

Green and sustainable logistics network: micro mobility in the first - last mile



Policy Brief

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Introduction

Since the beginning of the 21 century, ESCAP region along with the rest of the World experiences growth and transformation in the last-mile logistics caused by development of electronic commerce (e-commerce). Consumers increasingly can shop for goods, groceries, prepared meals, pharmaceuticals online and have them delivered to them. Entrepreneurs have more business opportunities in retail with easier access to customers to sell their products. As a result, there is constantly increasing demand for first- and last-mile logistics with growing number of trips and the range of problems this constant growth brings: more vehicles and types of vehicles involved and thus road safety issues, bigger demand for drivers/riders, overwork, congestion, pollution. Development of digital platforms aimed at tackling labor shortages and new types of employment they create (gig economy or uberization of services) pose new challenges for social security systems. Technological advances, such as autonomous vehicles or drones, pose new challenges for policymakers. COVID-19 pandemic with its lockdowns, curfews and social distancing requirements speeded-up and scaled up these processes bringing aspects of sustainability to everyone's attention.

Current policy brief is prepared by ESCAP to improve technical knowledge of the transport and logistics sector and to support human resource capacity-building notably among developing countries in the ESCAP region. First, the brief defines what is first- and last-mile delivery within the logistics network. Second, it describes recent trends in the last-mile logistics in connection to the e-commerce development from impact on warehousing network to how the last-mile delivery options are shaped by consumer demands and highlights the explosive changes caused the COVID-19 pandemic period. Lastly, the brief discusses the measures to mitigate the adverse effects of the way last-mile logistics currently operates.

First- and last-mile delivery

First and last mile delivery are distinct links within the logistics network:

- At the first-mile segment materials enter supply chain;¹
- At the last-mile segment the goods or final products get to the final destination or to the final consumer.

By their nature, these two parts of supply chain are more complicated for managing and implementation. In terms of e-commerce, the last-mile delivery is the final step in order fulfilment process and the last delivery segment. It is the growth of the e-commerce in retail, grocery and cooked meals delivery, especially the explosive one in pandemic period 2020-2021, that made this part of logistics visible to general public and upscaled problems associated with it making the need to address them more urgent.

Last-mile delivery trips have several characteristics that define their challenges for business and impact on environment (Figure 1):

- They are often shorter than other logistic legs;
- They often lie within or go through high traffic areas;

¹ Sometimes, logistics providers might use the term "first-mile" to refer to the first step in the delivery process when the goods leave warehouse or retail space on the way to the final consumer. It is often that the parcel has to go through intermediate stops where it is consequently reloaded to smaller vehicles before it finally loaded to van, two- or three-wheeler, bike, etc. to be delivered to final address. In terms of supply chain, all these steps are part of the last-mile delivery, and in this paper the terms "last-mile delivery" and "last-mile logistics" are used in the same sense: they refer to these steps as a whole, from warehouse/fulfillment center to consumer.

- Parcels/orders to deliver are small or relatively small and are aggregated to fill in a van or other vehicle to be distributed to a bunch of addresses;
- Delivery destinations are scattered within a residential or office area;
- Though the parcels might be left at the door/ in the lobby, often the delivery must be confirmed by signature;
- Customers are expecting fast delivery and/or within predicted timeframe (next-day, same day, 3-5 business days, etc.) and for some cases delivery within in a given time window (example, between 10-12 a.m. on certain weekday).

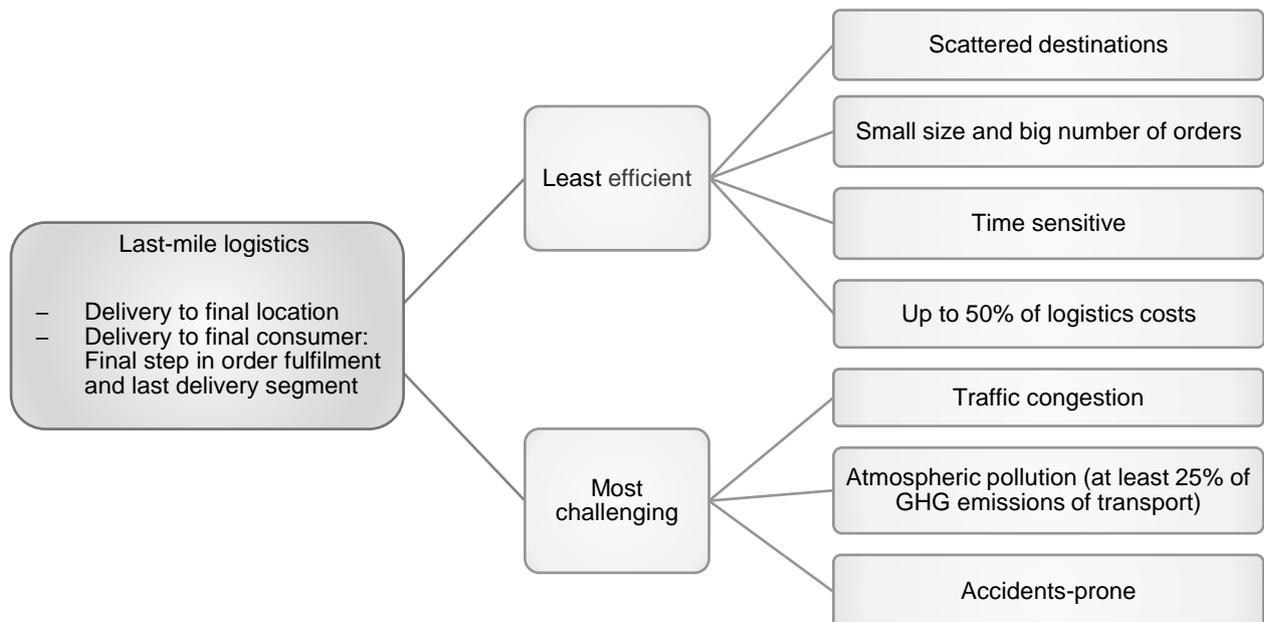


Figure 1 Challenges of the last-mile logistics

All of these mean more trips and more costs making the last-mile delivery inefficient, complicated for managing and implementation: last-mile delivery can make up to 50 per cent of total logistics costs at supply chain (1,2).

Increased number of trips to multiple addresses inadvertently affect people’s livelihood and environment:

- Local deliveries add traffic to the streets and lead to more congestion both by increasing the number of vehicles in the streets and by stopping for deliveries, sometimes obstructing traffic;
- More trips mean more emissions of pollutants: by some estimates 25 per cent of total emissions of greenhouse gases by transport might be generated by last-mile logistics activities;
- These local trips are accidents-prone worsening road safety situation (1,2).

Recent trends in last-mile logistics

For e-commerce companies, last-mile delivery is the key step when order comes to the hands of the final consumer and its accuracy, timeliness and quality is one of the main factors for the customer to return for future purchases and recommend the business to other potential clients.

If goods come damaged or in spoiled packaging, too late or lost all together, all this leads to financial, reputational losses. Therefore, consumer preferences rather than those of suppliers/sellers are the main driver shaping the service (3). Overall, Growth of e-commerce as a whole and online retail in particular brought several trends into in the last-mile logistics:

- Most directly, stable growth in number of the last-mile delivery trips;
- Growth in warehousing networks both in terms of size/ physical footprint and complexity;
- E-commerce companies creating their own delivery services to have more control over order fulfilment and to ensure its efficiency;
- Delivery options are shaped by consumer preferences in speed, timing, location, price of delivery and its price tag;
- Growing labour demand and crowdsourcing.

Trend: Warehousing and distribution network

Changes in warehousing network respond to the needs of prompt, reliable delivery and growing volumes of parcels. To increase efficiency of the fulfilment process, companies (both online/mixed type retailers and third-party logistics providers) create distribution networks with hierarchical structure of distributions points. Moreover, e-commerce created new type of distribution facilities, fulfilment centers, that serve large amount of heterogeneous goods that are sent to customers as parcels (3,4) .

Marketplaces and large online retailers use several types of facilities (actual names used by e-commerce companies, number of types used and if the facilities have clear-cut specialization or can be of mixed use vary from one marketplace/retailer to another):

1. Regional fulfilment centers

These facilities usually are set to serve a large area and they are not numerous; they store various goods of the marketplace or its sellers to be send out both as parcels for customers or distributed to other warehouses, fulfilment or sorting centers closer to consumers. For example, JD.com reports seven such facilities in China, Wildberries in the Russian Federation is reported to have 11 of them covering Eurasian Economic Union (5,6).

2. Local warehouses (front warehouses)

These facilities spread along the served area to minimize delivery times and might have hierarchy that would meet the needs or particular company. For example, to ensure its same and next day deliveries, JD.com designates 28 of its over 700 warehouses in 89 cities as front distribution centers to store high demand goods close to where this demand is (5).

3. Drop-off stations

Online retailers and marketplaces can accept goods from third-party sellers at warehouses, fulfilment centers, pick-up points. In addition to accepting goods at these points or in place of that they may have dedicated facilities for checking in the goods: drop-off stations. At these stations, the marketplace receives goods from third-party sellers to be than stored at regional fulfilment centers, local warehouses or packed as orders for further delivery. The practice is used in the Russian Federation by largest online marketplaces Wildberries.ru and Ozon.ru (6,7). In 2020, the former also started to use some of its pick-up points (initially 2.5 thousand) to check-in small batches and

loads of goods creating a case for micro-mobility in business-to-business transactions (8).

4. Sorting centers

Purpose of such facilities is to sort the packed orders (parcels) by geographic areas of their destinations. At this step the parcels/orders still not going to the final addresses; they are loaded on trucks and go to either more facilities on the way to their geographical area or to the pick-up stations or to the delivery stations.

5. Delivery stations

Delivery stations serve smaller areas and from there parcels go into the hands of couriers for the delivery to consumers. They are loaded onto smaller vehicles: minivans, cars, tricycles, cargo bicycles, etc. This is the step of the last mile delivery.

6. Pick-up stations

Pick-up stations are either lockers or shops from which customer can pick up their order. They might be as simple as one counter in a grocery/delivery shop that among other tasks passes the parcels on to the customers presenting proof of the order (Amazon in USA) or click-and-collect counter at a chain supermarket/retailer to dedicated shops with fitting rooms where customers may pay for order or return it on the spot (Lamoda, Wildberries in the Russian Federation). These stations might be mobile: an autonomous vehicle that is basically mobile locker (such as prototypes used, for instance, by JD.com, Alibaba's Cainiao or Korea Post) (9–11) or a truck from which driver distributes parcels to customers (12).

Traffic from the delivery stations to consumer is the last-mile delivery and traffic from the third-party sellers to the online retailer drop-off points/shipping service providers is the first-mile step for the order delivery.

Trend: Own delivery services of e-commerce companies

Importance of quality delivery service for e-commerce companies encourage them to open their own delivery networks and services. For example, Amazon started to build its distribution network in 1997, three years since its launch; in 2006 company launched "Fulfillment By Amazon" service that allowed the company to control fulfilment of orders of both its and the third-party sellers' customers and optimize costs and pricing for deliveries (13,14). In 2013, the company initiated work to gain control over the whole global supply chain from factory to the consumer. In 2015, it launched on-demand last mile delivery program Amazon Flex that allows gig workers to take up delivery orders in the way ride-hailing and restaurant delivery applications do (15). In 2018, Amazon Delivery Service was launched; it operates by inviting entrepreneurs to set a delivery company using Amazon technologies, value added services and assistance to serve a delivery station in a city (16). These measures made Amazon fourth largest shipping service in USA in 2019 (17). Development of the JD.com's own distribution network covering the whole supply chain up to the last mile started in 2007, four years after the preceding company started selling merchandise online (18). Alibaba created its logistics subsidiary Cainiao in 2013 (19). In 2020, in the Russian Federation, 65 per cent of parcels generated by e-commerce were delivered by the courier services of the e-commerce platforms (with Wildberries online marketplace delivering 34 per cent of total e-commerce parcels in the country) (20). It is noteworthy, that situation in e-commerce in the Russian Federation is different from the situation in which JD.com and Amazon were growing: online retails and market places started to develop first in the absence of the market of courier or third-party logistics companies, therefore, own delivery personnel and network of pick-up locations were

always the necessity. Current increase in use of third-party logistics or fulfilment companies in the country allows existing online marketplaces to diversify their last-mile delivery options and gives opportunities for new businesses in e-commerce (21).

Whether it is online retailers and marketplaces open their own last-mile logistics services to compete with shipping companies or third-party logistics and fulfilment industry growing to supplement own distribution network of said marketplaces, the result is increase in numbers of vehicles, trips and drivers. Development of restaurant meals deliveries, groceries deliveries from local shops via gig shoppers or other business models adds more trips and more types of vehicles: bikes, electric bikes, that are also less safe transport options.

Trend: Delivery options shaped by consumer preferences

Consumers prefer receiving their order quickly, when and where it is convenient to them. To meet these requirements, companies try to implement fast and superfast or on-demand deliveries. For instance, JD.com delivers about 90% of orders the same or the next day (22). Customers might also require not just same or next day delivery but a scheduled delivery within 1-2 hour window. This is often case for grocery deliveries.

Location is other aspect in which customers might need flexibility. While cheapest home delivery is the most desirable option (23) customers might need the order delivered to a locker or a pick-up point where, in case this is needed, they can also pay for it if online payments are not available for them or undesirable.

Trend: Growing labour demand and crowdsourcing

Growing last-mile logistics have increasing demand for labor. This demand is met by both new hiring and crowdsourcing/uberization. Crowdsourcing/uberization is used for on-demand (instant) deliveries. It means outsourcing the parcel delivery to the local drivers who takes the orders for such delivery via, often, mobile application the same fashion as drivers of ride-hailing services do and can perform the delivery using their own vehicle (car, minivan, bicycle, electric bike, tri-wheeler, etc.). The packaged orders – restaurant meals, bags of groceries, parcels – may be picked up by the driver from local shop, restaurant or in some cases, such as Amazon Flex, delivery station of an online retailer/market place. There are multiple examples across ESCAP region of on-demand delivery for prepared meals or groceries: some examples are Meituan (both), Fengniao Delivery (mainly delivers restaurant meals for Ele.me platform) in China, Swiggy in India, Eda.Yandex (meals) in the Russian Federation, operating in multiple countries Zomato and platforms under Delivery Hero umbrella (international Foodpanda, Yemeksepeti, leading food delivery platform in Turkey, etc.) (24–29).

Crowdsourcing the parcels/order deliveries, uberization, is new modality of jobs, bordering with self-employed status. It provides flexibility and wider opportunities for both companies/online platforms and workers. For companies, it allows access to wider pool of candidates and a tool to scale number of delivery workers depending on actual amount of orders at low cost. For workers it allows having income generating activity at hours that are free from other responsibilities and the duration of work hours they can adjust on their own.

Moreover, the digital platform for crowdsourcing deliveries, as well as other crowdsourcing platforms, bring innovations into ways of engaging workers, widen usage of fintech, create new jobs since people can pick up jobs in wider area or outside their immediate neighborhood.

However, this type of work engagement that overlaps in part with entrepreneurship often leaves workers without benefits and protection they might have if their relationships with the platform were classic “employee – employer” relationships. This type of “on-demand” or “gig” work is flexible and might be a lifeline for people who cannot commit to classic regular jobs due to

various reason. However, lack of retirement contributions, health insurance, unemployment protection in the long run might create even more inequalities (30). In case of last mile logistics, important issue is the auto insurance, incident insurance and third-party liability insurance for the trips made for online platforms under crowdsourcing model. Some platforms do cover related insurance costs, for example, Amazon Flex covers its drivers with Amazon Commercial Auto Insurance Policy at no cost for them (31).

Trend: Instant (on-demand) deliveries

Discussed above segment of instant/on-demand deliveries where the meal/grocery order is prepared and packed in local restaurant or shop and delivered by driver who picks it up in real time locally impacts not only employment practices. The success of business in the segment relies heavily on speed of delivery, so the industry coined the segment “quick commerce” or “q-commerce” (32). Therefore, to ensure this speed by alleviating difficulty of finding parking space, allowing more flexibility in routes selection and maneuverability on the road, the sector in ESCAP region often relies on bikes, electro-scooters, motorcycles and bicycles as delivery vehicles. Companies often call their delivery personnel not drivers but riders. Companies like Swiggy and Zomato, Foodpanda (at least in Philippines, Thailand, in other markets, the platform operates, cars might be acceptable) clearly state the need for a two-wheeler on their web-pages explaining how to join their delivery workforce (27,28,33,34).

Usage of two- and three-wheelers in Asia, especially in South and South-East Asia, is traditionally high: in 2014, in Indonesia, Malaysia, Thailand, Vietnam more than 80 per cent of households had a working scooter or motorcycle, 60 per cent in China and 47 per cent in India (35). Nevertheless, increase in use of two-wheelers by business in combination with push for speed to implement “instant” delivery brings to the front issues of safety of the delivery personnel and other road users in the streets and insurance coverage for injuries due to incidents. In the meantime, it also might provoke conflicts in usage of urban space by riders waiting for the orders to pick-up and pedestrians, other vehicles parking, etc.

E-commerce in pandemic and effect on the last-mile logistics

The need for social distancing, reduced mobility due to lockdowns and stay-at-home orders and people wary of venturing outside turbocharged development of e-commerce during COVID-19 pandemic period (2020-2021). Globally, online retail sales jumped 24.1 per cent year-on year in 2020, reaching \$4.29 trillion¹ (36). If in 2015 – 2019 the share of e-commerce in global retail sales was increasing by 1.2-1.8 per cent per year (from 7.4 per cent in 2015 to 13.6 per cent in 2019), then in 2020, the share increased by different estimates by 3-4.4 per cent reaching 18 per cent (Statista.com’s estimate) to 19 per cent (UNCTAD’s estimate, (37)).

In 2020, online retail sales in Asia made over half of global e-commerce, over 59 per cent. This is slightly less than 61.3 per cent in 2019 due to growth of online sales in other parts of World during pandemic related lockdowns (38). At domestic markets in Asia share of online retails grew more in 2020 than previous years. Preliminary assessments of UNCTAD showed that share of online trade in total retail sales added over 4 per cent to almost 6 per cent in China (to 24.9 per cent), Republic of Korea (to 25.9 per cent) and Singapore (to 11.7 per cent) during 2020, yet, the year before that was just 1-2 per cent (37).

More strokes to the picture are brought by statistics of e-commerce companies. UNCTAD’s data on their growth showed that most of the top 10 e-commerce business-to-consumer

¹ \$ - United States dollar.

companies globally are online goods retailers either by themselves or marketplaces or both. And for most of them growth in sales in 2020/2019 period exceeded the one in the 2019/2018 period (Table 1).

Table 1 Top business-to-consumer e-commerce companies by gross merchandize volume (GMV), 2020

Rank by GMV		Company	HQ	Industry	GMV (\$ billions)			GMV change (%)	
2020	2019				2018	2019	2020	2018-19	2019-20
1	1	Alibaba	China	E-commerce	\$866	\$954	<i>1,145</i>	10.2	20.1
2	2	Amazon	USA	E-commerce	\$344	\$417	<i>\$575</i>	21.0	38.0
3	3	JD.com	China	E-commerce	\$253	\$302	<i>\$379</i>	19.1	25.4
4	4	Pinduoduo	China	E-commerce	\$71	\$146	<i>\$242</i>	104.4	65.9
5	9	Shopify	Canada	Internet Media & Services	\$41	\$61	<i>\$120</i>	48.7	95.6
6	7	eBay	USA	E-commerce	\$90	\$86	<i>\$100</i>	-4.8	17.0
7	10	Meituan	China	E-commerce	\$43	\$57	<i>\$71</i>	33.0	24.6
8	12	Walmart	USA	Consumer goods retail	\$25	\$37	<i>\$64</i>	47.0	72.4
9	8	Uber	USA	Internet Media & Services	\$50	\$65	<i>\$58</i>	30.5	-10.9
10	13	Rakuten	Japan	E-commerce	\$30	\$34	<i>\$42</i>	13.6	24.2
11	5	Expedia	USA	Internet Media & Services	\$100	\$108	<i>\$37</i>	8.2	-65.9
12	6	Booking Holdings	USA	Internet Media & Services	\$93	\$96	<i>\$35</i>	4.0	-63.3
13	11	Airbnb	USA	Internet Media & Services	\$29	\$38	<i>\$24</i>	29.3	-37.1
Companies above					\$2,035	\$2,399	\$2,890	17.9	20.5

Note: Alibaba year beginning 1 April, Walmart year beginning 1 February. Figures in italics are estimates. GMV = Gross Merchandize Value (as well as Booking Value).

\$ - United States dollar

Source: UNCTAD, 'Estimates of Global E-Commerce 2019 and Preliminary Assessment of COVID-19 Impact on Online Retail 2020', 3 May 2021

Web-traffic is another telling statistics. In Southeast Asia in 2020, web traffic to shopping platforms rose mostly two-digits compared to 2019: the highest growth in Singapore 35 per cent, 15-21 per cent increase in Philippines, Vietnam, Malaysia, Thailand (39). The most visited of shopping platforms in Southeast Asia, Shopee, experienced 133% (2.3 times) growth in gross orders in 2020; as a result, it had 2.8 billion orders (40).

This growth in online shopping, by preliminary estimates, caused 25% increase in business-to-consumer parcels delivery (41). In 2020 in China, delivery companies (kuaidi) implemented delivery of 83 billion 360 million parcels, 31.2% more than in 2019 (42). This means serious pressure on last-mile delivery industry. In some geographical areas, obviously, this pressure was stronger and more explosive. World Economic Forum gives estimates that by 2030 demand for last mile delivery to grow 78% globally (43).

COVID-19 pandemic period sharply increased demand for online deliveries speeding up and scaling up previous development trends. Explosive growth of delivery services of all kind aggravated already existing problems of the last-mile delivery sector: its environmental impact, impact on urban transport and labor market. Even before pandemic, estimates of World Economic Forum showed that by 2030 the number of delivery vehicles in 100 top cities can grow by 36% increasing emissions of pollutants from these vehicles by 32% and congestion by 21% or 11 minutes (41,43).

Adverse impact of the first- and last-mile logistics and respective sustainable solutions

Policies to mitigate the impact of the last mile delivery on society and environment should be developed with the picture of recent trends and particularities of the industry in the focus, addressing the problems at their routes.

As mentioned above the main impact of the first- and last-mile logistics is due to its nature: big number of relatively short trips that sharply increased in course of COVID-19 pandemic period. Growing number of trips mean:

- More emissions of pollutants;
- More congestion on urban roads;
- Bigger labour demand and more prominent labour issues.

Environmental impact

Impact on environment might be mitigated by:

- Industry by switching to more sustainable solutions;
- Regulators by implementing incentives for using the sustainable technologies and solution and disincentivise polluting operation modalities and technologies.

Sustainable industry solutions may be found in several areas: first, warehousing network, then, last-mile delivery vehicles and, finally, in the trips themselves.

In the area of **warehousing network**, it is possible to reduce the emission concentration and volume within a territory by expanding the network of the delivery stations and pick-up points. Delivery stations, as mentioned above, are the points where the last mile delivery driver picks up the parcels for the last-mile delivery. Pick-up points are where customers can collect their orders themselves. Reduction in number and length of delivery trips by vans and bigger vehicles in this case is to bring down the carbon footprint of the last-mile logistics. In a study of potential impact of broader network of smaller delivery stations and pick-up points in Chicago, London and Sydney, Accenture and Frontier Economics estimated that emissions at the last mile might be reduced by 17-26 per cent and the traffic might decrease by 13 per cent by 2025 (44).

Then, companies might choose greener **delivery vehicles** either:

- More efficient gasoline/diesel vehicles with engines emitting less;
- Vehicles on greener fuel, for instance, biofuel;
- Non-motorized bicycles/tricycles;
- Electric vehicles: from vans, motorcycles, electric scooters (mopeds) to e-cargo bikes;
- Autonomous vehicles and modes: in strict terms these vehicles, drones are part of the previous category of electric vehicles, however, they deserve special mentioning as require not only change of fleet but special technologies and legal arrangements to be operated.

Lastly, there are ways to **reduce number of trips** and thus emission by:

- Better capacity utilization and parcels organization inside delivery truck;
- Providing incentives for customers (discounts, free delivery, bonus points for future purchases or free deliveries) to select “green” delivery options: some examples are delivery outside rush hours, setting a single delivery day so, if an order is delivered as

several parcels, they are scheduled to be delivered all together, picking up the parcel at a parcel locker/pick-up point, etc. For some categories of consumers, simply indicating which of the delivery options are “greener” might be enough to select them: over half of millennials point to the need for environment protection while choosing alternatives to home delivery (41);

- Installing receiving parcel lockers/delivery boxes at residential buildings/addresses. Home delivery should be received by the customer in-person. In case the customer was not at home and the situation is not allowing for leaving the parcel at the door unattended there would be repeating trip or trips. To avoid this, parcel lockers might be installed at residential building, increasing the pick-up point networks or individual reception/delivery boxes might be used. The later is not the widespread practice yet, though there were research and trials (1,12,45);
- Routes optimization, calculated using carbon emissions of particular types of vehicles: solutions to the vehicle routing problem and respective algorithms are important part of operations of any delivery business, however, they might take into account only time, number of stops, fuel consumption. Adding the emissions by types of vehicles is a way to set a route and assign vehicles to them in a way to reduce emissions as well (1,46);

Regulators and authorities might provide incentives to the industry to switch to more sustainable option:

- Regulations on emissions and requiring low or zero-emission vehicles:
In addition to standards on emissions of pollutants by engines of light-duty, heavy-duty road vehicles, quality of fuel used, and respective mandates, countries might set the timeframe to fully switch zero-emission vehicles (electric or hybrid, on hydrogen fuel) or to reach certain percentage of them in the fleet of light-duty vehicles, two- and three wheelers, the categories of vehicles used at the last-mile logistics.
- Adopt stricter fuel consumption limits, that would make electric vehicles more attractive than the ones with internal combustion engines, for instance, electric two- and three-wheelers over motorcycles (47).
- Adapt taxation regime to create incentives to switch and keep in the fleet electric vehicles by transferring environmental, infrastructure costs of operating, owning vehicles to less desirable models via:
 - tax exemptions for purchasing electric vehicle (for example, China’s tax exemption for purchasing new energy vehicles with regularly updated list of subjected passenger and freight vehicles models (48)),
 - purchase subsidies (for example, Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles Program in India that subsidises end consumer for purchase of eligible vehicle, including two-, three-wheeler, light commercial vehicle, etc.; size of subsidy depends on type of battery and fuel (49));
 - scrapping programs that provide subsidies for purchasing a new zero emission vehicle in case of trading-in older and less environmentally friendly car, such as Ecobonus purchase and scrapping subsidies scheme of Italy (50),
 - registration tax rebates and/or ownership tax reduction/exemption from for electric and hybrid vehicles,

- exemption of import duties/zero duties on import of electric vehicles, batteries for them (Kyrgyzstan (51)), etc.

Important part in developing plans for implementation of electric vehicles, drones is end of life/end of service issue. The biggest concern is the vehicle battery that is toxic waste, dangerous to be left at a landfill. Estimates of 146 million electric vehicles on road globally by 2030 and expected life of the batteries 15-20 years might mean respective number of battery units to scrap in 2040-2050s (52,53). Bearing in mind complexity, energy intensity and waste production of the current technologies of battery recycling, it seems important to incentivize both manufacturers and logistics industry to consider issues of dealing with batteries and old vehicles at the very beginning: during vehicle design for manufacturers or negotiating purchase terms from manufacturers for the logistics companies. Indeed, in 2017, China published the Plan on Extending manufacturer responsibility, the Plan extends responsibility on environmental and resource protection of a manufacturer on all stages of product life cycle from design to distribution, usage, to scrapping, recycling and final disposal. Among other items, the Plan explicitly requires manufacturers of electric vehicles and their batteries to take recycling and disassembling into account while designing, establish channels to recycle the batteries, recycle and reuse parts and vehicles (54).

- Regulations on autonomous vehicles, delivery drones:

Current road traffic regulations are created with having driver in mind: driver is the party responsible for safe operation of the vehicle, legally liable for incidents during driving from small infringements of the traffic rules to causing serious accidents. Autonomous vehicles do not have a driver by definition and thus safety concerns are paramount and the issue of legal liability is critical. The limits of the technology should be tested and the aspects to cover by respective regulations should be carefully developed. In this regard, for example, Beijing issued permits to operate autonomous vehicles only on some roads in Beijing Economic-Technological Development Area in Daxing district to selected group of companies: JD.com, Meituan, Neolix (55). It is noteworthy though, that introduction of autonomous delivery vehicle might require overall reconsideration of traffic within an urban area to lower the speeds in the street, reducing vehicular traffic volume and encouraging/facilitating walking, cycling. This not a coincidence that such autonomous delivery vehicles are often first introduced and tried out in university compounds with limited vehicular traffic (10,11).

- Reduce or eliminate fees related to vehicles operations:

For example, parking fees might be reduced or fully subsidized/cancelled. Some cities in China use an array on options for parking of zero-emission vehicles: first 1-2 hour free parking, 50 per cent off parking fees or totally free parking (56).

- Create infrastructure needed for electric vehicles:

Network of recharge stations is important part of the promotion of electric vehicles for both private and business users and this is widely understood by policymakers. China, for example, adopted in 2020 Plan on Development of Production of Vehicles on New Energy Sources 2021-2035 in which creation of infrastructure for electric vehicles, especially, recharging stations is one of the main work directions (57). Another example is Canada: to support total switch to electric and hybrid types of passenger and light-duty vehicles by 2035, Canada implements Zero Emission Vehicle Infrastructure Program to build network of charging and hydrogen refuelling facilities in the country (58). To benefit last-mile logistics, part of the network should be accessible by delivery

vans, safe for delivery two-/three-wheelers and located to both serve well to the deliver companies and to not create congestion at office or residential areas (44).

- Provide preferences for electric, hybrid vehicles on road and on urban vehicle infrastructure, such special lines for green vehicles, dedicated parking spots, longer stops for delivery of parcels, etc.

Road Congestion

The solutions that bring down the road congestions are intertwined or the same that reduces environmental impact of the last-mile logistics. And they also can be at both industry and regulators, urban planners' sides.

Industry might contribute to the alleviating the road congestion by:

- By using real-time data on road situation and dynamic re-routing to avoid areas where traffic is currently high;
- Capacity sharing between different last-mile delivery companies for delivery and return of parcels; usage of parcel lockers;
- Incentives for customers to use pick-up points: stationary or mobile, staffed or unmanned, with parcels lockers;
- Rolling out/accepting reception boxes as delivery destinations;
- Implementing nighttime deliveries that might be even more acceptable by cities in case the deliveries are made by electric vehicles that tend to be less noisy.

Sustainable **urban planning solutions** might include:

- Double-parking enforcement;
- Dedicated parking zones for delivery vehicles;
- Express lane privileges for delivery vehicles: urban planners might allow delivery vehicles to use high occupancy vehicle lanes, bus lanes during peak hours. Such privileges might be also based on whether the vehicle is electric or hybrid to further incentivize switch to desirable types of vehicles;
- Special lines for two- and three-wheelers;
- Real-time traffic lights.

Analysis by World Economic Forum showed that implementation of these measures across entire delivery fleet might bring congestion down by 25-30 per cent by 2030. However, the main factor in emission reduction would be switch to zero-emission vehicles: in the scenario where the total switch to the electric vehicles was not included estimates of emissions went down only 10 per cent by 2030; the total replacement of vehicles for electric ones was estimated to reduce emissions by 30 per cent (43).

Two- and three-wheelers are increasingly used for both personal use and for the last-mile deliveries. Special lines separated by barriers for growing number of this motorised two-wheelers is crucial road safety measure that would alleviate congestion as well. Cities might decide whether to have special lines for motorised two- and three-wheelers, should they include only two-wheelers or both of these types depending on the vehicle mix on their roads and trends in daily, weekly, monthly traffic volumes. It is noteworthy, that the experiments with dedicated motorised three-wheeler lanes did not show benefits (59).

This list of measures to tackle emissions and congestion issues is not exhaustive. Cities with different population size, vehicle mix, different structure of last-mile delivery (emphasize on pick-up points in cities of the Russian Federation or home delivery in Chinese cities, whether on-demand deliveries are rather done by bikes, electric scooters or cars, etc.) might find different mix of measures beneficial. City governments might work with logistics players on experimenting with developing sustainable solutions. They can try different rules, incentives, technologies discussing and adjusting them based on what they observe in their streets. Successful solutions, depending on which end they are implemented, business or regulators, city governments, might be copied by other cities or introduced by the e-commerce platforms in more territories where they do business.

Workers' protection

With growing number of last-mile delivery workers and popularity of crowdsourcing arrangements for their engagement, measures should be taken to ensure protection of their rights. While traditionally employed delivery personnel might not need this, rights of crowdsourced personnel, often called gig workers, for social security protection, such as medical insurance, accident insurance, medical leave, contribution to retirement and other depending on legislation of countries, should be enforced.

COVID-19 pandemic showed that last-mile logistics companies are able to provide workers protection: DiDi Chuxing in China has launched a special COVID-19 insurance program and created a \$10 Million Relief Fund for COVID-19 Infected Drivers in all countries its operates, similar funds were launched and/or paid medical leaves were provided by Amazon, DoorDash, Lyft, Uber companies in countries of their operations (60).

However, researchers warn against leaving too much in social protection in the hands of the companies, calling to the regulators to create flexible, universal and equally accessible, transferrable (easily moving with the worker then they change platform, employer) solutions using the tools and opportunities provided by technologies (30). Nowadays, the same technologies that power on-demand work platforms allow to create digital government solutions that would facilitate keeping track on social security contributions, employment changes, setting systems for filling needed documentation to obtain medical leave, disability, unemployment and other benefits for such fluid arrangements as long as rules on the taxation, social security payments and disbursement, medical insurance coverage are established by regulators.

Innovations

In conclusion, let's take a look at some examples of autonomous last-mile delivery technologies. In 2016, McKinsey company predicted that the last-mile logistics is moving towards a future with at least 80 per cent of deliveries is made by autonomous ground vehicles and drones. At the moment though, as discussed above, the technologies are just being tested while the required legal basis and understanding on whether and how the urban and rural space should be adapted to allow their operation are at the early, inception stage.

Drone technology is being tried by e-commerce companies across Asia and one of the examples with longer history is JD.com drone program. Drones under this program are in use since 2016 (61). There are several models, for both light (5-30 kg) and heavy (500 kg, 800 kg) load. Drones are used for deliveries in less accessible, often rural, areas and for crisis relief. They are loaded at a delivery station and then fly to a village promoter in the settlement of destination who then delivers them to consumers; at a point there were about 300,000 village promoters

(61). In 2019, there were 100 drone routes and 400 thousand minutes of flight accumulated (62). Drone delivery was also tried by Japan's Rakuten for deliveries to remote islands, mountain settlements, Fukushima area (63).

Autonomous delivery vehicles can address problems of lack of delivery workers and overworking while meeting the consumer demand for instant delivery. Being electric vehicles, they are one of the ways to reduce carbon footprint of logistics. The autonomous delivery vehicle might look like a moving parcel locker, but the technology behind it is much more complicated. It should allow the vehicles to recognize and avoid obstacles, plan trajectory at complicated intersection, respond to traffic situation, so to say to have the same capability as a self-driving taxi or car. In China, Meituan Group started use of such vehicles for restaurants take-out and groceries in 2018 (64). JD.com put autonomous vehicles in operations in 20 cities in China specifically to work on last-mile logistics and is testing technology in Beijing (9). Cainiao, logistics subsidiary of Alibaba plans to develop self-driving delivery trucks and introduce them in 2022 (10). In Japan, autonomous delivery vehicles are tried by e-commerce, fintech, communications and digital services company Ratuken and are planned to be tested by Japan Post in cooperation with Yamato (delivery service) (65,66).

Conclusion

Today's economy greatly benefits from technological development enabling electronic commerce and the sector is most likely to grow. First- and last-mile logistics is bound to follow with its own growth for foreseeable future.

The task for both businesses and policymakers is to ensure that this growth is sustainable for environment and society. To achieve this, they should take measures to reduce number of trips, replace polluting vehicles with zero-emission ones while being mindful of not replacing the issue of tailpipe emissions with other ones (millions of dead toxic batteries across landfills, for once), use algorithms to optimise routes, adjust warehousing system and encourage more use of pick-up points by customer instead to home/office delivery, work on parking rules and traffic lanes usage rules, address issues of road safety for both delivery vehicles and drivers/riders and pedestrians, protect delivery workers' rights.

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