DELIVERING SUSTAINABILITY: URBAN FREIGHT IN DEVELOPING CITIES

Module 1g
Sustainable Transport: A Sourcebook for Policymakers in Developing Cities
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OVERVIEW OF THE SOURCEBOOK

Sustainable Transport: A Sourcebook for Policy-Makers in Developing Cities

What is the Sourcebook?

This *Sourcebook* on Sustainable Urban Transport addresses the key areas of a sustainable transport policy framework for a developing city. The *Sourcebook* consists of 35 modules mentioned on the following page. It is also complemented by a series of training documents and other material available from http://www.sutp.org.

Who is it for?

The *Sourcebook* is intended for policy-makers in developing cities and their advisors. This target audience is reflected in the content, which provides policy tools appropriate for application in a range of developing cities. The academic sector (*e.g.* universities) has also benefited from this material.

What are some of the key features?

The key features of the *Sourcebook* include:

- A practical orientation, focusing on best practices in planning and regulation and, where possible, successful experiences in developing cities.
- Contributors are leading experts in their fields.
- An attractive and easy-to-read, colour layout.
- Non-technical language (to the extent possible), with technical terms explained.

How do I get a copy?

Electronic versions (pdf) of the modules are available at http://www.sutp.org.

Comments or feedback?

We would welcome any of your comments or suggestions, on any aspect of the *Sourcebook*, by e-mail to sutp@sutp.org and transport@giz.de, or by surface mail to:

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Sustainable Urban Transport Project

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Introduction

The development of urban agglomerations depends heavily on a reliable and efficient flow of goods and materials. This movement of goods - if not properly organized and regulated - has a range of negative impacts. Delivering sustainably in the urban freight sector in developing cities is highly complex due to the intricate nature of and interlinkages between the multitude of stakeholders and their interests; the decisions they take that determine the actual flow of materials and goods; and the characteristics of the networks that support such systems. The rapid evolution of urban freight due to digital transformations and technological advancements, changing socio-economic landscapes and consumer preferences pose risks and opportunities moving forward. Decisive action is necessary in order to ensure urban freight systems are geared towards sustainable pathways.

Globally, the importance of and need for promoting sustainable and climate-friendly urban freight is increasingly being recognized. A whole new variety of solutions are emerging, as fuelled by developments in technology, changing policy paradigms, as well as public mindset and participation. Developing cities will continue to urbanize and expand in the coming decades and will thus face increasingly difficult challenges relating to the planning and management of urban freight systems. Rapid urban population growth, increasing standards of living and consumption, increasing digitalisation and technological advancements, and changing business models are critical drivers that will accelerate the demand for urban freight movements in developing cities.

The ability to effectively address emerging pressures and impacts brought about by the intensification and further evolution of the urban freight sector will heavily depend on the ability of urban leaders in instituting dedicated long-term frameworks that capture visions that embody systemic sustainability with the accompanying locally appropriate measures that suited towards addressing the issues.

Strengthening internal capacities of urban authorities is crucial in ensuring that urban freight is given the much-needed governance attention that it deserves. This is a critical pillar towards the strengthening of the integration of urban freight into governance instruments and actions in effectively addressing the emergent needs of rapidly evolving stakeholder systems; and in effectively utilizing increasingly available technological solutions.

At a broader level, strengthened participation of the other actors within urban freight systems needs to be established through appropriate actions, whether they take the form of policies and regulations, information provision and education, and the establishment of mechanisms that enable participation and collaboration. Institutionalized dialogues and partnerships lead to a systemic elevation of awareness regarding the evolution of the policies, technologies, infrastructure, and stakeholder landscapes, and enables coordinated approaches towards setting of pathways and selection of appropriate solutions and actions. The old cliché goes, there is no silver bullet towards effective urban freight planning and management. However, a consolidated approach that is hinged on stakeholder engagement, evidence-based approaches, and the utilization of advantages being brought about by technology can potentially lead towards leapfrogging towards sustainability in the sector.

While urban freight movements may be local, urban freight is by no means a sole function of actors and processes that occur within the boundaries of a city. Urban freight has become more evidently global, local landscapes are influenced by global actors, and global practices. Therefore, it is also of importance that local authorities strengthen awareness and linkages to developments that are taking shape outside their boundaries, to effectively anticipate impacts that are being brought about by disruptive transformations in the sector.

Lastly, a holistic mindset that recognizes that urban freight is intertwined with wider economic, social, and environmental systems is needed. The recognition of such would enable paradigm shifts towards more sustainable ways to produce and consume by setting up systems that achieve better linkages between production and consumption; more equitable distribution of benefits achieved through urban freight; and improve the liveability of our cities.

This sourcebook module aims to assist policy makers in developing Asian countries, particularly those involved at the urban level, move towards making the urban freight sector more sustainable. The sourcebook module lays out a set of core actions that aim to serve as a basis of action for policymakers. Additionally, the module provides an overview of the measures and techniques that have and are being employed in the urban freight sector globally. The document is structured as follows:

Chapter 1: Towards Sustainable Urban Freight

This section discusses policy options and measures that can be used in addressing urban freight related issues. These measures have been structured to align with the "10 Principles of Sustainable Urban Transport" by the GIZ.

While this module focuses on the underlying actions and example interventions of the urban freight sector, a process that would institute long-term plans and programs is highly recommended. Considering the pace at which developing cities are growing, investing in long-term planning processes now would avoid significant amounts of costs associated with the potential growth of urban freight externalities.

Chapter 2. Why it's essential cities move towards sustainable urban freight

This chapter provides additional background on the role of urban freight, sector dynamics, challenges and opportunites:

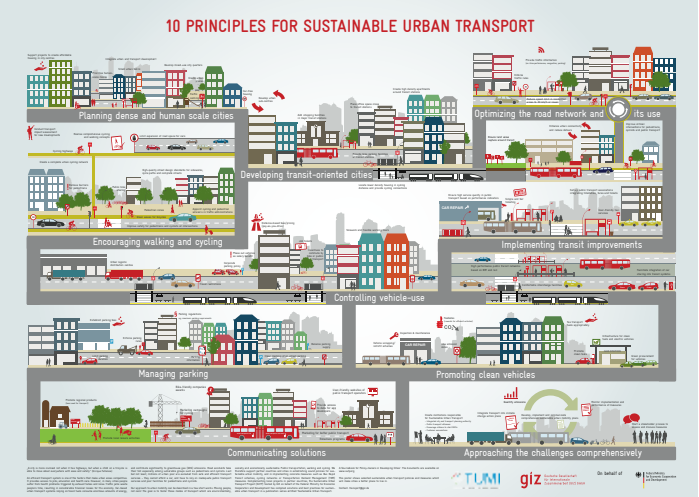
- Section 2.1. describes the concept of urban freight, its importance to urban development, and outlines the complexities surrounding the sector.
- Section 2.2. presents the current state and trends and future projections of urban freight.
- Section 2.3. discusses the common challenges associated with the governance of urban freight.
- Section 2.4. discusses opportunities towards making the sector more sustainable.

1. TOWARDS SUSTAINABLE URBAN FREIGHT

This chapter aims to generate momentum and action by policymakers and planners to move towards more efficient, safer and sustainable urban freight services. The module provides guided measures and key concepts associated towards sustainable urban freight. The starting point and developmental contexts will be different in each city. Some measures could be implemented by most municipal authorities immediately, with little planning and development work. Other concepts are more complex and are only feasible in the mid or long-term

More detailed guidance can be found in documents that are included in Annex 1.

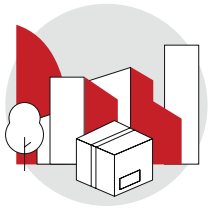
Based on the Avoid-Shift-Improve (ASI) approach, GIZ has designed a poster on 10 principles for sustainable urban transport. In the context of this module, these principles are complemented with measures and ideas in the field of urban freight.



This brochure is complementary to the EcoLogistic Principles developed by ICLEI: https://sustainablemobility.iclei.org/wpdm-package/ecologistics-principles-poster-english/

Actions	Description
1. Integrating appropriate urban freight systems for cities	Urban freight is a core component of urban transport systems and should be treated as such. Cities must strive to understand the current state and trends of urban freight in their jurisdictions, integrate urban freight considerations into wider plans, and make use of readily available instruments to help the integration of urban freight into urban governance.
2. Developing multi-modal urban freight-oriented cities	Urban freight is a complex system whose specific requirements can be served by different transport modes and combinations. Depending on the tasks, contexts, and stakeholders, shifting towards optimal modes and modal combinations should be sought.
3. Optimizing the road network and its use	Urban freight tasks are predominantly fulfilled by road-based vehicles. Cities can make use of measures that are easy to implement in the immediate term to improve current situations while longer-term measures are put into place.
4. Inclusion of active modes in urban freight	Promoting the use of active modes in urban freight can result in significant immediate benefits, as well as long-term transformative impacts to the way our cities functions and the health of its citizens.
5. Implementing urban freight systems improvements	Improving the flow of information and materials lead to systemic transformation. This can be achieved by measures that focus on promoting appropriate consolidation and coordination within the system, or through the provision of physical and digital solutions.
6. Controlling vehicle use	Avoiding unnecessary - and minimizing overall - vehicular activity in the fulfilment of the urban freight tasks is one of the basic tenets of sustainable urban freight. Controlling vehicle use is also an important principle to remember when it comes to addressing urban freight-related issues in specific areas.
7. Managing parking, loading, and unloading	Urban freight movement is not only about the movement of vehicles within the network links. Significant issues arise due to the lack of, or mismanagement of parking, loading, and unloading facilities.
8. Promoting clean vehicles	Even with efforts to avoid and minimize motorized movements, and to shift movements towards optimal modes (and modal combinations), motorized vehicles are, at the end, still needed. Improving the vehicle fleets by promoting the ownership and usage of cleaner vehicles (and fuels) would ensure that the negative impacts of motorized movements are reduced.
9. Communicating solutions and educating stakeholders	Raising the profile of the importance of urban freight requires a continuous, and comprehensive strategy towards educating the different stakeholders. Communicating the solutions also entice participation towards innovation and improvement.
10. Focusing on comprehensive approaches	Urban freight does not stand on its own. It is intertwined with multi-scalar, multidimensional issues, and significant synergies can be reaped if such are consciously sought.

10 ACTIONS TOWARDS SUSTAINABLE URBAN FREIGHT



ACTION 1

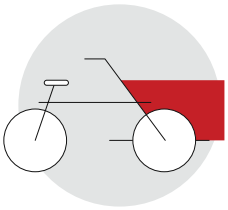
Integrating appropriate urban freight systems for cities

ACTION 2

Developing multimodal urban freight oriented cities

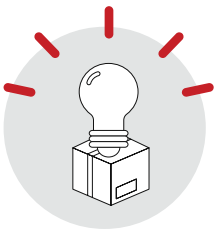
ACTION 3

Optimizing the road network and its use



ACTION 4

Inclusion of active modes in urban freight



ACTION 5

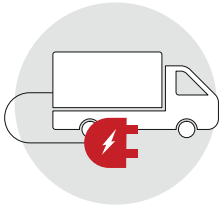
Implementing urban freight systems improvements

ACTION 6

Controlling vehicle use

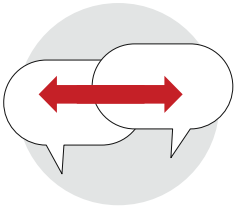
ACTION 7

Managing parking, loading, and unloading



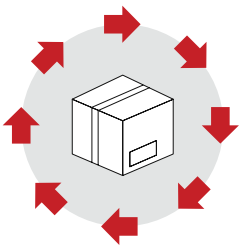
ACTION 8

Promoting clean vehicles



ACTION 9

Communicating solutions and educating stakeholders



ACTION 10

Focusing on comprehensive approaches

1.1. Action 1: Integrating appropriate urban freight systems for cities

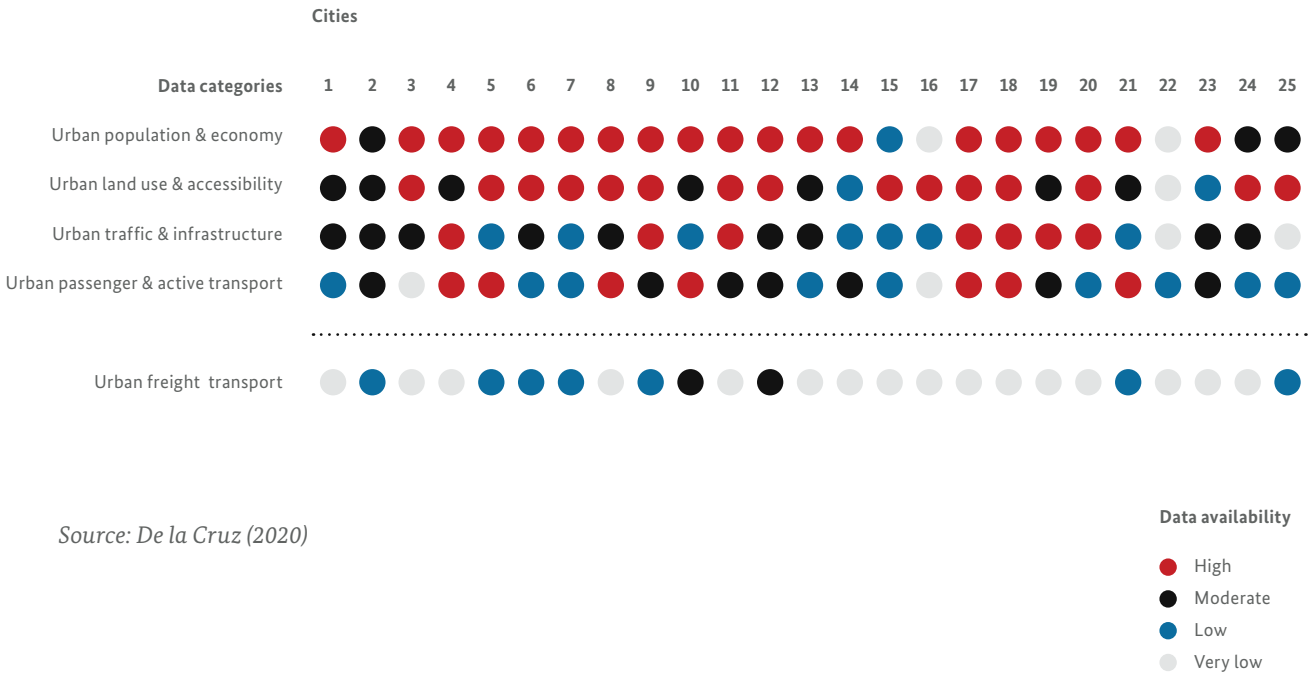
Transportation planning and management in many developing cities has paid little attention to urban freight. The importance of integrating sustainable urban freight into transportation plans and policies is essential in maintaining the functions of the urban ecosystem. The interaction between passenger and transport sub-systems should be recognized and emphasized in the formulation of urban transportation plans and measures. The way urban freight distribution channels are designed and implemented directly impacts how much people move, how they move, where they move and how they feel moving. Robust urban freight datasets are crucial, as well as the integration of urban freight considerations into building codes and planning documents. These are often potentially within the purview of local government units, and these measures can potentially have both long term and short-term impacts (NAS, 2013).

Urban freight data

Understanding the basic elements of transportation – demand, supply, infrastructure – through the provision of updated and representative data is essential for policymaking and governance. Freight demand, for example, is regarded as something that is derived from complex socio-economic systems, and it is essential to estimate the demand through representative surveys (Carotenuto et al., 2018). However, such data is often scarcely available in many developing cities, which then limits the insights towards meaningful strategy and policy development. The scarcity of such data may be due to a variety of factors related to costs, lack of trust among the relevant stakeholders, as well as the lack of dedicated and sustained resources to conduct such data generation and information packaging activities.

The neglect towards urban freight data collection is also present in more developed regions, such as in Europe. Even in advanced economies, while having relatively good consumer shopping trips, these datasets do not include significant data on basics such as deliveries and pickup trips (Gardrat, 2016). A recent survey was conducted in 25 European cities, with the results highlighting the significant absense of data on urban freight (De La Cruz, 2020).

FIGURE 1. STATE OF URBAN TRANSPORT DATA IN EUROPEAN CITIES



Source: De la Cruz (2020)

Key questions towards selecting the method and the scope of data collection are often related to the desired spatial and temporal coverage, the freight modes that are involved, level of accuracy desired, and most importantly, the resources that can be used for the data collection. Such questions are directly related to the objectives set in the relevant plan that is developed (see the sub-chapter 1.10). What would the city like to achieve, and how can it get there? A mapping of, and engagement with relevant stakeholders is crucial in determining data collection efforts, as these would set the base by which questions are formed, and to determine what data is already available.

The data and information generated through modern information and communication technologies also pose opportunities for promotion of bundling of consignments, better trip planning, and can feed into better urban policies and management practices such as traffic management. Detailed guidance on urban freight data and indicators can be found in NCFRP Report 14 (National Academies of Sciences, Engineering, and Medicine, 2012), Allen (2012), and van den Bossche et al. (2017).

FIGURE 2. URBAN FREIGHT DATA COLLECTION METHODS AND TYPES OF DATA GENERATED

Source: Allen et al. (2012)

Aside from the in-field and/or information technology-enabled data collection techniques, gathering data and insights through in-depth interviews, focus group discussions, and other similar techniques are critical in ensuring that logic and interlinkages between the different factors are established, and that factors that are not captured by numbers are unveiled. Mechanisms that enable public participation towards the gathering of and processing of important data (e.g. origin-destination, routes, etc…) relating to passenger and freight movements are now becoming more available. For example, the mypolislive.net platform enables the consolidation of crowdsourced GPS data to be able to conduct freight traffic profiling through the visualization of most frequent delivery stops, and most popular routes taken, as well as correlating freight traffic with the traffic related to passenger traffic (Liotopoulos, 2020).

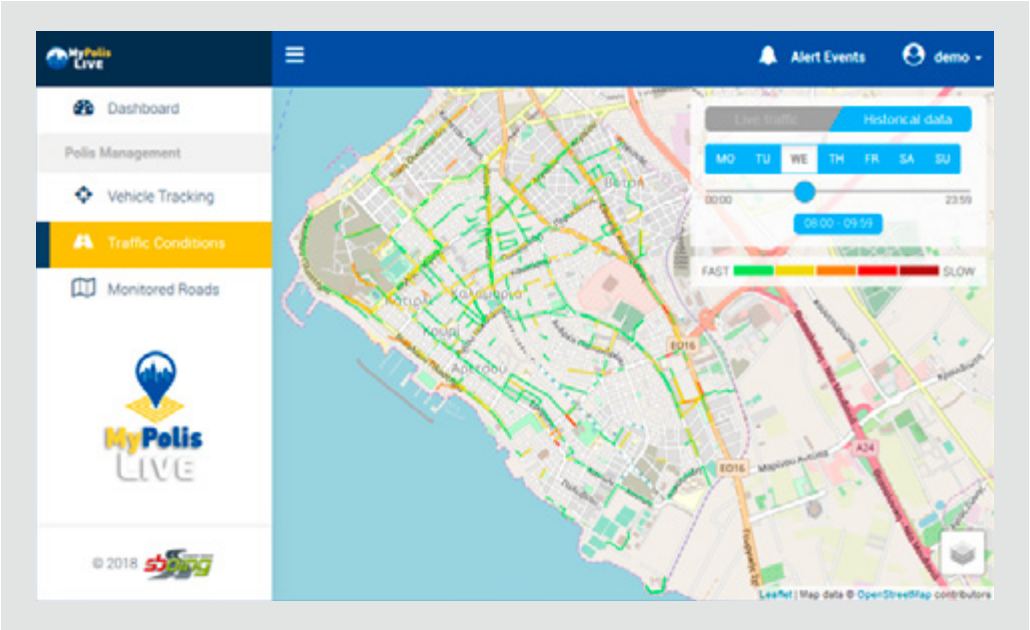
Open data systems are also enabling cities to maximize the utility of their data by granting access, and the right to use, reuse, and distribute such data for whatever intended purpose. Such a mechanism was used by New South Wales (Australia), which has opened its datasets which allows digital developers to create solutions (e.g. apps) which they can monetize, but at the same time, serve the public (TNSW, n.d.). Closely monitoring the development of e-commerce activities, and consciously incorporating relevant factors into development plans and policies will ensure that cities will be well adjusted to changes being brought about by overarching technological advancements. Increased cognizance of the importance of data on e-commerce is also needed due to the potentially significant impacts of such induced urban freight traffic, coupled with the fact that the state of accessible data on e-commerce and its associated movements (e.g. number of e-deliveries and pick-ups) is currently very poor (Dablanc, 2018).

Integration of Urban Freight Considerations into Land Use Plans

Urban freight transport is often neglected in land use planning This is the result of a lack of awareness and knowledge about the subject and the fact that passenger transport is most often a higher priority for many local and regional planning entities. Thus freight often falls into the cracks and is not integrated into land use and infrastructure planning in an appropriate way.

An urban freight-inclusive land use plan is needed to ensure that the urban freight needs are reflected in the planning and later investment programming of the city. The amount of resources (e.g. floor area) needed, the location of the facilities, the prioritization of the use of the zones of the cities are some of the key points that need to be integrated in such plans. In Orlando, United States, for example, a “Freight, Goods, and Services Mobility Strategy Plan” was developed to guide long-term infrastructure decisions that aim to achieve a balance between goods and passenger transport movements.

FIGURE 3. CROWDSOURCING PLATFORM: MYPOLISLIVE.NET



Source: Liotopoulus (2020)

The Paris Local Land Use Plan, for example provides for several key concepts that guide how it plans for and manages the transportation of goods in the city such as: implementing logistics in some urban areas; giving priority to the setting up of logistics activities in areas with rail or water connections and requiring main generators of freight to integrate delivery areas that are proportionate to the freight volume that they generate within their premises (National Academies of Sciences, Engineering, and Medicine, 2013).

Further integration of wider sustainable urban freight considerations is also encouraged. For example, the integration of urban freight considerations towards the development of electric charging infrastructure master plans would make a better case for such charging infrastructure systems. Shenzhen (China) utilized big data analysis to better understand the amount of charging stations needed and the optimal location of such to aid accelerated shifting towards e-mobility (GIZ, 2019). Overall, the integration of urban freight into land use plans needs to consider interrelated landscapes that consider political, socioeconomic, infrastructure, mobility, and information technology (adapted from Rodrigue et al, 2017). Additional information on urban logistics plans is available in Chapter 1.10.

Zoning and Building Ordinances

Setting policies and guidelines that integrate freight deliveries into zoning and building ordinances is one of the key tools at the disposal of local authorities. Zoning regulations focus on the shape, location, and operation of built components and essentially is a key tool for authorities for determining the overall direction of how goods are moved in urban areas.

For example, Barcelona requires that all bars and restaurants must allocate a storage area for bottles and drinks of at least 5 square meters. The logic behind this is that the bars and restaurants will not need a daily supply of beverages if they have sufficient space to store relatively adequate volumes and thus reduce the need for more frequent deliveries (NAS, 2013).

Local authorities can also set requirements for the presence and design of off-street loading zones, and loading docks, and determine the location, size, configuration, and operations (e.g. time of day, etc...) of other physical system facilities such as consolidation centres. Another relevant instrument that can be looked at by local governments are construction site policies, particularly in rapidly developing cities with intensive construction actvities. Additional on-site (off-street) space for delivery vehicles can be required as part of the construction regulations.

Overall, the key question to ask whenever zoning and building regulations are reviewed is whether they are still effectively covering the emergent system components and facilities that are being brought about by advancements in how goods are being demanded and supplied.

1.2. Action 2: Developing multi-modal urban freight-oriented cities

Urban freight is a complex system whose specific requirements can be served by different transport modes and combinations. Depending on the tasks, contexts, and stakeholders, shifting towards optimal modes and modal combinations is neccessary.

Multimodal transport is the combination of at least two or more different modes of cargo.[1] Multimodal transport enables a combination of movements – maximizing the comparative advantages of different modes and vehicles, depending on the context. Multimodality improves eco-efficiency on the line-haul, as well as contributes to the viability of a consolidated cargo distribution in the urban space (Herzog, 2010).

Finding the right combination of vehicles for the urban freight tasks

Urban freight transport is a collective result of logistics decisions made by the various players involved in the relevant processes and these decisions are manifested in two opposing forces that are very relevant to the discussion of modal choice in urban freight (Dablanc, 2018):

- Mass freight mobility which relates to the consolidation and reduced frequency of deliveries, through the utilization of larger vehicles to achieve economies of scale;
- Atomization which involves greater frequencies of deliveries, done by smaller vehicles.

[1] *Multimodal transport differs primarily with intermodal transport as multimodal transport is usually offered by carriers through one contract to the shipper, while with the latter, every part of the process is contracted with a different provider.xt needed*

TABLE 1. DELIVERY VEHICLES AND FREIGHT TRUCKS

Category	Van	Light delivery vehicle	Medium-sized truck	Heavy-duty truck	Truck and trailer
Weights ratio					
Gross weight (kg)	3,500	7,500	15,000	24,000	40,000
Payload (kg)	1,600	4,400	10,500	17,500	30,400
Payload/gross weight ratio	0.46	0.59	0.70	0.73	0.76
Volume and road space usage					
Load capacity (m3)	7.34	32.86	51.93	60.44	98.83
Road space occupation (m2)	47.51	78.60	103.71	115.89	168.00
Road space (m3/load capacity m3 ratio)	6/47	2.39	2.00	1.92	1.70
Energy consumption and emissions					
Diesel per 100 km	9.8	14.5	25.0	32.0	44.0
CO2 (g/km)	245	363	625	800	1,100

Source: Herzog (2010) , Notes: The figures are illustrative. It must be noted that various factors (vehicle-related, environment-related, operations-related) would play roles in determining the level of emissions emitted by different vehicles.

The movement of goods to, from and within cities would involves different types of vehicles, due to the differences in terms of the task at hand and the available infrastructure. Movement of consolidated goods to and from cities need to be done through higher capacity vehicles. The use of smaller vehicles may be more useful in areas that are served by smaller roads.

The optimization of the types of vehicles to be used is intertwined with discussions relating to infrastructure decisions. For example, the installation of small low-cost terminals that are close to the city would minimise the need for large long-haul trucks. Choosing the right combination of vehicles, as well as urban distribution system components can potentially reduce costs, as well as externalities, significantly.

The integration of facilities for active modes for urban deliveries is also worth looking into (see Section 2.4). Innovative schemes that integrate final delivery by cargo bikes are also a possibility that is now being enabled by advancements in information technology. The Goulburn Street Courier Hub in Sydney, Australia is an interesting case that integrates non-motorized last-mile deliveries by providing minor infrastructure (lockers) where participating van drivers can hand over the times to a bike or walking couriers who would then conduct the final leg of the delivery.

Shared Passenger-Cargo Systems

Setting up public transport systems that are attractive enough to citizens to use as a main mode for their shopping trips is also a key consideration towards reducing the need to use private motorized vehicles to do shopping trips. The convenience, safety and overall user experience all play a key role in determining such mode choices. Studies were recently conducted in the

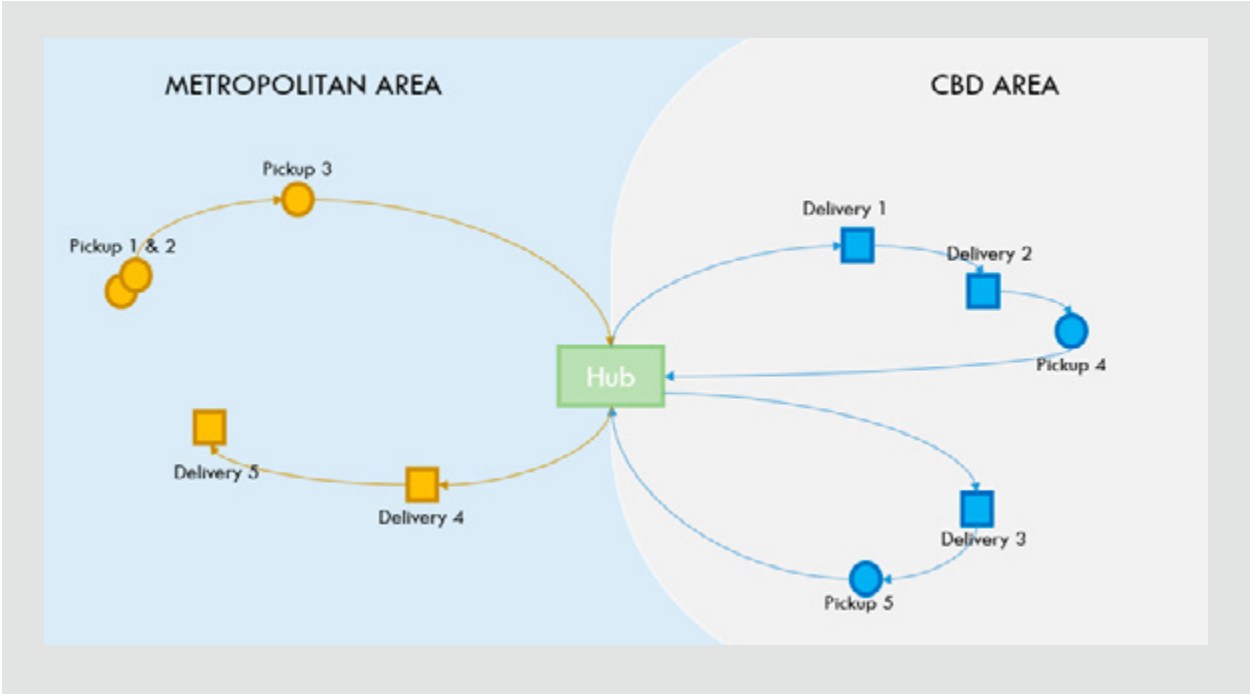
City of Funchal (Portugal) in terms of promoting the use of public transport as an efficient mode of transport for shopping. The city modified buses that would allow passengers to carry luggage on board comfortably and safely (Henriques & Figueira, 2020). In Paris, some bus lanes are being shared with delivery vehicles (NAS, 2013). Other pilots and initiatives are also focusing on the potential of employing shared passenger-cargo systems. The City of Frankfurt in Germany is exploring the use of a shared passenger-cargo tram, while intermodal transport using trams are present in Switzerland, and France (GIZ, 2019).

Mode shift programs

Mode shift programs encourage the use of alternative modes which might be able to contribute towards alleviating freight traffic. These programs are of much importance to urban freight, particularly when it comes to highly dense and congested areas. It must be recognized, though, that implementing such programs depend on their suitability in addressing specific issues at hand, and the availability of viable alternatives (Holguín-Veras et al., 2020). The impacts may also differ depending on the local situation. Experimentation in terms of shifting local freight from trucks to other modes may potentially result in overall net benefits. However, such shifts may typically increase upfront and total costs and may require significant subsidies (NAS, 2013).

Such modal shift programs have been implemented in cities such as Portland (USA) and New York (USA) which have implemented modal shift projects towards electric cargo tricycles. Other cities have implemented programs and projects that have strengthened the use of public transit to move cargo (Monoprix in Paris, France; Greyhound Courier Express in Canada and USA; Cargotram in Switzerland, among others) (National Academies of Sciences, Engineering, and Medicine, 2015). These mode shift programs are interlinked with the developments in accelerating the uptake of alternative vehicles (Section 1.8) and the provision of necessary infrastructure to facilitate the efficient and safe transfer of goods (Section 1.5).

FIGURE 4. COURIER HUB SCHEMATIC



Source: Stokoe (2019)

1.3. Action 3: Optimizing the Road Network and its Use

Road transport primarily dominates urban freight, particularly for last-mile deliveries. A governance mindset that resorts to road capacity expansion as a "default" solution for dealing with congestion issues would ultimately be unsustainable due to the inducement of further demand, while leaving other systemic issues unaddressed. Cities can make use of measures that can be relatively easy to implement in the immediate term to improve current situations while longer-term measures are put into place.

Re-timing of deliveries / timed delivery locations

Time access regulations are a common type of intervention that is being employed in different parts of the globe to maximize the use of the road network by redistributing the demand for road space temporally. These time windows have been popular for freeing up spatial resources at peak times, particularly in city centres, and heritage or historical areas. These may also contribute towards other goals such as increasing pedestrian safety and improving the public spaces in times when public usage is high. There are various versions of time-access restrictions, as historically, some cities have favoured either limiting the access in: the late morning and early afternoon (after morning peak); during morning peak; distribution of access restriction all day long; limiting the deliveries late at night.

Key considerations include the potential impacts on the carriers and receivers, as well as potential negative impacts such as significant elevation of noise (e.g. in the case of night-time deliveries), and potential reduction of overall efficiency (in the case where bottlenecks are created if the restrictions are too tight). In particular, time access restrictions pose significant routing optimization issues with third party carriers, particularly if they are servicing multiple clients that are distributed across the urban area. There is evidence that suggest that time access regulations may be more effective if coupled with financial incentives that aim at inducing shifts towards non-peak hours (Holguín -Veras, 2011). The provision of financial incentives for the receivers has been recommended in the case of New York in order to incentivize the behaviours of the receivers. The reduction in parking tickets for participating companies in the pilot tests in New York were estimated at 1,000 per truck, and delivery routes were completed 48 minutes faster than average (NAS, 2013).

The re-timing of deliveries would require changes in in the supply chain, as well as striking a balance between the different developmental objectives, a high degree of coordination with the other measures that aim to achieve sustainable mobility. It also requires consideration relating to the noise of the vehicles and handling equipment to be used (e.g. if deliveries are done at night).

Provision of Traffic Information

Orientation traffic is caused by drivers who are unable to efficiently navigate through the local network due to unfamiliarity. Simple means to avoid such would include proper provision of street names, traffic signs, as well as provision of maps (Herzog, 2010).

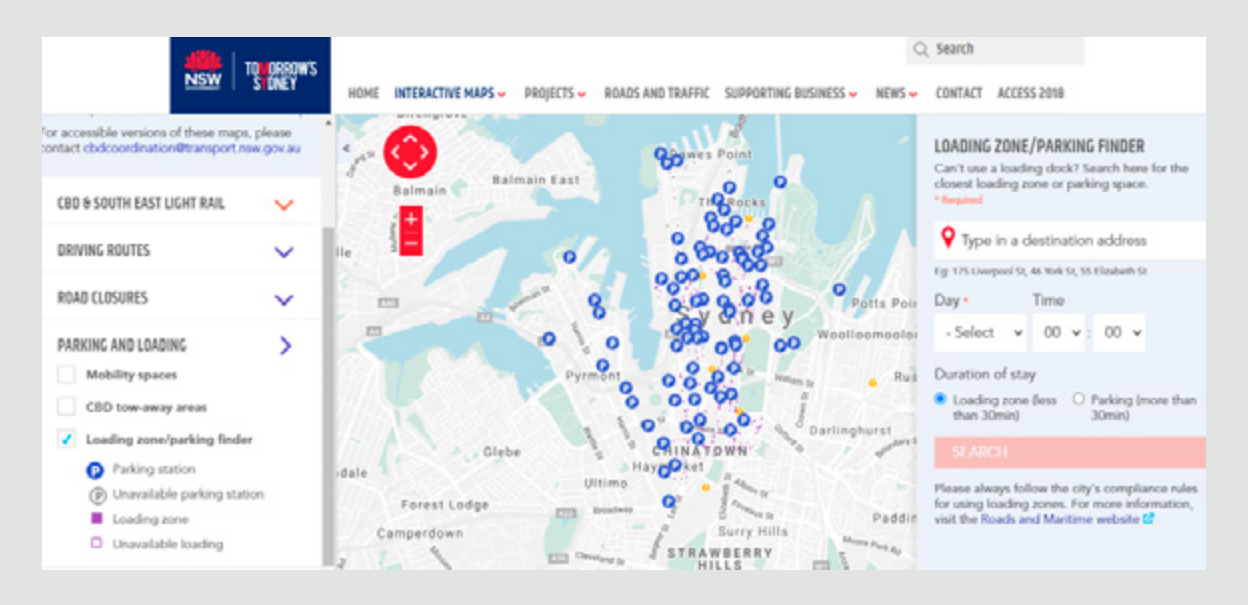
In New York, public outreach and communication activities have been instrumental in maximizing the benefits of the truck route network, and in minimizing the issues that arise due to uninformed drivers. The NYC DOT distributes approximately 80,000 copies of the route map each year, and is also available through its website (NYC, 2015). The said map incorporates feedback from the trucking industry, and relevant city, state, and federal agencies. The City is also improving the signages for the truck routes to facilitate better movement within the network.

The advancement of information technology is now also allowing cities to provide much needed information - such as road closures and driving routes to transport users that can help avoid unnecessary traffic congestion. Openly accessible routing apps are now available. There are still opportunities for cities to contribute, as there might be data that the city holds that can be opened-up and be included into apps that provide other complementary information for freight drivers and operators such as the example below from Sydney, Australia.

Traffic Management

The term traffic management refers to all measures which can be taken by local authorities in managing the flow of vehicles and the available traffic space through regulatory measures the provision of signages, control and enforcement measures, among others. Traffic management schemes must be based on holistic assessments of the city's core traffic problems which should take into consideration the interactions between urban freight and passenger transport systems, as they do share specific spatial resources in the system (e.g. roads, parking spaces). Some of the basic instruments for organising city freight traffic are the following: signage provision; light signalling; road markings; implementation of one-way schemes and circular routes; installation of physical barriers.

FIGURE 5. MY SYDNEY MAP



Source: Transport for NSW (n.d.)

Traffic coordination is also a key task that in some cases, falls into the hands of the local government units. The level of technology being utilized in the cities is a key factor that determines how the flow of traffic is effectively managed.

Enforcement

Enforcement of regulations is a core component of urban freight management. Access to loading facilities by non-loading vehicles would result in the prevention of illegal of the space and will also contribute towards use of additional space for parking or result in further congestion on the carriageway. Illegally parked vehicles can be a leading cause of non-recurring congestion, behind vehicular crashes and construction-related disturbances (Kawamura & Sriraj, 2015).

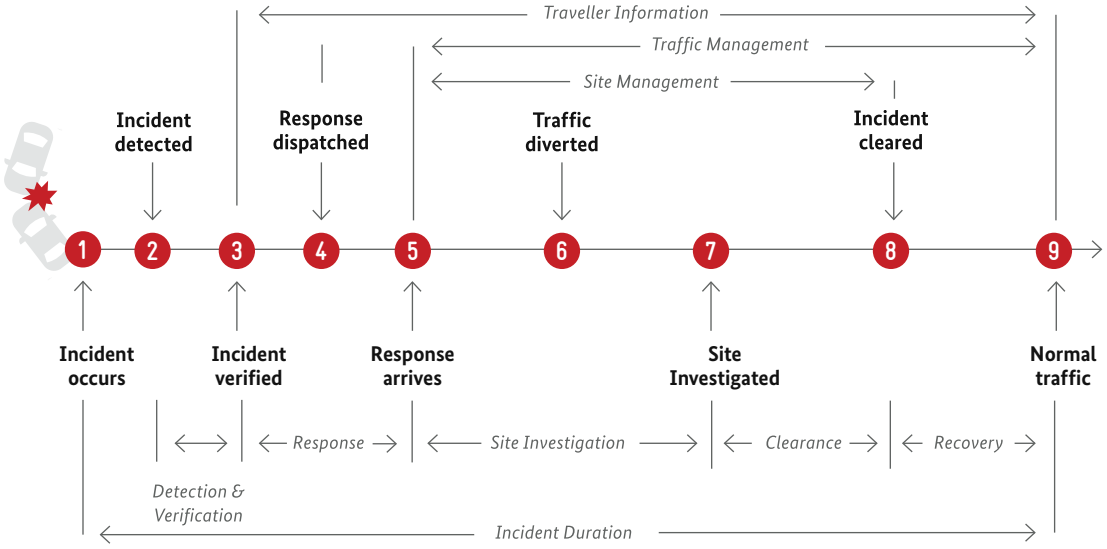
Some examples of innovative enforcement mechanisms have been implemented in different parts of the globe. Barcelona, Spain, for example has a "mobility motor squad" consisting of 300 officers who circulate on motorbikes to control on-street parking activities including loading and unloading areas. Such a crackdown would ease the restricted supply of space. A similar team was instituted in Los Angeles, aptly called the "Tiger Team" which have been deployed on designated areas with high levels of loading and unloading activities during peak hours. Similarly, enforcements "blitzes" are conducted in New York as surprise inspections on vehicles, illegal route usage, and garner information on freight users (e.g. origin-destination patterns).

Digital solutions that facilitate crowd-sourced information about illegally parked vehicles are also popping up. In Singapore, the police@SGMobile app enables citizens to report illegally parked vehicles through a "snap and send" feature. Jakarta, Indonesia has planned to use its Smart City application to monitor illegally parked vehicles which is also seen to reduce bribery and corruption among parking enforcers as they are required to report the cases of illegal parking through the system (Wijaya, 2016).

Incident Management

Incident management strategies are quite important, particularly in ensuring public safety and avoiding significant delays and congestion brought about by untoward incidences relating to heavier vehicles. Proper incident management systems involve elements that enable the following: early detection of incidents, coordination of appropriate responses, swift clearing, and management of affected traffic flows.

FIGURE 6. INCIDENT MANAGEMENT SCHEMATIC



Source: Austroads (2007), Traffic Incident management guide to best practices Research Report

Effective incident response entails the following: drafting of pre-planned response protocols; determination of the appropriate level of response, directing the necessary resources to the scene; establishing communication links and chain of command; and ensuring the availability of incident and traffic response units (Bliemer, 2017).

1.4. Action 4: Inclusion of active modes in urban freight

The inclusion of active modes in urban freight planning and management is important in the context of developing cities for several primary reasons: existing urban freight flows in many developing countries feature active modes; active mobility modes have quite significant advantages in specific niches in urban freight transport; the inclusion of active modes in urban freight planning and management considerations accelerate the transformation of cities towards become more inclusive of active travel in general.

Electric assist cargo cycles are said to be suitable for delivering payloads up to 450 kg within distances of up to 12 miles. In China, electric tricycles play a significant role in urban freight movements and can contribute up to 90% of all last-mile shipments in certain areas. The success of the three-wheeler is attributable to is cost-efficiency, ease of manoeuvrability, ability to circumvent traffic jams, significantly higher loading capacity than motorcycles, as well as the bans on trucks in cities during daytime (GIZ & Kalinowska, 2018).[2]

[2] *See also Section 1.8 for more information about electric vehicles in urban freight.*

FIGURE 7. MODERN CARGO BIKES

Photo by author

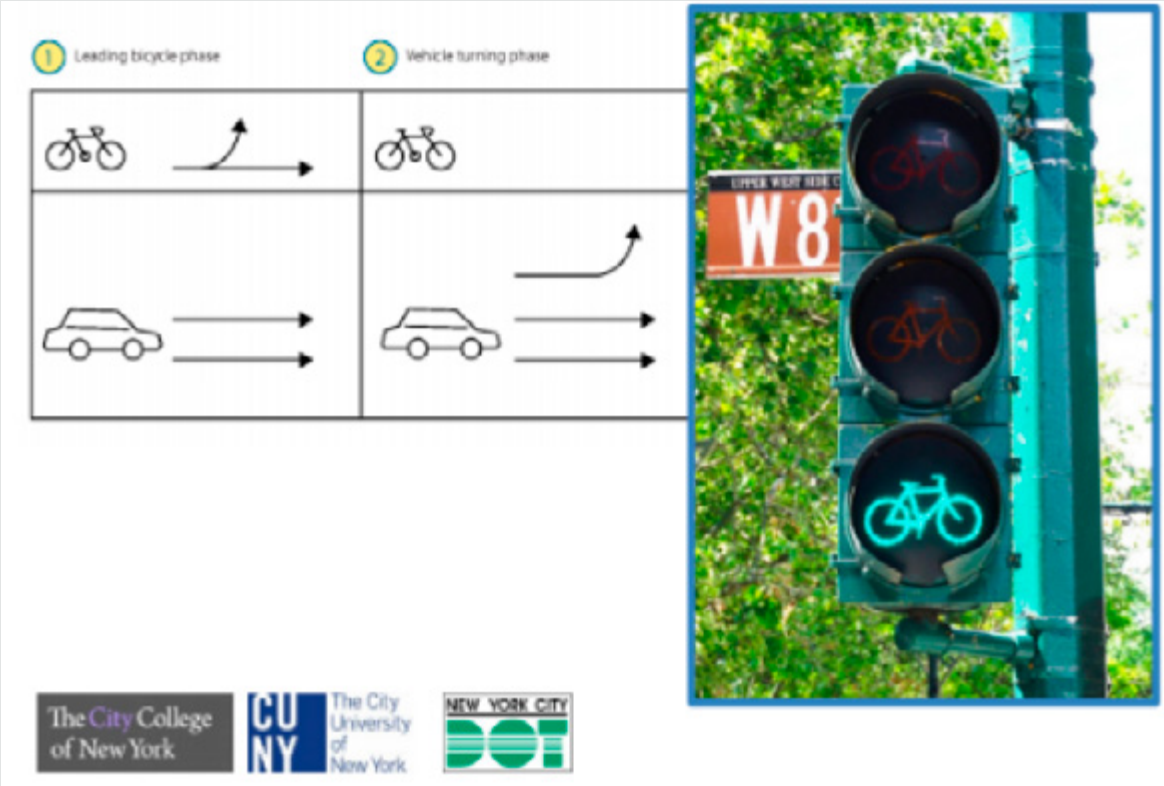
Infrastructure Planning and Design

The integration and prioritization of active modes in urban mobility planning, in general, is a key foundational element for gearing towards more sustainable urban movements. The modernisation of the road network needs to integrate innovative designs, as well as standards, in order to create an environment that provides high connectivity, safety, and convenience for non-motorized modes of transport. This action also applies for urban freight, as cycling (as well as walking) can provide services in terms of contributing to the urban freight tasks. On the other hand, considering active modes in planning and provision of design standards related to motorized urban freight activities, is crucial in ensuring the safety of cyclists and pedestrians, as urban freight activities directly interact with the space for such vulnerable road users.

The use of bikes for urban freight has picked up in developed regions such as Europe, particularly in terms of providing services for lightweight, time critical shipments in inner city areas (Assmann et al., 2018). Good design for cycling must be sensitive to physical conditions that may not matter much to other road users but are of priority to cyclists such as surface quality, type of material, gradients, deflections, and undulations (TfL, 2017). Cycle lanes and cycleways will also interact directly with loading activities if vehicles are to stop on them. Specific standards and guidance could be issued and adopted by cities to ensure that non-motorized modes are integrated safely and properly into the system. The London Cycling Design Standards, for example, includes advice regarding the management of curb side activity that considers cycling (TfL, 2014):

- Appropriate line marking and enforcement
- Timing of deliveries
- Potential for insetting bays
- Integration of cycle facilities with parking and loading.

FIGURE 8. INTEGRATION OF CYCLING INTO TRAFFIC MANAGEMENT INFRASTRUCTURE



Source: Conway (2020)

The Cyclologistics Project which concluded in 2014 was able to test 74 electric vehicles through 39 companies in 7 countries. The testing shows that the e-cargo bikes were well suited for replacing traditional vehicles without degradation in service levels and resulted in good company promotion. Two to three e-bikes can fully replace a delivery van, based on the case studies. The case studies also suggest that adding new nodes in the logistics chain (e.g. bike warehouses, micro-consolidation centres) may be needed, and that certain operational challenges specific to such vehicles need to be carefully planned for (e.g. driving in downhill terrain during rainy days) (Nocerino et al., 2016).

Incentives and subsidies for cargo cycles

Cargo bicycles may serve an economically viable alternatives to delivery trucks, particularly in highly dense areas with limited urban space for freight movements. In Europe, for example, the European Cycle Logistics Federation estimates that approximately half of all light goods, and a quarter of all goods can be moved by bikes (Auchapt, 2017).

Cargo bikes have a big potential for becoming significant modes for urban freight movement. The Cyclelogistics Project estimates that 51% of all motorized goods-related trips in European Cities can be substituted with cargo bikes (Schliwa et al. (2015) as quoted in Nocerino et al. (2016). More importantly, the shift from conventional urban goods vehicles towards such bikes require minimal infrastructure investments. The use of electric cargo bikes can potentially address specific logistics needs as it is positioned well between conventional human-powered bikes, and light cargo vehicles in terms of payloads, range, and costs (Lens & Riehle, 2013).

Promoting the use of cargo bikes is also essentially a measure that promotes active safety. As cities invest in infrastructure that promotes such delivery vehicles, and bikes in general, they invest in systemic changes towards making roads safer. Cities in Europe, for example are providing financial incentives to promote such. In the Paris region, the regional government provides up to 600 Euro subsidies for those who would want to purchase e-cargo bikes (Granes, 2020). The City of Lisbon in Portugal has initiated a municipal funding scheme for bicycles

and e-bikes. The initiative started off with a small pilot that allowed citizens to borrow e-cargo bikes for one month. The pilot was deemed as a success by the local government and has allocated a total funding of 3,000,000 Euros, out of which, 500,000 are allocated to e-cargo bikes (500 Euros/e-cargo bike) (Wrighton, 2020). The City of Gdynia in Poland provides 50% financing (maximum of around 1,000 Euros) for purchases of e-cargo bikes. In the UK, there is the e-cargo bike grant fund that is available for commercial entities. The City of Cambridge in the UK is also testing different initiatives: first mile delivery; residential sharing schemes; leasing scheme for young families for trying out cargo cycles before buying; shared scheme for inner city operations (Wrighton, 2020). Another interesting concept that is gaining traction in Europe (Germany, Hungary, Austria) is the concept of "commons cargo bikes" which are free of charge, shared, easily accessible cargo bikes. This concept started out in Cologne, Germany, where in 2013, free cargo bikes were made available for 3 days (Cyclelogistics, n.d.).

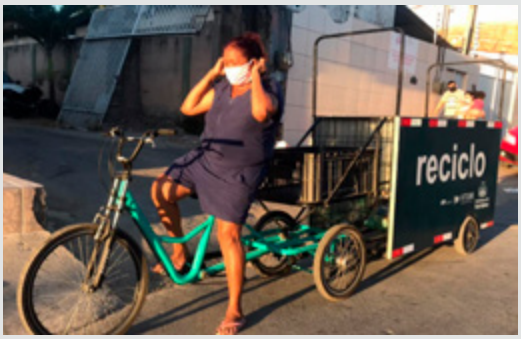
The Transformative Urban Mobility Initiative's (TUMI) "Re-ciclo" project is introducing manual and electric tricycles in Fortaleza, Brazil through a system that facilitates the exchange of hand-pulled carts for these tricycles. These tricycles are aimed to deliver health, social inclusion, and economic benefits, particularly for waste pickers, as the cargo capacity is bigger.

Cargo Bike Standards

Standards are an important part of promoting specific products as they ensure safety and interoperability and enable international market penetration. Such standards are also important for cargo bikes as they would ensure their safe operation. The European Standardisation Organisation (CEN) has recently established a cargo bike working group to develop standards for cargo bikes. Some countries have already established their own national standards such as Germany and France.

The draft German standards were opened for review in 2019 and contains specific requirements and test methods for single and multi-lane transport and cargo cycles, including those that relate to cycles that have electric motor support (van Schaik, 2019). The importance of electric 2-wheelers in developing countries in Asia, underlines the importance of having standards for such machines. More discussions pertaining to electric 2 and 3-wheeled vehicles are found in section 2.8 of this sourcebook.

FIGURE 9. RECICLO TRICYCLE IN FORTALEZA, BRAZIL



Source: Tasar (2020)

1.5. Action 5: Implementing urban freight systems improvements

Consolidation and Coordination

The lack of organised logistical arrangements among shippers and receivers of goods can result in poorly optimized vehicle trips and thus result in additional pressures to the system. Coordination services provided by distribution companies may potentially alleviate such (e.g. bundling of traffic combined with specialized delivery route optimization services) and result in reducing total vehicle trips and in optimizing vehicle loading factors. Such organized coordination services can particularly cater to those receivers who do not have the resources to organize their own logistical arrangements and/or have their own distribution centres.

Consolidation schemes seek to optimize vehicle trips by finding means to combine pick-up and deliveries of different shippers or receivers and focus on changing the supply chain, rather than the final steps of the chain (NAS, 2013). For example, a department store expects multiple deliveries from different vendors or suppliers. If the deliveries from the different vendors can be consolidated, more efficient routing and fewer trips can be made possible. The same action can be imagined if consolidation efforts are made within, say, a group of small stores (receivers) within an area.

A related concept is shared delivery wherein logistics companies share resources and bundle deliveries to

increase efficiency. By pooling delivery runs, they reduce empty runs and thus reduce cost and externalities. The City of Chengdu in China has set up several policies to promote shared delivery. It instituted access control policies to allow only a maximum number of vehicles to enter the city area. The city also provides preferential access to shared delivery vehicles. The City has also built three centralized distribution centres (1.5 million square meters of standardized storage facilities) to support the shared delivery concept (GIZ, 2019).

Exploring frameworks for possible cooperation agreements between the different stakeholders may prove to be a highly beneficial first step in implementing system-wide improvements. Improving coordination among various city departments must also be fostered.

Infrastructure Improvements

Transportation planning and management normally investigates three main clusters of elements: transportation demand, transportation supply and

TABLE 2. EXAMPLES OF INFRASTRUCTURE-RELATED INITIATIVES

Examples	Description
Major Improvements	
New and upgraded infrastructure, intermodal terminals	These initiatives aim at enhancing geometric design and physical characteristics of roads, railways, and intermodal terminals.
Freight cluster development / freight village	These foster relocation of large freight users (e.g. distribution centres, manufacturers, truck terminals, and intermodal facilities) to a specific area, usually outside the urban core which saves space within the metropolitan areas. This may thus result in longer travel distances for smaller trucks in conducting deliveries. The overall reduction in truck traffic may be small as these normally cater to business-to-business freight traffic, which in most cases, constitute a small portion of the freight traffic in cities. Noise and other negative impacts inside and around freight clusters are significant issues for local communities.
Minor Improvements	
Acceleration/deceleration lanes	These are primarily lanes that enable slow moving trucks to move to the side to allow faster traffic to move ahead.
Removal of geometric constraints at intersections	This is an issue relevant to older section of cities wherein intersection geometries can pose significant challenges to larger freight vehicles. Upgraded intersections can significantly improve traffic and safety. However, it must be noted that such can result in increased risks for pedestrians and cyclists (e.g. increased speeds at wider intersections).
Ramps for handcarts and forklifts	Building ramps on sidewalks to accommodate handcarts or forklifts can improve the efficiency of loading and unloading.

Source: Holguín-Veras (2020)

transportation infrastructure. Infrastructure management initiatives primarily utilize infrastructure improvements to better enhance freight mobility (Wilbur Smith Associates 2012). Infrastructure improvements can relate to the link (roads, railways) and the nodes associated with urban freight as described in Table 2 on the left.

The provision of appropriate and "right-fitted" infrastructure for urban freight is very much related to the discussions on how the sector is integrated into urban land use and development plans. Some of the key infrastructure concepts related to urban freight are discussed below.

Urban Consolidation Centres

One of the key infrastructure-related concepts that has gained traction in the last decade is the urban consolidation centre (UCC) which is essentially a logistics facility located near city centres or dense commercial areas where consolidated deliveries are carried out, and where a variety of other value-added logistics and retail services are provided (BESTUFS, 2007). Concerns relating to long-term viability are often attached to such facilities, particularly in areas where considerable amounts of existing facilities such as warehouses and distribution spaces maybe optimized (NAS, 2013). This was what happened, for example, to the London Construction Consolidation Centre (LCCC), which was co-funded by the Transport for London and private investors. UCCs can also lead to legal issues, as well as governance issues that are related to the operations and costs. In Vicenza, Italy, the city was taken into court by an association of freight transport carriers due to a local regulation that favoured a municipal UCC.

Cases of success, such as the consolidated delivery scheme in Motomachi, an upscale retail area in Yokohama, Japan, highlights the importance of the engagement of shopkeepers' associations (NAS, 2013). The following factors have been implicated as success factors for UCCs (NAS, 2013):

- Specific regulations that give priority city centre access to carriers using the UCC were elaborated
- Operation of the final deliveries was not given to a competitor but tot a logistics provider not previously involved in the local trucking activities which helped UCC user acceptability
- The consolidation scheme was based on a profitable business plan
- The experiments were conducted through public-private partnerships.

Distribution Centres

Goods distribution centres are meant for concentration, deconsolidation, and warehousing of shipments. However, these may directly fail in addressing distribution issues in downtown areas as other problems such as long-distance transport and transhipment may not be addressed. They may be seen as interruptions to the transport chains where the supposed functions of the distribution centre such as deconsolidation and warehousing may have already been optimized. A certain level of cooperation is also required from distribution companies which may be quite difficult to organize due to competition (PORTAL, 2003). Freight transport centres (or freight villages) aim to address these issues by allotting zones with optimal connections to the transport network where freight transport intensive enterprises such as logistics service providers and distribution companies can facilitate transhipment between different transport modes.

Another concept that has been popular in some portions of the globe, such as in Sweden is the CDC or coordinated distribution centre. These are quite similar to UCCs in the sense that they both function to fulfil essential functions such as reloading of goods, facilitating change among modes, and storage. Their differences lie in the targeted areas of delivery. A UCC supplies to city centre or commercial area, while a CDC aims to distribute goods to several municipal facilities in a larger region (Bjorklund and Gustafsson, 2015).

Microhubs

A delivery microhub is defined as a special case of UCC with closer proximity to the delivery point and serving a smaller range of service area (Urban Freight Lab, 2020). A microhub is a logistics facility where goods are bundled inside the urban area boundaries, that serves a limited spatial range, and that allows a mode shift to low-emission vehicles or soft transportation modes (e.g., walking or cargo bikes) for last-mile deliveries. While microhubs, essentially would require less investment costs, the success of such still relies on multi-sectoral collaboration (Urban Freight Lab, 2020). Another critical element to consider is the location of the microhub, as these would be more successful in areas where delivery by larger vehicles is limited by the curb space.

Collection and Delivery Points

Collection and delivery points (CDP) refer to convenience stores, plot properties, and other institutions which below to or cooperate with express companies and provide space where customers can come and pick up the goods (Wang et al., 2014). A network of CDPs, working as local collection and distribution points, may potentially alleviate vehicular movements related to picking up of goods that are ordered through phone or online. The use of CDPs, can potentially lead to significant reductions of mileage for failed first time home shopping deliveries (Wang, 2014) and can also result in benefits for the local economy as CDP users are found to make a purchase when collecting or returning parcels in points located in areas that already generate consumer trips (Wang, 2014).

Delivery Lockers

Delivery lockers enable customers to collect delivered items in special storage lockers which essentially avoids failed deliveries (e.g. due to absence of recipient at delivery point). Strategically locating such lockers are of key importance in ensuring their success. Failed deliveries have been estimated to cost at least €14 (per failed order) based on a research conducted with more than 300 e-commerce retails in the UK, US, and Germany (PCAPredict, 2018). This figure is said to be an underestimate as it does not consider the reputational damage associated with such failed deliveries.

In Jakarta, demonstration projects were done to test the concept of delivery lockers situated within metro stations. It was not found to be highly successful as it did not consider the distance of the last leg of the trip that the commuters make (i.e. from the metro stations to their homes) which was significant.

The German Packstation system consists of automated lockers which are operated by DHL, while the Kiala network in France, on the other hand, are managed by local businesses as an additional service to their customers. Setting up these networks were cost intensive, and requires significant freight volumes, and the ability to set up lockers in public spaces (NAS, 2013). Other examples are ByBox (United Kingdom), Givver (Netherlands), Inpost (Poland), POPStation (Singapore), and Hivebox (China).

FIGURE 10. PACKSTATION (PARCEL LOCKER) IN GERMANY

Photo by @maxim, Unsplash

Emerging Technologies

The role of emerging technologies is also becoming more prominent in delivering new innovations that are geared towards systemic improvements in urban freight.

Crowd Shipping

Crowd shipping, or crowd logistics, is an innovative delivery model that aims at maximizing unexploited transport capacity through the provision of shared mobility services by the "crowd." While it can lead to more efficient deliveries by potentially maximizing trips which would have happened anyway, its ability to reduce congestion and pollution is also questioned, in some cases, particularly in examples where it relies on dedicated trips using private motorized vehicles (Paoheimo et al., 2016). Environmentally-friendly crowd shipping based on the use of the mass transit network of the city is being explored in several cities globally. This model has been tested, for example, in Berlin (Germany), where the public can participate and take parcels from clients on routes on which they are traveling in anyway (Neuhaus, 2015).

Digital Urban Freight Platforms

Digital freight platforms are platforms that allow shippers to request and book transport services. These requests are assigned to service providers within the network. These online mechanisms can turn "dead mileage" into revenue-generating ones and can contribute towards making the road freight sector more efficient by reducing

empty vehicle-kilometres and reducing fuel wastage. These systems would also ideally reduce transaction times (e.g. reducing the need to do multiple phone calls and negotiations) in making transportation deals.

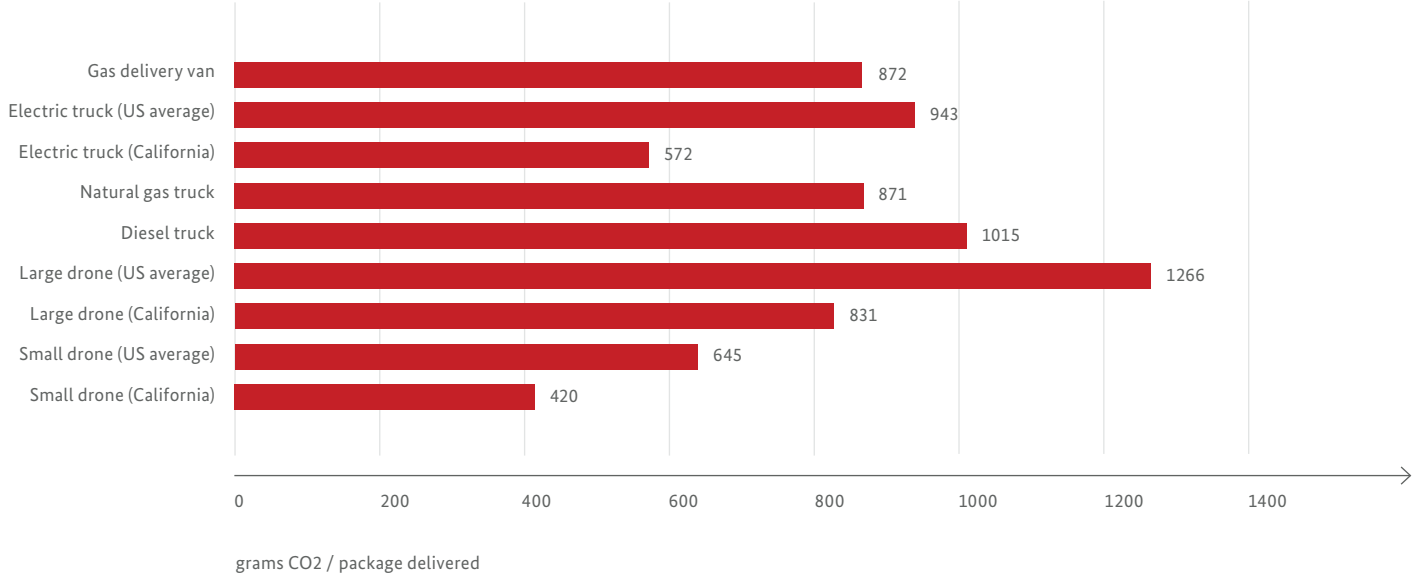
An example is being done in the Municipality of las Palmas de Gran Canaria (Spain), wherein the local government identified the poor degree of digitalisation of the local freight companies and lack of information about last mile deliveries as a key weakness in relation to urban freight. The municipality developed an app that would provide a smart distribution system to small businesses to make delivery processes more efficient. The app, called D4Service, automatically organises delivery routes and allows for real-time communication with customers. This was made possible through the collaboration of a private start-up and a research institution to develop the solution Henriques and Figueira, 2020). The app is said to have led to an increase in routes/deliveries per vehicle (+8.6%), reduction in fuel consumed (- 4.7%).

Drone Delivery

Drone delivery is considered to be a disruptive technology that is redefining the logistics and freight industry. Drones offer benefits in terms of speed, flexibility, ease in delivering goods to customers, as well as the reduction of operational and overhead costs (Wen-Chyuan et al, 2019 & Dronedeliverycanada, n.d.). Drones are particularly useful in performing emergency deliveries, rescue operations, as well as other hazardous tasks.

Stolaroff et al. (2018) estimates that the current average practical range of such drones is about 4 km considering current battery technology. While these drones are estimated to consume less energy per package-kilometre than existing delivery trucks, there are energy and emissions penalties that come with the additional warehouse facilities that are required, as well as the longer distances travelled by the drones in delivering each package. The study's results suggest that the realization of the environmental benefits of drone delivery depends on the minimization of warehousing, and in limiting the size of the drones.

FIGURE 11. ESTIMATED EMISSION FACTORS OF TRUCKS AND DRONES (GRAMS CO2/PACKAGE DELIVERED)



Source: Stolaroff et al. (2018)

One of the primary concerns about drone deliveries is safety. The robustness (and thus, weight), and the speeds needed for such operations make delivery drones a safety concern, particularly in instances of malfunction. Several hypothetical scenarios are given by Schenkelberg (2016) to illustrate the risks:

- Engine or battery failure could cause the drone to drop from the sky;
- Logic or sensor malfunction could cause erratic or blind flight;
- Drones can become obstacles in a crowded airspace;
- Drones can strike wildlife that it may not have the ability to detect or avoid.

The European Union Aviation Safety Agency (EASA) published a framework for unmanned aircraft system (UAS) operations in urban environment which also comprise the risk assessment methodology relating to flights overpopulated areas and assemblies of people, and the Airworthiness standards known as the "special condition light UAS medium risk." The U.S. Federal Aviation Authority has also issued its safety rules for drones. The rules focus on the remote identification of unmanned aircrafts (FAA, 2020) and operational rules that involve flying over people or flying at night (FAA, 2020b). A new classification will be set to cover drones that would receive airworthiness certificates. Drones that fly at night should have anti-collision lighting that can be seen from at least three miles. In Australia, drones are required to be registered, and operators need to be accredited by the Civil Aviation Safety Authority. Operating times for approved drone operators are limited to 7 am to 8 pm from Mondays to Saturdays, and 8 am to 8 pm during Sundays and public holidays (CASA, n.d.). It is important to be cognizant of these developments, as there are current initiatives that are testing the use of such vehicles, and these may result in the massive diffusion in cities later on.

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1.6. Action 6: Controlling vehicle use

Avoiding unnecessary - and minimizing overall - vehicular activity in the fulfilment of the urban freight tasks is one of the basic tenets of sustainable urban freight. Controlling vehicle use is also an important action to remember when it comes to addressing urban freight-related issues in specific areas.

Road Use Pricing

Road user charging has been a primary instrument for recovering infrastructure maintenance and capital costs, as well as for alleviating unnecessary congestion. Road user charges often feature differentiation mechanisms that allows higher fees to be charged to users of heavy vehicles (including those used for freight) due to their higher requirements for road space, and their potential to damage the road network. Common road use pricing strategies are depicted in Table 3 below.

Operational Restrictions

Truck access restrictions, for example, can be applied to certain routes, or whole areas. These restrictions can be based on various criteria and can be either permanent or limited to certain hours of the day or days of the week (NAS, 2013). Systems thinking approaches should be at the forefront of the evaluation of schemes that intend to restrict access. In the case of Metro Manila, for example, the national government issued an order in 2014 that prohibited all trucks that are more than 4.5 tons from plying streets between 5 am to 9 pm with the hopes of alleviating traffic conditions in the Metropolis. While it benefitted the driving public, it also led towards significant negative impacts as it created an artificial shortage of trucks which led to higher costs of trucking and resulted in temporary shortages of goods in the market. Moreover, the move caused significant port congestion, which also increased the costs of shipping (e.g. doubled for container shipping). An estimated 43.84 billion Philippine pesos was lost due to the truck ban (Llanto, 2016).

TABLE 3. COMMON ROAD PRICING STRATEGIES

Type	Description
Annual registration fee	Simple scheme that generates revenues by attaching fixed fees to different types of vehicles
Fuel excise tax	Simple scheme that incorporates the usage of vehicles (as well as the efficiency of the vehicles) in the amount of revenues to be generated.
Toll	Location-based scheme that generates revenues from the use of specific roads.
Cordon charging	Pricing scheme that can be implemented locally (area-based) and can incorporate time and vehicle-dependent price differentiation. This requires significant technology investments (e.g. cameras, sensors, gantries). Implemented in cities such as London and Singapore.
Kilometre charging	Generates revenues by attaching the fees to the distance travelled; price differentiation can also incorporate temporal aspects (time of day usage), location, and vehicle type; requires advanced GPS technologies to be installed in the vehicle. Implemented in countries such as Germany (€0.20 per kilometre for trucks) and the United States (e.g. €0.02 per kilometre in Oregon).

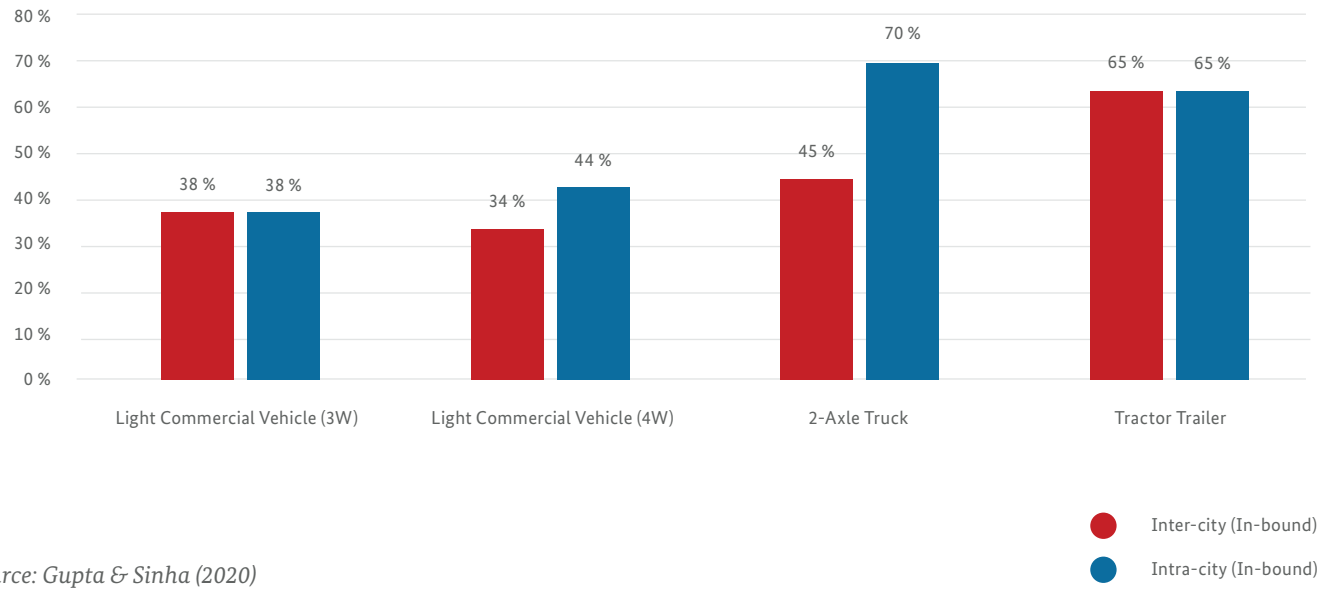
Source: Bliemer (2017)

Many cities are employing size-based, or maximum load-based, particularly for trucks due to safety, and road asset protection reasons. On the other hand, maximizing load factors is also seen as a key element of efficient freight movements. A study done in Rajasthan, India (Gupta & Sinha, 2020) shows observed empty trips of urban freight vehicles in the City:

The City of Göteborg has tested a scheme where access to different parts of the city centre entails that the weight or volume rate be at least 65%, or if there are more than 50 customer deliveries. The incentive was that such delivery trucks would have access to the special loading zones and bus lanes in the city centre. This scheme however, proved to be difficult as the participating entities deemed that it was too complicated, and found it difficult to fulfil the loading requirements (START, 2008).

Programs that prohibit vehicle idling can play a significant role in reducing the environmental impacts of urban freight vehicles. Unnecessary idling wastes fuel and emits harmful emissions. In Hong Kong, for example, internal combustion engine vehicles are not allowed to idle for more than three minutes in any 60- minute period. Certain vehicles are exempted, including refrigerated trucks carrying perishable goods at are needed to be maintained at certain temperatures (Hong Kong EPD, n.d.). Incentives for availing anti-idling technologies, public education, enforcement, and effective coordination are essential elements in the success of such anti-idling programs.

FIGURE 12. PERCENTAGE (%) OF OBSERVED EMPTY FREIGHT VEHICLES IN RAJASTHAN, INDIA



Source: Gupta & Sinha (2020)

FIGURE 13. AN IMAGE USED IN THE ANTI-IDLING CAMPAIGN IN HONG KONG

Source: Hong Kong EPD (n.d.)

1.7. Action 7: Managing parking, loading, and unloading

Urban freight movement is not only about the movement of vehicles within the network links. Significant issues arise due to the lack of, or mismanagement of parking, loading, and unloading facilities. The rapid increase in the number of motor vehicles, coupled with the inability of planning and infrastructure provision to catch up to the demand, and the lack of clear regulations would essentially result in further bottlenecks, not only for the flow of urban goods, but such impacts can spill over to passenger transport as in many cases in developing cities, parking spaces are shared by both freight and passenger vehicles. Significant vehicle activity – and thus fuel consumption and emissions - travelled can also be generated by vehicles, if suitable spaces for loading and unloading activities are not available, as they are forced to move around to avoid being penalized.

Supply Determination, Siting and Design

In some cases, it is not the volume of vehicles, nor the lack of street space that leads to congestion, but perhaps the lack of appropriate loading bays (Henriques and Figueira, 2020). Answering questions related to loading and unloading bays such as "how many?" and "where?" are critical for most cities, particularly in dense areas where different users of the streets compete for the limited space. Paris, for example, has come up with a method for quantifying the number of delivery bays needed based on the type and quantity of shops, and has produced an accompanying technical guide which imposes a minimum of one delivery space for every 100 meters within the streets in the city. These delivery areas must at least be 10 meters in length to allow the movements of the trucks (NAS, 2013). Barcelona, through a municipal ordinance, requires a determination of the number of loading bays according to the built floor area (sq. meters). Consideration for issues related to loading and unloading are critical in this process: physical location of the stops; time of the activity; frequency of the vehicles stopping in the facility; size of the facility and the vehicle; flow of traffic within the area (TfL, 2017).

The location of such loading and unloading bays to the destination has been suggested as a key factor that determines distribution techniques and impacts whether relevant agents are willing to use distribution centres and employing third party transporters (Marcucci and Danielis, 2008). As the weight/value/volume of the goods to be delivered and the distance by which the driver is willing to stop decreases. Drafting a delivery and servicing plan as part of a wider transport assessment can provide a framework that would enable better management of freight vehicle movements in urban areas (TfL, 2017). Parking design standards should be in place to ensure that the parking facilities are enable safe and efficient vehicle manoeuvring and transfer of goods.

Parking/loading areas management

On-street parking and loading initiatives aim at providing necessary curb side space for conducting activities for urban freight. These are particularly needed as denser areas in cities are not designed to handles significant volumes of traffic. Again, the challenge does not only concern freight vehicles, but also passenger vehicles as they also have needs for such a space (Holguín-Veras et al., 2020).

Cities have employed different strategies such as differentiated bays for smaller and larger vehicles, the use of special signs and road markings, strategic placement of loading/unloading bays, for example. In some cities, entire sections of parking lanes are allocated to deliveries during certain time windows (e.g. in Toulouse, France) (NAS, 2013). Roadway time sharing also exists in some cities such as Barcelona, Spain wherein the city introduced a scheme were some of the lanes in specific boulevards are allocated to traffic during peak hours but allot these to deliveries during off-peak hours. Barcelona also allows, under certain conditions, for shared delivery bays which can be arranged by several businesses and can be built in adjacent buildings and thus reduces the need to build around individual buildings.

Tokyo focuses on the maximization of the use of empty spaces and requires that two operators should be always present for operating delivery trucks (one driver, one loader) in order to reduce the parking time needed.

Loading and parking restrictions also come in different forms such as special truck only loading zones, passenger vehicle-only parking zones, time-of-use-based restrictions for parking in shared spaces, peak-hour clearways streets where curb side parking is prohibited), among others.

Parking Pricing

Fair and proper allocation of curb space, parking pricing can play a key role in sustainability initiatives, and improvement of traffic conditions (PIARC, 2011). The proper allocation of adequate space to freight vehicles, and careful consideration for the location of such spaces are linked to issues related to pricing. Ideally, prices should be time and location-related to limit the demand to about 85% maximum occupancy (Shoup, 2005). User fees should be sufficient to recover the construction and operating costs (Litman, 2020).

Efficiently pricing for on-street parking is particularly important, since these tend to be the most visible and convenient spaces and establish a maximum price for off-street parking (Litman, 2020b). Enforcement of on-street parking regulations and the associated fees/penalties is a key issue in many developing countries, as such is normally not aided by technologies such as parking meters and automatic vehicle identification technologies. New York City's commercial parking program uses parking prices to foster better use of curb space and faster turnover (National Academies of Sciences, Engineering, and Medicine, 2015). Such pricing measures can be effective, as shown in New York's experience. The City introduced hourly metered rates for previously unpaid commercial parking areas and utilized an escalating price scale (€2.03 for the first and second hours, and €3.25 for the third hour) which led an average reduction of parking duration from 160 to 45 minutes. The program is also deemed to be quite effective in improving mobility in narrow cross-own streets which normally would have exhibited issues with double-parked vehicles and blocked traffic – an issue that is also common in many developing cities (FHWA, 2012).

Off-street Loading

These measures focus on developing loading and unloading areas that are located off-street which makes public spaces less congested, and safer. Cities can potentially require the compulsory construction of off-street delivery areas for new developments to avoid truck parking on the sidewalks, as well as to prevent double parking. A critical element of the success of such ordinances is proper enforcement.

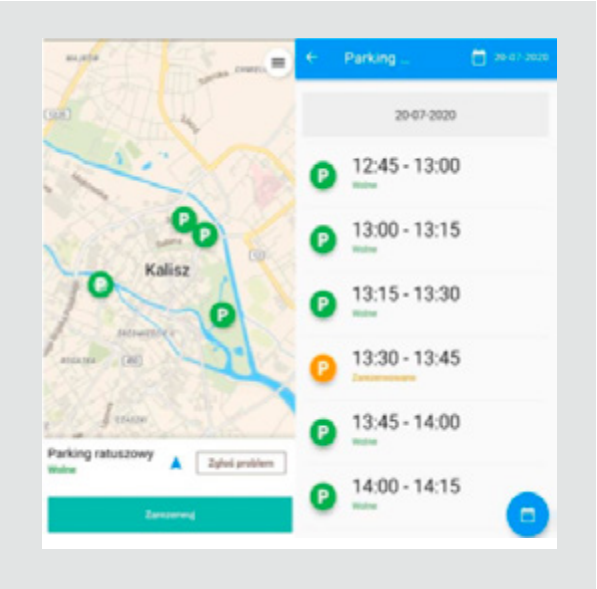
A common standard for many cities globally is to require many developers of certain facilities (e.g. department stores, offices, warehouses) that have a certain area to provide for dedicated loading and unloading facilities). The City of Paris, for example, imposes off-street loading bays for stores of at least 500 square meters, offices of at least 2,500 square meters, and hotels that have 150 rooms or more (Letnik et al., 2018). Similarly, Tokyo requires department stores, offices, and warehouses with floor areas more than 2,000 m2 are required to provide loading and unloading facilities. Detailed rules for off-street deliveries that consider the differences and characteristics of different districts, sizes of establishments, and the type of use are also something that cities ideally should develop.

Digital Solutions

Digital mobility solutions are now also being used for managing parking, through the provision of information about parking spaces, as well as features such as reservation and payment. Such possibilities are enabled through the internet of things that facilitates the communication of physical sensors with specific applications. These can result in significant benefits. For example, the simulation of ICT based management of loading bays shows that total delivery time can be reduced by 66% (Comi et al., 2017).

The City of Kalisz, Poland, for example, is currently piloting a digital solution for real-time and dynamic management of unloading operations in the city and is envisioned to reduce unnecessary truck traffic and manoeuvring, which is important in terms of environmental, as well as safety impacts. IoT-enabled parking lot sensors were installed in parking bays which enables the system to detect whether it is available or not. Users download a mobile app and register to the system which they can use for pre-booking specific parking spaces at specific times (SPROUT, 2020).

FIGURE 14. COMMERCIAL PARKING APP IN KALISZ, POLAND



Source: SPROUT (2020)

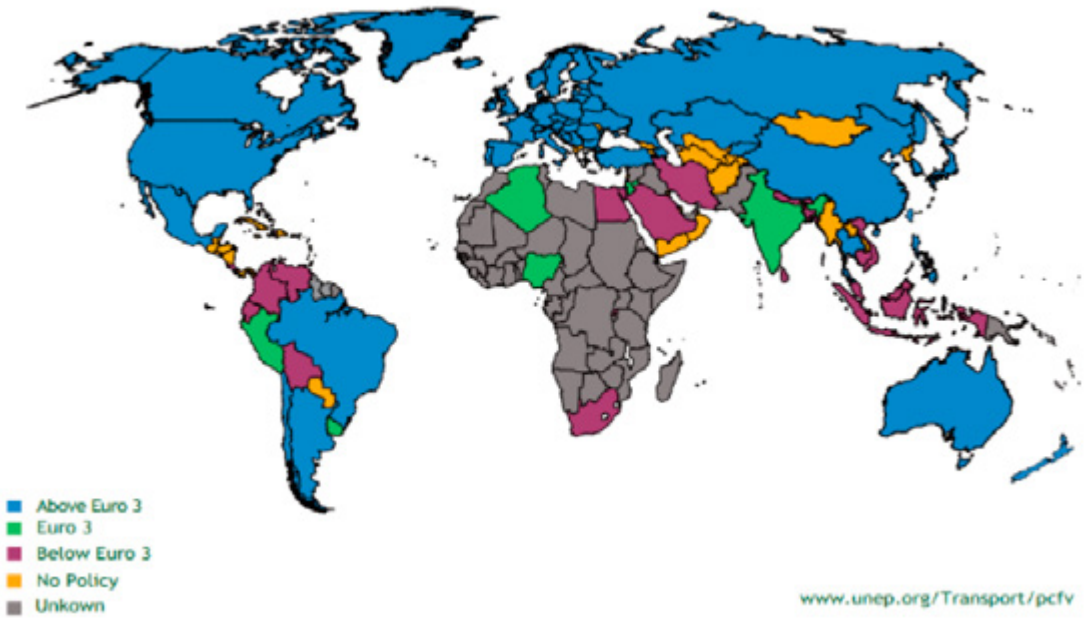
1.8. Action 8: Promoting clean vehicles

Even with efforts to avoid and minimize motorized movements, and to shift movements towards optimal modes (and modal combinations), motorized vehicles are, at the end, still needed. Improving the vehicle fleets by promoting the ownership and usage of cleaner vehicles (and fuels) would ensure that the negative impacts of motorized movements are reduced.

Vehicle and Fuel Standards and Regulations

Overarching vehicle-related standards, such as those related to vehicle emissions and fuel efficiency are critical in the overall transformation of the road freight sector, which inherently also impacts the sustainability of urban freight. While many countries have advanced their vehicle emission standards in the recent past, there is still significant room for improvement and leap frogging.

FIGURE 15. STATE OF VEHICLE EMISSION STANDARDS



Source: UNEP (2017)

Fuel quality standards normally would be aligned with the requirements of the vehicle emission standards being implemented (e.g. the high the vehicle emission standard, the higher the quality of fuel). One of the key parameters of fuel quality is the amount of sulphur in diesel fuel. This is of much importance to the freight sector as heavy-duty trucks primarily use diesel fuel. The shift towards higher vehicle emission standards (e.g. Euro III requires 350 ppm for diesel; Euro IV requires 50 ppm) would not be possible if fuel sulphur contents are high, as sulphur would make more advanced emission control systems (e.g. catalysts and diesel particulate filters) to be ineffective.

Aside from emission standards for new entrants to the vehicle markets, regulations and standards concerning imported used vehicles are important for developing countries to investigate, as most have limited or do not have such regulations (UNEP, 2020). Regulations for such can take different forms such as import bans, or age restrictions. Other supporting schemes such as fiscal incentives for higher standards (or newer) vehicles, labelling and awareness raising programs are also important options. Regulating imported used vehicles should strike a balance between environmental, social (health, safety, access) and economic (local vehicle manufacturing industries) goals.

Standards for electric two and three wheelers would ensure safety, quality, and compatibility with urban infrastructure are needed to facilitate adoption, including for urban freight applications. The need for such is becoming more important as "micro" electric vehicles (bikes and e-scooters) are being tapped into for delivering goods in urban areas. Big companies, like UberEATS and Deliveroo are moving towards increasing the utilization of such vehicles in their operations. In China, where electric two and three-wheelers has become a staple mode for last mile deliveries, cities are growing increasingly concerned regarding the safety of such due to lack of standardization. Shenzhen, for example, removed 18,000 e-2&3 wheelers in 2016 (GIZ & Kalinowska, 2018). The United Nations Environment Programme (UNEP) has developed guidelines for integrating electric two and three wheelers (e- 2 and 3 wheelers) as summarized in the table below. Wider sustainable mobility solutions related to 2 wheelers can also be found in Gota (2018).

Other standards such as fuel economy standards for commercial vehicles, as well as trucks are also progressing, particularly in more developed economies. The Japanese government, for example, was the first to introduce fuel economy standards for new heavy-duty diesel vehicles in 2005. The standards are applicable to trucks that are more than 3.5 metric tons in gross vehicle weight, as well as buses that have carrying capacities of more than 11 passengers. The standards are differentiated by vehicle type, class, and weight. Financial incentives such as progressive taxation (differentiated by weight and engine displacement) is provided to support the purchase of lighter vehicles. Purchasing vehicles that exceed fuel economy and emissions standards, may also result in additional vehicle tax reductions.

Operations-related Regulations

Low emission zones are zones in which minimum environmental performance standard are set for those vehicles that operate in these areas. They have been employed in large urban areas which have significant issues with regards to urban air pollution. LEZ rules are not confined with urban freight vehicles, but normally applies to passenger vehicles as well.

London started a ban on heavily polluting vehicles in 2008. It implemented an "ultra-low emission district" in 2013 and created enhanced emission regulations within wider congestion charging area. The City of Birmingham, in the UK has pursued a low emission zone in 2020. Milan, Italy, has recently implemented a zone covering 70 square miles wherein access to polluting older vehicles are restricted from most of the weekdays. Other cities in Europe are also implementing similar schemes such as Stockholm, Brussels, and Antwerp (CLARS, n.d.). The City of Quito in Ecuador is also planning to implement a low emission zone. It has established a "technical coordination table" which oversees planning. The corresponding city ordinance mandates that by 2021, only zero-emissions vehicles will be allowed to enter the zone. Beijing (China) has established a low-emission zone in 2017 banning heavy-duty freight vehicles with emissions below National IV Standards from entering the central city area for air quality and human health purpose. In 2018, it has further expanded from Sixth Ring Road to the whole city (WRI Ross Centre, n.d.).

Other types of regulations can be investigated by cities (and higher levels of government) to promote less-pollutive vehicles for urban freight. Loading and unloading regulations that incentivize e-vehicles such as in the Municipality of las Palmas de Gran Canaria. The City of Shenzhen (China) supports operational regulations (special access permits) are instituted by the government to entice companies to purchase and operate the NEVs.

TABLE 4. ELECTRIC 2 & 3-WHEELER STANDARDS AND POLICIES

Parameter	Description
Vehicle Performance Standards	Top speed; hill climb capacity; wet/dry breaking distance; maximum range; battery life cycles;
Environmental Robustness Standards	Compliance with tropical rain test; flood fording test; vibration test; drop test; knock over test
Electrical Safety Standards	Variety of technical standards concerning insulation resistance (wet and dry); hi-pot test; overload protection (overload cut-off); short-circuit protection; overcharge cut-off; over discharge prevention; maximum mains current draw; charger water ingress protection
Vehicle Accessories Standards	Lights; horn; noise device
Interoperability Standards	Electromagnetic interference/ electromagnetic compatibility; battery charger; removable battery and battery swapping standards
Road Usage Policy	Depicts where (and when) such vehicles can be used
Vehicle Registration Policy	Depicts the responsibilities of organisations, as well as the requirements in relation to the registration of such e-vehicles
Operator Age Requirement Policy	Depicts minimum driver age for using e-2 and 3 wheelers based on the class of the vehicle
Driver License Requirement Policy	Depicts whether a driver license would be required for different classes of e-2 and 3 wheelers
Safety Equipment Requirement Policy	Depicts the requirement for the use of safety equipment during the operations of different classes of the e-2 and 3 wheelers.

Source: UNEP (2020)

TABLE 5. LOGISTICS ACCESS RESTRICTIONS IN SHENZHEN

Restriction	Description	ICE not registered in Shenzhen	China III ICE Standard or Below	China IV – China V Standard	China VI	Electric Logistics Vehicles
Daytime entry	Diesel trucks registered outside Shenzhen are banned from entering the city everyday between 7 am to midnight	No	Yes	Yes	Yes	Yes
Exempt from odd/ even driving restrictions	Diesel trucks registered in Shenzhen that are at or below the China III standard are only allowed to enter the city every other day, based on whether their license plate ends in an odd or even number	No	No	Yes	Yes	Yes
Qualified to register in Shenzhen	Shenzhen is no longer accepting registrations for China IV and V diesel trucks	No	No	No	Yes	Yes
Permitted in green logistics zones	Diesel trucks registered in Shenzhen that meet or exceed the China IV standard are permitted daily entry but are banned in certain areas of the city called “green logistics zones”	No	No	No	No	Yes

Source: Shenzhen Trucks Road Restriction Policy Announcement 2017 as quoted in GIZ (2019),
Notes: ICE = internal combustion engine

TABLE 6. ELECTRIC VEHICLE BATTERIES SUBSIDIES IN SHENZHEN, CHINA

Battery Size (kwh)	Subsidy (Eur/kWh)
< 30	700
30-50	600
>50	500

Source: GIZ & Kalinowska (2018)

Clean Fuels and Vehicles Support Schemes

There are various schemes that have been implemented globally that incentivizes the purchase and use of cleaner vehicles for goods movement. A voluntary clean trucks program, known as the NYC DOT Clean Trucks Program (or Hunts Point/Port Morris Clean Truck Program), was implemented in communities in South Bronx, servicing food markets that generate approximately 15,000 truck trips daily. Funding is made available for owners of old trucks who would like to purchase new (hybrid electric, CNG, battery electric) ones (€13,820 to €73,145) that are compliant to the emissions standards that are set by the US EPA. Funds are also made available for installing vehicle exhaust retrofit technologies. The program offers a 100% rebate of the equipment purchase and installation costs of after-treatment devices, and exhaust retrofit technologies such as the following – diesel oxidation catalysts; passive diesel particulate filters; active diesel particulate filters. At the state level, the New York State Energy Research and Development Authority (NYSERDA) is also implementing the New York Truck Voucher Incentive Program which allocated around 17 million Euros. The State of California has implemented a "phase-in" option for entire fleets of heavier trucks, which allows owners to decide which vehicles are to be retrofitted or replaced, to meet an annual filter percentage requirement. The City of Shenzhen in China is providing subsidies for purchasing and operating "new energy vehicles" (NEVs) in order to boost the comparative advantage of such over conventional models. The subsidies are dependent on battery sizes. The government is requiring that the vehicles that will be subsidized be operated over 30,000 kilometres per year.

Cross-subsidies that favour cleaner freight elements are also possible. Differential parking charges are implemented in Copenhagen (Denmark) to support pollution reduction efforts and incentivise the use of cleaner vehicles.

Accreditation/Recognition/Certification schemes

Awarding of labels or recognition to companies that embrace sustainable delivery practices has proved useful in cities (NAS, 2013). Certification and labelling programs can be effective examples of voluntary regulation wherein the public sector negotiates with the private sector voluntary targets and/or operating rules that can be incentivised by recognition or other special benefits such that relate to operations- such as being allowed to access loading facilities or having extended delivery hours - or other procedures such as the provision of special lanes for business renewal, or reduced fees and taxes for certified entities (Dablanc, 2014). Such schemes arise from freight forums or similar participatory processes that engage public and private stakeholders, along with other relevant entities.

In the City of Parma (Italy), only accredited carriers can deliver in the historic centre, while others need to utilize the services of the municipal urban consolidation centre. The accreditation process for the carriers entails that their vehicles meet certain environmental standards, and equipment (i.e. GPS) and must be loaded at least 70% in terms of volume and weight.

In a world that is gearing towards a stronger business-to-consumer (B2C) business models, private carriers

seem to respond better to accreditation or certification programs due to pressure from consumer (Lubeth, 2020).

Promotion of Urban Freight Electrification

The electrification of urban goods delivery provides significant benefits as they have no tailpipe emissions. manner. Electric vehicles are also more suited to urban delivery conditions due to their higher efficiencies at lower speeds and the provision of regenerative braking that optimizes stop-start conditions.

The benefits to be accrued from electric delivery trucks are related to factors relevant to the conventional alternative such as fuel price, operating efficiencies under real life drive-cycles, as well as to the factors specifically influencing the electric trucks such as electricity generation and costs, transmission efficiency, recharging infrastructure, and vehicle price. A study by Lee et al. (2013) suggests that electric delivery trucks can emit 42-61% less GHGs, consume 32-54% less energy, and 22% less total cost of ownership against comparable diesel trucks. Such trucks also essentially eliminate tailpipe emissions of harmful criteria air pollutants which conventional diesel trucks are significant contributors to in urban regimes (e.g. particulates, NOx, SOx).

The City of Shenzhen has been quite active in incentivizing the purchase and use of electric logistics vehicles (ELVs) for urban deliveries which has resulted in an explosion of registered ELVs (300 in 2015 to 70,000 by the end of 2019). Leasing of ELVs has become dominant in Shenzhen, with 98% of the operational ELVs being owned by leasing companies. Such a leasing model has proved to be well suited in enabling the accelerated penetration of e-vehicles into the city fleet by essentially delegating capital costs to leasing firms which then leverage from the low operating costs and making profits from clients who may not have the capacity (financial and technical) to own such vehicles. The leasing agreement include maintenance services, and in some cases, the provision of drivers. A summary of the supporting policies instituted in Shenzhen are contained in the Table below (RMI, 2020).

TABLE 7. INCENTIVES FOR PROMOTING ELVS IN SHENZHEN, CHINA

Type	Description
Purchase subsidy	Following the National EV subsidy scheme, it has been implemented since 2015, and gradually adjusted to subsidize by battery size (see Table 10) then changed the strategy to operation incentive scheme. It has completely phased out by August 2019.
Operation incentive scheme	Up to €9,460 pay-out within 3 years to complied operators. It was innovative policy firstly employed in China, with the purpose to enhance the use of NEVs.
Access privilege	All digital registered (with an RFID) light duty new energy trucks and new energy minivans are eligible to drive in Shenzhen city all the time. This was one of the most important policy for ELV operators that have given them a competitive advantage.
Green Logistic Park Policy	Shenzhen has setup green logistic parks to ban light duty diesel trucks in order to boost the application of ELVs.
Charging facility subsidy	Provide subsidy to charging facility operators by the power of charging pile to encourage charging facility network planning & building.

Source: UNEP (2020)

On the other hand, Shenzhen has also decided to phase out 3-wheelers and issued a policy for scrapping them within two years due to the difficulties it has faced in dealing with the negative behaviours of the users of such vehicles (e.g. disobedience to traffic and parking rules.

FIGURE 16. ELECTRIC 3-WHEELERS OF PHLPOST PASIG (PHILIPPINES)

Photo by the author

Other cities and entities are also testing the use of e-vehicles. The Philippine Postal Corporation (PHLPost), together with the City of Pasig (Philippines) is in the process of testing the use of electric tricycles in its operations and will soon test electric quadricycles as well. The City of Delhi, India, is now embarking on a pilot project that involves the deployment of a thousand electric vehicles to companies that are involved in last mile urban delivery. Aside from such local initiatives, the private players are also gearing towards electrification. UPS, for example, has announced its first all-electric fleet in early 2020, and Amazon ordered 100,000 electric delivery vans in 2019.

Shared E-Delivery

The widescale adoption of modern and clean vehicles in urban freight is hindered by high upfront costs. One potential solution is to utilize a vehicle sharing scheme which allows participating entities to consolidate their deliveries and make use of the shared fleet of clean vehicles. A pilot in the Valleta Region in Malta, for example, is being conducted in order to test the use of shared vans to deliver goods from the centre of a crafts village to the centre of the Valletta. The delivery of the goods is being coordinated by an association of the participating entities (Henriques and Figueira, 2020). This does not only lower down the acquisition costs of such vehicles but will also reduce overall operating costs for the participating entities and adds value to the group collectively by bringing forth marketing benefits (being green). Such sharing schemes can potentially reduce total vehicle-kilometres travelled, and thus, pollution, and impacts to congestion.

1.9. Action 9: Communicating Solutions and Educating Stakeholders

The transformation of urban freight towards sustainability requires raising the capacities of different stakeholders within the system to understand the sector's issues, and the solutions and interventions that are available towards addressing such. Communications, the provision of information, and education-related initiatives are crucial in ensuring that knowledge is disseminated, and that overall capacities within the urban freight systems are improved.

Local Government-led Solutions

Leading by example is a powerful measure that can be employed by local government units towards strengthening its pursuit of sustainability in the urban freight sector. Decisions taken by local governments that would influence their own operations towards becoming more sustainable would not only show the public, as well as the private sector about its commitment towards transformation, it would also lead towards better-informed governance as challenges and barriers will be experienced first-hand.

In terms of urban freight, local governments can introduce procurement procedures that would better support freight service providers that embrace sustainability principles. Local governments can also procure greener vehicles for their own operations. The municipality of Las Palmas de Gran Canaria is taking the lead in the pursuit of the goals of its Sustainable Urban Logistics Plan by purchasing new (Euro 6) vehicles for its waste management operations, and e-vans for its municipal fleets. Another example of municipality-led solutions is the use of cargo bikes for interdepartmental delivery of documents in Leipzig, Germany. The City decided in August 2020 that all delivery of documents between the 24 city departments would be done through cargo bikes (Wrighton, 2020). Similarly, the City of Pasig in the Philippines is also embarking on the use of e-vehicles.

Demonstration projects

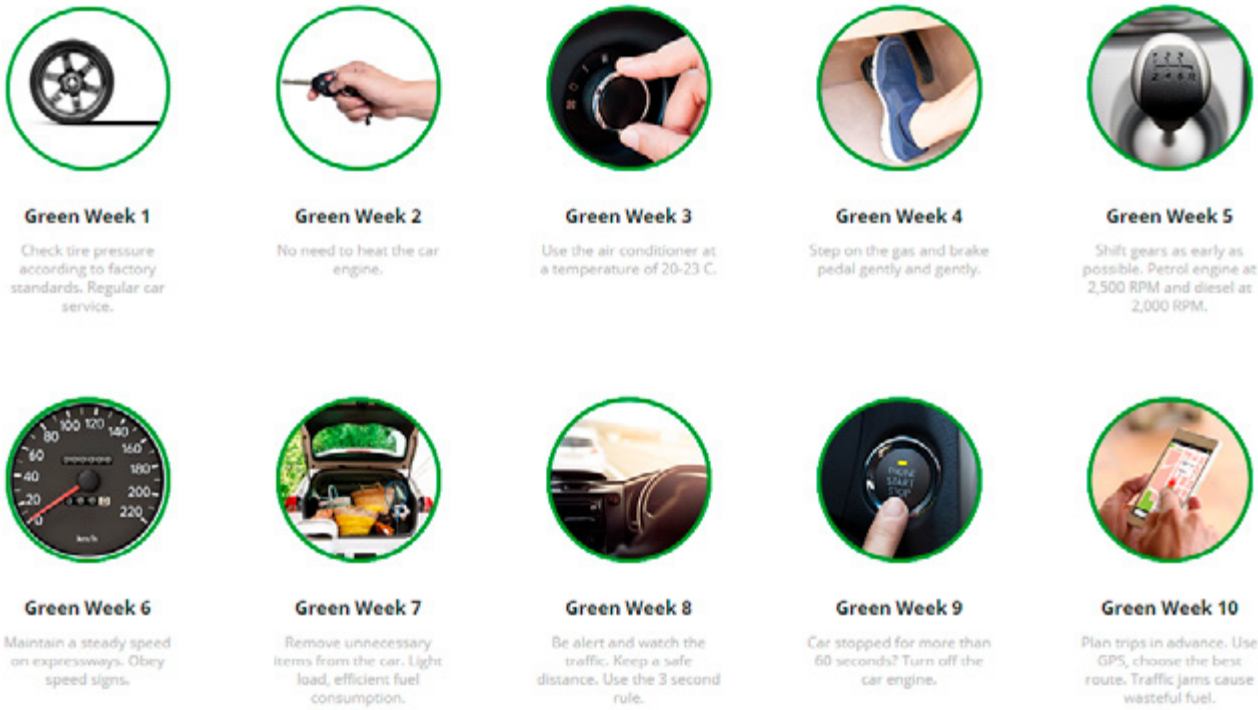
Demonstration projects are quite important in understanding the potential and limitations of newly introduced innovations and solutions. Conducting demonstration activities, particularly for those solutions that can potentially entail significant costs and legacy impacts, are crucial in determining the viability and effectiveness of such.

A relevant concept that has gained global popularity is the concept of a "living laboratory" which essentially takes experiments into dynamic, real-life environments. The planning and design of such experiments, as well as the associated policies, regulations, and innovations, involve stakeholders, and takes into consideration wider contextual elements, and real-life practicalities and implications of the tested solutions (Twisse, 2020).

Situating such demonstration as a microcosm of the wider socio-technical systems is something to strive for to recognize the importance of different actors at different levels (including the private sector. Demonstrating benefits + capturing and articulating relevant challenges (e.g. through user needs assessment) and turning them into opportunities can accelerate the sustainable urban freight agenda/ Experiences and solutions from different parts of the globe can potentially work in emerging economies if these should be assessed for their appropriateness in specific contexts & tailored accordingly.

Many of the initiatives that have been adopted at a wider scale discussed in this sourcebook have started off as pilot projects. A pilot project in Gdynia, Poland, for example, had sparked significant transformations. Recognizing the need to address urban freight issues, the City first invited international city partners to visit and give their thoughts on urban freight issues. The advice from the visitors gave impulses to Gdynia to start a small pilot project focusing on planning delivery bays in three main streets. The demo pilot attracted the interest of politicians and helped them understand the benefits of addressing the problem on a city scale. This pilot has now also led to some long-term transformations as a growing number of shops from different areas of the city are now applying to the city for designated loading bays in their areas (Freight Tails, 2019).

FIGURE 17. ECO DRIVING PRINCIPLES



Source: Ecodriving Indonesia (n.d.)

Capacity Building and Awareness Raising

Capacity building and awareness raising programs form an integral part of the transformation towards sustainability. This is particularly important in urban freight, particularly in developing cities, as a wide range is expected in terms of the level of awareness amongst the different stakeholders in relation to sustainability issues in the sector. The design of such programs is highly dependent on the overall goal, the method of delivery, and the effectiveness of communications. Some key examples related to urban freight are discussed below.

Bespoke and Targeted Training Programs

The effectiveness of establishing dedicated personnel handling freight issues in local authorities can be bolstered by conducting bespoke training activities which can be done through partnerships with the academia and other government agencies. For example, the Ile-de-France Region and the Paris School of Urbanism have recently collaborated to conduct a special training course on logistics focusing on Greater Paris (CAF, 2020). In Vilnius, a training program for the professionalization of the logistics sector was organized in cooperation with the local chamber of commerce. Similar arrangements with academic institutions may also be explored. For information on readily available training (online) programs, please refer to Annex 1.

Eco-driving Programs

Eco-driving refers to a method of driving that optimizes fuel efficiency, reduces variable costs (repair and maintenance, tires), increases effectiveness (reduced vehicle downtimes), reduces emissions, and increases road safety.

The pilot that was done in Malmo (Sweden) showed an average reduction of 16% in fuel consumption (139 drivers) during the training sessions, as well as lower levels of goods damage and vehicle accidents (approximately 20%) (CIVITAS, 2015). A project implemented in Snaga (Slovenia) which involves a waste collection and management company shows an average of 4.23% reduction in monthly fuel consumption. In Indonesia, an eco-driving campaign has been launched recently. While the campaign itself does not specifically targets urban freight, the actions are essentially applicable and highly relevant to urban freight driving as well.

Public Campaigns

The "Say No to Diesel Vehicles" campaign was initiated in 1999, and subsequently the "New Market Creation Strategy Council" was formed by the Tokyo Metropolitan Government in cooperation with auto manufacturers, gas station operators, and corporate users of diesel vehicles to promote alternative fuelled vehicles, including trucks (e.g. LPG and CNG). Over 200 participating companies adopted such vehicles through the joint initiatives by the partners. The "Tokyo Declaration for New Market Creation" was announced to expand the initiatives (Bureau of Environment, n.d.).

1.10. Action 10: Focusing on Comprehensive Approaches

Effective solutions towards addressing issues related to urban freight are ones that consider the embeddedness of such issues within a multi-scalar and multi-sectoral web of intricacies. Mechanisms that consider the views and goals of the different stakeholders, both from a horizontal and vertical point-of-view are much needed. Increasing the capacities of governing entities can also potentially accelerate the agenda for sustainable urban freight, and ultimately facilitate the inclusion of such agenda into wider policies and strategies.

Urban Freight Fora/ Local Freight Groups

Formalized partnership initiatives in cities which were instrumental in raising awareness among different freight transport companies have been studied as an effective and efficient means to manage urban freight (NAS, 2013). These formalized partnerships – aimed to be long term - within the realm of urban freight are often referred to as "urban freight forums/partnerships" which enable the holistic understanding of different parties of the constraints and goals of the different stakeholders that are involved. It provides a unique venue by which actors can talk and cooperate - such as private companies which otherwise would not be willing to communicate and collaborate.

Examples of such formalized consultation schemes have been established, for example in London, Paris, and cities in the Netherlands. In the case of Greater Lyon (France), public-private partnerships were key in addressing difficulties by private practitioners to understand the structure of multi-layered administrative organisations. The partnership also provides an opportunity for the transport operators to identify who to contact when problems occur, and it also helps the authority to stay

informed of the new practices, organisations, constraints and aims of operators (Lindholm & Browne, 2015). Currently, the early stages in the formation of sustainable freight partnerships are being facilitated in Surat and Bangalore through the support of the Environmental Defense Fund (EDF). The partnerships would first focus on developing a knowledge base and creating an online platform on innovations and insights on best practices, as well as activities towards facilitating greater cooperation and networking among the different stakeholders (EDF, 2020).

Planning for sustainable urban freight would also benefit from similar participatory processes. A multi-stakeholder platform (MSP) is recommended by Aifandopoulou & Xenou (2019) as a key element in the development of a sustainable logistics plan. The MSP is a mechanism for enabling industry and local governments to work together in partnership to produce solutions towards addressing localised freight problems. It also plays a key role in the definition of a vision, as well as in the identification of measures and interventions towards attaining the vision.

Such forums and groups can also be a means for aiding the institutionalisation of data collection. The Smartway Partnership in the United States, for example, uses a mechanism wherein data provision by the partner entities (along with their initiatives) are incentivized through recognition. Lindholm and Brown (2015) proposes to consider the following factors in the establishment of freight partnerships:

TABLE 8. IMPORTANT CONSIDERATIONS FOR ESTABLISHING FREIGHT PARTNERSHIPS

Element	Important Takeaways
Configuration	● Identification of the relevant stakeholders is important ● It is important to involve different types of stakeholders such as retailers, transport operators, property owners, authorities ● Cities should assess their own situation and formulate their goals, and then identify stakeholders to ensure that the objectives of the partnership are relevant to the stakeholders
Management	● Effective management of the partnership is crucial ● An action plan or similar document must be developed which will structure the discussions and ensure that these are aligned with the long-term vision ● Discussions should be kept to a manageable number (10 to 25) in order to keep engagement levels high ● Stakeholders within the partnership should have the capability to impose change within their organisations
Outcomes	● Documentation and communication of outcomes will be essential in maintaining the momentum of the partnership ● Avoid seeking single solutions ● Consider measures as business propositions ● Consider both hard (concrete, tangible outputs) and soft (general improvements in working processes) achievements

Source: Lindholm & Browne (2015)

Incorporation of Urban Freight into Public Governance Structures

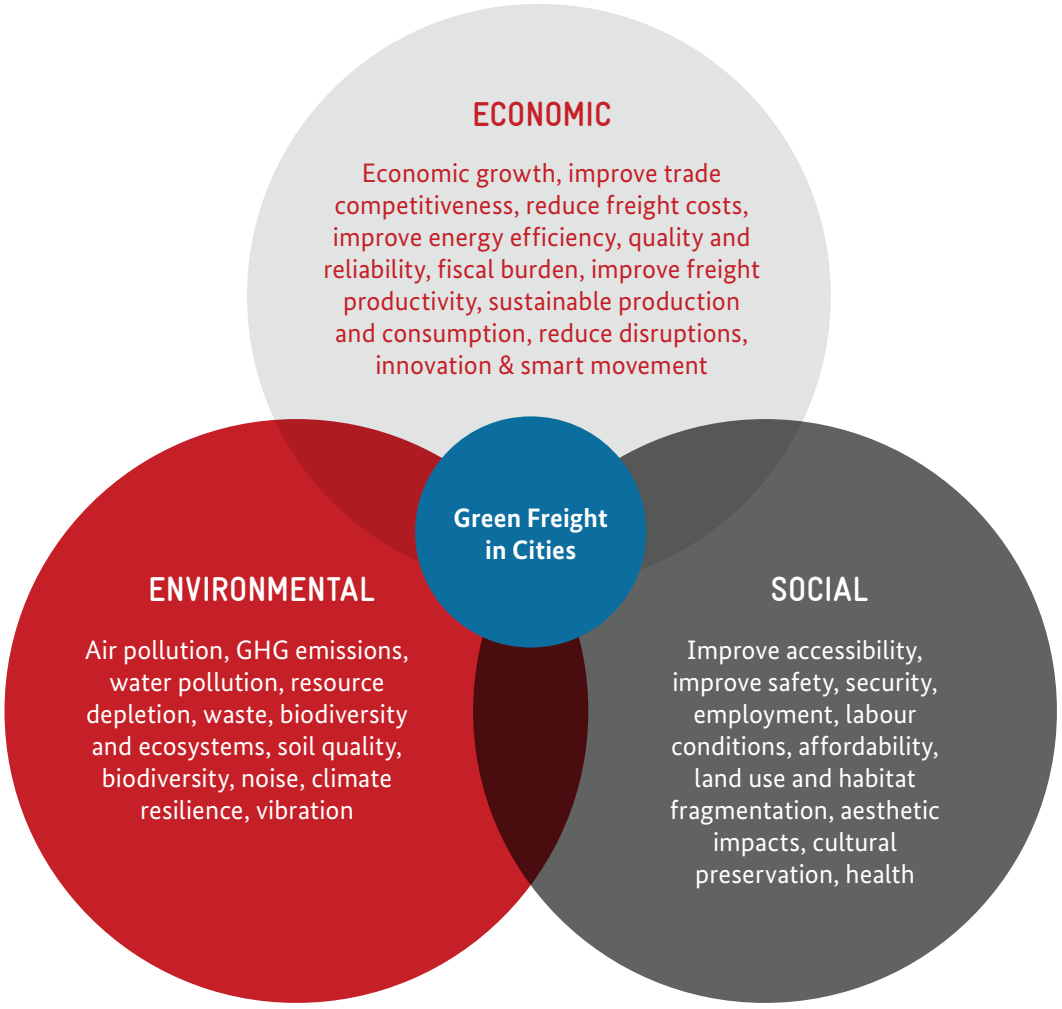
An increasingly recognized best practice among local authorities that can prove to be instrumental in facilitating outreach and discussions with other stakeholders is the introduction or the concept of a "freight champion" within the organisation. These are individuals who lead communications between departments and liaise with external parties to ensure that solutions are effective and considers views from the wider community (TfL, 2017).

London has set up a specific "Freight Unit" that is composed of 35 people which were later distributed to the different departments at the Transport for London. The freight unit was responsible for the development of the London Freight Plan and for setting up freight quality partnerships. In Bogota, the Mayor's Office created a "cargo group" in 2016 which focuses on developing innovative policies related to urban freight and logistics (CAF, 2020).

Alignment of freight goals with other goals (climate, air pollution, safety, gender)

Multiple urban developmental goals are intertwined with urban freight and potential synergistic benefits can be reaped if alignment of such, while ensuring minimum acceptance levels for stakeholders, can be achieved. Clear understanding of the appropriateness of potential measures into local situations, coupled with a systematic approach towards assessing their potential impacts in terms of the different dimensions (economic, environmental, social) are at the core of the identification of specific measures that would yield the greatest amounts of benefits.

FIGURE 18. GOALS RELATED TO URBAN FREIGHT

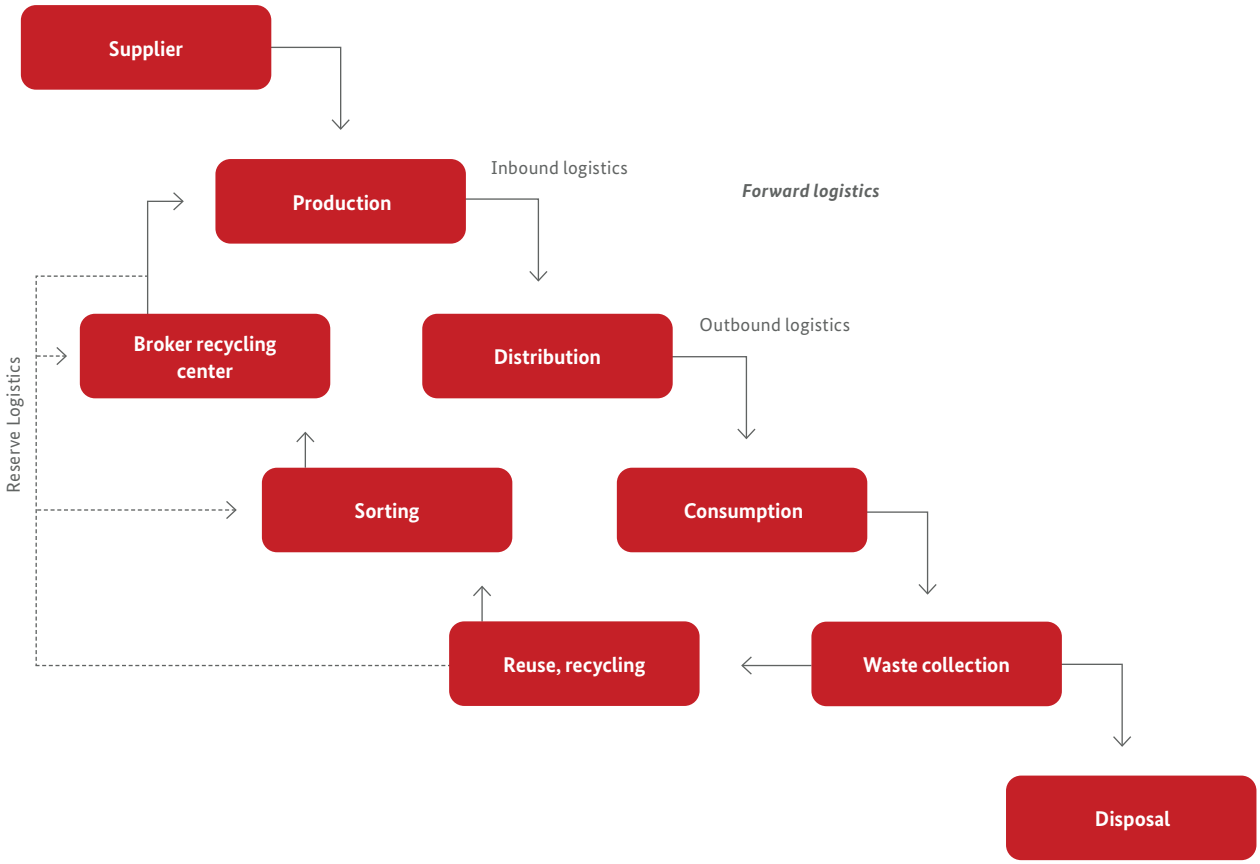


Source: SFC (2017) adapted from UNCTAD (2016)

Climate mitigation planning and target setting can include freight-related elements. The Environmental Master Plan of Tokyo, for example, which targets a 40% reduction in the GHG emissions of the transport sector, includes targets on loading ratios and travel speeds. The local urban plan of Paris, for example, not only organises land use, but takes into consideration issues related to aesthetics, safety, energy, and environmental standards including those that relate to logistics buildings.

As waste from urban goods delivery is amplified by the strengthening e-commerce industry, coordinated responses with national governments should be investigated. Regulations that are grounded in the action of "extended producer responsibility." In India, for example, the Solid Waste Management Rules (2016) and the Plastic Waste Management Rules (2018) primarily puts the responsibility of recycling and collection of plastic, corrugated boxes, and other related packaging material into producers, importers, and brand owners. Linking such actions with reverse logistics can strengthen overall waste management efforts as reverse logistics aims to add value to products that are recovered. The Brazilian National Solid Waste Policy, for example, aims at decreasing the total volume of waste and increase the sustainability of solid waste management at different levels of governance. It outlines different options for producers to work together within their sectors, with governments, as well as reverse logistics service providers to manage waste flows and recapture, recycle, and dispose materials (Alnuwairan & Zafar, 2018). These essentially highlight the importance of urban freight in circular economies as fuelled by the cradle-to-cradle principle.

FIGURE 19. FORWARD AND REVERSE LOGISTICS SCHEMATICS



Source: Adapted from Alnuwairan & Zafar (2018)

Another important theme to consider is having a gendered perspective on transport policy and planning, in general (Rosqvist, 2019). Urban freight planning, policy making, and associated design processes should also consider the creation of conditions by which women are able to move safely. Conscious consideration towards the needs of women is needed towards striving for the achievement of sustainability in urban mobility. In Sweden, for example, gender equality has been a declared goal of transportation policies since the late 1990s and has established a "Gender Equality Council for Transport and Information Technology (CIVITAS, 2014).

Different goals by different stakeholders at different levels may not necessarily be in conflict. Maintaining active engagements and discussions, coupled with transparent assessment methods would be key in identifying and implementing synergistic measures towards sustainable urban freight.

Formulation of a Sustainable Urban Mobility and Logistics Plan

The importance of integrating urban freight into wider land use planning policies is of critical importance for moving towards more sustainable long-term development trajectories. However, integration of such is not an easy task due to the complexity of the sector which is driven by the vast range of activities resulting from the relationships of the different actors and their needs. The CAF (2020) recommends that such urban freight plans should have a metropolitan vision, but measures that are focused and limited to the sphere of the municipalities due to jurisdiction-related practicalities. Such plans should either be integrated to, complemented by, or aligned with other plans.

In the EU, the development and implementation of sustainable urban mobility plans (SUMPs) have strongly been supported at the regional level. SUMPs are strategic plans designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life (Aifandopoulou & Xenou, 2019). Official guidelines on the formulation of SUMPs were initially released in 2013 and have recently been updated in order to tackle issues related to sustainable urban logistics planning.

The City of Bologna, Italy, implemented an innovative approach in the development of its sustainable mobility plans. The City's SUMP has been developed for the entire metropolitan area and closely aligns with sectoral plans for urban logistics as well as biking. The City Mobility Planning Office had the intention of bringing these elements together from the beginning. Bologna's experience highlights that stakeholder engagement is a crucial aspect of any decision-making process in a metropolitan area. The main challenge was to find feasible and effective ways for policy makers to steer urban logistics, which is a market dominated by private businesses with often little municipal planning experience (Rupprecht Consult, 2019).

The formulation of the SULP in Funchal (Portugal) started off through a territorial diagnostic which was dedicated towards collecting data towards the assessment of freight logistics operations in the city. This featured data collection activities on traffic counts, monitoring of loading and unloading in dedicated parking spots and surveys that targeted drivers and local traders. An urban logistics group was created as part of the diagnostic process which spearheaded the identification of strategic measures. The city focused on regulations, awareness campaigns, reorganisation of parking spots, creation of terminals, purchase of electric vehicles and real time monitoring systems, among other actions. Appropriate business models were also outlined in order to further engage the different stakeholders and freight agents. The city also embarked on pilot projects (e.g. on loading and unloading monitoring). An online ITS system was created to aid the management of the delivery schedules according to the demand and supply of goods in the target area which is the historic city centre (Henriques & Figueira, 2020).

Many developing cities still do not have sustainable urban mobility plans. In many cases, either due to lack of capacity, complexities brought about by governance structures, cities may not even have urban mobility/transport plans. However, there is always a time to initiate the development of such, whether it be a SUMP that integrates freight and logistics issues, or a stand-alone sustainable urban freight/logistics plan, or a similar plan that explicitly defines long-term goals and the set of measure needed to attain them (SFC, 2017). The important thing is that the process be initiated. This again, calls for mechanisms that enable the engagement of different stakeholders. Academia can also play a key role in supporting the formulation of such plans, and long-term partnerships with the local government can be sought in order to support not just the initiation of the plan, but also the assessment of the progress towards the stated goals of the plan.

FIGURE 20. STEPS TOWARDS DEVELOPING SUMPS

Source: Rupprecht Consult (2019)

2. WHY IT'S ESSENTIAL CITIES MOVE TOWARDS SUSTAINABLE URBAN FREIGHT

2.1. Describing the Concept of Urban Freight

What is Urban Freight?

This module refers to urban freight simply as the movement of goods and materials (including waste, building materials, industrial supply, energy, etc.) in urban areas. This definition encompasses the origin and destination of the goods; the diversity of the types of goods and materials being moved; the multitude of modes and vehicles being used in these movements ;as well as the importance of the different parts of the movement process (e.g. handling, packaging, etc...) that are interrelated with different operational and policy issues. The description also recognizes the importance of large movements, as well as small (single trip) movements which are becoming more important in the era of digitalization and e-commerce.

The Importance of Urban Freight

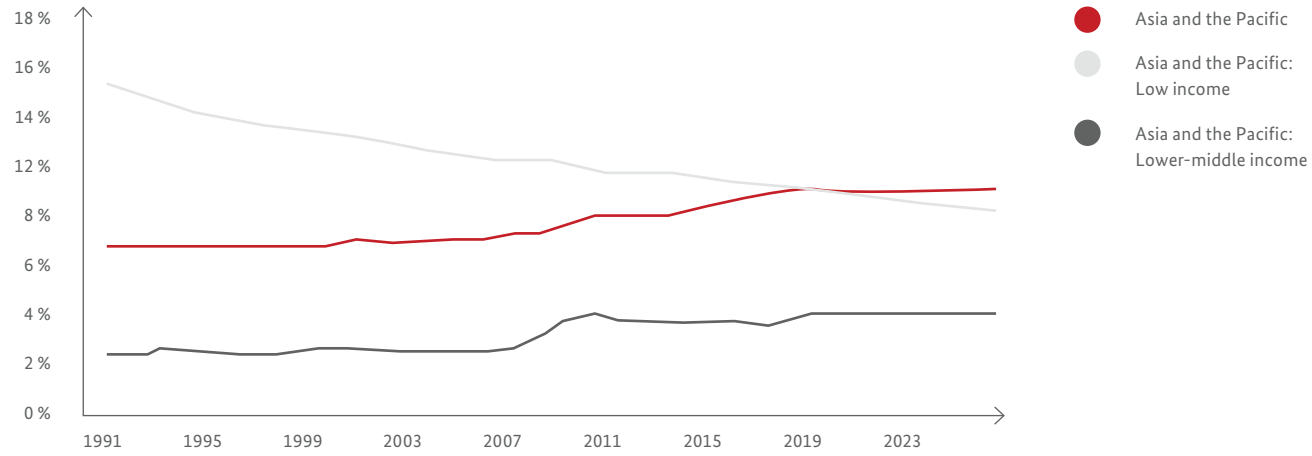
Due to the many issues associated with urban freight, policy makers and planners have tended to view urban goods movement as a problem rather than an essential component of urban development. Urban freight plays an essential role in the sustainable development of cities. The efficiency of urban freight contributes to the competitiveness of the economic fabric of a city, its attractiveness to visitors and the well-being of the citizens. Effective, safe, and sustainable goods movement is at the core of the liveability of cities. As we have seen during the COVID-19 pandemic, cities during these modern times can function without passenger movement, but they cannot function without the movement of goods.

Economic

Urban freight is an important source of employment, providing an estimated 5 to 10% of the total employment in large urban regions (IFSTTAR as quoted in CAF, 2020). These estimates exclude temporary employment which is important within the contexts of developing cities. In Asia, while there is no comprehensive dataset that shows direct employment related to urban freight, the total employment under the category "transport and storage" provides us an idea of the importance of the sector. The International Labour Organisation's employment statistics show that in 2018, 10% of total employment in the region was in transport and storage (ILO, 2019).

In addition, urban freight offers opportunities for people with low qualifications and employability issues (CAF, 2020).

FIGURE 21. SHARE OF EMPLOYMENT BY TRANSPORT AND STORAGE IN ASIA (%)



Source: ILO (2019)

FIGURE 22: DEPICTION OF THE DIVERSITY OF URBAN FREIGHT TRANSPORT CHAINS

Source: JL Perrin (n.d.) as quoted in DaBlanc (2018)

Social

The movement of urban goods is also critical in weaving the social fabric of our cities. Basic urban services - including health, sanitation, education - all rely on the movement of goods. For example, the ability to maintain appropriate levels of housing stock in urban areas, and thus the ability to access affordable housing, is dependent on the ability of housing materials to be moved..

Other activities that enrich the lives of the citizenry whether that be cultural, social, or recreational activities, all depend on the movement of goods. Effective responses during times of disasters, also rely on the efficient distribution of necessary materials and goods. The movement of goods also ensures the availability of and maintains the variety of choices being enjoyed by end consumers.

Environmental

Urban freight is essential in maintaining environmental sustainability in urban areas. First and foremost, the movement of waste materials is key in achieving transformative environmentally sustainable actions that minimise waste and increases the recirculation of input materials (such as cradle-to-cradle product approaches). Urban freight systems also impact the amount of waste being generated, particularly packaging material.

Urban Freight: Intricacies and Complexities

Urban Freight Tasks

The concept of urban freight involves different transport tasks that are related to the direct movement of goods, provision of services that involve the movement of goods, as well as construction activities. These tasks are demanded and supplied by a multitude of stakeholders that may be operating from within, or outside the city and happen at different times of the day, depending on the requirement for the tasks. Aside from the vehicle movements, the transport of goods requires a great deal of coordination in the conduct of other related activities such as handling and storage of items, management of inventories, and dealing with waste and returns (Aifandopoulou & Xenou, 2019). The evolving business models also result in evolving transport chains as depicted in Figure 22 above.

FIGURE 23. VARIETY OF VEHICLES USED IN URBAN FREIGHT IN ASIA

Photos by the author

Urban freight movements can vary widely in terms of purpose and characteristics. The origin and destination of such trips, for example, may impose certain conditionalities that are important to consider in policymaking and governance (e.g. different measures to address intra-city and through freight traffic). The conduct of urban freight tasks in many developing countries feature much more informal arrangements than in developed regions, which increases its complexity. There are other relevant concepts that are prominent in many developing cities that add to the complexities of urban freight such as direct selling, organised street markets, wholesale, and morning markets for perishables, among others (Herzog, 2010).

As compared with passenger transport, the transport of goods and materials needs to deal with a huge variety of items (physical dimensions, packaging, weight, density, transport requirements, etc...). The assortment types or variety of goods distributed, product volumes and drop sizes vary in different distribution channels. The nature of the goods being delivered, also heavily influences what policies and interventions might be appropriate. Different commodities have different freight requirements which may need to be considered in deciding policies and interventions. Moreover, freight movements primarily feature one-way movement of materials which cause significant levels of empty runs.

Urban Freight Vehicles

The conduct of urban freight involves the use of a multitude of different transport modes and vehicles. Smaller vehicles are favoured due to their flexibility in dense urban environments. In Asian cities, urban freight is commonly conducted by bikes, ricksaws, tuktuks etc. The delineation between a goods vehicle and passenger vehicles is often unclear. In many Asian countries, vehicle registration systems include ' multi purpose vehicles'. This can make governance of the urban freight sector more complicated. While such phenomena is should

not necessarily be taken as a negative one per se, it does make governance more complicated. To make matters more complicated, multiple vehicle configurations also exist in freight transport, which is also partly due to the lack of standards.

The further "atomization" of the conduct of urban freight tasks is now being accelerated through technology-enabled business models which enable the engagement of the wider public in the sector, and the expansion of the variety of vehicles used in the sector (e.g. two-wheelers used in commercial deliveries but not registered for commercial use).

Supply Chains and Distribution Channels

Urban freight traffic involves many different sub-sectors and types of delivery services, involving different supply chains. As such, many different strategies and distribution channels for fulfilling the freight tasks are employed. The nature of the distribution channels (route taken by a product from organisation to organisation from producer to the end consumer) is related to how the coordination role is being done, and by whom. This coordination task, in turn defines how the flow of the goods are being made towards the final consumers. An example of such distribution channel options is given in Figure 24 below. More intricate versions are expected in real-life distribution in developing cities, wherein the informal sector is much more engaged.

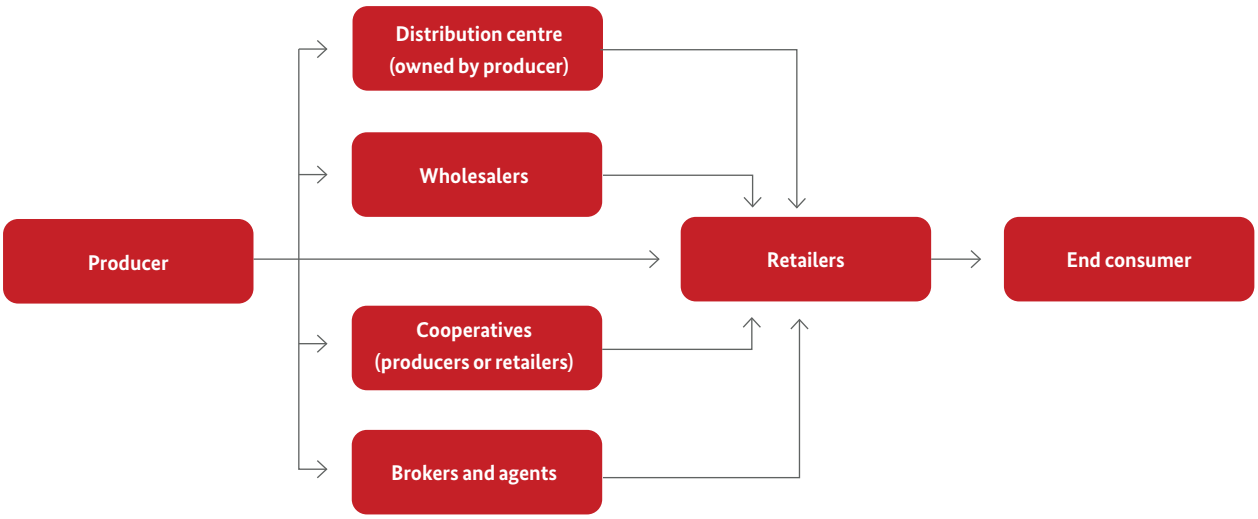
The requirements of the chain, as well as the types of actors involved heavily defines business arrangements (e.g. if specialised transportation is needed, definition of whether the movement requires full truck load or partial truck loads, or would require express couriers, or whether to sub-contract transport providers).

Consideration for movements concerned with materials other than consumer goods is also becoming increasingly important for developing cities such as those needed for construction and utility-related activities. Waste management is a key sector that is also quite interrelated with urban freight as the growth in cities translate to proportional (or higher) growths in terms of waste. While some cities have the legal responsibility for collecting waste, some also employ the services of private entities.

Infrastructure

Urban freight systems embody different facility and flow set-ups as required by the different distribution chains for different goods, in different markets that are present in the urban area. To accommodate the different types of physical movements, as well as the requirements of the contracts involved in goods movement, a variety of urban freight-related infrastructure exist in our cities. The inability to plan and provide proper infrastructure for urban freight is a key factor that exacerbates system inefficiencies, and thus negative externalities.

FIGURE 24. DEPICTION OF DIFFERENT DISTRIBUTION CHANNELS (URBAN RETAILING)



Source: Adapted from Danielis et al. (2010)

It is helpful to distinguish between the different types of physical infrastructure that are utilized in urban freight. Meza-Peralta et al. (2020) reviewed literature on urban logistics spaces and came up with the following typology which are primarily related to the nodal parts of the urban freight networks:

TABLE 9. URBAN FREIGHT INFRASTRUCTURE CONCEPTS

	Description	Functionalities
Warehouse	Space dedicated, under certain conditions, to the storage of different goods.	Storage of goods and operation information
Logistics centres/logistics platforms	Logistics platform is an infrastructure in which products are stored and various logistics operations are carried out.	Logistics operation of a similar type
Multi modal logistics platforms	Articulation between di erent modes of transport is carried out, in order to carry out more quickly and efficiently the operations of transhipment of materials and goods.	Articulation of transport for the distribution of goods
Logistics agencies	Company dedicated to the management of logistical processes or the provision of certain services in the sector. Establishment that depends on another larger (main) space where the same activities are carried out.	Design of the management and of the di erent networks for the distribution of products
E-commerce deposits	It is the space where the activity of storage, distribution, parcels of urgent services, freight forwarders and other logistic operations is developed.	Storage of the products of companies with virtual management.
Interior ports/ dry ports/ terminal	A dry port is an inland intermodal terminal, connected by road or rail to one or more marine terminals, with the ability to postpone customs control until entry into the dry port.	Possibility of postponing customs control until entry into the dry port
Transhipment centres	Transhipment centres.	Consolidation and deconsolidation of goods with possible storage
Crossdocking platforms	Spaces where the preparation of order is carried out, one of the functions of the logistic warehouse without placing goods in stock, nor picking operation. Strictly speaking, cross-docking is done without any type of intermediate storage.	Load preparation without inventories and without harvesting
Logistics parks	Spaces where the preparation of order is carried out, one of the functions of the logistic warehouse without placing goods in stock, nor picking operation. Strictly speaking, cross-docking is done without any type of intermediate storage.	Large areas of logistic and industrial activities, reduction of logistic costs

	Description	Functionalities
Urban distribution centres	Logistics platform in which products are stored and delivery orders are delivered for distribution to retailers or wholesalers.	Shipment of goods of the same type or of di erent types
Free trade zones/ logistics zones	It is described as a defined geographical area within the national territory, where various industrial activities of goods and services or commercial activities are carried out, under special regulations in tax, customs, and foreign trade matters.	Allows parafiscal benefits in each territory
Multiple logistics platforms/ multipurpose terminal	Multipurpose Terminals: These are ports specialised in handling different types of cargo. They have large storage spaces on land for their products. Logistics Platforms are delimited areas created with the aim of collecting cargo for distribution.	Reception and management of different types of cargo
Collection centres	Collection points where carriers can drop parcels so that final consumers can pick them up (and thus avoiding risks of failed home deliveries).	Storage of goods for final collection of consumers
Parking areas	Parking spaces to the physical space where large vehicles are stored. Parking of large vehicles at certain points of exclusive commercial premises for cargo vehicles for the loading or unloading of goods.	Parking of freight vehicles
Load and unload facilities	Dedicated facilities for the preparation or loading and unloading of goods.	Load preparation and readiness
Sea ports/coast zones	Places located on the coast or on the bank of a river where ships perform loading and unloading and loading and unloading operations.	Load and unload (maritime)
Consolidation centres/ micro-consolidation centres	In consolidation centres, shippers pay rates by volume of cargo, as they are all shipped at the same time instead of making small shipments separately. This is an advantage for shippers who only have a few pallets of products they wish to pack and ship in one container.	Large-scale consolidation of goods to reduce costs
Lifting platforms	Integrated lifting platform for storing and receiving containers autonomously from a separate storage shelf.	Storage and reception of containers autonomously to avoid excessive movement when moving a container from one train to another
Delivery centres centres	Points where the merchandise is received for commercialisation and to establish contact with the consumer for his purchase.	Merchandise marketing points Merchandise marketing points

Source: Meza-Peralta (2020)

It is of basic importance to recognize the interaction between passenger and freight movements, particularly in road transport. This is true in terms of both the links (e.g. roads) and the nodes in the transport network. This is an important complexity to consider particularly in terms of ensuring safety of movements.

Stakeholders

The flow of goods is dependent on decisions that are taken by different stakeholder, both from the supply and demand sides of the urban freight equation. The very nature of transporting goods inherently results in the need to involve additional stakeholders which, for example, are not present in passenger transport. Goods transport need people (or additional machines) who would be involved in the loading, unloading, and transferring the products, as well as people who would handle the processing of information that facilitate the movements (e.g. logistics managers). As such, the transport chain also involves manufacturers, distribution companies, the consumers/receivers, and other relevant groups (e.g. other users of road space and infrastructure, interest groups). Due to the complex nature of stakeholders, who are driven by different goals and aims, practical schemes have primarily been driven by the political reality (Huschebeck, 2000).

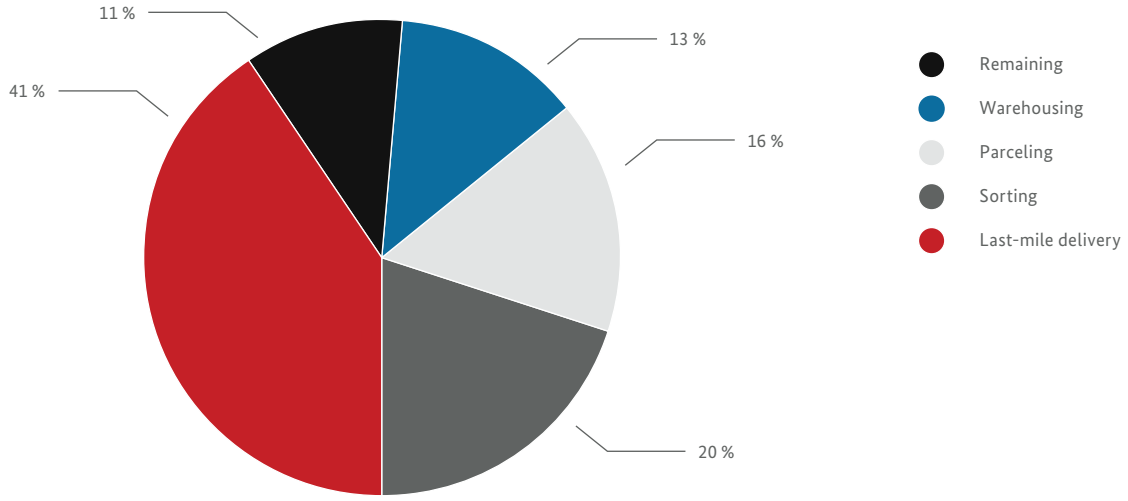
Multiple actors are involved in the urban freight and logistics chains such as those involved in the production, wholesale, transporting, retailing, and consuming of products who have different interests as shown below.

TABLE 10. GENERAL CATEGORIES OF MAJOR STAKEHOLDERS IN URBAN FREIGHT

Stakeholders	Description
Shippers	Actors who send the goods and arrange the transportation, including those who perform their "own-account" transport – entities whose main business functions are non-transport related (Ballantyne et al., 2013). From a practical standpoint, this category includes the likes of Amazon (which now handles almost half of its own packages) as well as its merchants. They expect reliable and cost-efficient delivery.
Customers	Customers could include both consignees of goods (e.g. shops or restaurants), as well as end-consumers (e.g. residents) who may opt to complete the last mile delivery of goods privately. Customers may have an interest in cost efficiency, reliability, and other aspects such as the attractiveness of urban areas, safety and security, and environmental issues.
Freight Transport Operators	Include third party logistics operators or hauliers who are responsible for logistics operations in urban areas (Ballantyne et al., 2013). Is forced to cut operational cost wherever possible while maintaining the customer needs and interests (Herzog, 2010). In the world of e-commerce, this category of stakeholders would now include the individual sub-contractors that are being hired by e-commerce companies to fulfil the transport tasks, particularly last-mile deliveries.
Authorities	Most relevant to urban freight are local authorities whose primarily goal are geared towards the ensuring the safety, sustainability, and economic vibrancy of their jurisdictions. Other government entities in higher levels (regional, national) are also important. They have similar types of goals but at a wider scale.
Other stakeholders	Other relevant stakeholders are vehicle manufacturers, public transport operators and commuters' associations (i.e. due to the interactions of freight and passenger transport in physical networks), landowners, among others (Landqvist & Rowland, 2014).

Source: UNEP (2020)

FIGURE 25. SHARE OF TOTAL SUPPLY COSTS WORLDWIDE IN 2018, BY TYPE OF COST



Source: Capgemini Research Institute (2018)

Minimizing last mile delivery costs is still particularly important in the freight sector and is a key priority for private sector actors. The total costs of last mile deliveries, for example, relies heavily on the price of manpower, operational efficiency, and material resources (Wang et al., 2014). The expectations of the end customers (e.g. delivery fees, speed, time slot, delivery dates, etc...) are key towards determining the costs and operational complexity of the deliveries.

The changing digital landscape is now adding new stakeholders into this list, such as those that provide the platform for facilitating goods deliveries. It must also be noted that there are other potential intermediaries within the whole supply chain that also need to be taken into account in the planning and management of goods flow in urban areas. In a simple example of food supply chains, one might think of the slaughtering industries, and other food processing industries which might be operating within the urban area of concern.

[3] *Five hundred (500) grocery retailers and consumer product firms from Netherlands, Germany, France, United Kingdom and United States.*

Stakeholder management in urban freight in developing countries is further complicated by the strong permeance of informality, as well as fragmentation. Fragmentation is a common feature in most urban freight systems globally, including carriers. In Europe, it is estimated that 80% to 90% of freight carriers have five or fewer vehicles (Mckinnon, 2015). Urban freight service companies are also commonly small, with 85% of them having less than five employees (ALICE, 2015). In China, there are approximately more than 6.79 million trucking companies, with more than 90% of these featuring self-employed driver-owners (CRTA, 2014). Majority of the truck operators operating in the GMS region are classified as small and medium enterprises that operate less than 10 trucks (ADB GMS, 2015). The high fragmentation of the freight and logistics sector leads to substantial inefficiencies that drive costs.

On the receiving end, the retail sector in many developing countries, for example, can be far more fragmented, and informal, than those in more developed countries. Nano stores, for example, are a dominant form of business model that abound in countries (e.g. sari-sari stores in the Philippines, and kirana shops in India). The presence of such come with high level of fragmentation, as individual stores are primarily owned by individual business owners with different tactics in terms of re-stocking supplies. The digitalisation of such nano-stores is also on the horizon. Amazon, for example, has recently launched a program in India that helps kirana store owners to sell their products online.

FIGURE 26. "SARI-SARI" STORE IN THE PHILIPPINES

Photo by the author

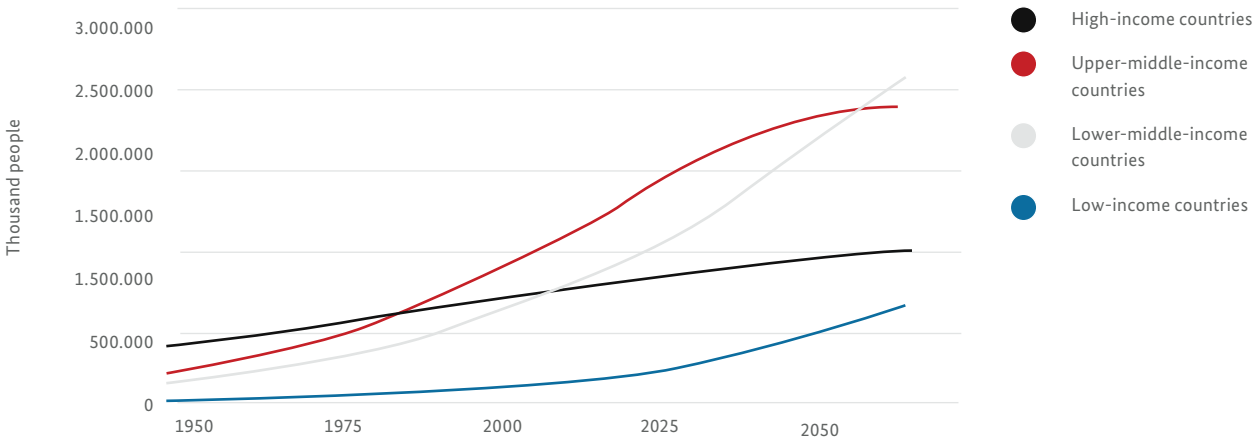
2.2. State and Trends: Growth and Transformation in the Urban Freight Sector

Growth of Urban Freight

Rapid urbanisation and increasing per capita incomes drive the rapid growth in urban freight demand in developing cities. The global urban population share is estimated to grow from 55% in 2018 to 68% by 2050, which equates to roughly 2.5 billion people being added to urban areas. The United Nations expect that 90% of this growth will be taking place in Asia and Africa. India, China, and Nigeria will account for 35% of the projected growth in urban population (UN, 2018). The fast pace of urban population growth in lower middle-income countries is depicted in the graph right.

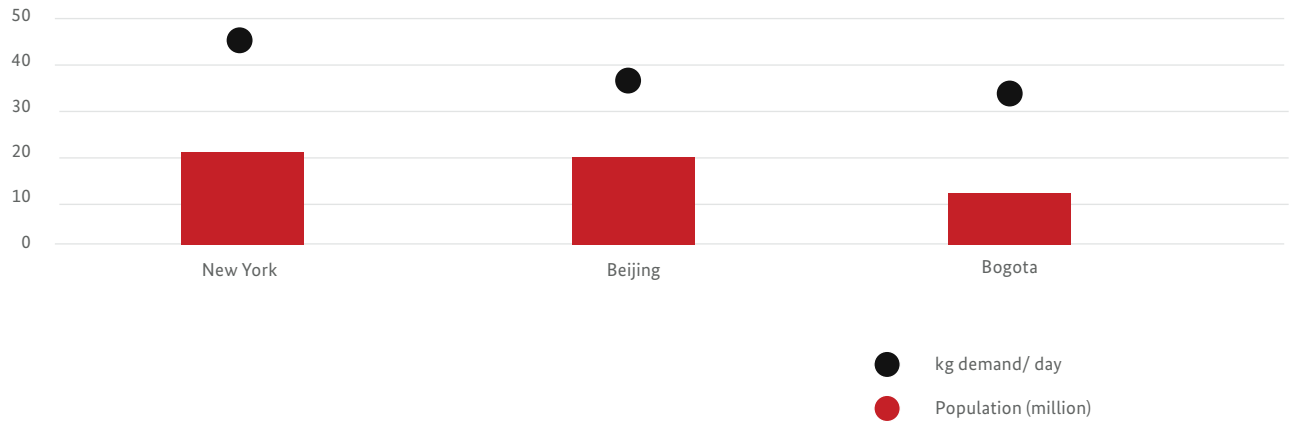
Increasing per capita income is associated with a higher demand for goods, and thus an increase in the demand for freight transport. The International Transport Forum (ITF) estimates that cities in developing countries will experience rising incomes faster than anywhere else. The GDP per capita in China will nearly quadruple by 2050. Average GDP per capita in India will more than quintuple. Urban areas are expected to account for 81% of the global GDP by 2050, from 60% in 2015. Such increases in wealth will push global freight demand to grow more than triple between 2015 to 2050 (ITF, 2019). While overall freight movements are dominated by sea freight (in terms of overall ton-kilometres transported), road freight dominates the movement of goods in urban areas. To put things into perspective, a person in New York (USA), Beijing (China), and Bogota (Colombia) is estimated to generate an average of 45, 35, 32 kilograms of goods demanded each day (Rensselaer Politechnic Institute as quoted in CAF, 2020).

FIGURE 27. GLOBAL URBAN POPULATION (THOUSAND PEOPLE)



Source: UNDESA (2018)

FIGURE 28. GOODS DEMAND (KG/DAY) AND POPULATION (MILLIONS) – SELECTED CITIES



Source: CAF (2020)

Rapidly Changing Landscape

Digitalisation and E-commercialisation

Information technology is moulding modern lifestyles, economies, and how goods are being demanded, and delivered. The number of digital buyers worldwide is expected to almost double from by 2021 from 2014 levels, thereby increasing the share of online global retail sales to up to 22% (from 7.4% n 2014) (eMarketer, 2017).

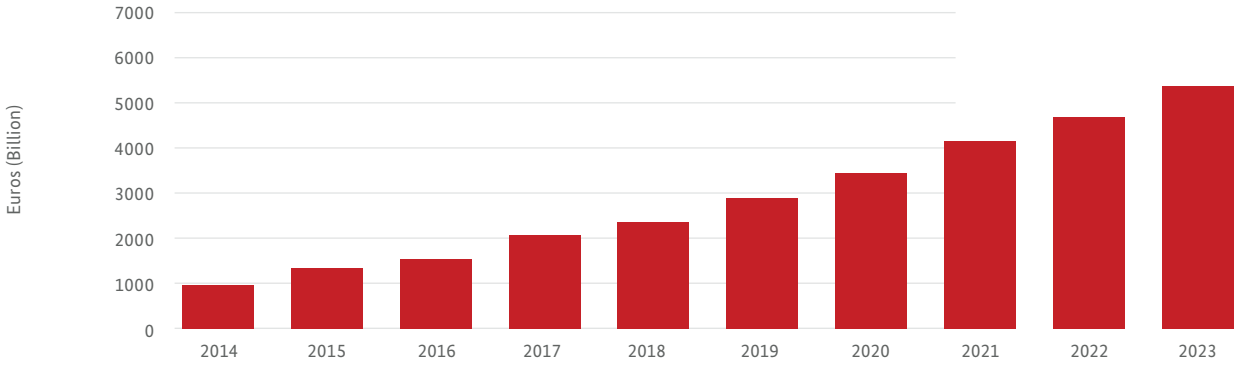
In particular, emerging economies are exhibiting strong growth in terms of e-commerce as depicted in the estimated compounded annual growth rate (CAGR) estimates between 2020-2023 as provided in Figure 29.

The COVID-19 pandemic has had significant impacts on consumption of different types of goods (and services). We have yet to see if such trends continue, which might have longer-term impacts as supply chains are disrupted and fully transformed.

[4] *Worldwide; week ending 9/6 compared to reference (Jan 6 to Feb 16); 1,400 sites; 7 billon sessions.*

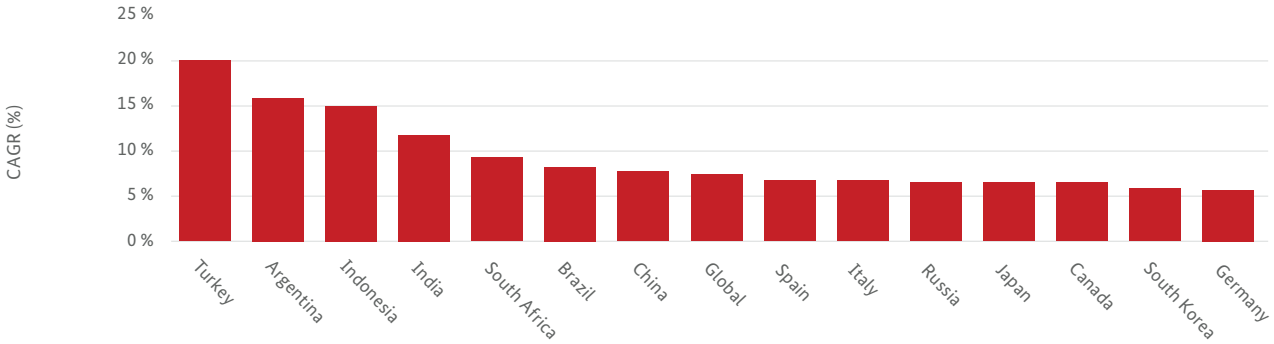
© @purzlbaum, Unsplash

FIGURE 29. WORLDWIDE RETAIL E-COMMERCE SALES ESTIMATES: 2014-2023 (IN BILLION EUROS)



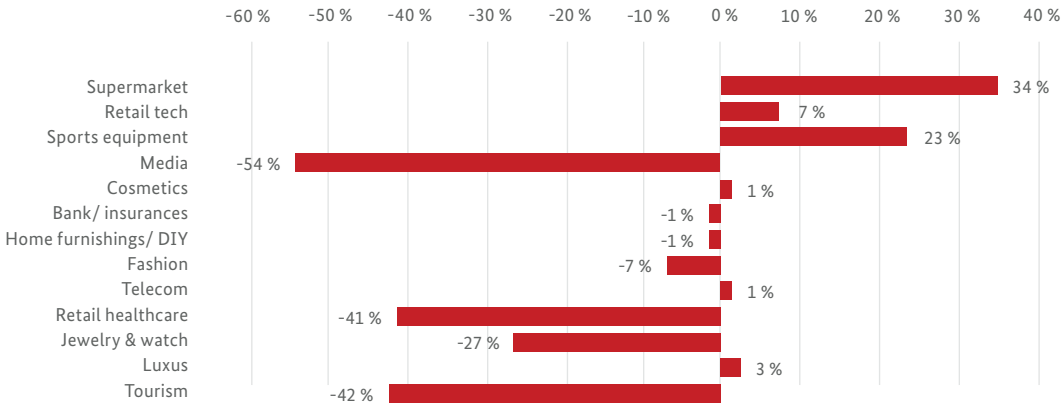
Source: eMarketer (2019)

FIGURE 30. RETAIL E-COMMERCE SALES CAGR FOR SELECTED COUNTRIES: 2020-2023



Source: Statista (2020)

FIGURE 31. CORONAVIRUS IMPACT ON ONLINE TRAFFIC OF SELECTED INDUSTRIES WORLDWIDE[4]



Source: ContentSquare (2020)

Evolving Business Models

The emergence of new business models, particularly those enabled by information technology is transforming urban freight. E-commerce has also influenced the types of vehicles being used for deliveries through the engagement of new players (e.g. private providers of transportation services) and innovations (information technology-enabled platforms). Digitalisation is now enabling thriving models of business that are outside of the traditional business-to-business (B2B) and business-to-consumer (B2C) modalities:

E-commerce is also facilitating the push towards direct consumer deliveries thereby transforming the B2C realm (resulting in more trips that involve small-volume, low-weight parcels). This modality has led towards increased volume and complexity of urban distribution logistics. Parcel deliveries high costs for both the couriers (extended delivery routes) and consumers (high prices), as well as to the environment (Carotenuto et al., 2018). Attended home deliveries (AHD) have been generally preferred by consumershowever, this type of delivery is problematic in terms of service and programming costs (Morganti et al, 2014).

Overall changes in global supply chains that imbibe reducing the costs of inventories in warehouses (e.g. just-in-time deliveries, small inventories, lean production) and customer-oriented production chains also result in intricacies that need to be considered. These shifts towards more dynamic and efficient supply chains require adaptive governance responses.

Governance Challenges

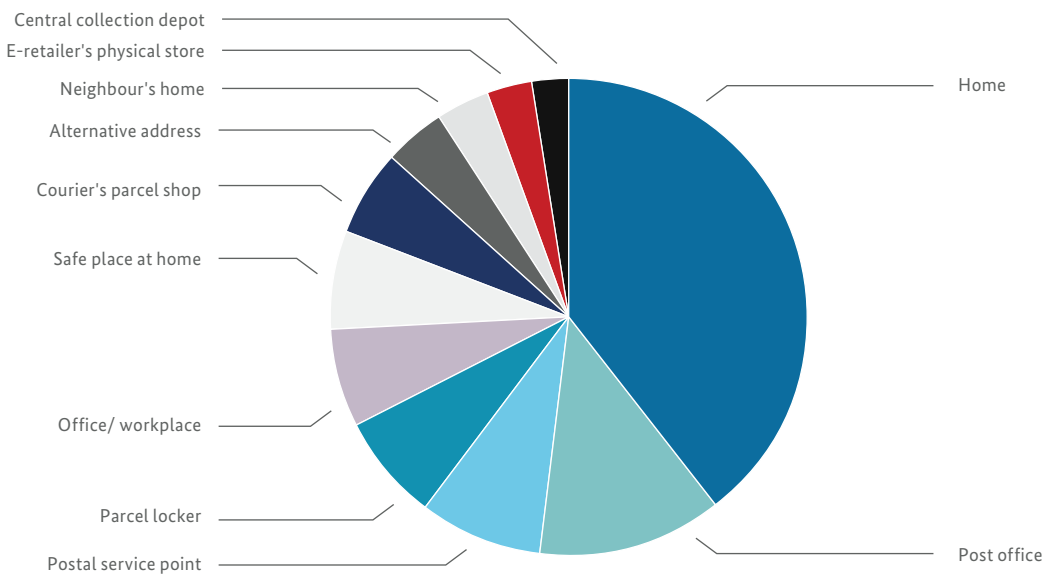
The governance of urban freight is burdened with intricacies resulting from the complex nature of the sector and is challenged by the presence of diverse range of participants – both active and passive – who are driven by different and often conflicting interests. Urban freight planning and integrating such into wider mobility and development planning is becoming an even more complex task due to the increasing number of stakeholders and their evolving interactions which result in a large number of potential policy options and interventions, numerous pathways towards implementation, and a wide range of possibilities as to how stakeholders would respond.

TABLE 11. BASIC CATEGORIES OF BUSINESS MODELS

Category	Description
Business-to-business	Businesses selling/buying products from one another as part of their supply chain.
Business-to-consumer	B2C e-commerce business model wherein businesses sell to individuals through online modes (e.g. Amazon, Lazada, Shoppee).
Consumer-to-consumer	C2C platforms enables end customers to trade, buy and sell their items. The actual deliveries/transfer of goods can be done by the participants themselves or hire an entity to do the delivery (e.g. either through post, or pick-up and drop-off delivery).
Consumer-to-business	C2B is a growing model where consumers are enabled to sell goods and services to businesses (more prominent in the service sector).

Source: Tamilarasi and Elamathi (2017)

FIGURE 32. MOST USED METHODS IN PACKAGE DELIVERY WORLDWIDE (2019)



Source: IPC (2020)

Note: Worldwide; September 16 to 30, 2019; 35,737; frequent cross-border online shoppers, who have bought physical goods online at least once in the last three months and have made a cross-border online purchase in the past year.

The rapid evolution in the sector that is being driven by digitalisation is also putting additional layers of complexities, as additional expertise and knowledge are needed by the governing authorities to ensure safe, efficient, and sustainable flows of goods in urban areas.

Moving Goods is Less of a Priority

Considering the variety of developmental challenges that most cities face, building a case for the provision of proper attention towards the transport of often inanimate goods is difficult. However, it must be recognized that sustainable urban mobility cannot be achieved if the urban freight sector is left unattended.

Promoting Systems-based Approaches

Urban freight, which primarily limited to the confines of the urban areas, is significantly defined by transactions and flows, as well as regulations that govern such, which are not necessarily within the jurisdiction of the urban authorities. Urban freight players also operate in a realm where rules are set at different governance levels, for examples, regulations that are set at the national level.

Holistic perspectives are required towards avoiding unintended consequences of policies and interventions. A common approach for managing urban freight is through regulations and restrictions, for example, the imposition of weight or time-based restrictions for road trucks in certain areas. Such regulations may indeed lead to undesirable consequences such as increased emissions for the directly affected trips, as the vehicles are required to take other potentially longer routes. However, these types of regulations are not necessarily done for the sake of improving urban freight efficiency, but for other goals such as safety, or preserving the environmental sensitivity of certain areas (Ballantyne, 2013).

Linkages and Conflicts with Stakeholders within and outside of Urban Freight

The governance of urban freight is also intertwined with intricacies brought about by linkages with other wider goals. The planning and management of the urban freight sector requires careful balancing of measures to be employed and how they might impact different priorities.

Private entities aim for profit maximization and minimization of totals costs and time, final consumers primarily look for quality and cost-efficiency. Public authorities primarily aim for wider goals such as the optimal use of limited resources, minimization of negative impacts, and provision of urban services, and enhancing economic welfare and competitiveness. Urban freight measures may not also align with other sectors (e.g. balancing cultural heritage preservation goals and urban freight efficiency targets in heritage areas).

While different stakeholders may have different motivations and targets, there are synergies to be found. Depending on the local context. there might be specific measures that lead towards significant overall positive benefits, and result in negative impacts that are reasonably acceptable to the relevant stakeholders. Careful analysis of such impacts, communications, and coordination, are of course, much needed in this regard.

Limited Resources and Capacities

The lack of capacities and expertise on freight is an issue that is not only present in developing cities (Ballyntyre, 2013). The lack of awareness and knowledge on urban freight transport by the local authorities also fuel the lack of involvement by the other stakeholders in the issue. A recognition by authorities at different levels that urban freight is not a discretionary task, and that is something that needs to be integrated higher into the planning hierarchy is a key foundation for moving towards sustainability in the sector, as strategic decisions in terms of providing dedicated resources and staff are dependent on such realization.

2.3. Negative Impacts of Urban Freight

Essentially, the goal of urban freight policymaking is to maximize the benefits of freight flows while minimizing associated negative externalities (Holguín- Veras, 2014). This section provides an overview of the most common negative effects associated with urban freight.

FIGURE 33. NEGATIVE IMPACTS OF URBAN FREIGHT

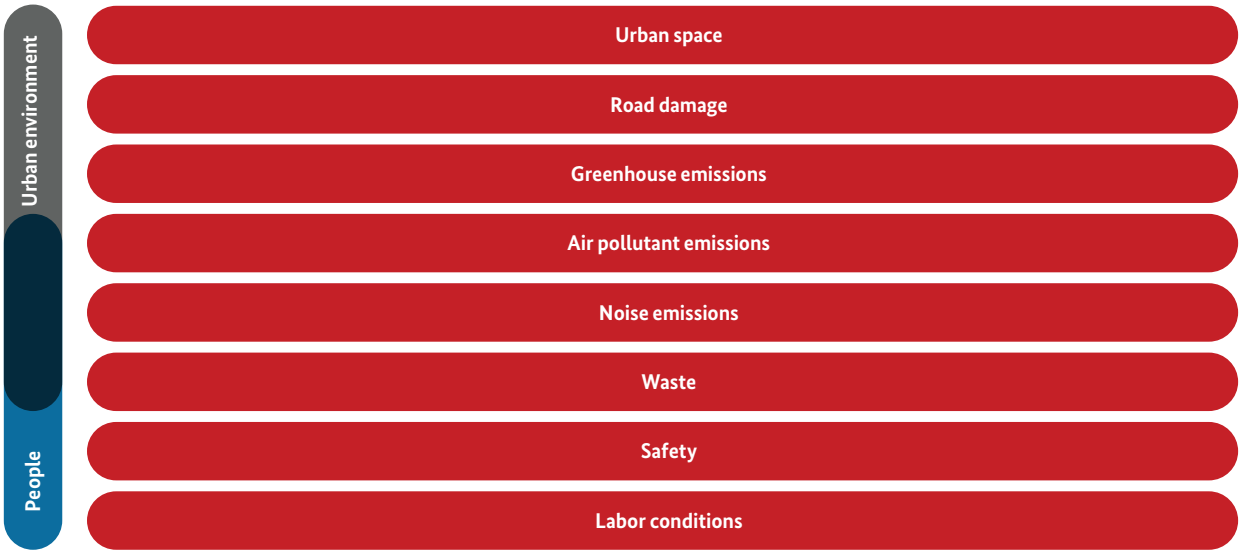


FIGURE 34. OVERLOADED TRUCK IN INDIA

Photo by studelt (2008)

Need for Urban Space

Urban space is a limited resource that needs to be managed and balanced between different uses by the urban eco-system. Moreover, infrastructure expansion is highly limited by geographical factors, as well as available actual land resources, and the costs of the space. The growing demand for goods, coupled with high costs of space within city centres are encouraging logistics sprawl which can lead to other impacts such as increased vehicle activity. Moreover, many developing cities are also faced by issues that are compounded by rapid population and economic growth, and difficulties in upgrading transport infrastructure towards a state that can keep up with the growth (e.g. prevalence of narrow, and/or low-quality roads, lack of parking spaces).

Essentially, congestion occurs when the volume of demand for space exceeds the designed capacity of the infrastructure. Urban freight vehicles do not only contribute towards urban road congestion due to their usage of the carriageway, they are also quite important users of parking spaces, particularly the huge lorries/ trucks. Urban freight vehicles can encroach into available road space if no appropriate (or available) space is provided which can cause bottlenecks on the traffic flow.

Road Infrastructure Damage

Heavy-duty trucks, which also make their way into the road networks within cities, have been studied to have a significantly greater impact in terms of damaging road infrastructure primarily due to their weight. Specific malpractices such as operation of vehicles that are not road worthy, as well as overloading - which may aggravate road damage which then result in excessive wear and tear of other vehicles - are common issues in many developing countries.

Greenhouse Gases (GHGs) Emissions

Estimates show that 15-20% of the vehicle kilometres (four wheel or more) travelled in urban areas can be attributed to commercial vehicles, it is estimated that they take up roughly 20% to 40% of motorized road space occupation and cause 20 to 40% of CO2 emission (Herzog, 2010). The International Transport Forum estimates that 5% of the total CO2 emissions from all of transportation is emitted by urban freight vehicles in 2015. The entirety of the freight sector is estimated to have contributed 36% of the total transport CO2 in 2015, and its estimated contribution is estimated to increase to 42 % by 2030, and 49% by 2050 (ITF, 2019).

The urban freight sector impacts GHG emissions directly – through tailpipe emissions from motorized cargo vehicles – as well as indirectly – due to the congestion impacts that such vehicles have on the network. Other factors such as low load factors and empty running, long dwell times at loading and unloading points which keeping the engine running, are some of the associated issues that increases direct vehicle emissions (MDS Transmodal, 2012). The congestion impacts may be due to the impacts of the cargo vehicles - especially the larger ones - on the capacity of the transport roads, particularly if the goods peak flows coincide with passenger peak flow, as well as the congestion impacts due to manoeuvring into and out of access points to facilities, as well as improper loading and unloading practices that can spill over the carriageway.

Urban Air Pollutant Emissions

Urban freight is a particularly important sector when we talk about urban air pollution in many developing cities due primarily to the characteristics of the vehicles and fuels being used, the proximity of their operations to the urban populations, and the magnitude of people living in developing urban areas. Freight trucks are often implicated as having a disproportional contribution to the amount of pollution that they emit. Trucks in China account for 11% of the vehicle stock, they contribute disproportionally high amounts of criteria air pollutants: HC (19%); NOx (57%); PM (78%) (SFC, 2017). In Europe, it is estimated that urban freight contributes between 30% to 50% of relevant air pollutant emissions such as Particulate matter and NOx (ALICE, 2020).

Older vehicles (i.e. lower emission standards) being used in freight transport tend to release significantly more air pollutants as compared to newer counterparts as depicted in Figure 36 below (Ntziachristos & Samaras, 2020).

Older vehicles are still primarily dominant in urban freight systems in many developing countries. It is not uncommon to relegate older vehicles in urban freight applications, as opposed to them being used in intercity or long-range freight movements. Figure 37 below depicts the average age of the truck fleet being used by third party logistics and freight forwarders in the Philippines and shows the dominance of trucks that are over 10 years old. These figures are also reflected in survey data gathered in the Greater Mekong Sub-region where fleets average more than 10 years (ADB GMS, 2015).

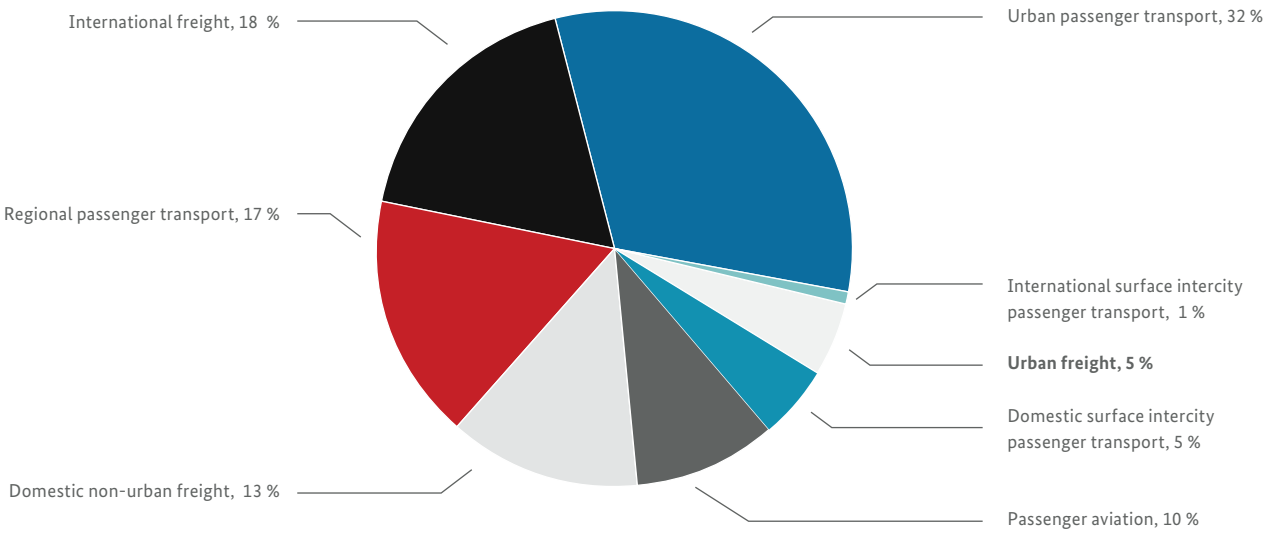
Heavy-duty diesel vehicles are also implicated as a major source of black carbon emissions (25% of global emissions) which are estimated to have a warming impact on the climate that is 460-1,500 times stronger than CO2. Black carbon is also a key component of PM2.5 which are pollutant particles that are small enough to penetrate the deepest regions of the lungs and can cause respiratory diseases and premature deaths and are carcinogenic(CCAC, n.d.).

Noise Emissions

Noise is essentially defined as unwanted sound which can be intrusive and also physically harmful if it is sufficiently persisent and/or loud. The human ear can hear noises about 20 decibels (dBA) and up. Noise emissions from land transport can depend on factors such as speed and volume of traffice, the traffic mix and the type of surface. Table 12 depicts indicative ratings interms of acceptability in relation to noise exposure levels (Stopher & Stanley, 2014).

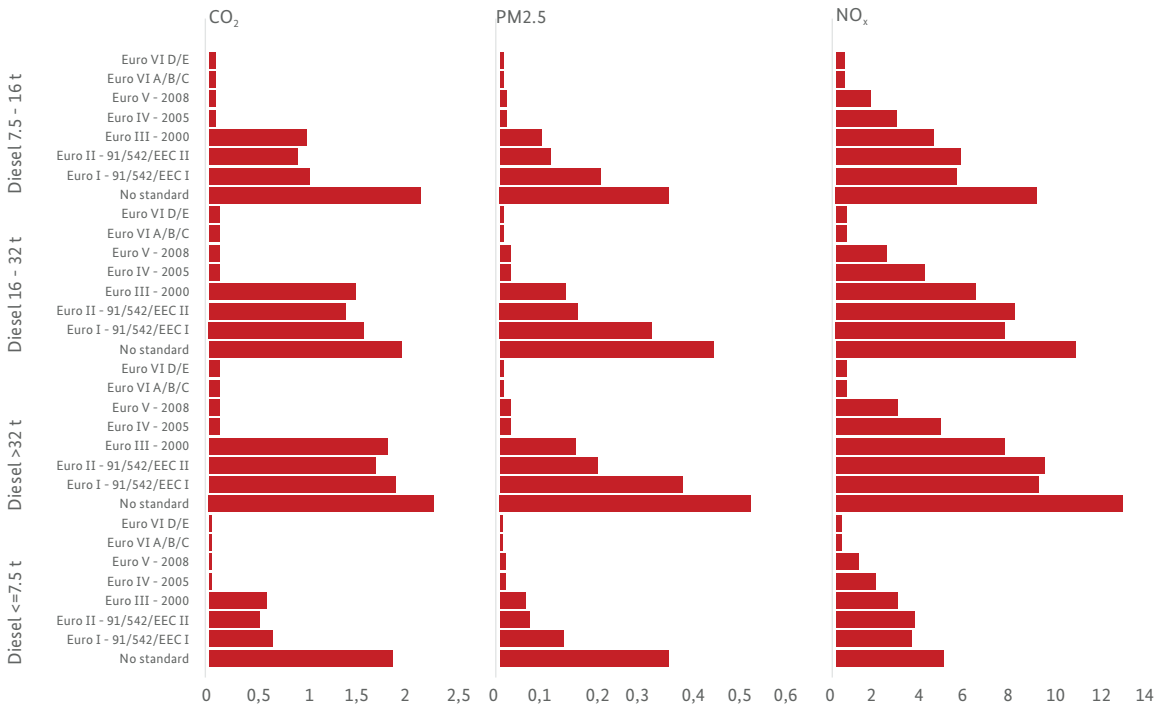
[5] *HC = Hydrocarbons ; PM = Particulate Matter; NOx = Oxides of Nitrogen*

FIGURE 35. SECTORAL SHARES OF CO2 EMISSIONS (2015)



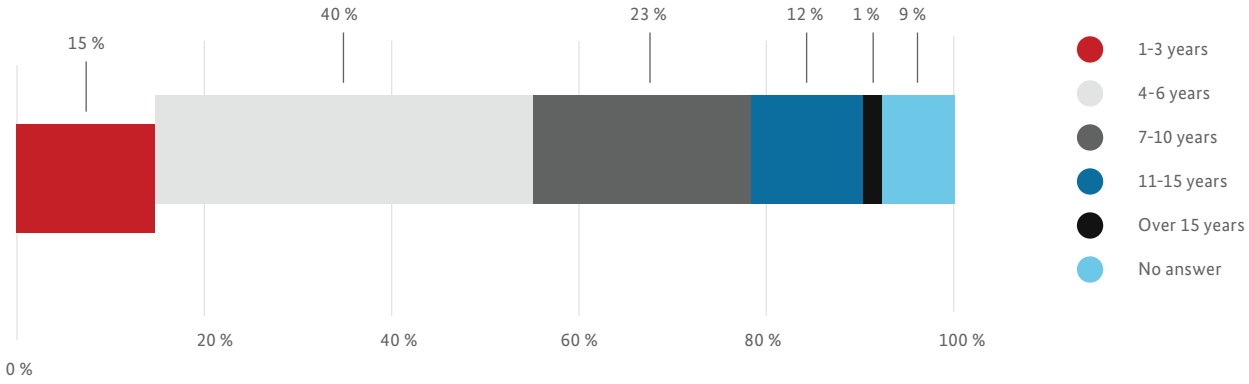
Source: ITF (2019)

FIGURE 36. EMISSION FACTORS FOR HEAVY-DUTY VEHICLES (GRAM/VEHICLE-KILOMETRE)



Source: EEA (2020)

FIGURE 37. AVERAGE AGE OF FREIGHT TRUCKS (PHILIPPINES)



Source: Romero & Agatep (2018)

TABLE 12. EXPOSURE TO NOISE AND RATINGS OF ACCEPTABILITY

Rating	General External Exposure
Unacceptable	>80 dBA 60 minutes in 24 hours >75 dBA 8 hours in 24 hours
Normally unacceptable	>65 dBA 8 hours in 24 hours (comparabe to a busy street)
	Loud repetitive sounds
Normally acceptable	<65 dBA more than 8 hours in 24 hours
Acceptable	>45 dBA less than 30 minutes in 24 hours

Urban freight transport accounts for a significant part of ambient noise in cities and mainly causes discomfort to people during the night, when no appropriate measures are taken. Lowering the noise related to handling, loading and unloading of e goods are critical during night deliveries (ALICE, 2015). In this guide, there are several measures that are discussed that may also alleviate noise pollution from urban freight such as operational rules (e.g. low speed zones, time-based access), use of innovative design technologies (e.g. for loading and unloading), and provision of appropriate infrastructure (e.g. consolidation centres) for conducting freight-related activities.

Waste

Urban freight strategies are also intertwined with issues concerning waste generation and management. As the on-demand delivery regime is strengthening, waste generation due to increased demand for packaging material will rise. The emergence of e-commerce for food and parcel delivery is increasing the demand for packaging and thus proper disposal of associated waste – single-use plastic, paper, bubble wrap, cardboard cartons, tape. To put it simply, online B2C transactions adds one extra layer of packaging (DHL, 2019). In the United States, for example, the cardboard used for packages shipped to the country is estimated to be equivalent to 1 billion trees (Bird, 2018). Cities in China are also implementing initiatives to reduce waste from e-commerce in line with the country's broader strategy to reduce plastic consumption including a phaseout of single use plastic by 2025. Shanghai, for example, issued new regulations to reduce waste from e-commerce packaging and has tasked its post offices to reduce the use of non-biodegradable plastics in express delivery, and plans to ban non-biodegradable tape by 2023 (Borak, 2020).

Another key issue associated with e-commerce is reverse logistics which is concerned with the return of the product from the customer to the supplier as this is related to both waste generation (additional waste, in terms of packaging due to customer returns of defective and unwanted products), as well as waste disposal.

Safety Concerns

There are a range of safety issues with freight in dense urban areas.

The manoeuvring of larger vehicles is a risk to pedestrians and other transport network users, including in parking spaces. Trucks have been implicated towards having disproportionately high share in the number of road accidents. In India and Bangladesh, trucks make up six per cent of on-road vehicles but are involved in 26% and 24% of road accidents respectively (UNCRD, 2014).

Many developing cities also rely on a diverse set of vehicles for freight transport – bullock carts, motorcycles, trucks. This diverse mix makes safety much more of a complex issue to regulate and govern. More importantly, the lack of standards, as well as weak enforcement of rules relating to roadworthiness and safe operational practices are primary issues in many developing cities.

Other factors such as of payment schemes for couriers, including those that are part of the e-commerce eco-system, play a role in safety issues. Schemes that base compensation on the number of deliveries made per day can lead to riskier driving behaviour on the road.

Labour Conditions

The emergence of the importance of the sharing economy in urban freight, which facilitates the direct participation of individuals in the provision of goods transport services is also generating concern in many cities due to the risk of labour exploitation or unfair compensation practices (CAF, 2020). Subcontracting – wherein the last mile of the delivery is made by a different operator from the one formally hired - is a key aspect of the organisation of urban deliveries and is often associated with negative labour practices such as hiring of undeclared workers (Dablanc, 2009). The absence of formal contracts opens possibilities for exploitation.

2.4. Opportunities Moving Forward

Growing Recognition of Importance of Urban Freight

The importance of urban freight is now being recognized at different global and regional processes that are geared towards sustainable development as explained in the initiatives below:

- **2030 Agenda for Sustainable Development**: This marks the global collective journey towards sustainable development. While there is no single sustainable development goal (SDG) that focuses on transportation, the importance of transportation, including that of urban goods transportation, in the attainment of many of the SDGs cannot be undermined. The freight concept is directly mentioned under indicator 9.1.2. passenger and freight volumes by mode which is an indicator towards measuring

progress towards SDG 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation (UNSD, 2018).

- **New Urban Agenda (NUA)**: The implementation of the NUA aims to contribute to the localization of the 2030 Agenda for Sustainable Development in an integrated manner, and to the achievement of the Sustainable Development Goals and targets, including Goal 11 of making cities and human settlements inclusive, safe, resilient, and sustainable (UN, 2017). It includes a declaration of support for the promotion of access to sustainable urban mobility including the promotion of ""urban freight planning and logistics concepts that enable efficient access to products and services, minimizing their impact on the environment and on the liveability of the city and maximizing their contribution to sustained, inclusive and sustainable economic growth."

- **Sustainable Freight Transport Framework**: The United Nations Conference on Trade and Development (UNCTAD), as part of its efforts to help developing countries mainstream sustainability considerations into their freight-transport policies, plans, operations, and investment decisions, has developed the Sustainable Freight Transport Framework (UNCTAD, n.d.). The said framework provides a step-by-step methodology, as well as accompanying tools, to support the design, formulation, and implementation of sustainable freight transport strategies, including those related to urban freight.

- **Intergovernmental Environmentally Sustainable Transport Forum in Asia**: The intergovernmental Asia EST Forum, through its "Conceptual Background Paper Towards the Development of a Draft 2030 Declaration on Sustainable Transport in Asia" has recognized that a better balance between passenger and freight transport need to be aimed for in the follow-up regional declaration on sustainable transportation in the region (UNCRD, 2019).

- **Transport Decarbonisation Alliance (TDA)**: A global collaboration platform between countries, cities/regions, and the private sector that aims to contribute towards accelerating worldwide transport systems towards net-zero emissions by 2050 has also recognized the importance of urban freight through the issuance of a zero emissions workplan for urban freight (TDA, 2019).

- **European Commission (EC)**: In Europe, a goal of achieving essentially zero CO2 emissions urban freight transport in major urban centres by 2030 has been set forth through the "White Paper on Transport" (EC, 2011). Regional-level initiatives at the European level, such as the issuance of a "call for action on urban logistics (EC, 2013)" have set the stage for the gradual movement towards urban freight integration into urban plans.

Local actions towards the strengthening of the integration freight and logistics into their respective plans are also gaining traction. In all cities throughout Europe, urban freight and last-mile logistics are a growing concern, linked with the exponential growth of on-demand shipping (UNECE, 2020). In a study done by Letnik et al. (2018), they found that 77.5% of the 129 cities that they surveyed in Europe have plans which have integrated (in one form or another) freight and logistics measures. On the other hand, only 9 cities were found to have fully developed sustainable urban logistics plans. For detailed guidelines on developing and implementing a SULP, please see Ambrosino (2015).

Technology-Enabled Transformation

Aside from the shifting of governance paradigms towards the recognition of the importance of urban freight, the wider developments in technology poses significant opportunities for accelerated transformation of the urban freight sector towards sustainability. Several technology-aided solutions are discussed as examples in this sourcebook.

Emergent technologies, particularly those that relate to information technology, electrification, and automation, pose potential significant disruptions that can lead to unprecedented transformations in the urban freight landscapes. Digital data collection tools, advanced predictive analytics, machine learning applications and the increase in big data and open data systems, can potentially aid in the generation of much needed data, and associated decision support systems necessary for gaining insights on urban freight systems towards the crafting of plans and policies, as well as in lowering the associated transactions costs. Advancements in vehicle technologies – such as the emergence of drones and

autonomous vehicles - also put forth possibilities in terms of transforming how goods are moved within our cities. Connected technologies – through the internet of things (IoT) – can lead towards systems and service quality improvements that can yield benefits for the shippers, carriers, receivers, and the governments. Perhaps 3D printing can also impact the need for moving certain goods to be moved, as they can ultimately be produced closer (if not at) to the point of consumption. Advancements in vehicle technologies – more efficient internal combustion engine vehicles, cleaner fuels, and electrification – also offer opportunities for reducing the negative impacts of urban freight.

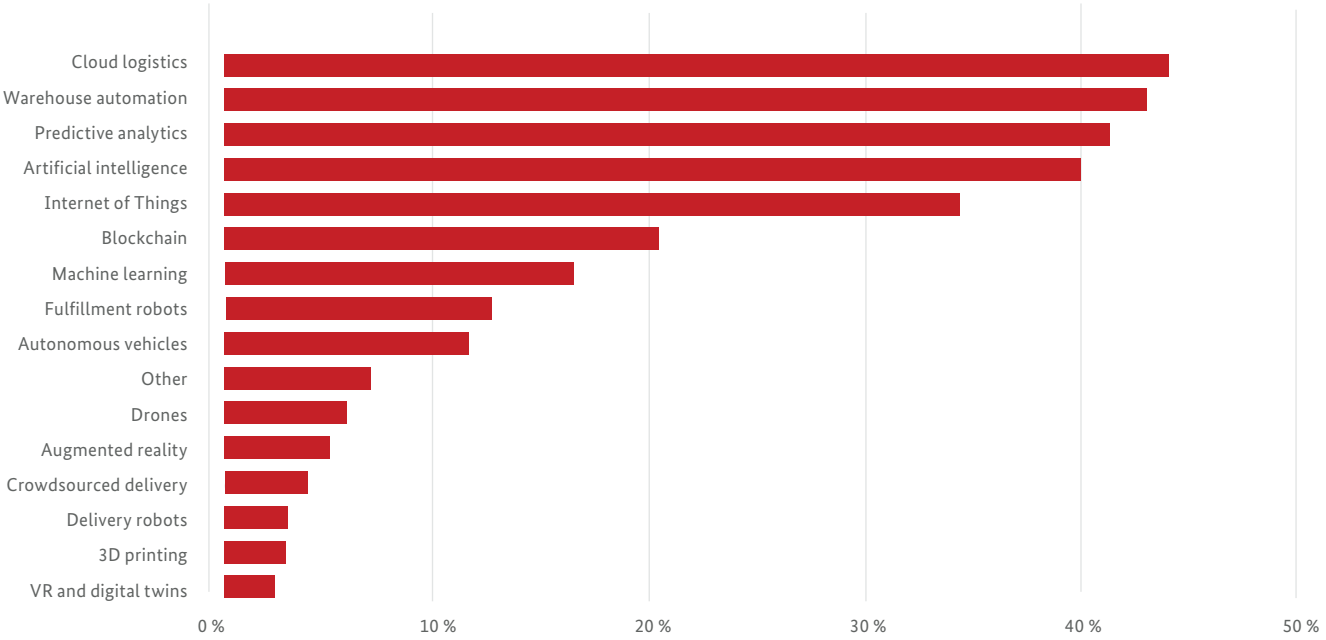
Figure 38 reflects the sentiments of global companies involved in last mile logistics in terms of the types of technologies that they are investing in.

Mindsets and Collaboration Mechanisms

The developments in the multi-scalar policy spheres, coupled with the technological advancements in both the physical (e.g. vehicles, smart facilities) and digital elements associated with urban freight are now leading to opportunities for better collaboration between the different actors. The recognition of the multi-layer intricacies in urban freight also highlights the importance of vertical and horizontal coordination.

The political developments are providing the basis for supporting collaboration platforms as we are now seeing in developed, as well as in developing regions, which are enabling more “embedded” steering approaches in governing urban freight - a dual control mechanism which involves both the governing and the governed (Gammelgaard et al., 2017). The strengthening of the B2C segment also poses potential opportunities for accelerating sustainability in the sector, due to the increasing demand from customers for greener and more sustainable freight operators (Lubeth, 2020). The advancements in digital technology are now enabling collaborations that would enable accelerated knowledge building through open data systems. New business models that are now gaining traction which may potentially aid the maximization the efficiency of urban freight systems such as sharing economy platforms which enable the utilization of idle assets and increase the participation of the public in urban freight.

FIGURE 38. TECHNOLOGIES BEING INVESTED INTO BY LAST MILE LOGISTICS COMPANIES



Source: eft, Statista estimates & Zoho (2020)

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ANNEX 1. RESOURCE MATERIALS

Title	Source	Topic	Type	Link
Two-and-Three-Wheelers A Policy Guide to Sustainable Mobility Solutions for Motorcycles	Gota, GIZ (2018)	2&3 Wheelers	Reference document	*https://www.sutp.org/publications/sutp-module-4c-two-and-three-wheelers/*
Policy Guidelines for Electric 2&3 Wheelers for Southeast Asia	UNEP	2&3 Wheelers	Reference document	*https://cleanairsolutions.asia/wp-content/uploads/ASEAN-E2-E3Vs-Policy-Guidelines.pdf*
A Handbook on Sustainable Urban Mobility and Spatial Planning: Promoting Active Mobility	UNECE	Active mobility in urban freight	Reference document	*https://www.unece.org/fileadmin/DAM/trans/main/wp5/publications/1922152E_WEB_light.pdf*
Best Practices in Urban Freight Management	Dablanc et al. (2013)	Best practices	Reference document	*https://hal.archives-ouvertes.fr/hal-00854997/document*
Planning of Cargo Bike Hubs	Assmann et al	Bike hubs	Reference document	*http://cyclelogistics.eu/sites/default/files/downloads/Hub Planning Brochure_EN_Web_final.pdf*
Business models for urban freight transport solutions	Novelog Project	Business models	Reference document	*https://www.researchgate.net/publication/335396943_Novelog_Project_D73_Business_models_for_urban_freight_transport_solutions*
City Changer Cargo Bike	Cyclelogistics	Cargo cycles	Website	*http://cyclelogistics.eu/sites/default/files/downloads/Hub Planning Brochure_EN_Web_final.pdf*
Freight TAILS	Freight TAILS Project	Case studies	Website	*https://urbact.eu/sites/default/files/urbact-stories_of_change-web.pdf*
SPROUT Website	SPROUT Project	Case studies	Website	*https://sprout-civitas.eu/*
SUCCESS Toolkit	Success Project	Consolidation centres centres	Toolkit	*http://144.217.37.164/success/*

Title	Source	Topic	Type	Link
London Cycling Design Standards	Transport for London	Cycling design standards	Reference document	*http://content.tfl.gov.uk/lcds-chapter1-designrequirements.pdf*
Survey Techniques in Urban Freight Transport StudiesTechniques in Urban Freight Transport Studies	Allen et al.	Data	Reference document	*https://www.researchgate.net/publication/254325073_Survey_Techniques_in_Urban_Freight_Transport_Studies*
Freight Data Sharing Handbook	National Academies of Sciences, Engineering, and Medicine	Data	Reference document	*https://www.nap.edu/catalog/22569/freight-data-sharing-sourcebook*
Framework for Data, Information and Knowledge Collection for Urban Freight and Service Demand Understanding	Novelog Project	Data	Reference document	*https://ec.europa.eu/research/participants/ documents/downloadPublic?documentIds=080166e5a5d21478&appId=PPGMS*
Aurora Urban Freight	Aurora	Data	Website	*https://sites.google.com/uw.edu/aurora-urban-freight/home*
Indicators and data collection methods on urban freight distribution	Van den Bossche et al.	Data and indicators	Reference document	*https://repository.uantwerpen.be/docman/irua/5fc710/165613.pdf*
Transport Decarbonisation Alliance	Transport Decarbonis-ation Alliance	decarb-onisation	Website	*http://tda-mobility.org/*
ICLEI Ecologistics	ICLEI	Ecologistics; sustainable urban freight	Website	*https://sustainablemobility.iclei.org/ecologistics-initiative/*
How to encourage increased electric mobility in the logistics sector	EU TIDE Project	Electric mobility in logistics	Online course	*https://www.mobility-academy.eu/course/view.php?id=11*
eMob Calculator	UNEP	Electric mobility; GHG	Calculator	*https://www.unenvironment.org/resources/toolkits-manuals-and-guides/emob-calculator*

Title	Source	Topic	Type	Link
Electric Urban Freight and Logistics	EUFAL Project	Electric urban freight	Website	*https://www.eufal-project.eu/home*
State of the art and practice of urban freight management Part II	Holguín Veras et al.	Finance, demand management	Reference document	*https://www.researchgate.net/publication/328830183_State_of_the_art_and_practice_of_urban_freight_management_Part_II_Financial_approaches_logistics_and_demand_management*
SmartWay	USEPA	Freight partnerships	Website	*https://www.epa.gov/smartway*
Gender equality and mobility: mind the gap!	CIVITAS	Gender	Reference document	*https://civitas.eu/content/civitas-policy-note-gender-equality-and-mobility-mind-gap*
EcoLogistics Self-monitoring tool	ICLEI	GHG calculator	Calculator	*https://sustainablemobility.iclei.org/wpdm-package/iclei-ecologistics-self-monitoring-tool/*
Good Practice Guide on Sustainable Urban Freight Transport	BESTUFS	Goods vehicle access; last mile solutions; urban consolidation centres	Reference document	*http://www.bestufs.net/gp_guide.html*
State of the art and practice of urban freight management Part 1	Holguín Veras et al.	Infrastructure, vehicles, traffic operations	Reference document	*https://www.researchgate.net/publication/328713106_State_of_the_art_and_practice_of_urban_freight_management_Part_I_Infrastructure_vehicle-related_and_traffic_operations*
Kerbside Loading Guidance	Transport for London	Kerbside loading	Reference document	*http://content.tfl.gov.uk/kerbside-loading-guidance.pdf*
Citylab – City Logistics Living Lab Guide	CITYLAB Project	Living Labs	Reference document	*http://www.citylab-project.eu/deliverables/D3_1.pdf*
Observatory of Strategic Developments Impacting Urban Logistics	Dablanc et al.	Logistics sprawl; ecommerce; service traffic	Reference document	*https://hal.archives-ouvertes.fr/hal-01627824/document*

Title	Source	Topic	Type	Link
NOVELOG Toolkit	NOVELOG Project	Measures	Toolkit	*http://www.uct.imet.gr/Novelog-Tools/Toolkit*
Common Microhub Research Project	Urban Freight Lab	Microhubs	Reference document	*http://depts.washington.edu/sctlctr/sites/default/files/research_pub_files/SCTL-Microhub-Research-Scan.pdf*
ChemMultimodal Toolbox	ChemMulti-modal Project	Multi-modality	Toolkit	*https://www.interreg-central.eu/Content.Node/ChemMultimodal.html*
Contemporary Approaches to Parking Pricing: A Primer	U.S. Department of Transportation	Parking	Reference document	*https://ops.fhwa.dot.gov/publications/fhwahop12026/*
Parking Pricing Implementation Guidelines	Litman	Parking pricing	Reference document	*https://www.vtpi.org/parkpricing.pdf*
ALICE- Urban Logistics	ALICE	Research and innovation	Website	*https://www.etp-logistics.eu/?page_id=96*
Reverse Logistics and Urban Logistics: Making a Link	Rubio et al.	Reverse logistics	Reference document	*https://www.researchgate.net/publication/336554108_Reverse_Logistics_and_Urban_Logistics_Making_a_Link*
Developing and Implementing a Sustainable Urban Logistics Plan	ENCLOSE Project	SULP	Reference document	*https://www.eltis.org/sites/default/files/trainingmaterials/enclose_d5_2_sulp_methodology_final_version_0.pdf*
Planning and Development of Sustainable Urban Logistics Plan	NOVELOG Project	SULP	Reference document	*http://novelog.eu/wp-content/uploads/2018/07/NOVELOG_SULP-Guidelines.pdf*
Sustainable Urban Logistics Planning	NOVELOG Project	SULP	Reference document	*http://novelog.eu/wp-content/uploads/2018/07/NOVELOG_SULP-Guidelines.pdf*

Title	Source	Topic	Type	Link
Destinations Project	Holguín Veras et al.	Finance, demand management	Website	*https://www.researchgate.net/publication/328830183_State_of_the_art_and_practice_of_urban_freight_management_Part_II_Financial_approaches_logistics_and_demand_management*
Guidelines for developing and implementing a Sustainable Urban Mobility Plan	Rupprecht et al.	SUMP	Reference document	*https://www.eltis.org/mobility-plans/sump-guidelines*
Urban Mobility Observatory	SUMP	Reference document	Toolkit	*https://www.eltis.org/mobility-plans/sump-guidelines*
UNCTAD Framework for Sustainable Freight Transport	SUMP; case studies	Toolkit	Toolkit	*https://www.eltis.org/sites/default/files/trainingmaterials/enclose_d5_2_sulp_methodology_final_version_0.pdf*
SUM4ALL	Sustainable freight	Toolkit	Website	*https://www.sft-framework.org/tools/key-performance-indicators*
Developing a Sustainable Urban Freight Plan – a review of good practices	Sustainable mobility	Website	Reference document	*https://sum4all.org/*
Guidelines for developing and implementing a Sustainable Urban Logistics Plan	Sustainable urban freight plan	Reference document	Reference document	*https://www.smartfreightcentre.org/pdf/Developing-a-Sustainable-Urban-Freight-Plan-a-review-of-good-practices-SFC-Final-June2017.pdf*
Guide to Good Practices in Sustainable and Safe Urban Logistics (Spanish)	Sustainable urban logistics plan	Reference document	Reference document	*https://www.eltis.org/sites/default/files/trainingmaterials/enclose_d5_2_sulp_methodology_final_version_0.pdf*
Smart choices for cities Making urban freight logistics more sustainable	Urban freight	Reference document	Reference document	*https://scioteca.caf.com/bitstream/handle/123456789/1510/LOGUS_Guia_de_buenas_practicas_en_logistica_urbana_sostenible_y_segura.pdf*

Title	Source	Topic	Type	Link
Inner Urban Freight Transport and City Logistics	Portal Project	Urban freight	Reference document	*https://www.eltis.org/sites/default/files/kt8_wm_en_6.pdf*
Urban Freight for Liveable Cities	Volvo Research and Educational Foundations	Urban freight	Reference document	*http://www.vref.se/download/18.11165b2c13cf48416de7e59/1377188311719/FUT-Urban-Freigth-Webb_low 2012.pdf*
Freight Transport for Development Toolkit: Urban Freight	Volvo Research and Educational Foundations	Urban freight	Toolkit	*https://olc.worldbank.org/content/freight-transport-development-toolkit-urban-freight*
BESTFACT Knowledge Base	BESTFACT	Urban freight	Website	*http://www.bestfact.net/best-practices/cl1_urbanfreight/*
BESTFACT Website	BESTUFS	Urban freight	Website	*http://www.bestufs.net/index.html*
VREF Urban Freight	Volvo Research and Educational Foundations	Urban freight	Website	*http://www.vref.se/urbanfreight.4.75d335e1145f6aef2e3c9f8d.html*
Quantification of Urban Freight Transport Effects	BESTUFS	Urban freight impacts	Reference document	*http://www.bestufs.net/download/BESTUFS_II/key_issuesII/BESTUF_Quantification_of_effects.pdf*
Quantification of Urban Freight Transport Effects	BESTUFS	Urban freight impacts	Reference document	*http://www.bestufs.net/download/BESTUFS_II/key_issuesII/BESTUF_Quantification_of_effects.pdf*
A unified typology of urban logistics spaces as interfaces for freight transport: A Systematic Literature Review	Meza-Peralta et al.	Urban freight	Reference document	*http://novelog.eu/wp-content/uploads/2018/07/NOVELOG_SULP-Guidelines.pdf*

Title	Source	Topic	Type	Link
Organising and Managing Urban Freight Partnerships	Lindholm & Browne	Urban freight partnerships	Reference document	*https://www.chalmers.se/en/centres/lead/Documents/PDF-dokument/RB04-2015-05-22-low.pdf*
Improving Freight System Performance in Metropolitan Areas: A Planning Guide	National Academies of Sciences, Engineering, and Medicine	Urban freight planning	Reference document	*https://www.nap.edu/catalog/22159/improving-freight-system-performance-in-metropolitan-areas-a-planning-guide*
Synthesis of Freight Research in Urban Transportation Planning	National Academies of Sciences, Engineering, and Medicine	Urban freight planning	Reference document	*https://www.nap.edu/catalog/22573/synthesis-of-freight-research-in-urban-transportation-planning*
Introduction to City Logistics	SolutionsPlus Project & Mobility Academy	Urban freight/ logistics	Online course	*https://www.mobility-academy.eu/course/view.php?id=67*
Sustainable Urban Freight Transport: A Global Perspective	TuDelft	Urban freight/ logistics	Online course	*https://online-learning.tudelft.nl/courses/sustainable-urban-freight-transport-a-global-perspective/*
SFC Online Training Courses	Smart Freight Centre	Urban freight management	Online course	*https://www.smartfreightcentre.org/en/training/*
Enabling sustainable development of urban freight from a local authority perspective	Letnik, et al.	Urban freight; energy efficiency	Reference document	*https://www.researchgate.net/publication/327007462_Review_of_Policies_and_Measures_for_Sustainable_and_Energy_Efficient_Urban_Transport*
Enabling sustainable development of urban freight from a local authority perspective	Lindholm, M.	Urban freight; local government	Reference document	*https://www.researchgate.net/publication/277193481_Enabling_sustainable_development_of_urban_freight_from_a_local_authority_perspective*

Title	Source	Topic	Type	Link
POLIS Network	POLIS	Urban freight; urban mobility (general)	Website	*https://www.polisnetwork.eu/topic/urban-freight-2/*
Suits Capacity Building Toolbox	SUITS Project	Urban mobility; urban freight	Toolkit	*https://cbt.suits-project.eu/about*
ReVeAL Project	ReVeAL	Vehicle access	Website	*https://civitas-reveal.eu/*
Zero Emission Zones How-to Guide	TCA, C40, POLIS	Zero emission zones	Reference document	*https://www.polisnetwork.eu/wp-content/uploads/2020/12/ZEZ-F_How-to-Guide_low.pdf*

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