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Multi–Donor Trust Fund for Sustainable Logistics (MDTF–SL)

Position Note Urban Logistics and Port-Cities

The Multi-Donor Trust Fund for Sustainable Logistics (MDTF-SL) commissioned a series of short notes from recognized thought leaders to better understand burgeoning issues within the MDTF-SL's thematic pillars. This note explores issues within the Urban logistics & Port-Cities thematic pillar and has been prepared by Dr Edgar E Blanco from MIT, USA.

The Urban Logistics / Port-Cities pillar is one of three focus areas, or thematic pillars, for the MDTF-SL. The goal of this pillar is to finance activities that will assist developing countries in two areas; addressing urban congestion resulting from retail distribution of goods, and improving the sustainable design and operation of port–cities.

Activities under this pillar will concentrate on reducing congestion and pollution by focusing on the efficient distribution of goods in urban environments. Additional emphasis will be placed on the urban planning tools and investments required for port–cites to address sustainability issues endemic to densely populated economies serving as either a local or regional transport hubs.

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WORLD BANK COMMISSIONED CONCEPT NOTE

Urban Freight and Port Cities

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1 THE URBAN FREIGHT DILEMMA

The world is undergoing a wave of urban growth. The world population is expected to increase from 7.0 billion to 9.3 billion from 2011 to 2050. The percentage of inhabitants in urban areas are projected to grow from 78% to 86% and 47% to 64% in the more developed and less developed regions respectively [1]. But urbanization and economic development go hand in hand. As cities grow, their economic activities and consumption patterns typically become larger, more intense and more complex. As one outcome of the urban development process, more goods need to be delivered into cities to satisfy consumption needs of growing urban populations. Based on data from developed urban cities, a city generates about 300 to 400 truck trips per 1000 people per day, and each person consumes about 30 to 50 tons of goods per year. This increased freight activity, translates into increased use of road space and infrastructure. Urban freight takes up 10-15 percent of the total miles traveled on city streets and 3-5 percent of urban land [2].

Although urban freight vehicles make up a small share of all vehicle traffic, they generate a disproportionate share of several externalities, such as congestion on local streets and highways, infrastructure damage, pollution, greenhouse gases, and noise [3]. This is particularly acute in dense city areas in developing countries with limited or no space for road capacity expansion, with land uses which developed organically over time and potentially incompatible with logistics demands. Thus, urban freight is often seen as a nuisance from the public perspective.

Urban planning often does not take urban freight into account and it faces three tensions that prevent a natural adoption. First, there is a widely accepted view, especially in the developing world, that urban sustainability is improved by increasing density, mixing economic activities, promoting public transportation and reducing private vehicle use (e.g. [4]). Thus, cities are investing in public transportation rather than highways and roads, reducing road and parking spaces in favor of pedestrian and public transit infrastructure. But there is a conflict between freight and such urban planning perspectives. Modern logistics systems are designed toward efficiency. As demand for products grow in urban areas, it makes economic sense to *consolidate* multiple operations under one roof. Larger shipments and larger warehouses leverage economies of scale in distribution operations, but supporting larger logistics operations require more land use. Dense urban areas, however, have limited road capacity and are incompatible with large trucks and residential communities (e.g. noise), not to mention the increase cost of the land. As urban density increases and road networks are constrained, logistics facilities *decentralize:* they move further away from urban centers. In Paris, parcel and express transport companies, on average, located their terminals 6.8 miles farther away from their geographic centroid in 2010 than in 1975, while businesses and shops have only moved 1.8 miles away during the same period [5]. But consumers of products are still located inside the urban areas. Since "boxes" cannot leverage the investment in public transportation, a larger quantity of increasingly small delivery vehicles is needed to navigate the shrinking road space, contributing more to traffic and congestion.

Second, designing effective policies for urban freight is complex. On one end, there is a huge diversity in the urban freight needs from one economic sector to another and across urban areas. Such diversity makes it difficult to find "blanket" regulatory solutions, identify common technologies or transfer knowledge between metropolitan areas. Combined with a fragmentation of the actors involved in policy making

in cities and metropolitan areas, such as planning agencies, port operators or transit authorities, decision-making crosses multiple jurisdictional barriers. The city of São Paulo, for example includes 39 municipalities and 460 traffic zones that will need to coordinate for an integrated policy for urban freight.

Finally, urban freight is just the last (or first) mile of a much larger supply chain that expands beyond the borders of the urban area, into regional, national and global economies. This is very different from traditional urban planning that focuses towards people mobility and accessibility mostly contained within geographical boundaries. This larger geographical span, makes supply chains flexible to adapt in various ways to policy intervention, making the long-term outcomes of urban intervention very uncertain. [6]

1.1 Port Cities

Trade hubs and gateways such as ports, airports, border crossings and intermodal transfer points are notable elements in the urban landscape of many cities, and an extreme example of the tensions between local urban needs and freight. These trade hubs are often at the heart of major urban centers, are important contributors to local economies but also generate significant externalities including urban freight.

As these trade hubs grow in importance, they achieve efficiencies by a much larger *consolidation* process (larger conveyances and facilities that can achieve even larger economies of scale), but unlike private urban logistics operations, they seldom *decentralize*: their advantage is tied to their historical infrastructure investments and geographical location. Instead, they put further pressure to their urban context by expanding their activities into extensive inland/hinterland regions, which in turn increases the flow of freight that flows through the city. Finally, these trade hubs have even more jurisdictional and regulatory complexity due to their scale and sheer volume of activity.

Understanding the relationship of ports and cities is of special importance, especially in the developing world. Roughly 77% of the world trade by value occurs between countries that do not share a border via airports and ports. The largest share of that trade by volume happens using ocean transportation [7] .In 2012, 60 percent of the world exports and 58 percent of the imports were loaded and unloaded in developing countries ports [8]. Ports are also large truck and train traffic generators, with many thousand of truck trips per day, imposing traffic impacts, noise and pollution on local residents.

Ducruet and Lee [9] developed a matrix to understand the relationship between the port and the city. The matrix, shown in Figure 1, uses the concepts of centrality (importance of the city and the port in value chains) and intermediacy (importance of the port in trade networks). Paraphrasing their description, one diagonal illustrates a progression from a 'coastal town' (e.g. a small coastal village) to the 'global hub port city' where the two dimensions are of equal importance (e.g. New York, Hong Kong, Singapore). The second diagonal shows the most imbalanced situations: from the port hub, with limited centrality (e.g. Freeport) to the general city with limited intermediacy (e.g. Stockholm, Tunis, Calcutta).

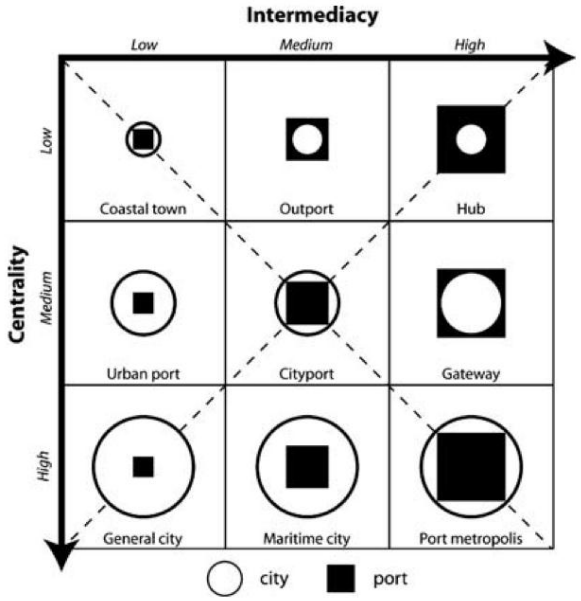

Fig. 1 *A matrix of port-city relations.*
Source: [9]

They argue that the theoretical balance, the 'cityport', is unlikely to exist. Instead, unbalanced profiles are more likely such as a 'gateway' which is subdued to its hinterland and develops few activities apart from

heavy industry and logistics (e.g. Le Havre, Genoa, Rotterdam); the 'maritime city' where port functions are efficient in spite of an important urban environment (e.g. Barcelona, Capetown, Buenos Aires); the 'urban port' which has some importance in the urban system but with limited port activity (e.g. Incheon, Bordeaux); and finally, the 'outport' which is usually dependent on nearby cities and whose port functions do not act as a mechanism for developing its own urban economy (e.g. Buenaventura, Felixstowe, Apapa). These archetype relationships, are crucial to understand the relationship between port activities and urban freight, but have only been used tangentially to inform urban freight policy in port cities.

1.2 Urban Freight in the Developing World

Cities in the developing world face the same challenges in dealing with urban freight as cities elsewhere, with three main differences. First, these cities have grown at significant faster speeds and will continue to grow. Between 1995 and 2005, the urban population of developing countries grew by an average of 1.2 million people per week, and is expected that, by the middle of the 21st century, it will more than double reaching almost 5.2 billion. Urban infrastructure and policies have failed to keep up with this fast growth, and freight movements have to compete with much more constrained land and road space.

Second, the level of density of cities in the developing world is orders of magnitude higher than high-income economies (see Table 1). Combined with the lack of road infrastructure, this increased density leads to congestion that makes mobility and accessibility throughout the city much harder.

Table 1 *Urban density of a sample of 84 cities worldwide. Source: [11]*

Region	Density (person/ha)
China	146
Low-Income Asia	204
Latin America	75
Africa	60
Middle East	119
Eastern Europe	53
Western Europe	55
High Income Asia	150
Australia/New Zealand	15
USA	15
Canada	26

Thirdly, these cities are characterized by unprecedented income disparities. The improvement of the average urban income per capita is not necessarily a good indicator of widespread economic improvement. There are extremely poor neighborhoods within the cities (e.g. slums, favelas, comunas) that cover a large portion of the population, with minimal infrastructure, a cash centric informal economy and acute security problems.

Besides the obvious implications to urban freight movement in these developing cities (more congestion, less infrastructure, more informality), these unique characteristics create a salient emerging property for urban freight. There is a large share of small, owner operated retail outlets that provide goods and services in urban areas in developing countries. Blanco and Fransoo [12] refer to these channels as 'nanostores'. These nanostores represent a much larger share of consumer product goods, upwards of 40% in Latin America and Asia. In Mexico City, for example, there are over 100,000 nanostores, an average of 200 people per nanostore [13]. Unlike modern retail channels in North America and Europe, nanostores are family owned and operated, cash based, with very limited product assortment and shelf space, a small geographical market area and with lack of processes and technology, besides a personal mobile phone. Servicing these nanostores require small vehicles, frequent deliveries due to the small volume and lack of shelf and storage space. There are no widespread studies, but it is not uncommon for a single nanostore, of less than 20-30 square meters, to receive over 30 deliveries per week [13]. These levels of logistics activities make the prominence of urban freight in developing cities even larger than cities in high-income countries.

2 STATE OF THE ART IN URBAN FREIGHT

There is an extensive body of literature related to urban freight research in North America, Europe and Japan including urban freight in port cities. An extensive review, focusing in the US and the EU, can be found in [3] and [14].

Besides infrastructure investments, Giuliano and Dablanc summarized the most common urban freight strategies, along with an assessment of their effectiveness and applicability to both the EU and the U.S. This comprehensive list, included in Table 2, is organized in four major categories: flows in the urban core (e.g. downtowns), metropolitan wide flows (e.g. truck vehicle-miles-traveled), environmental impacts (e.g. pollution) and freight hubs (e.g. ports).

They argued that the most effective strategies were the following:

- *Off-hours deliveries*. This strategy seeks to shift truck activity out of the peak traffic periods and reduce congestion and emissions. However, few examples of large-scale successful implementation exist since it requires changing hours of operation and coordination of shippers, drivers and most importantly receivers. There are many point examples of successful projects (e.g. Barcelona), but there is only one large-scale policy project in New York City that is currently under development.

- *Voluntary programs*. These are private-public partnerships aiming at engaging the freight actors to agree on voluntary operating rules and targets to improve urban freight. Cities like London and Paris have decades of successful experience in managing programs. They are also very common in the U.S..

Table 2 *Summary of urban freight strategies and its effectiveness and applicability to the U.S. and EU. Source [14]*

	Strategy	Effectiveness	U.S. Applicability	EU Applicability
Metro Core	Traffic and parking regulations	Medium	High	High
	Local planning policy	High	High	High
	Off-hours deliveries	High	Medium	Medium
	Negotiated programs	High	High	High
	City logistics and consolidation programs	Low	Low	Medium
Environment	Truck fuel efficiency and emissions standards	High	High	High
	Low-emission zones (LEZs)	High	Low	High
	Alternative fuels and vehicles	Low	Medium	Medium
	Alternative modes	Low	Low	Low
	Community environmental mitigation	Medium	High	Medium
Metro Flows	Intelligent transportation systems (ITS)	Medium	Medium	Medium
	Road pricing	High	Low	Medium
	Dedicated truck lanes	Low	Low	Low
	Mitigating rail impacts	High	Medium	Medium
Freight Hubs	Logistics land uses	Medium	Medium	Medium
	Port appointment systems	Medium	High	High
	Port pricing	High	Low	Low
	Equipment management	Medium	Medium	Medium
	Accelerated truck emissions reduction programs	High	Medium	High
	Ocean vessel emissions reduction programs	High	High	High

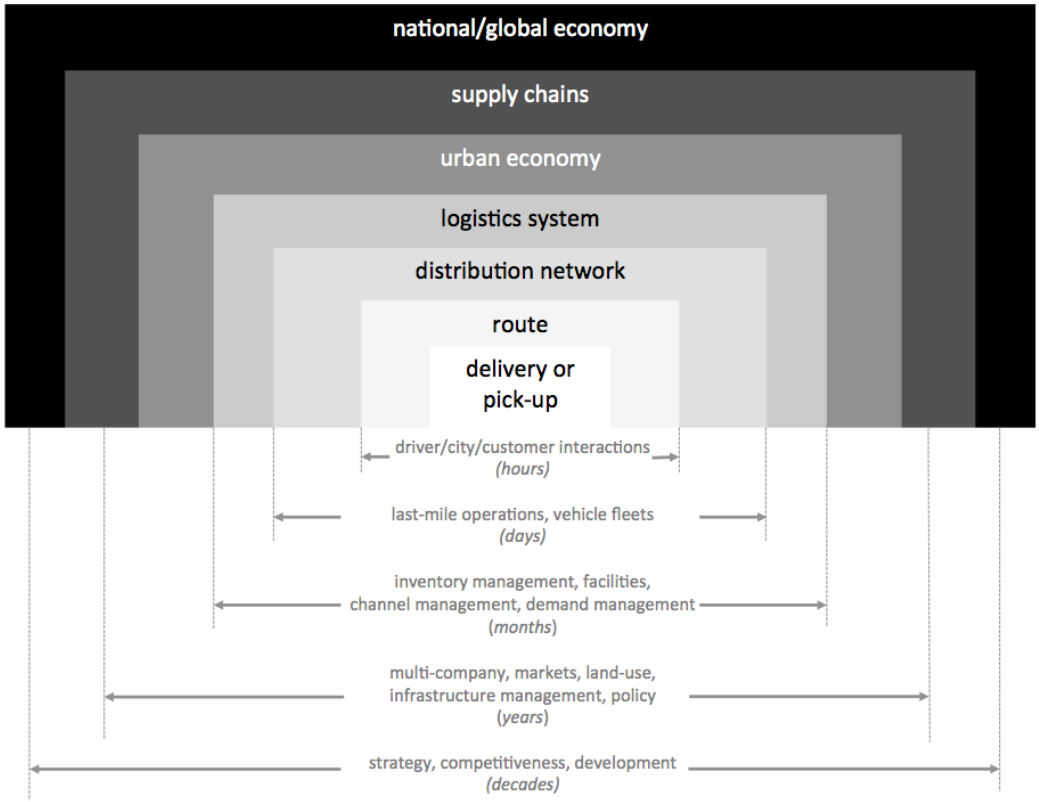

Fig. 2 *Framework to understand the various levels of analysis of the urban freight system. Source: Author adapted from [15]*

- *Local planning policy*. Where cities have established urban planning processes and institutions, adding freight standards on loading/unloading zones, parking, storage areas and hours of operation to urban development improve the interaction between freight and the cities. Paris, London, Tokyo and Barcelona are examples of developed city and metropolitan institutions with long term urban freight plans. Tokyo and Barcelona have gone as far as too add strict freight guidelines into new real estate developments.

- *Road pricing*. The goal of road pricing is to manage congestion in major roadways using dynamic pricing. It has not been implemented in the U.S. but it is increasingly being used in Europe and Asia. Its effectiveness in reducing truck flows is still undetermined due to the asymmetry between the entity paying the price (e.g. truck owner or driver) and the entities that generate the demand (e.g. shipper and driver).

- *Accommodation of Rail*. Urban rail intersections disrupt both freight rail traffic (lower speeds) and vehicles (stopping for large trains) at rail crossings. Reducing at-grade intersections improves flow but requires significant capital investments. The 20-mile Alameda Corridor in Los Angeles remains the showcase project in the U.S. where 200 at-grade railroad crossings were avoided.

- *Efficiency standards*. These have proven to be the most effective tools for reducing environmental impacts of urban freight. The "Euro standards" and the U.S. CAFE standards are widely known and are increasingly raising the bar on truck environmental emissions.

- *Low-emission zones*. These are urban areas in which a minimum standard for environmental performance is set. Freight vehicles that do not meet the standard are excluded from the zone. LEZs have been established in several European cities including London, Copenhagen and Milan, reporting significant reduction in PM and NOx emissions.

- *Port gate pricing*. The goal is to use pricing to shift truck usage of port gates to hours with less traffic. The main example is the PierPASS program in California charges a fee for every container moved in or out the Los Angeles and Long Beach ports between 8 and 5 pm. This has resulted in shifting 30% of the traffic to off-peak hours.
- *Truck emission reduction programs*. Drayage trucks, used in moving containers and cargo short distances between ports and other facilities, are often more polluting than long distance trucks. The ports of Seattle and Oakland, for examples, have offered incentives to truck owners to accelerate the use of cleaner fuels and to replace aging equipment.

- *Ocean vessel emission reduction programs*. Ocean vessels are the largest contributor to PM emissions in ports. Since ocean vessels are not subject to local regulations, European and U.S. have developed incentive programs to reduce speed, use cleaner fuels and minimize waiting times near the port.

It is important to highlight that some of the more commonly discussed policies such as *restrictive traffic and parking regulations*, although effective to certain degrees, have proven difficult to scale due to the complexity of strict enforcement, but most importantly, because cities have no control over the demand of pickups and deliveries. Ultimately, shippers, drivers and customers, find a way to circumvent the restriction by other means with worse consequences (e.g. use of private vehicles, double parking). Another popular academic recommendation is *consolidation and integrated city logistics* planning. These aims at reducing truck traffic by combining pickups and deliveries from various companies serving the same area. Due to the multiple actors required, these are often successful at small-scale, at the private level or as part of larger voluntary programs.

On the private sector side, companies like DHL or UPS constantly invest in information technology and better planning and logistics systems to improve their operations in urban areas. There has not been any major large-scale adoption of information technologies tailored to urban freight, beyond improvements of logistics operations in the private sector (e.g. vehicle routing).

2.1 A System View of Urban Freight

The list of initiatives presented before tackle the urban freight problem at multiple levels. A more comprehensive framework of the urban freight system is needed to further understand why are these policies more or less effective, but most importantly, to adapt them to a wider set of cities.

A system view of the urban freight system is presented in Figure 2. At the lowest level of the system, we have the *delivery or pick-up*. This is the moment where the actual commodity reaches (or leaves) its destination (origin). This is the most visible part of urban freight: when the driver stops the vehicle, loads/unloads the boxes and gives it to the customer. Tens of thousands of these interactions happen daily. All the decisions are within the influence of these few actors spread across the city, and are heavily influenced by the city physical topology (e.g. lanes, congestion, parking spaces, curb, enforcement). To reach its destination, the driver follows a route that generates multiple "trips" in the city. This route may have as little as 3 stops or as many as 100, depending on the city, commodity and company. The driver is often responsible of making all the route decisions, navigating the city and following guidelines provided by the transportation operator. The size of the vehicle, congestion and road and zone restrictions heavily influence the route operation. This routes are often completed within a day, in some instances doing multiple of them depending on the type of business.

But these routes are part of a much larger *distribution network*, a level up in the system that includes multiple facilities, vehicles, drivers and warehouse operators. In most cases it also includes more than one company, coordinated by a single responsible party: the delivery company. The execution and coordination of the routing and the delivery/pick-up across a city is often

referred to as "last-mile" operation. These operations are revised and planned weekly or monthly intervals. Up to this point, most of the management and decision-making is done by individuals that work and live in the city.

The distribution network is part of a much more complex *logistics system*. This third level may or may not be planned and controlled by individuals that live in the city. But their decisions shape the distribution network: how to manage inventory, where to locate facilities, which companies operate the distribution network, how to service the various customers and how to plan for the changing patterns of demand. It constantly balances much-larger cost-benefit trade-offs than the . Decisions and policies are revisited every six to 18 months, depending on the complexity and cost of the change.

The logistics system, its distribution network, the delivery routes and the final delivery is all managed mostly by a private actors focused on achieving their corporate goals (e.g. a brand owner, a wholesaler, a retailer, a logistics provider and a truck owner). The combination of thousands of logistics systems together, are the ones that enable the *urban freight* economy, the next level up in the urban freight system. Each of the companies that deliver/pickup goods across the city share the city infrastructure, competes for talent, resources and customers, and creates value and externalities. They all operate under the common market and regulatory conditions, infrastructure, land-use restrictions and policies.

Finally, beyond the *urban economy*, these logistics systems are embedded in *global and national supply chains*. Decisions are made outside the scope of the urban context and trade-offs involve global priorities with local constraints (e.g. where to locate manufacturing plants, where to source products from).

Using this urban freight system framework, we can revisit some of the effective policies. Off-hour deliveries, traffic regulations and port-gate pricing, tackle the delivery/pick-up operation. Here the focus is on influencing the interaction between the driver and the customer. The interventions are simple (e.g. a establishing loading/unloading zone) but due to the large amount of actors affected they require extensive communication. For example, the City of London continuously creates pamphlets and guides to educate and influence delivery/pick-up activities.

Low-emission zones (LEZ) and road pricing, directly affect last-mile operations. They often face resistance since they require re-designs of distribution networks from all affected private actors, contracts between them and start involving managers that do not have direct interaction with the urban context beyond its market potential. Their outcome is uncertain and are slower to design and implement.

Voluntary programs, at the city or at the port, aim at engaging multiple stakeholders operating in an urban area, and drive change in hundreds of logistics systems without affecting the urban economy. They are often precursors to specific policies (such as LEZ) and try to recognize the diversity of the supply chains involved. They require long-term commitment from all actors and require strong institutional support and public-private partnerships.

2.2 Selected Case Studies

Several European projects (see [16],[17] and [18]) have focused on documenting successful urban freight policies and case studies. In this section we highlight a few that are illustrative of the state of art of urban freight policy around the world.

London: Planning & Guidance Documents

The Transport For London (TfL) Freight Unit leads the freight plan for 33 boroughs of the city. Besides active multi-stakeholder programs, including a logistics recognition program, it publishes several booklets to help all urban freight stakeholders improve freight logistics. These publications include detail guidance and sharing examples of best practices. Figure 3, for examples, shows a diagram with detailed specifications of the space required around a loading vehicle from one of the TfL guides. These diagrams help both real estate developers and city planners design adequate infrastructure.

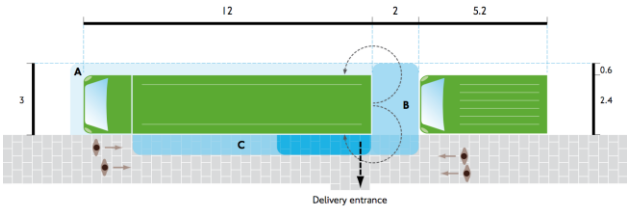

Fig. 3 *Space Requirements in meters around a loading vehicle. Source: [19]*

TfL also disseminate best practices. Kentish Town, a dense urban area in the city of Camden, underwent a review of all freight loading/unloading areas to simplify and streamline operations. Figure 4, shows Kentish town easy to use inventory of parking areas and regulations that was distributed to all businesses, included in a TfL guide.

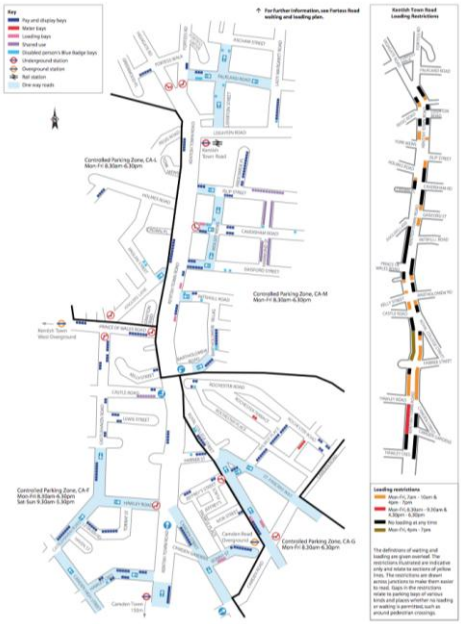

Fig. 4 *Kentish Town loading and pay map. Source: [19]*

Barcelona: Flexible Road Infrastructure

Flexible use of road infrastructure is another strategy was successfully implemented in the city of Barcelona. As part of a long-term plan to improve urban mobility, the city of Barcelona successfully transformed 5.5 kms of traditional roadway into multi-use lanes. These lanes are controlled by Variable Message Signs (see Figure 5) to allow for the same infrastructure to be used by public transport, freight loading/unloading and private vehicle parking. During peak hours exclusively buses and taxis use the lanes. In between peak hours they are used for short term parking of cars and freight vehicles (max. 30 mins). At night and over the weekends, they can be used for regular parking. The estimated cost per lane was of 500,000 Euros, with an estimated three-year payback time. Strong enforcement and dissemination, was a key component of the success of this project.

Fig. 5 *Variable Message Signs in multi-use lanes. Source: Ajuntament de Barcelona*

Paris: Urban Mode Shift

The repurpose of obsolete (or underutilized) infrastructure, has also been used to improve urban freight. The most well known project is the collaboration between French retailer Monoprix and the city of Paris that shifted distribution from road to rail. Instead of using standard trucks to replenish its stores in Paris, Monoprix now uses a rail connection to move the products in bulk from its distribution center to an urban rail terminal. The goods are then distributed in shorter delivery routes using Clean Natural Gas (CNG) powered vehicles. Beginning to end, this project took three years, an investment of 10 million Euros by the Paris City Council in upgrading the rail terminals and infrastructure and special

financing to help purchase the CNG vehicles. Although there was a significant environmental benefit from this initiative (36% reduction in PM, 47% reduction in CO_2) the logistics cost per pallet increased between 26% and 32%.

Tokyo: Freight Consolidation

The Shinjuku area is one of the busiest in Tokyo with more than 130,000 workers and more than 20 high-rise buildings. In a private sector initiative, supported by the city of Tokyo, a group of 35 office supply delivery companies got together to create an urban consolidation center: instead of delivering to each of the high-rise buildings individually, they created a third-party logistics operator to consolidate all the deliveries in a small 330 m^2 warehouse (i.e. a private urban freight consolidation center). Deliveries are then sorted and distributed using specially designed trucks and equipment that can efficiently deliver the goods in the high-rise building environment. The new company, Shinjuku Mantenro, established collaborations with the buildings in the area to allow for efficient parking and access to elevators to improve productivity. Although no financial details are available, the private initiative is growing and is estimated that has removed over 50 trucks per day from the road while delivering half a million packages per year.

Los Angeles: Smoothing Traffic in Ports

A concern in port cities is the queuing of trucks outside the port gates waiting to load/unload containers. Besides congestion, this creates significant environmental emissions. Although legislation was approved by the California Assembly to establish penalties for missed appointments in port gates, it was ineffective to change port operations.

Instead, the Ports of Los Angeles and Long Beach, started in 2005 a voluntary extended hours program known as PierPASS. They assessed a Traffic Management Fee (approximately $120 per 40-foot container) on containers moved between 8 am and 5 pm. Fees collected were used to pay for additional capacity over the weekends. The ports reported that almost 30% of the traffic moved to nights and weekends.

Seattle: FAST Corridor

There are three ports in the Seattle metropolitan area that are expected to move 8 million TEUs by 2020. In 1998, after a four-year collaboration process, the Freight Mobility Roundtable (a private-public voluntary organization), proposed the creation of a FAST corridor that will streamline freight movement to/form the ports. Over 25 infrastructure projects were identified including grade separations at rail/road crossings and truck access. To date, the project has invested more than USD$500 million in developing the FAST corridor [20].

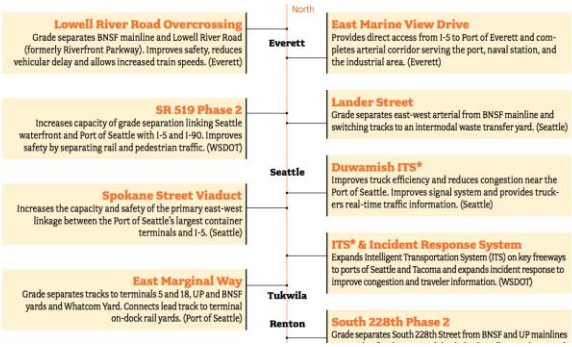

Fig. 6 *Sample FAST Corridor Projects. Source:* [20]

Valparaiso: Reshaping the Hinterland

One of the challenges of port cities is the proximity, and often the "enclosure", of the port hinterland to the city. The port of Valparaiso in Chile, for example, is completely surrounded by the city which some of its cliffs considered World Heritage sites. By 2006, over half a million trucks were accessing the narrow streets of Valparaiso to reach the port. After a public bid, a private operator constructed 11 kilometers of tunnels and highway to decouple the port truck access with the urban infrastructure. A logistics and operational center, ZEAL, was built outside the city where all the customs processes are performed before reaching the port terminals. This effectively move hinterland operations outside the dense urban area. The project, required over USD$21 million dollars in investments over a two year horizon. In addition to the physical infrastructure investments, the private operator designed electronic gate management systems to

manage the flow of trucks from the logistics terminal to the port facilities.

Fig. 7 *ZEAL logistics platform relative to the port of Valparaiso. Source: www.puertovalparaiso.cl*

3 APPLICABILITY TO DEVELOPING CITIES

The majority of the strategies described in the previous section, were developed and implemented in high-income urban cities. Most of them are still applicable in cities and port cities in the developing world. Voluntary programs, developing of local planning freight policies, efficiency standards and transfer directly. For port cities, improving port operations using port appointment systems, gate pricing and voluntary emission reduction programs for oceans and vessels are sensible strategies.

Other policies are less effective due to the unique nature of the developing urban cities. For instance, off-hour deliveries require changes in operation hours for shippers, drivers and receivers. The large number of nanostores makes this very complex or with very limited impact: nanostores have a single owner that will very unlikely be willing to receive shipments at night, not to mention the risks in moving freight in poor neighborhoods. Road pricing is also difficult to implement. There is a lot of informality in the transportation sector that makes these solutions much harder to deploy, and politically even more challenging.

There are also some salient examples of innovative solutions that illustrate the potential of improving freight in very complex urban environments.

Mumbai Dabbawalas

The dabbawalas are a cooperative of delivery of home prepared meals in India. They are well known in their field of logistics for achieving beyond six sigma level of accuracy in their operations (1 error in 16 million deliveries) despite working with low education workforce, minimal management and no technology. From an urban freight perspective, their success is due to leveraging the public infrastructure in Mumbai. Every morning, lunch boxes are collected by bicycle and foot and transported, via multiple transfer points, using the public rail transport. The dabbawalas' logistics system involves 25 km of public transport and 10 km of footwork with multiple transfer points. Since the majority of the journey involves public transport, the timing of the dabbawalas is dependent on Mumbai's suburban rail network. The dabbawalas use the rail network very effectively by employing simple, straight routes, mostly north-south, and limit sorting to a few central points [22].

Gammarra District.

The Gamarra district in Lima, is one of the largest wholesale and retail areas of Perú, mostly composed of informal merchants. It covers an area of 60 hectares with 17,000 nanostores and generating 60,000 jobs. All the logistics in and out of the Gamarra district are managed and organized by a private business cooperative. Loading/unloading areas and schedules have been designated in the area by community consensus and a network of 400 manual porters move merchandise throughout the district using specially designed hand trucks. Although the area is chaotic due to the high volume of trade, and lacks any urban planning and municipal management, the urban logistics solution was extremely effective in removing all vehicular freight traffic from the district [18] and creating a de-facto LEZ. There are however, spillover impacts to the surrounding neighborhoods that are not addressed.

Fig. 8 *Uniformed porters in Gamarra District. Source: [18]*

4 RECOMMENDATIONS

Partly due to environmental concerns, freight has gained more attention from European and North American authorities. There is a rich set of case studies and documented initiatives addressing urban freight. The experiences of high-income cities and port cities have proven to be complex and tailored to the specific urban context. Based on these experiences, below are some recommendations of priority areas to invest in developing cities and port cities to improve urban freight:

1. *City Freight Plans*. All large-scale successful solutions in urban freight have started with strong freight plans. These plans need to be developed by authorities in consultation with the private sector. These plans require long-term funding mechanisms at the metropolitan or city level, driven by technical staff. Supporting cities to create strong "urban freight" units that drive the planning process is a pre-requisite for the robust urban freight policy. Adequate staffing is required. For example, cities like Bogota or Rio de Janeiro only have 1 or 2 people (often part time) in charge of managing all the freight dimensions of cities of millions of people.
2. *Port freight plans*. Ports seldom have long-term freight plans that include the impact in their surrounding urban areas. These freight plans should initially focus on identifying urban corridors that need interventions to smooth their interface with the city. These freight plans could also include urban freight operation guidelines geared towards private fleet operators that interface with the port to foster efficient operations.
3. *Context specific urban freight studies*. Most cities can't answer how many vehicles are engaged in commercial activities, the number of deliveries or the freight patterns of establishments in the city. Development of robust methodologies and data repositories (see an example Figure 9), will support city freight plans and enable better planning and execution by private actors. Technological platforms should be evaluated to disseminate the information widely, probably leveraging "smart city" initiatives, fashionable in developing cities today. Well documented case studies applicable will help accelerate knowledge transfer between cities and foster communities of practice.
4. *Developing Urban Logisticians*. Both private and public sectors need to understand the urban freight system (see Figure 2) and its interactions. Investing in developing urban logisticians is of paramount importance to seed the talent needed to support freight plans and adequate last-mile operations. This needs to be done both at the public level and private levels, in collaboration with academic institutions and trade associations.
5. *Financing of voluntary programs*. Voluntary initiatives have proven successful to advance solutions tailored to complex urban contexts. Very often, these voluntary initiatives require financing and/or investments to scale their solutions. Cities and governments should participate in co-financing these pilot initiatives to seed innovation in their cities.
6. *Multi-use Infrastructure*. Most cities in the developing world do not have additional space for new urban infrasrtructure. Creative ways to increase utilization of existing infrastructure for freight (e.g. use parking lots for freight operations), leverage new transit infrastructure (e.g. allow freight in bus lanes) or transform abandoned infrastructure (e.g. urban rail) needs to be part of the investment portfolio of city freight plans.
7. *Logistics land-use*. Urban freight will always need space for warehousing and cross-docking activities. As land becomes scarce in developing cities, land-

use plans need to explicitly incorporate logistics space differentiated from "commercial" use..

8. *Freight Emission Standards*. In order to mitigate pollution from urban freight activities, cities should design freight emission including incentives to adequately dispose of aging fleets.

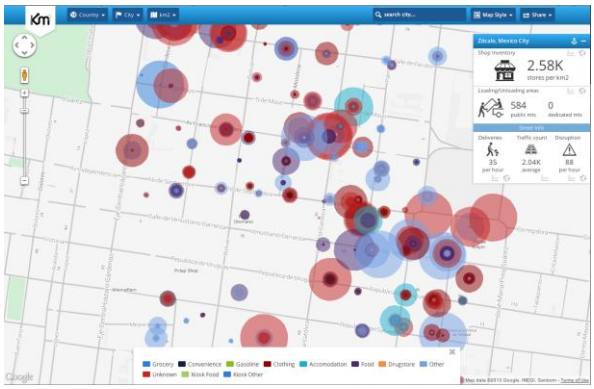

Fig. 9 *Prototype Urban Logistics Atlas. Source: [13]*

Urban population in developing countries will continue to grow [10]. There is urgency and an opportunity to accelerate the adoption of innovative urban freight solutions to guarantee a harmonious development process in cities in the developing world.

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