INTERMODAL TRANSPORT AND CITY LOGISTICS POLICIES

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ABSTRACT

Since the 1990s, international supply chains have experienced tremendous progress owing to changes in the division of labour and the globalising economy. In order to enjoy the benefits of free trade, intermodal freight transport system is advocated and introduced to provide efficient just-in-time door-to-door long-distance services in a more environmental-friendly manner.

This paper aims to build a research framework on intermodal transport in the context of city logistics. The paper tries to clarify the interactive relationship of intermodal transport and city logistics through a comparative discussion of the intermodal transport share, intermodal and city logistics policies, and governmental initiatives in the European Union (EU), the United States and Japan.

INTRODUCTION

According to the World Bank, the number of intermodal containers passing through ports worldwide has doubled over the last decade, with similar progressions in intermodal air, rail and truck traffic (Horn and Nemoto, 2005). The development of intermodal transport has thus become a key policy priority and challenge at the global level. In many EU member countries, intermodal transport is an important part and objective of sustainable transport policies often accompanied by modal shift actions diverting freight traffic from road to rail, and, where feasible, to coastal shipping and waterways. In the U.S., intermodal transport is driven by the market and it is the business sector that has pushed intermodal use without major governmental subsidies. In Japan, although the focus is on the development and efficient operation of its unimodal transport systems, it has started to recognise the need for an overall intermodal transport policy that will serve the domestic and international freight flows.

Intermodal transport is justified by utilising rail or sea mode in the long haul of the international or intercity supply chains. Intermodal transport, however, has two important implications on city logistics policies. First, most of the intermodal terminals are located in urban areas, requiring urban planning considerations. Historically, intermodal terminals including ports, airports and rail terminals were developed in urban areas, in which extra growth were experienced due to these facilities. Also, load units designed for the convenience of intermodal transhipment could be further modified so that they could be utilised in intracity transport as well. Second, in environmentally-sensitive or highly congested areas, alternative short-distance intermodal systems to replace trucks are being experimented in several countries with governmental supports. It is necessary to evaluate the experiments at this moment.

In this paper, we will first build a research framework where we will define intermodal transport and discuss the implications of intermodal transport on city logistics policies. Second, we will be comparing the intermodal transport characteristics of the EU, U.S. and Japan, particularly in terms of intermodal transport share. Third, we will try to give a comprehensive review of their intermodal transport policies focusing on those that relate to city logistics. Fourth, actual cases of intermodal transport initiatives in urban areas will be introduced and their apparent effects will be discussed as well. The paper aims to clarify the relationship between intermodal transport and city logistics and how each affects the other.

INTERMODAL TRANSPORT IN THE CONTEXT OF CITY LOGISTICS

Definition of intermodal logistics

As part of integrated advanced logistics and supply chain management, intermodal logistics is defined in terms of seamless door-to-door freight transport operations using at least two different modes of transport. In general, the initial/terminal portions are short and by road, and the main long haulage of containers, swap bodies, trailers or trucks is by rail, waterway, sea or air. Intermodal logistics is also characterized by the absence of or minimal handling of goods during transfers. Instead, load units like containers or transport units, such as swap bodies, are interchanged between modes.

Long distance transport is in general the home market for intermodal transport. The details of this type of intermodal transport are already described in several publications (e.g. Van Duin, 2003). In general, intermodal transport consists of three moves: 1) collection, 2) trunking and 3) distribution (Figure 1).

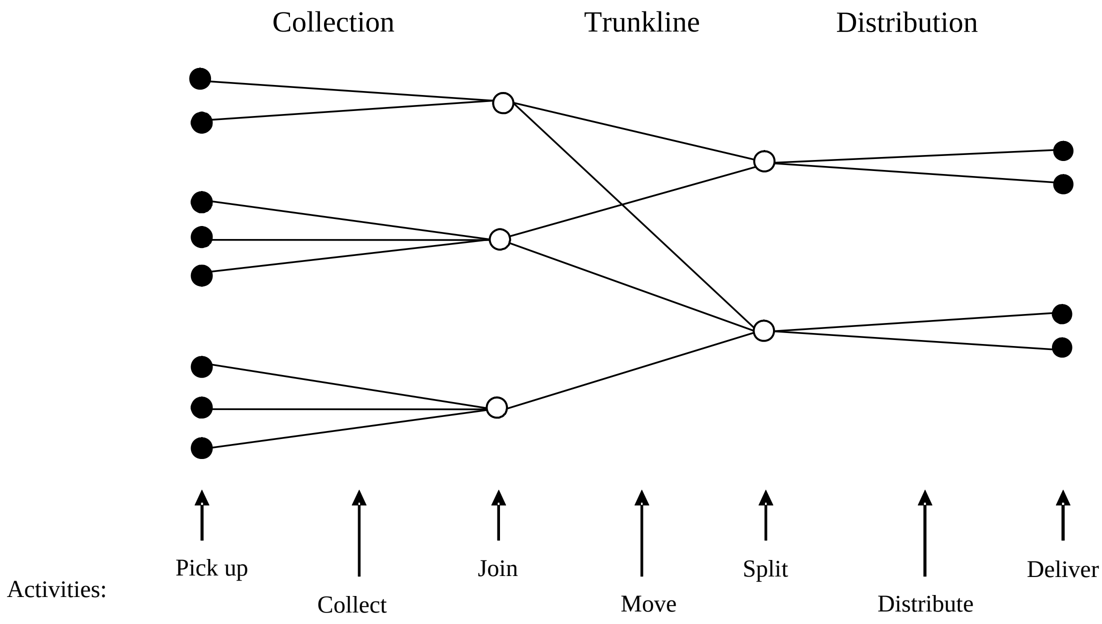


Figure 1 Components of intermodal transport

These three moves take place by using different networks and using at least two different transport systems. Waterborne and rail are typical transport modes for trunkline moves in an intermodal transport chain, while the collection and distribution moves take place by road. Depending on how intermodal is defined, a road-road transport chain can also be considered as an intermodal transport chain.

The essence of using different transport modes is consolidation, in particular in the more longer-distanced trunkline move. Consolidation leads to economies of scale and the possibility to transport goods at higher speeds, for instance by the use of aviation. In return, extra activities have to be fulfilled, such as join and split (i.e. mode change) activities, but also it is likely that detours have to be made. The extra costs and delay that goes with this, but also the smaller volumes, makes it difficult to set up intermodal transport services for the delivery of goods in urban areas.

Implications of intermodal transport on city logistics policies

Intermodal freight transport for road-rail or road-ship could decrease negative environmental impact in terms of CO_2 and other hazardous gas emissions. However, intermodal freight transport inevitably requires mode changes at connecting points or terminals. It requires huge investments for constructing and maintaining intermodal terminals and entails added cost during transhipments. The functions and efficiency of these terminals are crucial for successful intermodal operations.

Figure 2 shows an example of costs for intermodal freight transport by road and rail. The cost for railways per ton-kilometre is generally lower than that for roads, and therefore, the slope of the line representing railways between intermodal terminals is smaller than that for roads-only transport (C_R). But at intermodal freight terminals, since loading and unloading costs (C_T) are incurred, the total cost for intermodal freight transport (C_I) will be higher than the cost for the road-only transport for trips with shorter distances than critical distance, d_c. For trips longer than critical distance, intermodal freight transport will be more cost efficient. Studies in Europe had shown that a critical distance of about 400-500 kilometres is necessary to ensure successful operation of intermodal transport.

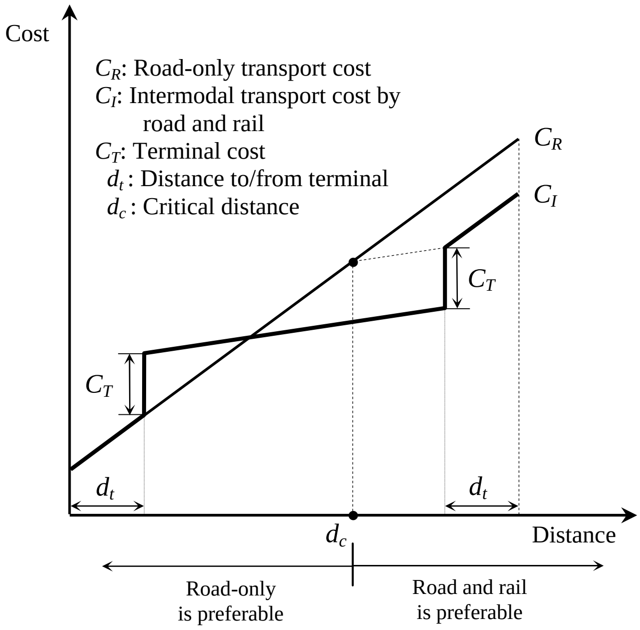


Figure 2 Costs for intermodal freight transport

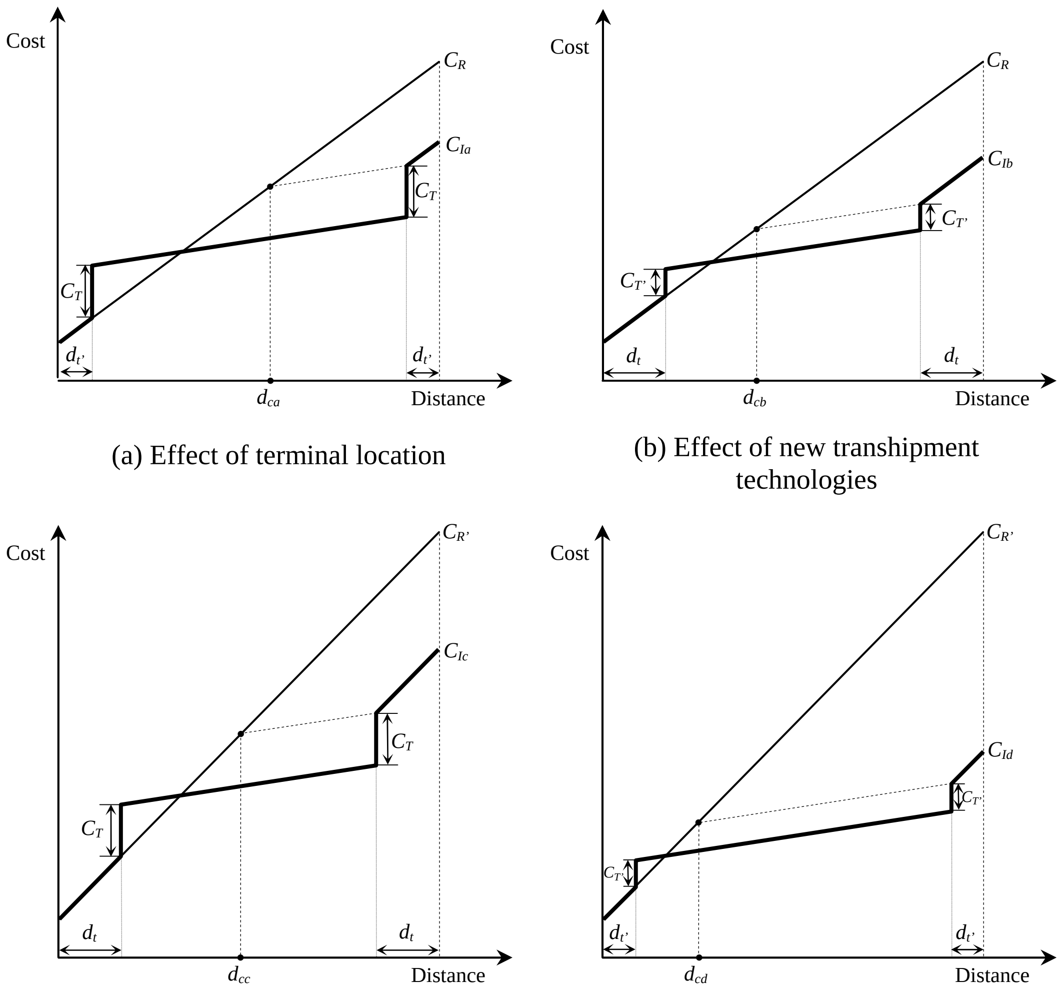
The ultimate objective, therefore, is to reduce the critical distance and enhance the feasibility of intermodal transport over short and medium distances. The main factors that could significantly affect this are: 1) terminal location, 2) use of new transhipment technologies, and 3) inclusion of external costs in the calculation of freight transport costs.

On the issue of terminal location, because majority of transport volumes are transported from and into the urban area, terminals should be located as near as possible to the city center to reduce the distances for truck collection and distribution ($d_{t'}$). Shorter distances would also ensure higher truck turnaround rates. Figure 3(a) shows the effect of terminal location on intermodal freight transport costs and how the critical distance can be reduced.

If new technologies for the transhipment of goods allow reduction of loading/unloading costs at intermodal freight terminals ($C_{T'}$), the critical distance becomes shorter to ensure acceptability of intermodal transport (Figure 3(b)). Such example is the introduction of standardised load units to reduce costs and delay. Standardisation of load units is a critical success factor for city logistics services (Rijsenbrij, 2004). With standardised load units, such as small containers, the move and split activities are simplified consisting of transhipment activities. Transhipment of standardised load units is faster and costs lesser than traditional loading and unloading. In addition, the same containers used for long-distance transport can be used as well in intracity transport to reduce transhipment costs. Small containers can be combined or modularised to form larger container units. Also, the use of standardised and closed load units would make the layout of freight terminals to be much simpler. Without load units, the transfer activities require a freight center or a distribution center. Furthermore, new transhipment technologies, such as roll-on roll-off systems, in which no terminals are necessary to transfer goods from one mode to another, would further reduce transhipment costs thereby reducing the critical distance.

The inclusion of external costs, such as environmental costs, in transport cost calculation would also have a large effect on the determination of the critical distance. The current transport system does not consider the widespread external costs that road transport generates. However, if we incorporate the amount of externalities for each mode in transport cost calculation, regardless of the actual introduction of taxes or penalties based on them, then the slope of the line for road transport would be steeper, as shown by $C_{R'}$ in Figure 3(c). The critical distance would then become shorter because of this change.

Combining the three factors would theoretically result in a much larger reduction of the critical distance, as shown in Figure 3(d). Therefore, it can be said that terminal location, use of new technologies, and inclusion of external costs are important concerns in the successful operation of intermodal transport in urban areas. An implication of this result is that it might be possible that a sustainable intermodal freight transport system could exist within the confines of the city.



(a) Effect of terminal location

(b) Effect of new transhipment technologies

(c) Effect of external cost inclusion

(d) Effect of all three factors

Figures 3(a)-(d) Effects of various factors on the critical distance

Intermodal transport is expected to have significant environmental impacts in terms of reduced pollution as shown by numerous studies done by the European Union (EU). In regions where the environment takes primary priority, intermodal transport is being practiced such as in the transport of waste materials by rail and inland waterway even for short trips within the city. The EU studies revealed the social cost savings that may accrue from the use of intermodal freight transport. The following shows some of the merits of intermodality:

- intermodal freight transport results in 60-80% lower accident figures and 40-50% lower CO_2 emissions than road transport
- overall social cost saving of 33 - 72 % compared to road transport
- external cost saving of 1 Euro for 85 ton-km shifted from road to rail, for 52 ton-km to inland waterway, and for 50 ton-km to coastal shipping

INTERMODAL FREIGHT TRANSPORT

Intermodal freight shares in the EU, the U.S., and Japan

Table 1 shows that there is relative reliance on trucking especially in Japan and in Europe. In the U.S., short sea shipping seems lagging behind, while inland waterways are well-utilised. Table 2 shows the share of intermodal transport for the three regions.

Table 1 Modal split (% tonne-km) of EU15, U.S. and Japan

	EU	U.S.	Japan
Road	43.8	30.0	53.7
Rail	8.1	38.2	4.0
Inland waterways	4.1	9.4	0.0
Coastal sea	41.3	7.4	42.3
Pipelines	2.8	15.0	-

Sources: U.S. BTS, EU, MLIT 1999/2000

Table 2 Intermodal freight transport shares of EU15, U.S. and Japan

	Intermodal share in % of total freight	Intermodal share in % of water & sea freight	Intermodal share in % of rail freight
EU15 in tonne-km	8.6	15.0	25.8
• Germany in tonnes			>10.0
• Netherlands in tonnes	8.0	24.0	
• U.K. in tonnes	20.0	22.0	13.0
U.S. in ton-km			19.0 – 30.0 (a)
Japan in tonnes (b)	1.5 (c) (d)	7.9	50.0

(a) 30.0 % if automobile transport on rail (around 11 %) is included
(b) 82.9 % is “road only” according to an ad hoc 3-day survey for tonnes transported domestically in 2000
(c) “Road and sea (container ship, ferry and RORO)” is 1.0%
(d) “Road and rail (container train only)” is 0.5%, 1.0% if conventional freight trains are included

As shown by official European statistics and estimated U.S. data, “intermodal” rail is between one fourth and one fifth of total rail traffic. The U.S. freight rail system provides intermodal “land bridge” operation across the country and is an essential intermodal link for international trade serving the seaports that act as major container gateways. In Japan, based on an ad hoc 3-day survey in 2000 covering certain commodities transported domestically, the share of intermodal transport is half of rail freight, although the share with respect to the total freight is relatively low. Intermodal rail transport mostly uses 12-ft containers standardised by Japan Railway. Owing to its geographical situation, Japan has high shares for water and sea, most of which are not intermodal.

REVIEWING INTERMODAL AND CITY LOGISTICS POLICIES

Reference should be made to the extensive effort of an advisory group on intermodal freight transport established within the OECD, which subsequently published two reports dealing with institutional aspects (OECD, 2001) and benchmarking (OECD, 2002) of intermodal freight transport, and a follow-up research on intermodal policies (Horn & Nemoto, 2005).

European intermodal and city logistics policy

Many European governments emphasize the need for an intermodal transport and logistics policy to combat highway congestion and environmental problems, and to increase overall traffic efficiency and profit from the benefits of coordinating modes. Table 3 summarises the key elements of the EU’s basic intermodal policy as put forward in the European Commission’s 1997 Communication.

In Europe, intermodal transport has a large share in hinterland transport to and from seaports, rail transport, in particular in Belgium and Germany, and water transport in the Netherlands. The rise of the sea container in maritime transport has played an important role while the shuttle rail concept and the introduction of container barges made it possible to transport containers in large quantities by rail and waterborne systems. In order to promote these systems, intermodal terminals have been built at the vicinity of urban areas. The vast majority of recently developed intermodal terminals in Europe are built on a distance from urban areas because of their size and hindrance to the surrounding.

Table 3 Elements of intermodal policy in the EU

Infrastructure	Technology	Rules and Standards
• Intermodal design of Trans-European Networks (TEN) • Missing links (intermodal priority projects) • *Design of intermodal transfer points*	• IT system, ITS • Satellite based communication system • EDI • Value-added logistics services (esp. E-logistics)	• Intermodal competition rules • Intermodal liability, work regulations • Common charging and pricing • *Interoperable systems & equipment (esp. load units)*

Another focus is on testing and implementing innovations in logistics concepts and systems, harmonising and standardising intermodal loading units (pallets, containers and swap bodies) and creating the right technical conditions for stimulating the development of “freight integrators" specialising in the integrated, seamless transport of full loads at the European and global level.

American intermodal and city logistics policy

Efficient logistics system in North America is indispensable for the North America Free Trade Agreement (NAFTA) involving the U.S., Canada and Mexico. Because of the size of its economy and its central geographical location, the U.S. has a factual leadership position and has taken initiatives in enhancing intermodal logistics and transport in the region. The original milestone of American intermodalism was the Intermodal Surface Transport Efficiency Act of 1991 (ISTEA '91) which provided the legislative framework to develop "a National Intermodal System that shall consist of all forms of transportation in a unified, inter-connected manner".

Table 4 summarises the essential elements of the U.S intermodal policy. Its basic philosophies are: 1) intermodal is industry and market driven, and 2) government acts as a convener and catalyst, i.e. few public sector interventions and few governmental initiatives.

Table 4 Elements of intermodal policy in the U.S.

Infrastructure	Technology	Rules and Standards
• National corridor development • Coordinated border infrastructure program • *NHS intermodal freight connectors* • *Intermodal cargo hubs*	• ITS intermodal freight program • Intermodal border clearance • R&D	• Freight facilitation strategy • Freight partnerships • Freight analysis decision framework • Education & training • *Standards, "size & weight" of containers*

U.S. executive and legislative bodies are discussing the renewal of the next long-term transport legislation, called SAFETEA, i.e. the Safe, Accountable, Flexible and Efficient Transport Equity Act. Several different drafts of the forthcoming legislation have been put forward and, as usual, discussions about funding and taxation are at the forefront. Broadly speaking, freight mobility, global connectivity, security and border infrastructure are among the priority goals.

Restraint measures against freight vehicles in urban areas are not common in the U.S. except in large cities (e.g. New York). It is because there are few conflicts between urban activities or urban land uses (e.g. commercial and residential uses), owing to spacious area and strict land use controls.

Japanese intermodal and city logistics policy

According to the OECD report prepared by the Asian Task Force (2003), several countries including Singapore, Korea and Japan have developed well-defined comprehensive logistics policies. Most of the countries, however, have mode-specific freight transport policies, while Malaysia and the Philippines explicitly refer to the importance of intermodality. Clearly, it will take some time to have a region-wide intermodal logistics policy in Asia. In this paper therefore, we concentrate on reviewing Japanese logistics policies as an Asian case study.

About the same time as the EU's intermodality communication, the Japanese Government decided on the "Comprehensive Program of Logistics Policies." The goal is to strengthen competitiveness by promoting integrated logistics. As such, Japan does not have an "intermodal" policy, but clearly there are many elements and features that address the intermodal challenge. Table 5 summarises the key elements of this policy agreed at a Cabinet meeting in April 1997.

Three levels of logistics systems were distinguished, each involving a number of intermodal elements:

- city logistics - rationalising door-to-door deliveries, use of railway and inland waterway, waste logistics, improved terminal transport
- regional logistics - modal role-sharing, promotion of coastal shipping and related equipment, promotion of rail cargo, access roads to other modes
- international logistics – container terminals and cargo handling, import/export procedures; domestic land transport of marine containers and larger semi-trailers, expansion of domestic coastal shipping; promotion of competitive international sea and air cargo transport

Table 5 Elements of intermodal policy in Japan

Infrastructure	Technology	Rules and Standards
• Co-operation between modes • Elimination of bottlenecks • *Development of international hubs* • *Development of intermodal terminals*	• IT applications, computerization • ITS, GPS • EDI • SCM, E-commerce • New transport technologies	• Less government interventions • Simplifying regulations • Abolishment of demand/supply regulation • Facilitation of logistics market • Pricing mechanism • *Standards, codes, pallets, containers*

In Japan, where the international flow of goods has been continuously increasing, ports have played a vital role as intermodal terminals for handling imports and exports. While these terminals are basically located in large cities, such as in Tokyo, Yokohama, Nagoya, Osaka and Kobe, large trucks and trailers used for dispatching and receiving operations have become the major cause of congestion in the city. Among the measures being considered to prevent the entry of large trucks in cities is to develop the logistics network, particularly the expressways. Improving access routes to railway stations and sea ports is essential for promoting intermodal freight transport. If door-to-door travel times can be reduced by improving access routes to intermodal terminals, it is possible to get more cargoes shifting from trucks to intermodal systems.

Policy implications

Most freight nodes, distribution centres and intermodal transfer points (i.e. ports, airports, railway terminals) are located in cities - generating important freight flows with significant impacts in terms of congestion, liveability and pollution. One of the crucial tasks in freight transport policy making, which has not been extensively understood, is the issue on how to effectively plan and coordinate intermodal and city logistics policies.

In reviewing European, American and Japanese policy statements, we find a high degree of commonality. We have found that the policy intentions pursue the same broad directions: Intermodal policies are expected to make the logistics system efficient and environmentally friendly with systematic applications of advanced technologies and innovation in intermodal facilities and operation. In particular, some references point out the strong association of existing city logistics policies on intermodal policies related to infrastructure and standards, such as in the development and utilisation of ‘intermodal terminals’ and ‘load units’, shown as italics in Tables 3, 4 and 5.

INTERMODAL TRANSPORT INITIATIVES IN URBAN AREAS

European initiatives

Rail for trunkline and distribution

There are two ways rail can be used in intermodal urban freight transport; namely rail for the trunkline network (i.e. traditional rail) or for distribution purpose (i.e. tram, metro, light rail).

In Europe, container transport by rail is almost synonymous with intermodal rail transport. Traditionally in a number of European countries intermodal rail transport is used for waste transport.

Ruesch (2004) describes several rail bound systems in use or in demonstration phase in Switzerland, such as ACTS and Cargo Domino system. Both systems are based on using standardised containers. In Berlin, an intermodal concept using shuttle trains has been studied but turned out to be not feasible (Dorner, 2001). The shuttle concept leads to less environmental emissions and less trips but is unrealistic for urban freight purpose because of cost and time consideration. In terms of energy consumption, rail transport is only about 25% of energy usage as compared to road transport. However, it has limited flexibility, and the fact that it is rail mounted and additional transhipment is necessary often results in higher costs than road based transport.

The SNCF-Fret in France has been working on new rail freight projects in urban areas. Some industries are now using rail freight transport, especially in the transport of building materials and beverages for cafés, restaurants and hotels, because of the high volume and the need for low transport costs. SNCF-Fret now wants to use inner city rail terminals to create urban logistics centres in the freight stations. A feasibility study showed that there is interest from industries that have activities in urban areas. Furthermore, using rail to get into the city seems economically viable. However, it is a long term process. Currently, three projects are running in Lille-Paris, Toulouse and Strasbourg.

An example of tram usage is the freight tramcar in Dresden (Rijsenbrij, 2004). However, it is used only for point-to-point transport and not for general cargo. The CarGo Tram project is a co-operation between DVB, Volkswagen and the government. The decision to start up the CarGo Tram was undertaken in 1999 and the CarGo Tram became operational in November 2000. Volkswagen wanted a competitive solution compared to road transport. The main key to the viability of the project is the length of the tram (60 meters) and the load capacity of 2.5 lorries (max load 60 tons and a load space of 214m^3). The CarGo Tram runs 6 days per week at 16 hours per day. A similar project, referred to as “GüterBim”, is currently taking place on the rail system in Vienna. The project, which started in August 2004, is viewed by the project team as a good way to make freight transport possible on the existing rail infrastructure, and thereby to reduce its environmental impact. An adapted rail vehicle is being used to move goods between the main workshop in Simmering and the rail stations (Anon, 2005).

Underground freight transport systems have existed for years in the past (e.g. Visser, 2003 and Visser, 2004). New ideas have been developed in Europe but have not yet really been implemented. Examples are Metrofreight in the UK, OLS (Underground Logistics Systems) in the Netherlands and Cargocap in Germany.

Although there are several advantages of rail based transport, the implementation is difficult due to the following:

- Complicated and costly system compared with road transport and distribution
- Not useful for local distribution
- Implementation depends on cooperation between partners in a logistics system
- Due to differences in transport systems (heavy/ light rail/ road), transhipment is necessary resulting in more required standards, especially standardised container systems.

Revitalisation of inland waterways

In urban areas with lots of canals, waterborne systems can have advantages than road bound systems. In Venice, general cargo distribution by boat is common. Other examples are the delivery of beer and other beverages in the canals of Utrecht and parcel transport in Amsterdam. In the case of Amsterdam, waterborne transport is combined with delivery by cyclists. Amsterdam also has a long tradition of transporting waste using barges. In the demonstration project Distrivaart, waterborne systems are used for the transport of goods between factory and the distribution center using palletised cargo, like beer. Normally palletised goods are transported on road (see Rijsenbrij, 2005). The operation of this system has recently been stopped due to disinterests from other beer producers.

In the UK, Transport for London (TfL), the integrated body responsible for London's transport system, in coordination with the Mayor of London, are continuing to develop a strategic approach to freight transport. TfL has been setting up several research projects and trials involving the use of rivers and canals for freight transport in London. Among the projects being carried out is the Grand Union Canal Study, which aims to identify potential wharf sites and opportunities for waste, recyclables and construction materials. The work, undertaken to raise awareness of the potential for using the canal during the canal survey, has helped to initiate projects including the movement of 70,000 tons per annum of cardboard from Park Royal to Maidenhead. This equates to 8,750 lorry journeys and 271,000 lorry miles saved per year (Peter Brett Associates, 2004). Stage 2 of the Grand Union Canal has built on the first phase to identify volumes of commercial and industrial waste and other ‘bulk’ commodities suitable for transport along the canal and the anticipated volumes which could be transported now and in the future.

TfL has also produced a guide to identify and prioritise inland waterway wharf sites for waste and construction materials. Selective dredging is being undertaken on London’s waterways to increase the capacity for freight movements along the Grand Union Canal. The construction of the Old Oak Sidings canal wharf is being planned for the proposed Material Recycling Facility at Willesden. This canal facility would play an important role in achieving a modal switch to water for recyclables and secondary aggregates. In the London Borough of Hackney, the

Waste-by-Water pilot project was undertaken in 2004 to determine the costs and benefits of a multi-modal method of municipal waste and recyclables collection using multi-modal refuse collection vehicles and transfer to the Edmonton waste incinerator by barge on the River Lee (TfL, 2005).

Road bound systems

Several examples of road bound systems already in use or still in the phase of feasibility or demonstration can be found in Europe. The Stadsbox project (Rijsenbrij, 2004) in the Netherlands is based on standardised small containers, while the IDIOMA project in Zurich (Ruesch, 2004) uses small containers used by the Pistor company.

Small containers can also be used for a hub and spoke home delivery system as Ocado has demonstrated in the UK (Clancy, 2003). Ocado operates a hub and spoke system based initially on a single order picking point. The downside of having a single picking center is higher delivery mileages, since the trunking cost could potentially outweigh any benefits in centralising order fulfilment. But using a "demountable pod" concept has allowed Ocado to expand its geographical coverage without a huge increase in operating costs. Pre-loaded demountable bodies or pods are mounted transversely six at a time on special articulated vehicles and trunked from Hatfield to Weybridge, where they are transferred to 3.5-tonne vehicles for final delivery. Ocado will continue to add spokes to the hub, and it is thought that the hub-and-spoke concept will eventually enable the company to serve areas some distance from London. Ultimately Ocado aims to serve 60 per cent of UK households.

American initiatives

Intermodal freight connectors

As part of the Intermodal Surface Transport Efficiency Act for the 21st Century (TEA-21), National Highway System freight connectors, i.e. public roads leading to seaports, airports and major intermodal terminals, were assessed by the Department of Transport. The aim was to see how land access to U.S. intermodal cargo hubs could be facilitated. Ultimately, connectors to 517 freight terminals (i.e. port, rail, pipeline) and 99 major freight airports were selected for enhancement and improvement, altogether 1222 miles in length. Table 6 shows some of the major selection criteria used to identify these intermodal connectors.

Table 6 Intermodal connector selection criteria in the U.S.

Airports	100 trucks/day in each direction or 100,000 tons/year arriving or departing
Ports	> 50,000 TEU's/year, 500,000 tons bulk /year or 100 trucks/day in each direction
Rail terminals	> 50,000 TEU's/year or 100 trucks/day in each direction
Pipelines	100 trucks/day in each direction

Up to 2001/2, total funding for the construction and improved traffic operation of intermodal connectors was about U.S. $ 1.5 billion through federal, state, local and private sources and the new draft federal legislations starting in 2004/2005 foresee a funding level of U.S. $ 3 billion. A few intermodal projects in Alameda, Maine, Washington State, New Jersey, New York City were also undertaken.

Intermodal rail system: The Alameda Corridor Project

Apart from the rapid growth in demand for container transport in the Asian region, another significant factor for the rise of intermodal transport in North America is the increased usage of low-cost double stack trains, which use the then low-efficient trans-continental railway where containers are stacked in two levels, resulting in cheaper rates than truck or trailer-type transport.

Because railway companies are owned by the private sector, they do not receive any subsidies from the federal government. However, since it has been widely acknowledged that the use of rail is better in reducing traffic congestion and is more appropriate in handling increased volume of cargo demand passing through intermodal terminals located in cities, a subsidy from the highway trust fund was allocated to improve the intermodal infrastructure.

This subsidy from the government needs to satisfy several criteria. First is that the project should be viable after conducting cost-benefit analysis. Another is that the project should be able to determine its effects on the external economy and to justify the involvement of the government, such as in the achievement of objectives relating to national defence. In addition, should the government be involved, it cannot be directly involved in the disbursement of the subsidy as infrastructure users, which are the direct recipient of benefits brought about by reduced logistics costs, should be the ones to shoulder expenses.

The Alameda Corridor Project, which started its services on April 2002, is an example of an intermodal infrastructure resulting from the joint cooperation of the federal government and the private sector. The Alameda Corridor is a project of national significance serving the ports of Long Beach and Los Angeles which are major gateways for Asian trade. The ports, the railway companies and multiple public authorities joined to finance and build the 20-mile grade-separated intermodal freight rail corridor from the ports to the inland intermodal rail yards. As a result of the project, 200 railway grade crossings in the urban area were eliminated resulting in decreased congestion, air and noise pollution. The US$ 2.4 billion project was financed through a private/public partnership by bonds (i.e. railway container charges) and a mix of local, port, state and federal grants and loans.

ITS to support intermodal systems

The aim of the ITS Intermodal Freight Program is to enhance the reliability, responsiveness and security of the intermodal freight system. Opportunities to accelerate the application of ITS to intermodal freight movements are investigated including operational tests and demo projects. These center on the development of an ITS architecture and standards, especially for freight identification technologies to ensure interoperability and security controls. Intermodal freight applications of ITS aim at:

- Supply chain management, e.g. door-to-door shipment,
- Node management, e.g. rail terminal, port, and airport management, and
- Link management, e.g. tracking and asset management of trucks chassis, rail equipment, vessels.

It should be emphasized that the use of ITS should be exploited at intermodal terminals to better improve and streamline operations.

Japanese initiatives

City rail for transport of waste materials

Kawasaki City, located in south-west of Tokyo, initiated transporting waste materials using railways in 1995. There have been needs for transporting waste materials, which are generated in the northern part of the city with increasing population, to Ukishima waste disposing center at the southern coastal area of the city that contains larger disposing capacity (900 ton/day). Fortunately, a railway line exist connecting the northern and southern areas of the city and a freight railway station is located near Ukishima waste disposing center. Kawasaki City then planned intermodal freight transport of waste materials using railways in trunkline, although the length between railway stations is only 23 km. This system carries general house garbage, large house garbage, incinerated ash, cans and bottles in containers. Table 7 shows the amount of transported waste materials in 1999. Specific containers were developed for general house garbage, large house garbage, incinerated ash and cans.

Incinerated ash had been transported by trucks before intermodal systems were introduced. The number of trucks used for carrying incinerated ash by intermodal systems was reduced to 7 from 14 for trucking systems. A substantial reduction of hazardous gas emissions was realised.

Intermodal freight transport systems are competitive in general for long distance transport over 500 km. However, in the Kawasaki case, the distance using railways is only 23 km. Reasons of its success are: a) the railway was existing in the ideal location for the project, b) they could receive subsidies from the Ministry of Environment for the initial investment of systems because it can decrease negative environmental impacts, and c) Japan Railway Freight Company was eager to increase the operation rate of their freight stations.

Table 7 Amount of transported waste materials in Kawasaki City

Item	Container capacity (ton)	Number of containers per day	Owner of container
General house garbage	10	19	Kawasaki City
Large house garbage	5	20	Kawasaki City
Incinerated ash	10	20	Kawasaki City
Can	5	10	Freight carrier
Bottle	5	10	Japan Railway Freight

Inland waterway transport

Inland river shipping used to be dominant for freight transport in urban areas before railways became popular in the 19th century in Japan. Inland river shipping has declined with the development of railways and roads. At the moment, just a small amount of oil, gravel and waste materials are carried by barges and small tankers.

A good example of an intermodal initiative involving inland waterway transport can be seen in the transport of gasoline by small tankers from Kawasaki City, Kanagawa Prefecture to Wako

City, Saitama Prefecture via Arakawa River. Wako City is located at 31 km upstream from the mouth of Arakawa River. Tanker capacity is about 500 kiloliters. It leaves the oil refinery of Kawasaki City at early 3 AM and arrives at a quay of Wako City at 7-8 AM. The gasoline is carried to an inventory center from the quay by pipeline and then distributed to gas stations by tank lorries to Saitama Prefecture and northern part of Tokyo.

Another example, supported by the Tokyo Metropolitan Government, is the transport of waste materials by barges from 5 waste material collection points via Arakawa River and its branch rivers. Two types of transport by bulk and container are applied.

Inland waterway transport has received attention in terms of alleviating road congestion, reducing negative impacts on environment and alternative mode in emergency of disaster. However, there are several issues to be solved as listed below.

- Whether or not to be competitive in terms of total costs including transhipment at quay in rivers?
- Improve river space suitable for shipping by keeping the depth of water, the clearance under bridges and width at gate
- Improve reliability of barge transport due to natural conditions including typhoon and flood
- Improve facilities of quay and storage

Despite these problems, it may be preferable to transport waste materials and construction materials by inland shipping compared with road transport from the environmental point of view. We need to consider inland shipping as an option for urban freight transport. Moreover, inland shipping can be an alternative mode to road in emergency cases of strong earthquakes. Therefore, there is a need to build loading/unloading facilities along rivers for emergency cases.

CONCLUSIONS: CITY LOGISTICS TO PROMOTE INTERMODAL TRANSPORT

This paper examined the relationship of intermodal transport and city logistics. It revealed that both have basically similar objectives of improving efficiency to attain environmental-friendly logistics. However, they had been handled as separate policy concerns and their interactions were mainly not considered in policy planning. Since intermodal transport performance mainly depends on city logistics policies, and vice versa, it is desired that they must be planned in coordination with each other to attain better results. If the needs or requirements of each could be considered and incorporated in planning, a more efficient and environmental-friendly logistics system can be established.

The paper also identified several factors that could significantly affect the successful operation of intermodal transport over short and medium distances. Terminal location, use of new transhipment technologies and inclusion of external costs are among the main concerns that could reduce the critical distance needed to ensure feasibility of intermodal transport in urban areas. By combining the reduction effects of the factors, it might be possible to design a sustainable intermodal freight transport system within the urban area.

The comparative policy review has shown that we can indeed learn from differing intermodal policy emphases and directions in other regions. As a decision support tool, and to benefit from more detailed international analyses of intermodal projects and experience, it would be worthwhile to select and assemble data on a few global logistics indicators for monitoring and benchmarking, focusing on key features of intermodal logistics. In particular, the impacts and effectiveness of short-distance intermodal systems have not been completely recognised, and thus, it is important to ascertain assessment criteria using these indicators. This could be effectively done through the network of international organizations active in global trade and transport, and now security as well, for which an enormous amount of data are now being collected and exchanged.

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