REVIEW OF GOOD PRACTICES IN URBAN FREIGHT TRANSPORTATION

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ABSTRACT

This paper provides information on freight transport policies implemented in several countries in Asia, Europe and North America. It defines objectives for sustainable freight development as follows: a) Reducing energy consumption per ton-kilometer; b) Decreasing ton-kilometers of less sustainable transportation modes such as road transport, and c) Increasing usage of more environmentally friendly transport modes such as rail and water transports. Implemented policies and measures in each of the categories are discussed based on their contribution to achieving the stated objectives, and their practicality is analyzed. Issues of concern with each policy are also presented.

Freight centres and consolidated deliveries provide the most promising way to achieve sustainable development as they can reduce the use of road transport, which generates the most negative environmental impact. Multi-modal facilities of freight centres together with the development of rail and water transport networks are highly recommended since they respond to the objective of increasing the share of more environmentally friendly modes, as well as increasing the opportunities for consolidated delivery that can reduce trip numbers. Coordinated implementation of the measures is also recommended in order to improve the chances of success. Successful implementation of measures will also require cooperation from the private sector operators.

Keywords: urban freight transport, freight transport, sustainable transport

INTRODUCTION

Freight transportation is critical to economic growth in any country. Efficient freight transport and logistics systems can strengthen the business competitiveness of a country. The cost of logistics is generally computed as a percentage of gross domestic product (GDP) of a country. According to a report from Bangkok Bank (2007), in developed countries, such as the United Kingdom of Great Britain and Northern Ireland or Japan, the logistics cost is around 10 per cent of GDP, while for countries in Asia and the Pacific region, the median cost is higher, at about 11.6 per cent of GDP. However, the cost varies from one country to another and for most developing countries, it is much higher. For example, in Thailand the estimated logistics cost is about 19 per cent of GDP. This means that Thailand is in a less competitive position in the global market.

Environmental as well as economic concerns of high logistics cost should be examined. During the last 10 years, environmental questions have become more pressing around the world. In 1987, the Brundtland Commission declared that sustainable development was the key for future development. The word “sustainable” and its implications in terms of resource use, for example, have become part of the development agenda since then. Sustainable development in the freight sector is important for both economic and environmental considerations. The objectives for more sustainable freight transport development can include: a) reducing energy consumption per ton-kilometre; b) decreasing ton-kilometre of less sustainable transportation modes (such as road transport); and c)

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increasing the use of environmentally friendly transport modes, such as rail and water transport. The issue is how these objectives can be achieved in practice.

To move towards a sustainable freight transport system, one needs to understand the whole logistics system. Each purchase by an end customer is the result of several previous activities. Raw materials, while being transformed into a finished product, are moved around several times. For example, raw materials from their origins are moved to manufacturing units, where they are changed into a packaged product, before being transferred to warehouses. From warehouses, the finished product is moved to wholesalers and then on to retail shops, waiting for the customer to purchase it. In reality, the system is usually more complicated.

Understanding the actors involved, their roles, and the scope of their activities will be important when deciding on suitable freight policies. Taniguchi and others(1999) classifies the actors in city logistics, who are referred to as “freight actors”, into four groups: shippers, receivers, carriers, and administrators. Shippers and receivers are the actor of supply and demand for products. Carriers have a major role in today’s transport system. They respond to the demand for transportation of products between shippers and receivers. Finally, administrators play a role in controlling the functioning of the whole system through encouragement or enforcement of measures related to freight transport.

Transportation inevitably has a major share in freight movement costs. Transportation costs are estimated to represent as much as 40 per cent of the total logistics costs. Private sector actors, of course, try to reduce costs as much as possible, and may be less concerned with environmental or safety issues. The city planner, however, can be expected to be directly concerned with safety and environmental questions, as well as economic growth. In fact, it is not easy for the city administrator to enforce strong measures to control the activities of the private sector. Inappropriate policies could harm the wider economic system. It is hard for a city planner to deal with diverse actors with different perspectives and to find a compromise between their interests and those of the wider population.

In developed countries, policies and measures to address the environmental impact of freight transportation have been considered since the 1990s. Among the implemented measures, some have succeeded and many have failed. This paper presents a general review of sustainable freight transport policies and identifies the key determinants of their success or failure; gives a summary of policies and measures that have been implemented in some countries; offers a categorization of implemented policies and measures together with their advantages and disadvantages; and finally presents a set of conclusions and recommendations.

Objectives for Sustainable Freight Transportation

The paper sets the objectives for sustainable freight transportation based on the European Federation for Transport and Environment (2000) on ways to achieving greater freight transport sustainability. The objectives are as follows:

(a) Reducing energy consumption per ton-kilometre;

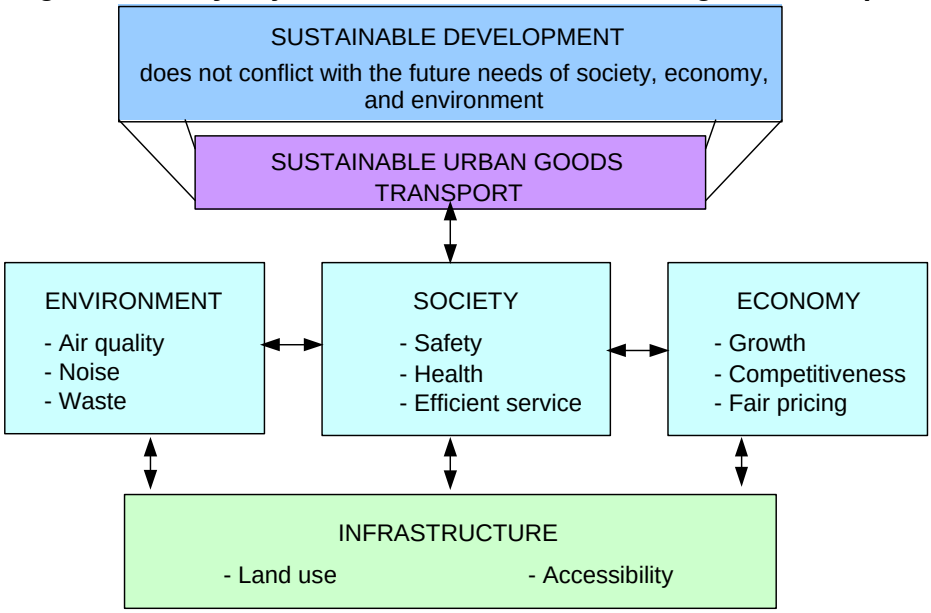
(b) Decreasing total ton-kilometres of less sustainable transportation modes such as road transport; and

(c) Increasing the use of environmentally friendly transport modes such as rail, water, and inland water transports.

However, environmental issues are the primary concern of these objectives. Sustainable development requires a more comprehensive approach considering other aspects of development, namely society and economy.

Taking into consideration a wider approach, Visser (2006) presents the policy objectives for urban goods transport as shown in figure 1. Sustainable development, precisely "sustainable urban goods transport", requires that it is compatible with the future needs of the society, the economy, and the environment. Focusing solely on single aspect could hurt the other two. Transport development should serve all the three aspects of sustainable development, and improving the competitiveness of the economy should not compromise the environmental and social issues.

Figure 1. Policy objectives for sustainable urban goods transport



Source: Adopted from Visser (2006).

I. FREIGHT TRANSPORTATION POLICIES

Based on Visser's categorization of freight policies (2006), the report on European freight policy by EXTR@Web (Exploitation of Transport Research via the Web, 2006), and a sourcebook of good practice in freight transport by the European Commission (2000), the policies on freight transportation can be categorized into five groups:

(a) Licensing and regulations;

(b) Freight centres and consolidated delivery;

(c) Vehicles and fuel technology: optimized vehicles, low-emission vehicles, alternative fuels, and broader use of environmentally friendly modes;

(d) Information technology (IT) and driver training; and

(e) Freight transportation systems for the new century.

The first two categories of policy development should be government led. Policy measures in categories (c) and (d) usually require considerable input from and cooperation of the private sector. Category (d) policy measure benefits the private sector most directly through improved human and technological resources. Policies in category (e) deal with the

future development of freight transportation systems and may require a completely different approach than that of today.

A. Licensing and regulations

This approach is the one most widely used. Examples of licensing and regulation can include, weight restrictions, eco-zoning, and truck bans during certain hours. Government regulations can be effective, for example, in introducing weight restriction systems to prevent large vehicles from entering restricted zones, which are normally residential areas and city centres. Eco-zoning systems is a new trend to allow only low-emission vehicles to enter the restricted zone. The restrictions can differ according to: time period, emissions level, weight limit, and size of vehicle.

A selection of measures in the licensing and regulations category is presented in this paper. These include:

Low emission zones have been implemented in: the Kingdom of Sweden; the Kingdom of the Netherlands, Amsterdam; and the United Kingdom, London. Emission criteria are set out by the local government to allow only vehicles that meet the desired emission level to enter to the restricted zones (Seattle Urban Mobility Plan, 2008).

Combined use lanes. Variable Message Signs (VMS), for example, in the Kingdom of Spain, Barcelona, alter the usage of lanes at different times of the day, such as through-traffic only during peak periods, temporary truck loading stops during the day, and on-street parking during the weekend (Seattle Urban Mobility Plan, 2008).

Freight-exclusive lanes are implemented in the United States of America but are limited to truck traffic to/from port facilities or at international border crossings. For example, at the Port of New Orleans, the roadway to the Port is split one half for general traffic and the other for commercial vehicles (2 lanes each). In Laredo, Texas, the 8-lane commercial-traffic only highway was built to serve the increasing trade at the border between Mexico and the United States, Texas (Seattle Urban Mobility Plan, 2008).

Incentives for off-peak delivery are, as the name implies, measures intended to shift deliveries to the off-peak period. An example of such actions is the introduction of a fee for commercial vehicles entering a restricted zone during peak periods. This was implemented at the Ports of Los Angles and Long Beach in 2005. A Traffic Mitigation Fee is required for truck movements during peak hours. Seattle Urban Mobility Plan (2008) reports that 30-35 per cent of typical day containers have changed to off-peak hours since the implementation of the measure.

Restricted delivery hours are one of the most popular policies, being implemented in several cities. For example, in Boston, vehicles with commercial license plates are prohibited from using certain streets in downtown, except during a certain time period. Only certain companies such as the United States Postal Service and newspaper delivery firms are allowed to enter after 2 p.m., while other companies who want to enter the restricted zone have to apply for a one day special permit (Seattle Urban Mobility Plan, 2008).

Truck ban policies, are similar to the restricted delivery hours. The difference is that the focus of truck bans is generally on larger commercial vehicles. Here, truck ban refers to restrictions for a specific kind of truck, prohibited from the designated areas during a certain period of time. A truck ban policy has been implemented in Manila, the Republic of the Philippines. Punzalan (2000) studies the socio-economic impacts of truck ban policy on truck operators, drivers, and truck operation in Metropolitan Manila. The study reveals that truck operators prefer using their usual routes, and rather than using alternative routes shift the driving time to night-time or in-between the truck ban times instead. Night-time driving, evidently, results in undesirable impacts on truck operators and drivers as it disrupts driver's sleeping patterns and hence may increase the risk of accidents.

Parking restrictions in different forms are adopted widely. Parking spaces for commercial vehicles is one of the most crucial problems, especially in the central areas. Insufficient loading space for truck operations leads to problems such as double parking. Regulations need to be enforced consistently and effectively for these vehicles. Some examples in Japan include providing a specific space for commercial vehicles in each parking area in the city centre, or specifying a space for commercial-vehicle-only parking in low traffic volume areas. This arrangement helps to improve efficiency and safety. In addition, the installation of parking meter can improve turnover rates.

Road pricing is applied widely in many countries. Mostly, the charges are applied to both passenger and freight vehicles. Road pricing schemes aim to reduce the number of vehicles entering into the city. The objectives are to manage demand and to generate revenue for the operation and maintenance of the infrastructure, and to recover external costs directly from the users of the infrastructure. However, in applying this method, fair pricing is required. With respect to commercial vehicles, Allen and Eichhorn (2007) reported that urban goods transport pricing could not effectively manage demand, as most goods would have to be transported to their destinations anyway and it is difficult to reduce the vehicle operation.

Results from the implementation of licensing and regulations can be expected in the short-run. For example, large truck ban policies are expected to result in an improvement in environmental conditions in the restricted zone. In addition, from a safety perspective, a ban can be effective as large trucks maneuvering in dense city centres cause numerous safety problems. However, in the long-run, implementing restrictions without considering their economic and social impacts may cause other problems.

B. Freight centres and consolidated delivery

Browne and others (2005) explains the meaning of freight centre, or urban freight consolidation centre (UCC), as they call it in Europe, as principally a logistics facility located in close proximity to an urban area to serve consolidated deliveries within that area. The UCC has also several other names; such as urban transshipment centres, consolidation centres, urban distribution centres, and city logistics.

Freight centres and consolidated delivery systems seem to be the best way to achieve sustainable freight development. The concept of consolidation is the same as for passenger transportation (buses, trains, etc.), where shipments sharing the same origin and destination are consolidated into a singe vehicle to reduce the number of vehicles used. Consolidated delivery is generally performed for the delivery of shipments of a single company. Consolidated deliveries for multiple companies may be possible. However, in practice this is not easy to implement as it impacts on the competition among them and companies may be reluctant to share their delivery technology.

Freight centres are designed to promote consolidated deliveries. Large long-haul trucks stop at the freight centre and transfer their shipments to smaller trucks, a process known as transshipment, before these smaller trucks enter the city centre. In addition, with freight centres, it is possible that the shipments from different companies can be consolidated before deliveries are sent to downtown. With this type of arrangement, one can obviously expect a reduction in the number of trucks operating in dense city centres, hence less congestion and safer environment.

The advantages of urban freight consolidation centres are as follows:

- *Environmental aspect:*
  - Less emissions and noise because of a smaller number of trucks operating in the city centre;

  - Improved opportunities for usage of other non-road modes that are better from an environmental perspective such as rail and inland water transport.

- *Social aspect:*
  - Health and safety improvements due to fewer trucks (especially large trucks) maneuvering in the city centre;
  - Less congestion in the city centre due to fewer trucks;
  - More efficient services to customers due to faster deliveries.
- *Economic aspect:*
  - Participating companies gain benefits from reductions in vehicle trips and vehicle-kilometers;
  - Improvement of load factor that reduces the unit cost of transportation of goods;
  - Opportunities to gain revenue from the return trip by carrying some products back instead of running an empty truck.

Despite the attractiveness of these advantages, among the many UCC that have been piloted in several countries, a few of them have succeeded but a large number of freight centre projects have failed. City logistics, or City logistik is the German equivalent to the UCC. In 1999, the Federal Republic of Germany launched “City Logistik” schemes in about 80 German cities for the consolidation of shipments outside the city centre (Seattle Urban Mobility Plan, 2008) and for joint deliveries of goods from different companies to urban areas (Visser and others, 1999). However, the majority of these projects were suspended. Nobel, 2007 reported that among these pilot projects, consolidation centres were still operating in only 5 cities: Aachen, Bremen, Essen, Frankfurt and Regensburg.

The Best Urban Freight Solutions (BESTUFS) Project under the auspices of the European Commission, which aims at identifying problems and providing solutions related to city logistics in European cities, states that the key to success of UCC projects is that publicly organized UCCs should be led and operated by one or several major commercial players. In addition, there should be sustained support from the public sector for research work and studies related to the UCCs, otherwise such operations are unlikely to succeed.

Points of concern when adopting UCC schemes are as follows:

- High set up costs.
- A need for several UCCs in large urban areas since a single UCC usually cannot handle the full range of goods and is likely to be less attractive for freight operators.
- Careful selection of participants to avoid the risk of creating monopolistic situations.
- Consolidated delivery lessening direct interactions between suppliers and their customers.
- Difficulties in attracting large companies because of their having a similar system of consolidated shipments.

A Freight village is a freight centre with transshipment terminals grouped in a specific area with designated transport services provided. The examples are Guterverkehrszentren (GVZ) in Germany and Interporti in the Republic of Italy. “GVZ” and “City Logistik” in Germany differ with respect to their targeted geographic zones. GVZ is designed to serve inter-regional freight movement between conurbations, while City Logistik is for the joint deliveries of goods within urban areas. GVZs are often a form of a multimodal freight centre in which road, rail, and/or water transports can be connected. Multimodal freight centres are

one of the most interesting approaches by which the objective of sustainable freight systems can be achieved through increased usage of environmentally friendly modes. With multimodal facilities transportation choices become wider and it increases the probability of operators choosing rail and water transport that can be more economical when transporting over long distances.

In Japan, there are facilities to gather small and medium size wholesalers (SMEs) of food products in a selected area, which is known as a wholesale market. In these markets the wholesalers are provided with dedicated logistics facilities coordinated with local transport operators. The wholesale market is classified in the business group development category. The operation of the wholesale market has been successful in increasing competitiveness among the companies. At present, there are numerous wholesale markets of this kind operating in most cities in Japan. This kind of freight centre is very promising. Since the facility gathers the same type of firms in a single space, there are increased opportunities for coordinated deliveries.

For the operation of UCCs and other similar arrangements, public private partnership (PPP) is the recommended organizational structure for freight facilities. It is important to note that the key to success for most schemes is the enthusiasm of the private sector operators participating in the project. The development of an understanding of the benefits of sustainable transport among private sector operators is very important, since the benefits in reduced costs are not always obvious, and can cause the private sector to lose interest in the long run.

C. Optimized vehicles, low-emission vehicles, alternative fuels, and greater use of environmentally friendly modes

The shift to environmentally friendly modes is a key step in creating sustainable transportation systems. Road transport is the most popular delivery mode because of its flexibility, punctuality, security, and competitive cost. However, traditional freight vehicles worsen air quality and cause numerous other environmental and social problems. A sourcebook of good practices in freight transport, published by the European Commission (2000) points out that a switch from road transport to other environmentally friendly modes will deliver immediate improvements. The more environmentally friendly modes include rail, inland waterways, and coastal shipping. Many studies reveal that large amounts of energy can be saved when goods are transported by train or waterways. For example, a German food company has saved as much as 40 per cent in energy consumption by switching off to rail for long distance transportation (European Commission, 2000). Generally, rail is a very competitive option on price and delivery time for long distance deliveries. The sourcebook also suggests that combined transportation, such as between road and rail, provides very cost-effective and reliable alternative to the road only option and can avoid congestion. Multimodal facilities are, therefore, necessary to promote the combined transport option. In addition, multimodal facilities could operate as freight centres creating opportunities for consolidated deliveries by firms.

Another example of modal shifts for deliveries in cities is the City Freight project adopted in Europe. The project recommends a strategy of combining freight traffic with passenger traffic within cities. This can include using cargo trams, electric and hybrid vehicles, bicycle couriers, and messengers on foot.

Since road transport is unavoidable for deliveries in urban areas, much research has been devoted to lowering emission rates and to the development of alternative fuels, such as compressed natural gas (CNG) or low sulfur diesel. However, there is a need for the public sector to ensure sufficient infrastructure for the supply of alternative fuels. An inadequate

supply infrastructure is a major obstacle to the widespread adoption of these alternative vehicles. In addition, alternative fuels may entail additional costs for transport operators.

A company in Denbighshire in the United Kingdom (Welsh Assembly Government, 2008) proposes the utilization of dual-purpose vehicles to improve freight efficiency and reduce emissions from freight vehicles. Each vehicle would be equipped for both highway and maintenance operations, instead of using a vehicle solely for each purpose. The multiple-usage of vehicles can reduce the total number of vehicles required for both operations and can also prevent many vehicles from being idle for long periods of time.

Another factor to consider is the size of vehicles for urban distribution. The current trend is for greater numbers of lower weight deliveries which create more trip requirements. Egger and Ruesch (2003) recommended optimized vehicles with higher cubic capacities and lower deck heights, equipped for handling, for example, fragile or temperature sensitive goods.

D. IT and driver training

The development of technologies for improved efficiency and driver training tends to be the most attractive option for the private sector. Encouragement to use these technologies is apparently the easiest way to achieve win-win solutions for both the public and private sectors. The companies benefit from their improved service, such as reduced energy wastage when efficient delivery routes are used. At the same time, city dwellers can expect a better quality of life resulting from the environmental and social benefits of the measure.

Several projects related to applications of technology have been launched in Europe. The European Commission (2006) recommends supporting the development of web-based technologies and E-commerce and to standardizing the traffic information data. Web-based technologies can be used, for example, for finding the shortest routes for delivery service, online vehicle routing, track-tracing systems, and vehicle fleet management.

Another technology that can be shared with passenger transportation is intelligent transportation systems such as electronic toll collection (ETC) and the global positioning system (GPS). ETC systems automatically debit toll fees from road users with no stoppage required. At present, ETC systems have already been implemented in many countries, such as Japan, the United States and European countries. The system can significantly reduce congestion and allows for variable charges depending on the time of day and type of vehicle. Commercial vehicles, operating within an ETC set up, can profit from reductions in travel time delays when using the expressway networks. Travel time information systems on highways are also very useful for users to receive timely information on congestion and traffic incidents, so that they can avoid delays. In Japan, the system called vehicle information and communication system (VICS) provides such traffic information through electronic boards set up along the highways and expressways throughout the country. Global positioning systems (GPS) have become common in vehicles in Japan. Vehicles equipped with GPS systems are positioned on the network map in real-time and are easily guided to the most efficient routes. Information on the travel times on links is automatically updated from the traffic information centre.

One of the most interesting freight systems for urban areas is that of the eDRUL project which has been implemented in Siena, Italy and Lisbon, the Portugese Republic (EXTR@Web consortium, 2006). The “Park and Buy” service adopted in Siena has been very successful. There are about 20 shops enthusiastically participating in the project. The system facilitates customers, who previously had to walk into the pedestrian city centre to buy heavy items, by offering a booking and delivery service that allows consumers to

purchase items and have them delivered to a collection point in a car park. The system resolves the customer's parking problems and increases the sales.

Unattended delivery systems resolve delivery problems when recipients of goods are neither at home or in their office. A considerable amount of energy is lost when a truck attempts to deliver goods and finds that the recipient is not there to receive them. The truck then has to return to the depot and must try to deliver the goods later. This may double the amount of energy used. An example of an unattended delivery system is the online book store developed by Yahoo in Japan. The system allows the customers to choose and get the books delivered at home or to pick up the books themselves at a convenience store of their choice. Another method implemented by some online businesses in Japan is that the customer is allowed to choose the location to have the products dropped there when he/she is absent.

The economic gains from the more ecological ways of driving are not negligible. A driver training scheme can save significant amount of energy as well as improve safety. A report on "eco-driving" schemes in Japan reveals that savings of 12 per cent in fuel consumption can be made after a company adopts such a programme (Japan Institute of Logistics System, 2008). Similar findings are reported in several other countries (European Commission, 2000): For example, truck manufacturer, Mercedes-Benz pointed out that between five and ten per cent fuel consumption reduction was achieved after they organized courses and training programmes for the company's drivers. In addition, up to 18 per cent fuel consumption reductions are reported to be reached by the driver training schemes of a British company. The increase in fuel-efficiency is achieved by encouraging drivers to use gears properly, to switch off the engine when the vehicle is stationary, and to avoid fast accelerations.

E. Freight transportation systems for the new century

In the Netherlands, there is a move to develop a new form of urban freight systems which is called Underground Freight Transportation (UTF) (Pielage, 2001). Planning began in 1995 and the project is still in the development stage. The concept is to move freight vehicles underground in order to reduce their impact, especially in the city centre. The implementation of this system is feasible with the currently available technology. For example, the Mail Rail system in London, which began in 1927, was an automated underground transport system that had operated for more than 75 years. The UTF system is similarly designed to transport goods using underground pipelines. Transport through the pipelines is planned to be fully automated. When this new system comes into operation, the government expects enormous benefits from improvements in the environment and people's quality of life.

In Japan, a similar study has been undertaken on the feasibility of an underground freight system for Tokyo. The study (Taniguchi and others, 2001) estimates that NOx and CO_2 would be reduced by 10 per cent and 18 per cent, respectively. A reduction of 18 per cent in energy consumption and an increase of 24 per cent in average travel speed are also predicted.

II. Comparisons among the freight practices and recommendations

Table 1 provides a summary of the policies on freight transport practices, their advantages and short remarks on each of them.

Table 1. Comparisons of freight policies

Category	Policies and measures	Regions/cities	Advantages	Remarks
A	*Licensing and regulations*			
	Low emission zones	Cities in Sweden, Amsterdam, and London	• Immediate results can be expected from the improvements in safety and in environmental conditions.	• Social side-effects from changing delivery times in response to the policies, such as increases of accident rates due to drivers' lack of sleep and truck overloading. • Opposition from the private sector due to increased costs for additional vehicles. • Advised to be adopted together with other schemes for better results, such as the provision of freight centres, so that the private sector has more choice and a less negative reaction.
	Combined use lanes	Barcelona, Spain		
	Freight exclusive lanes	New Orleans, Laredo, United States		
	Off-peak delivery	Long Beach, Los Angles, United States		
	Restricted delivery zones	Boston, United States		
	Truck ban	Manila, Philippines		
	Parking regulation	Many countries in Europe, North America and Japan		
	Road pricing	Many countries in Europe and Japan		
B	*Freight centres and consolidated delivery*			
	Multimodal freight centres	Germany, Italy	• Increased likelihood of using other more environmentally friendly modes: rail and water transports. • Increased opportunities for consolidated delivery that will reduce commercial vehicle trips entering the city centre.	• A very effective spur to sustainable development, but difficult in practice. • High investment costs. • Large area is required. • Strong cooperation from private sector is required for success.
B (cont'd)	Urban freight centres	Germany, Japan	• Increased opportunities for consolidated delivery.	• Education on the advantages of consolidated delivery is

Category	Policies and measures	Regions/cities	Advantages	Remarks
				necessary.
	Business group development such as wholesale markets in Japan.	Japan	• Economic growth from a firm's improved competitiveness. • Increased opportunities for consolidated delivery. • Successfully adopted in most cities in Japan.	• High investment costs. • Large area is required. • Need to provide competitive transportation services to prevent companies preferring their own vehicles.
C	*Low-emission vehicles, environmentally friendly modes, and alternative fuels*			
	Increasing use of low-emission modes such as rail and water transports.	Europe	• Large environmental and safety improvements from reduction in road transport.	• To increase the usage of other modes, the public sector has to provide sufficient facilities to support flexible multimodal transport
	Encouraging the development of low emission vehicles, multi-purpose vehicles, and alternative fuels.	Europe, Japan	• Technology ready: important developments on low-emission vehicles (e.g. hybrid vehicles) have already been achieved.	• Suggesting implementation together with "Licensing and Regulation" policy. • For alternative fuels, a need to provide adequate supply facilities to ensure widespread adoption.
D	*IT and driver training*			
	Intelligent transportation systems (ITS), such as ETC, GPS, and traffic information system.	Europe, Japan, United States	• Can be shared with passenger transport operators. • Mature technology that is widely adopted in developed countries.	• High set up costs. • This does not increase the use of more environmentally friendly transport modes

Category	Policies and measures	Regions/cities	Advantages	Remarks
D (cont'd)	Service improvement trough technologies such as web-based delivery routing system, park and buy, and unattended delivery systems.	Europe, Japan	• Inexpensive cost of implementation. • Likely to be well-received by the private sector.	• Encouragement from the public sector is often required, e.g. providing low cost technologies that are affordable for most private sectors.
	Driver training	Europe, Japan	• Not expensive. • Positive private sector response. • Environmental and social benefits from reduced energy usage and lower accident rates.	• Encouragement from the public sector is important, e.g. organizing training courses for the private sector.
E	*New freight transport system*			
	Underground freight transport	the Netherlands, Japan	• Alters the urban structure. Freight vehicles are separated from other traffic, resulting in reduced negative impacts from freight vehicles.	• Enormous investment costs. • Still in the development stage.

The policies discussed above are recommended for coordinated implementation since many of them are mutually supportive of each other. Policy coordination greatly strengthens the chance for successful implementation, notably through reduced negative reactions from the private sector. From the viewpoint of the public sector, Category A: *Licensing and Regulation* is particularly attractive, and immediate results can be expected. However, undue regulation can elicit negative responses from the private sector. In addition, some policies, like the truck ban as implemented in Manila, evidently causes other negative impacts as transport operators are obligated to shift deliveries to night-time. Accident rates may increase due to drivers' disrupted sleep patterns and overloaded trucks, when operators try to maximize efficiency during restricted periods (Castro and Kuse, 2005).

In principle, consolidated delivery is the best way to achieve sustainable freight development by reducing freight trips and, hence, energy consumed: However, it is not easy to implement such a system practice. In addition to relatively high set up costs for freight centres, understanding and cooperation from the private sector are necessary. Multimodal freight facilities are also recommended to increase the use of other more environmentally friendly modes. A problem for most developing countries is that infrastructure is insufficiently developed for transport modes other than roads. Developing railways, inland waterways, and coastal transport systems concurrently with provision of facilities to support flexible multimodal systems is the most promising option. Transportation costs can also be reduced for long-distance deliveries since rail and water transports are often cheaper. The option of business group development, such as wholesale markets in Japan, is also a promising approach to sustainable freight transport development. Gathering wholesalers together in a dedicated facility strengthens the competitiveness of businesses. Moreover, shipments can be grouped together, resulting in reduced transport costs and emissions. If the facility is well planned and provides high quality transport services, the probability is that consolidated delivery of goods will increase.

Category C includes measures supporting the adoption of low-emission vehicles and alternative fuels. Several technologies have been developed for both passenger and commercial vehicles: low emission vehicles, such as hybrid vehicles and electric vehicles; and alternative fuels, such as CNG and low sulfur diesel. However, the main problem is that there are insufficient supply infrastructure facilities for these special vehicles. Hybrid vehicles have no problem because they consume gasoline, but, for electric or gas vehicles, supply facilities remain limited. This situation has caused many to drop the idea of using such new vehicles. Governments that promote low emission vehicles and alternative fuels need to invest more in supply facilities, as well as research on the new technologies.

Among the categories presented above, Category D (IT and driver training) is likely to achieve the most positive response from the private sector. Affordable technologies and driver training courses provided by the government can be very attractive. Companies gain benefits from using these technologies through improvements in their efficiency and reductions in costs, resulting in increased competitiveness. Citizens also gain benefits from these measures which make city traffic safer. Compared with the high set up costs for intelligent transportation systems (ITS), investment costs for online technologies and training courses are low. Investments on ITS systems benefit passenger and freight vehicles. Commercial vehicles enjoy benefits from reduced travel delays and from easier delivery scheduling. However, ITS systems are, clearly, not the way to reduce the share of road transport, which is an important goal of sustainable development.

The 'new freight system', that is, an underground freight transportation system, is an innovation as it completely separates freight transport away from passenger traffic. Negative impacts of freight transport operations, such as exhaust gas and accidents, can be significantly reduced, along with improvements in delivery times and in reliability. However, the choice of this type of system seems to be available only to wealthy countries.

The implementation of a combination of the policy measures is highly recommended. For example, regulation, such as low emission zones, combined with the provision of freight transshipment facilities is a good option. This combination provides choices for freight operators and opportunities for consolidated delivery. In addition to licensing and regulations, support from Governments in the adoption of new technologies, such as new engines and new fuels and service improvements, such as web-based technology and GPS navigation systems, is critical to their successful implementation as they are often expensive. Finally, it is essential that the private operators understand the benefits from sustainable development policies.

CONCLUSION AND RECOMMENDATIONS

It is reasonable to assume that with further economic development the demand for freight transportation will continue to increase. However, policies that can reduce the total demand should be encouraged. These may include buying locally produced goods and carbon taxes. It is important to note that more efficient transport systems will not only reduce pollution for a given quantity of ton-kilometres transported, but they will also encourage a larger quantity of ton-kilometres to be transported. Hence, policies that lead to more efficient transport systems and that reduce demand for transport should be implemented in unison.

Policies discussed in this paper have different impacts on freight operators, the wider economy, and the environment. Governments must choose where their priorities lie. In order to achieve the best results, coordinated implementation of the policies is recommended. Many of the measures are mutually reinforcing and a balanced overall package of measures can increase cooperation from the private sector.

The key idea for sustainable freight transport is to use road transport only when it is necessary. Immediate changes can be expected through the development of freight centres concurrently with increasing the use of the more environmentally friendly modes. For the long distance deliveries, it is strongly recommended using the less polluting modes. However, appropriate infrastructure facilities are necessary to support flexible intermodal delivery systems. The development of multimodal freight facilities, such as GVZ in Germany and Interporto in Italy, is necessary to connect between rail and/or waterway to road transport to enter the urban areas. It is also important to increase the capacity of railways, waterways, and coastal shipping.

In urban areas, road transport seems to be the choice of transport operators due to its flexibility. The policies of urban freight centres and consolidated deliveries provide a way to reduce the number of truck trips entering into cities. However, it is not an easy task. Many urban freight centres and consolidation schemes have failed for various reasons. In many cases, the implementation of urban freight centres leads to increasing costs to the freight operators. Even for the City Logistik scheme in Kassel, Germany, which claims not to generate any extra costs to the participants, it has been reported that some companies have already left the scheme because of such extra costs. This experience demonstrates the need to give adequate attention to cost efficiency for operators in the implementation of consolidation schemes.

Licensing and regulation should be carried out concurrently with the implementation of urban freight centres and consolidation schemes. Implementation of pricing and regulation schemes with the introduction of freight centres and consolidation programmes can increase the opportunities for cooperation among freight operators. However, it does not always guarantee the best result. Implementation of strong regulatory measures without well planned freight centres may lead to undesirable effects.

Technology for improved efficiency, as well as consolidation schemes, can lead to a reduced number of freight vehicle trips in cities. Proper route planning and vehicle fleet management help to reduce unnecessary delivery trips. In addition, this approach is easier to promote among freight operators since the benefits of reduced costs can be clearly seen.

Supporting the development of low-emission vehicles and alternative fuels for freight vehicles obviously reduces the pollution in cities. Although the scheme itself cannot reduce the number of truck trips entering into the city, implementation of such measures together with pricing and regulation can achieve significant improvements in air quality.

The proposed underground freight transport system in some countries is very promising despite the huge investment required. The promotion of modal shift to increase the usage of rail and waterway may not work for several reasons, such as when, most trips are short distance deliveries and other modes are not attractive for freight operators.

Encouraging cooperation among private sector actors is suggested as well. The success of many European businesses comes from their cooperation: Consolidated delivery and sharing of technologies can reduce operation costs and at the same time decrease the environmental impact. In developing countries, similar cooperation should be encouraged. Incentives for shifting deliveries from shipper's own trucks to using services provided by freight forwarders are also recommended in order to increase the chance of consolidated deliveries. The public sector should also be ready to intervene to support the business of professional carriers in order to increase competitiveness in this field. Encouragement of the use of low-emission vehicles, service improvements, and organizing driver training appear to be the easiest measures to implement and are likely to be very well received by private sector operators. In addition, particular attention should also be given to aiding small and medium enterprises (SMEs) to acquire new technology, as their operations are often less efficient due to lower economies of scale. Considering the large number of SMEs operating in the transport sector in developing countries, significant improvements can be expected if sufficient attention is paid to their particular needs.

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