - Explore using the power of city procurement contracts to adopt safer, more efficient freight management practices such as side guards' requirements, freight consolidation, off-hour deliveries.
7. **Is there anything else that you want to add to help the City of Portland understand concerns and challenges in e-commerce logistics and how it is changing?**
- Develop partnerships with freight industry, establish a freight advisory committee or freight quality partnership to bring them to the table and work on solutions together.
 - Updating the payment schedule for commercial space usage *variable pricing” by time of day and geography.
 - Placing sensors in commercial loading spaces to monitor usage and to direct truck drivers to where there's available space.
 - Replace any spaces lost to mobility projects that remove commercial spaces.
 - Limits of some kind will need to be placed on freight and e-commerce deliveries or the City's sustainable transportation goals will suffer.
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- Understanding the full scope of the urban freight operation is an important first step in bringing all types of businesses to a planning process to understand what efficiency changes can be made easily and what will require more incentives or legislation and be longer term projects.

Insights Gained from Interviews

And while each of the cities are excited about the use of e-bikes and other smaller nonpolluting vehicles to make last-mile deliveries, industry representatives indicated that 90% of all e-commerce deliveries are still made by truck. All agree that developing partnerships between cities and other roadway authorities and shippers and carriers is critical to developing solutions.

While some cities are hopeful that encouraging off-hours deliveries will help overcome congestion at the curb and along roadways, and shippers and carriers would like to be able to transfer more of their loads to off-hour periods, their ability to do so is restricted by neighborhood noise ordinances and complaints from residential neighbors near distribution centers and delivery warehouses.

In addition, carriers and shippers expect to see an increase in handoffs from one mode to another either at distribution centers or informally on roadways and/or parking lots.

E-commerce packages and deliveries are a relatively low margin enterprise compared to delivery of business-to-business packages. The profit margins tend to be higher with business-to-business deliveries and the volume is more stable. According to the FedEx representative, that was the primary reason for the company no longer serving Amazon.

The interviews also show that shippers and carriers are extremely flexible and open to the manner in which last-mile deliveries are made, and that there's a heavy reliance on third party vendors to complete last-mile deliveries.

Considerations for the City of Portland

The comments and response from the interviewees not only verified and provided additional detail to the research uncovered in *Technical Memorandum No. 1 - Expected Growth in E-Commerce Delivery*, they also provided information about several strategies that could provide benefits to the City of Portland. These should be reviewed with the Study's Peer Review Committee and considered for the Freight Master Plan Update.

In no particular order, they are:

- **Monitoring and analyzing use of curb space** by different types of vehicles by time of day and length of time – underway in Seattle, Los Angeles and New York City.
- **Direct truckers to where there's available curb space** – examine effectiveness of the range of apps on the market to detect available on-street delivery zones such as those that already identify available on-street and off-street parking spaces, and off-truck truck parking at truck stops.
- **Variable pricing use of curb space** based on usage and intended purpose such as San Francisco's pricing program which adjusts rates every two months.
- **Off-hours deliveries** – program in New York City has been a true partnership with industry and has over 400 subscribers.
- **Incentives for emission-free last-mile delivery** – e.g., installation of electric charging stations with discounted rates for electric trucks, or preferential on-street delivery zones for electric trucks, bicycles, and other non-polluting delivery vehicles.

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- ***Developing a common off-street loading and/or pickup facility for tenants*** from a pool of adjacent or nearby developments – is commonly employed throughout Japan and Australia - can be considered during development review.
 - ***Form-based ordinances/codes for warehouse/distribution/freight developments*** – some cities have adopted these kinds of hybrid code ordinances where the City has completed due diligence including getting approval from adjacent/nearby communities which can reduce cost and development review time for developer and get the City exactly what it wants.
 - ***Central city logistics centers*** – these are very common in Paris, France, and are often part of a mixed-use facility containing recreational/institutional/cultural facilities. As discussed in Technical Memorandum No.1, they are also in place in the CBD of Chicago in a City-owned parking garage.

Appendices

Appendix A. Questionnaire issued to following E-Commerce Industry Shippers, Carriers, Freight Forwarders, and Professor of Freight Planning

City of Portland Bureau of Transportation: E-Commerce Research Project

E-Commerce Research Interview Questions

Project Purpose: Allow the City of Portland to better understand how increased e-commerce delivery is impacting the transportation network and industrial land supply and what implementing actions the City can pursue to help facilitate efficient delivery services demand while also accommodating multiple roadway user needs.

Interview Objective: Gain insights from the delivery service providers perspective on how the growing e-commerce market is shaping the logistics industry and company travel patterns and what actions local governments and other public road authorities should take to ensure efficient goods movement.

Interviewer Types:

- Carriers/Warehouse (FedEx, 3PLs, Supermarkets).
 - Customers/Receivers (Multi-tenant office buildings, private customers, individual businesses).
 - City DOTs
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Questions:

Do you wish to remain anonymous in our documentation?

1. What are your companies' top challenges and concerns in respect to serving your customers and moving freight? What keeps you up at night?
 2. What are some logistic industry trends and innovations you expect with regard to:
 - Warehousing and Fulfillment Center
 - Use of different delivery vehicles types and modes (cargo vans, electric trikes, drones, autonomous vehicles)
 - Federal, state and local regulations
 - Other?
 3. What changes, if any are you making to your business practices in response to growing e-commerce delivery demand?
 - extending delivery hours
 - adding more fleet vehicles and drivers
 - change in delivery vehicle type (cargo vans, passenger cars, delivery bike/trike, hand carts, etc.)
 - technological improvements (routing and tracking software)
 - use of centrally located fulfillment centers/warehouses
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4. What adverse impacts, if any, do you see e-commerce having on the Portland economy?
 - Higher level of workforce training needs?
 - Reduction in traditional “brick and mortar” stores?
 - Greater traffic generation from increased deliveries?
 - Other?
 5. In your view what can the City of Portland do to help facilitate efficient freight movement. What are your greatest “last mile” transportation challenges in respect to serving your customers:
 - Allocating curbside loading and parking space
 - Improved truck wayfinding signage
 - Require dedicated loading space in central city buildings
 - New infrastructure projects
 - Land use changes
 - Other?
 6. Is there anything else that you want to add to help the City of Portland and other policy makers understand concerns and challenges in e-commerce logistics and how it is changing?

Appendix B. Questionnaire issued to following City Departments of Transportation:

- Seattle
- San Francisco
- Washington, DC
- NYC

City of Portland Bureau of Transportation: E-Commerce Research Project

E-Commerce Research Interview Questions for City DOTs

Project Purpose: Allow the City of Portland to better understand how increased e-commerce delivery is impacting the transportation network and industrial land supply and what implementing actions the City can pursue to help facilitate efficient delivery services demand while also accommodating multiple roadway user needs.

Interview Objective: Gain insights from the delivery service providers perspective on how the growing e-commerce market is shaping the logistics industry and company travel patterns and what actions local governments and other public road authorities should take to ensure efficient goods movement.

Interviewer Types:

- Carriers/Warehouse (FedEx, 3PLs, Supermarkets).
- Customers/Receivers (Multi-tenant office buildings, private customers, individual businesses).
- City DOTs

Questions:

Do you wish to remain anonymous in our documentation?

1. What are your City's top challenges and concerns with respect to accommodating freight deliveries?
2. What are some logistic industry trends and innovations you expect with regard to:
 - Warehousing and Fulfillment Center
 - Use of different delivery vehicles types and modes (cargo vans, electric trikes, drones, autonomous vehicles)
 - Federal, state and local regulations
 - Other?
3. What changes, if any, are you seeing from carriers and shippers in response to growing e-commerce delivery demand?
 - extending delivery hours
 - adding more fleet vehicles and drivers
 - change in delivery vehicle type (cargo vans, passenger cars, delivery bike/trike, hand carts, etc.)
 - technological improvements (routing and tracking software)
 - use of centrally located fulfillment centers/warehouses

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4. Does your City have any pilot projects, plans, etc., underway that are associated with accommodating e-commerce delivery?
 5. Has your City collected data focused on the volume et al of e-commerce delivery trips,?
 6. In your view what can the City of Portland do to help facilitate efficient freight movement. What are your greatest “last mile” transportation challenges:
 - Allocating curbside loading and parking space
 - Improved truck wayfinding signage
 - Require dedicated loading space in central city buildings (“last 50 feet”)
 - New infrastructure projects
 - Land use changes
 - Other?
 7. Is there anything else that you want to add to help the City of Portland and other policy makers understand concerns and challenges in e-commerce logistics and how it is changing?