Impacts of Information and Communication Technology on Urban Logistics System

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1. Introduction

The prices of Information and Communication Technology (ICT) have been reduced dramatically so that private firms and consumers are now changing their behaviors, and without doubt it has influenced the urban logistics system. However, we do not have a common clear perspective of the impacts of ICT, except for several alternative scenarios.

One scenario is that e-commerce would make it easy for the consumer to purchase products from his home and then have them delivered right to his door. This would result to an increased number of direct home deliveries with tight time schedules. The increased volume of freight vehicles required to fulfill strict delivery requirements would aggravate traffic congestion and environmental problems in urban areas. Therefore, the general public would want to restrict the movement of freight vehicles, which may become one of the causes of bottlenecks for the further development of e-commerce.

Another scenario is concerned with its positive impact on transportation. Monitoring consumer demand through the Internet makes it possible to produce goods only on demand, while simultaneously reducing dead stock in the warehouse and transportation demand. Furthermore, the private sector will try to find solutions to quickly respond to consumer needs with the help of Internet and Intelligent Transport System (ITS); for example, real-time procurement of transportation services from third party logistics (3PL). This implies that the Internet and ITS can offer opportunities for efficient logistics operations, and then more opportunities for e-commerce.

In this paper, we will first build a framework to evaluate the impacts of ICT on urban logistics system by describing the nature of influencing ICT (i.e. Internet and ITS, particularly, in the mobile environment), and by defining major stakeholders and their concerns in the urban logistics system. Then, we will try to evaluate the likely impacts of ICT, based on which policy implications are concluded.

2. Framework to evaluate the impacts of ICT

2.1 Influencing ICT

How is ICT influencing our lives? The most logical answer is the drop in prices of personal computers and related equipments, and communication costs including Internet services and subscription charges. The introduction of cheap materials and technologies always changes the best mix of resource allocation. For example, prices of personal computers with the same calculation capacity have fallen by an average rate of 26 percent annually between 1995 and 1999 in the United States (American Department of Commerce), and charges for domestic and international phone calls in Japan have been reduced 78 percent to 93 percent in the last 15 years (Japanese Ministry of Posts and Telecommunications).

Among the ICT, the Internet is believed to be one of the most innovative technologies in terms of interoperability of communication means and speed. Thus, it has become a popular tool in the transaction of Business-to-Business (B2B) and Business-to-Consumer (B2C) e-commerce. Supported by the TCP/IP protocol, any personal computer and local area network can be connected with one another, regardless of hardware vendors, operating systems, and copper wires or optical fibers.

Furthermore, ICT has been introduced in the field of transportation, grouped and named Intelligent Transport System (ITS). ITS applications enable us to track the position of vehicles or cargoes on the way by utilizing data from Global Positioning System (GPS) or Dedicated Short Range Communication (DSRC), and to optimize vehicle routing based on shipper's request and real-time traffic information.

It is notable that new mobile applications of ICT have been released in the market, and is becoming more and more popular. For example, mobile phones are spreading worldwide and are expected to play an important role in communication, particularly the next generation of mobile phones with capability to provide long e-mail services, music clips and videoconferencing.

In Japan, mobile phones have diffused dramatically. The number of mobile phones (56 million) had exceeded the landline fixed phones (55 million) at the end of 1999, and has reached 65 million as of February 2001. This increase was triggered by the introduction of Internet Mobile Phones (IMP), which can access web sites directly and enjoy information and mail services with or without additional charges beyond the basic communication charge. Three major IMP firms are competing in order to gain more shares in the market. Their brand names are i-mode, Ezweb, and J-sky. Although the IMPs only started in February 1999, their number has already reached 31 million by February 2001 and accounts for almost half of the total number of mobile phones.

With a press of a button, Japanese users can access over 1,480 authorized menu sites and 40,000 voluntary sites via their i-mode phones (http://www.nttdocomo.com/i/index.html), and enjoy specialized services such as long e-mail, online shopping, ticket reservations, databases to news, entertainment, transactions with several Japanese banks, and cargo tracking services of freight carriers. Japanese consumers can check the availability of air tickets, reserve them, and settle accounts by using the IMPs. A navigator for railway travelers is another popular site, with which they can choose the fastest or cheapest railway route on real-time basis. Its additional monthly charge is just 100 yen, regularly collected by the mobile phone firm on behalf of the information service provider.

2.2 E-commerce and logistics system

E-commerce defined as **"**doing business over the Internet**"** could cover any transactions between the organizations and people in the society, although the past literatures regarded B2B and B2C as important in terms of market size. In this paper, however, the government will be referred explicitly because they have responsibility to establish new logistics policies under different ICT conditions.

Another original viewpoint is to divide "Business" into "Shipper" (e.g. suppliers, manufacturers, wholesalers, and retailers) and "Logistics Service Provider" (e.g. freight carriers, warehouse firms, and third party logistics). B2B usually means the transactions between shippers (S2S). It seems effective for us to distinguish the transactions in the market of logistics services, between Shipper and Logistics service provider (S2L) and between Logistics service providers (L2L). As e-commerce becomes common practice, the more likely the shippers tend to outsource logistics services. We should recognize four major stakeholders if we want to analyze the impacts of ICT on the logistics system (Figure 1).

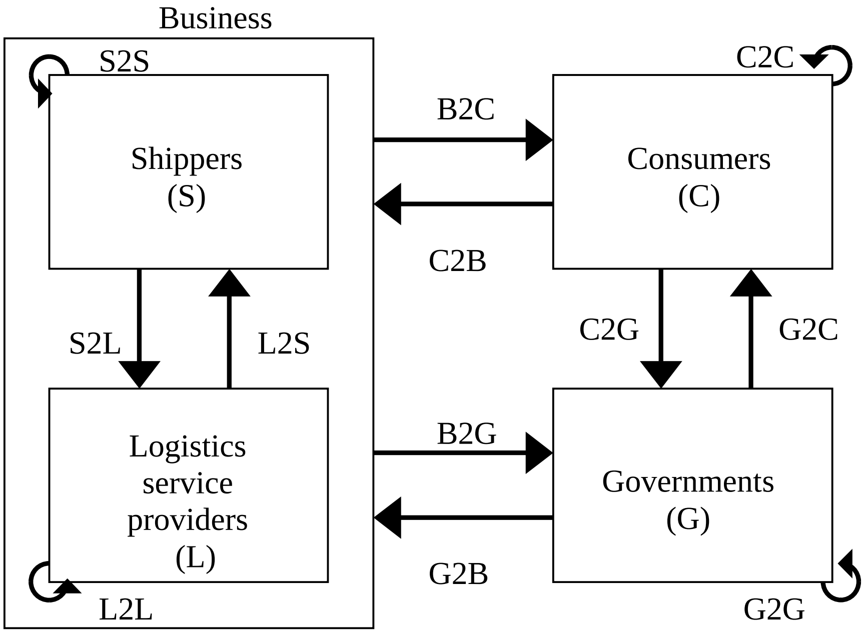

Figure 1. Stakeholders in logistics system

Shippers are either the consignors who send goods or the consignees who receive goods in the supply chain. Their concerns are to maximize net profits by reducing lead-time from ordering to fulfillment, and decreasing opportunity cost resulting from failing to cope with changeable consumer needs, among others. Some of the shippers have the logistics functions in-house, because their logistics system makes their competitive power stronger. However, the share of logistics activities conducted by logistics service providers has been increasing in Japan.

Logistics service providers are trying to minimize logistics costs (transportation cost, stock cost, data processing cost etc) while meeting the requirements from the shippers. The requirements have become sophisticated and costly, including time-window for delivery, temperature control, and tracking information services for valuable goods.

Consumers like to maximize consumer surplus by purchasing favorite goods conveniently at reasonable prices. The important aspect is that the price is one of the factors affecting consumer's satisfaction. They are willing to pay more money if quality goods are delivered just in time. We cannot neglect the fact that the consumers are at the same time the residents suffering from traffic congestion, traffic accidents, and environmental problems (air and noise pollution). Therefore, they hope that these problems be alleviated and a comfortable urban environment is maintained.

Governments represent the local governments and other agencies concerned. They are tasked to maximize net social benefits (gross social benefits - gross social costs) in the new situation where e-commerce and related logistics operations are actively performed by the private sector. Their interventions might be justified in providing public goods such as logistics infrastructure, in regulating logistics operations for safety purposes, and in internalizing externalities to make efficient and fair resource allocation (e.g. road pricing).

Table 1. Concerns of stakeholders

Shippers	Maximizing net profits by reducing lead time, decreasing opportunity cost, etc.
Logistics service providers	Minimizing logistics costs (transportation cost, stock cost, data processing cost, etc.)
Consumers	Maximizing consumer surplus, maintaining comfortable environment
Governments	Maximizing net social benefits by providing logistics infrastructure and internalizing externalities

2.3 Urban logistics system influenced by ICT

ICT will affect the logistics system in different ways. Concerning the influence of ICT on the logistics system, three aspects should be examined (Figure 2):

- The Internet changes the B2B and B2C business style, thus increasing/decreasing the demand of freight transportation (e-commerce).
- The Internet also changes the S2L and L2L market of logistics services where fragmented transportation needs might be consolidated (e-logistics).
- ITS makes logistics operations more efficient by optimizing the fleet management based on real-time traffic data (e-fleet management).

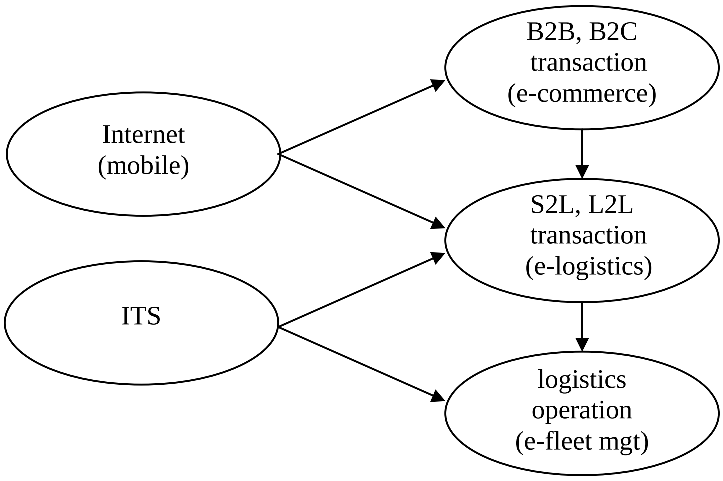

Figure 2. ICT and urban logistics system

2.3.1 E-commerce

E-commerce is expected to change the supply chain. Suppliers, manufactures, wholesalers, retailers, and consumers can choose their trade partners directly. As a result, logistics operations are affected immensely. Even small and medium-sized firms in local areas can demonstrate their products to overseas consumers, investigating the detailed needs. Parcel delivery firms can efficiently manage goods transport, and the accounts can be settled with credit cards or other services.

Not only B2C but also B2B transactions would be affected. In the United States, the automobile industry established a web site involving several firms (suppliers, car dealers, and logistics service providers) where trade information are exchanged and shared, such as part order, inventory information, and even information on new designs. The Internet is used as a tool to cooperate with a small number of partners, as well as to procure mass-produced parts at a low price from all over the globe. The Internet can be the catalyst to accelerate the standardization of EDI (Electronic Data Interchange) between firms, which progressed slowly before.

2.3.2 E-logistics

Competition is certainly promoted by the development of e-commerce, as firms and consumers can easily contact with more potential purchasers and suppliers. Therefore, a firm that has a competitive manufacturing know-how about a certain product might dominate the market entirely. Furthermore, the agent function, which helps us find the cheapest price of a certain product automatically, is promoting competition.

When competition is intensified, the organization and activities that do not contribute to strengthening the competitive power (core competence) of the concerned firm should be restructured. In particular, logistics operations such as transportation, storage, packing, etc. are not necessarily profit-making activities with specialties. In many cases, it is more likely that outsourcing the logistics services makes more profits.

In Japan, a seller or a consignor is responsible for the transport of the purchased goods to a buyer or a consignee traditionally. On the contrary, the consignee is often responsible in Europe and America. In both cases, however, the shippers (consignors and consignees) face difficulties if they themselves transport the ordered goods via the Internet. E-commerce changes the supply chain from a large-lot thick stream (factory - wholesaler - retail store) to many small-lot narrow streams (factory - consumer). That is why shippers pressed for efficient employment of resources tend to outsource logistics services to third party logistics (3PL), which is neither the consignor nor the consignee.

2.3.3 E-fleet management

Logistics service providers should meet the shipper’s requirements for qualified services, while preventing additional cost increase at the same time. ITS could help them reduce the daily fleet operation cost, together with other ICTs such as IMPs. Important applications of ITS include tracking vehicles with GPS, tracking freight containers or palettes with Automatic Equipment Identification (AEI) and DSRC, route planning to avoid congested roads based on digital maps and real-time traffic information, electronic road pricing or toll collection, and reserving unloading spaces in advance.

Mobile phones have influenced the fleet management in the Japanese trucking business. Previously, trucking firms employed multi-channel access radio systems installed in vehicles, which were inconvenient for communicating with drivers who are often out of their vehicles. This sometimes caused unacceptable delays in responding to the shipper’s request. According to a survey conducted by the Japanese Trucking Association (JTA), mobile phones are diffused to 72.9 percent of drivers of both TL (truckload) and LTL (less than truckload) carriers in 2000, which is a significant increase from the 56.8 percent rate in 1996 (Figure 3). On the contrary, the use of public phones and specialized radios has decreased.

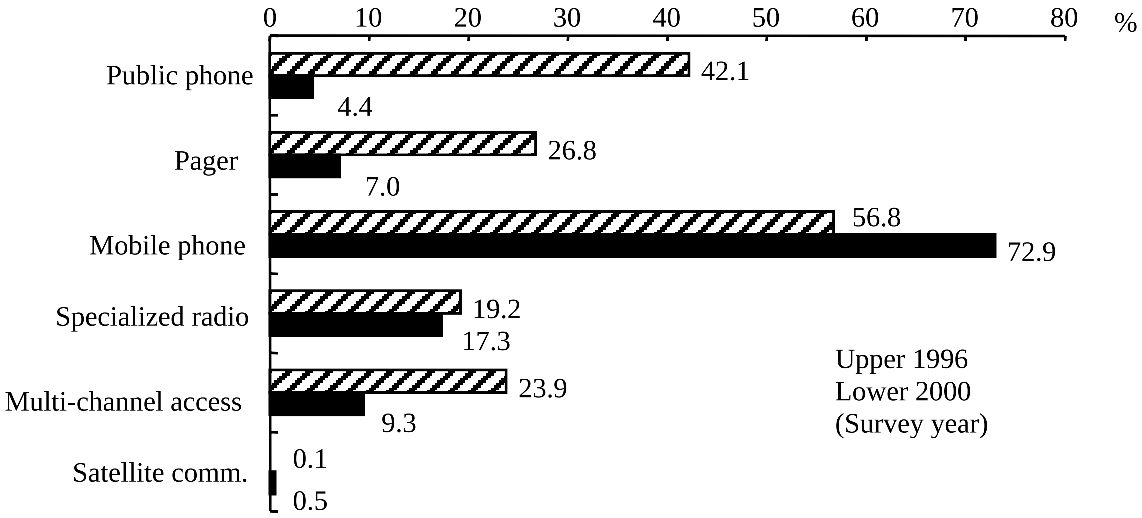

Figure 3 Communication media between drivers and dispatchers in freight carriers

3. Assumptions on the impacts of ICT

In the following sections, we will introduce several assumptions to clarify the likely influences and effects brought about by ICT.

Assumption 1: E-commerce will increase spending on more value added products and thus increase the demand for freight transport.

First, we will discuss whether e-commerce changes the demand for goods. Theoretically, the reduction in transaction cost would bring a reduction in prices, which may encourage an increase in the amount of purchase. Another question is if e-commerce generates additional new demands. It is notable that in the B2C business, more customized products or more value added products can be ordered, manufactured, and transported to the consumers, who are more than willing to pay more prices for these products.

In Japan, mobile phones are to some extent used for e-commerce purposes (mobile commerce), thus creating new demands. The turnover for mobile commerce was only 59 billion yen in 2000, while the total business turnover for all e-commerce activities was about 22,424 billion yen (Figure 4, http://www.ecom.or.jp/ecome/press/index.html). However, we should not underestimate the magnitude of mobile commerce, as it has increased by 1,300 percent since 1999 - the first year of the IMPs. Many related businesses started as well, such as businesses that provide the hardware, software and orgware to make mobile commerce and other information services possible. The total estimated turnover of mobile-commerce-related businesses was 169 billion yen in 1999.

From existing data, we could not judge whether the net amount of purchase has increased. This trend is hardly recognizable in statistics of consumer spending. For instance, statistics in the Netherlands show that consumer spending on consumer goods is more or less constant. This implies that some sort of substitution is taking place there. The phenomenon observed in Japan ironically indicates that the amount of purchase of ordinary consumer goods has decreased in order to cover payment of frequently changed models of mobile phones and communication charges. More observations for the different situations are required.

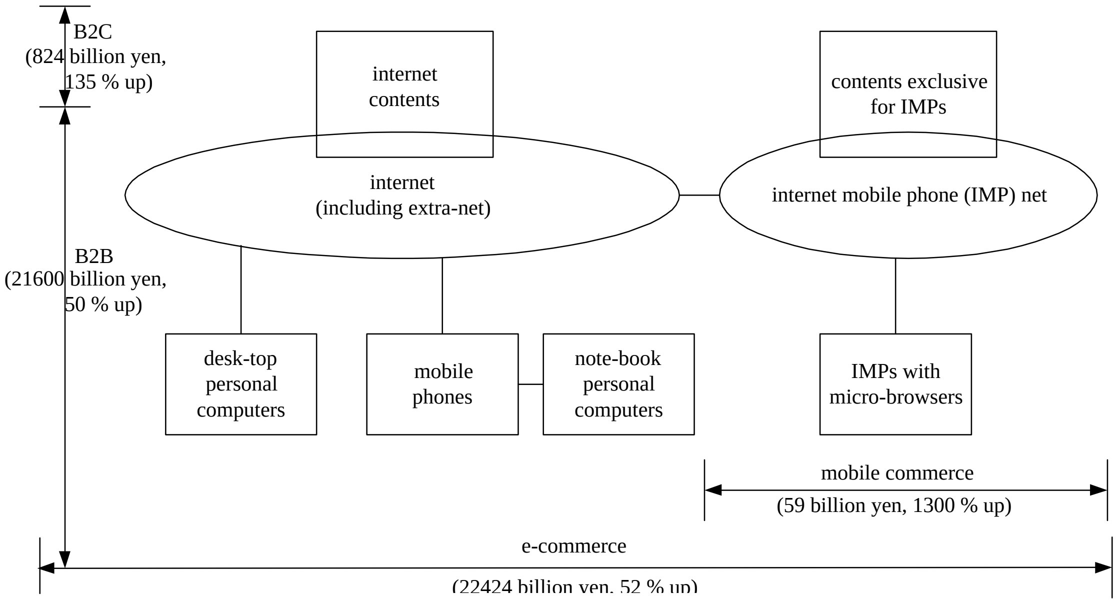

Fig.4 E-commerce in Japan in 200
Figure 4. E-Commerce in Japan in 2000

Assumption 2: E-commerce will substitute traditional B2B and B2C business, resulting in less passenger traffic with business/shopping purposes.

E-commerce can increase freight delivery trips by trucks, and reduce passenger trips by cars with business/shopping purposes. The extent of substitution, however, depends on the urban structure and the people's transportation behaviors. According to the 1998 Person Trip Survey, the modal share of people in central Tokyo (23 Wards) with trip purpose of shopping or leisure are 39 percent by foot, 23 percent by rail, and 23 percent by two-wheel vehicles (Table 2). The modal share of car is only 12 percent, which means little possibility of substitution.

Table 2. Modal shares by trip purpose in Tokyo in 1998

	Trip purpose	Modal share (%)				
		Rail	Bus	Car	Two-wheeler	Foot
Tokyo Metropolitan Area (34 million pop)	Commuting	46	2	32	13	7
	Shopping, leisure	13	3	34	21	29
Central Tokyo (8 million pop)	Commuting	73	2	9	10	6
	Shopping, leisure	23	3	12	23	39

Source: http://www.iijnet.or.jp/tokyopt/

More drastic changes are expected in the case of products that can be transferred by the Internet, for instance by downloading. If publications, such as newspapers, e-books, documents or brochures, and music or software products can be downloaded, there would be no need for freight and passenger transportation.

Assumption 3: E-commerce will increase global procurement thus increasing the average trip length.

E-commerce makes it possible to order goods from any location the customer wants. For instance, people in Japan and in the Netherlands often buy products in the USA because of the lower prices (due to lower taxes), or because new products are introduced to the market sooner. The current practice shows that e-commerce customers often buy a product located farther away than when they bought it in the traditional way. E-commerce thus increases the transportation distance of goods.

Assumption 4: E-commerce will be a driving force for direct home delivery in small shipment sizes.

The most important consequence of e-commerce is the increase in direct home delivery. Home delivery leads to less consolidated deliveries and thus to more freight traffic. In the traditional business, the distribution of goods to retail shops consists of one or more boxes, pallets, racks, roll cages or containers, filled with a number of homogenous goods. This is not the case with home delivery. Home delivery is usually only one (small) item for each address. When there is some level of bundling, it consists of different goods bundled for one neighborhood, but the goods are not packed together.

The transport costs per delivery could be higher for home delivery. The environmental costs, for instance in terms of noise and air pollution, could be higher as well. In order to avoid this, it is relevant to consider other alternatives. In particular, ways to promote consolidation are worthwhile to examine from a commercial and environmental point of view.

Assumption 5: E-commerce will provide optional qualified transportation services for time-sensitive customers.

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E-commerce businesses are trying to compete on the price of certain markets with traditional businesses. At the same time, they have to deliver the goods fast, on time, and in good order to meet the time-sensitive customer's requests. Therefore, the quality of services is of great concern as well as the logistics costs. Customers, who order their goods on-line, expect that the goods would be delivered almost immediately. The home delivery service must match the easiness of buying goods on-line. Just-in-time and reliable transport services are thus required.

Qualified transportation services would be so expensive that the e-commerce business cannot shoulder all the costs. Therefore, it is reasonable that they prepare several options of transportation services, and ask the customers to choose among them at their expense. The optional services are likely outsourced to the logistics service providers.

Assumption 6: Couriers handling parcel delivery will have a large share in the distribution of goods generated by e-commerce.

E-commerce brings business opportunities to the logistics service providers, particularly couriers handling parcel delivery. A research in the US shows that many businesses do not have the capacity, the capital or the knowledge to do the distribution by themselves. These distribution activities, as well as all administrative services, tracking and tracing, invoices, repairs and the return of goods, are sourced out to specialized couriers, such as UPS, Federal Express, DHL or US Postal Service in the US, for example.

Home delivery is the core business for parcel delivery services and couriers. According to UPS (Groeneveld, 2000), about four to six percent of all their transport movement is already generated by e-commerce. A Dutch parcel service company, Van Gend en Loos (N.N., 2000), which was very active for some time in the Netherlands setting up consolidation system in several cities, expects that e-commerce will increase their number of customers by 50 percent, and will make use of their services.

Table 3 shows more and more shippers tend to outsource logistics operations in Japan. The share of freight carriers (trucks in commercial use) increased from 19.0 percent in 1980 to 36.2 percent in 1999, in the total freight traffic in terms of vehicle-km. The loading rate of trucks in commercial use is much higher than that of trucks in private use, thus having an effect in reducing the vehicle-km traffic. Actually, the shift to commercial trucks is not a recent phenomenon. Small-sized frequent shipments started in the 1980s with the penetration of JIT production system and Quick Response in the retailing business in Japan, which was accompanied by shipper's outsourcing. When trying to understand the trend of freight traffic in vehicle-km and in ton-km, we could not neglect the deregulation on the maximum truck size introduced during the period, which partly canceled out the effects of small shipments. More detailed analysis is required to distinguish the inter and intra urban transportation.

Table 3. Freight traffic in terms of vehicle-km, ton-km and ton in Japan

	Freight traffic in vehicle-km			Freight traffic in ton-km (billion ton-km)	Freight traffic in ton (million ton)
	Billion veh-km	Share of commercial trucks (%)	Share of private trucks (%)		
1980	141	19.0	81.0	178	5,317
1985	146	23.7	76.3	205	5,048
1990	170	28.4	71.6	274	6,113
1995	182	33.0	67.0	294	6,016
1998	179	35.2	64.8	300	5,819
1999	181	36.2	63.8	307	5,863

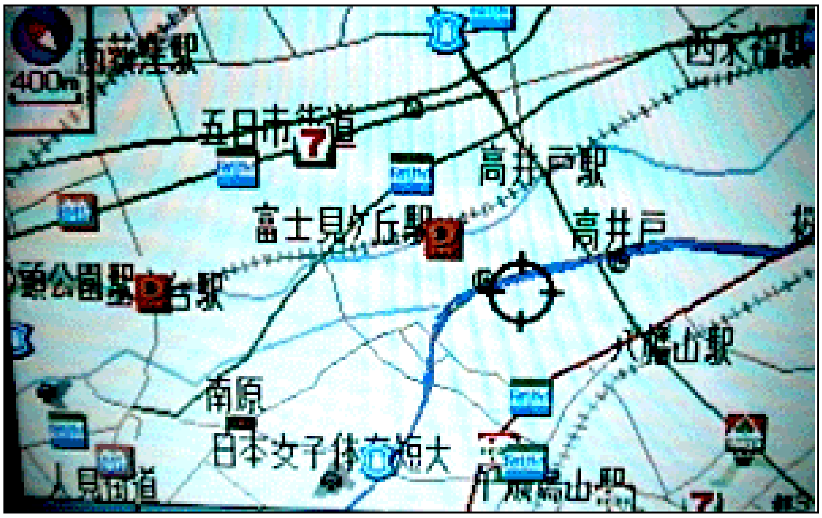
Source: http://www.mlit.go.jp/

Assumption 7: Pick-up points will play an important role in the physical distribution of e-commerce goods.

An arising problem from home delivery is that the customer is not always at his home. In this case, four scenarios are conceivable:

- The delivery goes back to the shipper - this scenario is unattractive for all persons involved and should be avoided as much as possible.
- The carrier tries again at a different moment - this generates extra costs for the carrier but is considered as a service.
- The carrier leaves his delivery behind in a specific facility at the receiver's home in a "locker". Ideas about such facilities at homes exist, but are very limited in practice.
- The customer picks it up at a specific pick-up point - postal and parcel services make use of pick-up points such as post offices and small convenience stores, which seems the most attractive scenario.

The concept of local pick-up points is described in Browne at al. (1997). These facilities can be located near shopping areas or shopping centers, in particular near parking facilities. The pick-up and delivery services can be combined with other services, for example, like the post office services in the Netherlands. In Japan, it is common for small convenience stores to offer this service both for extra revenue and in the hope of generating more in-store traffic. 32,000 convenience stores are densely located within walking distance (for instance, more or less within 500 m in the residential area in Tokyo), being open almost all the time (e.g. 24 hours). They can also settle accounts with the consumers on behalf of the e-commerce firms.



(Source: Toyota car navigation system, 2001)

Figure 5. Densely located convenience stores in Tokyo

Assumption 8: Marketplaces of logistics services via the Internet will be economically feasible under certain conditions.

Logistics service providers can make better use of truck capacity by consolidating cargoes than the shippers. There is still a need to reduce empty mileages and to raise the loading rate. The cargo and truck matching business is not a new but a traditional practice between freight carriers. For example, in the case of a freight carrier requested to transport a cargo to an inconvenient destination and another carrier having no scheduled cargoes on his way back to the destination, they have economic incentives to trade. Matching systems using fixed phones or pagers exist and work to some extent in the local areas.

After the Internet makes the situation more open and transparent, the carriers would have more chances to trade the logistics services. The Internet would invite more freight carriers with different profiles, who otherwise abandon the trade. Not only the carriers but also the shippers can join the market, which was shown below in the business model of the National Transportation Exchange (NTE). Furthermore, when the prices of logistics services become a stable market price and a common knowledge, more and more carriers and shippers are confident to trade the logistics services.

One of the well-known marketplaces is run by the NTE in the United States (http://www.nte.net/). They do not provide any transportation or warehousing services by themselves (then called non-asset 3PL), but manage a marketplace where pre-qualified shippers and freight carriers identify their available shipment or capacity with business requirements via the Internet. They automatically filter their requirements to identify the compatible trading partners within a couple of hours, which is called real-time transportation procurement services. These sorts of businesses have started in many countries.

Dozens of cargo and truck matching system were established since 1999 in Japan. Unfortunately, however, most of them do not make profits. The exceptionally successful sites are managed by the dominant freight carriers who can benefit from further adjustment of fleet operations based on offers from small and medium-sized carriers.

An important warning is made on the marketplace of logistics services (http://www.eyefortransport.com/archive/newslettered29.shtml).

> Auction models were of value to shippers only in cost savings, and this was often associated with extra risk which comes about from using untested/unknown transportation providers, the cost savings did not outweigh the risks involved...plus the fact that contract transportation makes up 90% of the market resulted in a shipper receiving better rates only on a small proportion of it's logistics requirements for an increased risk.

At least it can be said that any marketplace could not survive without a mechanism to reduce the associated risks.

Assumption 9: Cooperative delivery systems will be realized with the help of the Internet and ITS.

Another traditional effort for consolidation is called cooperative delivery system to deliver and pick up cargoes with different destinations jointly in the urban area. Usually a common terminal is introduced for consolidation and deconsolidation purpose, and a carrier is commissioned to transport cargoes on behalf of all the participating carriers.

Cooperative delivery system is theoretically attractive, but difficult to implement. It is not easy to monitor costs and benefits of the system, and to make their distribution fair among the participating carriers with different cost and revenue structure. Though carriers having a small number of cargoes benefit a lot from the system, carriers having an enough number of cargoes do not benefit nor have any incentive for cooperation. This is why most of the efforts had failed in the past (Nemoto, 1997).

The Internet and ITS might make it easy to share shipment information, vehicle location, delivery status information and so on, so as to provide more opportunities for the cooperative delivery system. The promising tool is the IMP that has ability to transmit both images and text. Already, the dispatchers in some carriers communicate collection and delivery instructions with visual data directly to the drivers.

An innovative pilot project conducted in 2000 by the Japanese Ministry of Land, Infrastructure and Transport (MLIT), was about a delivery information sharing system for cooperative system consisting of small and medium-sized carriers (Figure 6). In this project, the drivers are requested to report the delivery status of cargoes via the IMPs with user-friendly interface (Figure 7). The status information is stored in the Web site (Table 4) and shared among the carriers, so that the cooperative system could suggest coordinating the delivery order of the carriers concerned, if necessary. This system is helpful, for example, when the shipper sets a time-window for pick-up and the assigned vehicle is involved in unexpected traffic congestion.

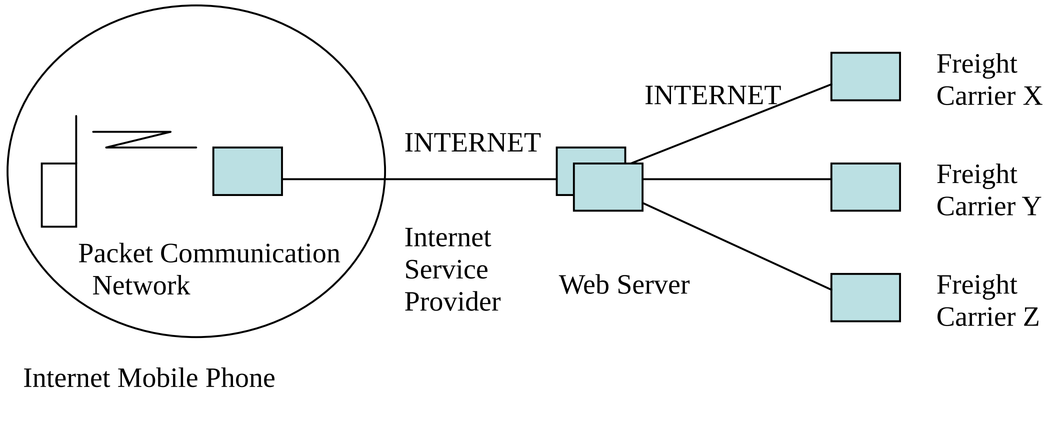


Figure 6. Sharing information on delivery status with IMPs

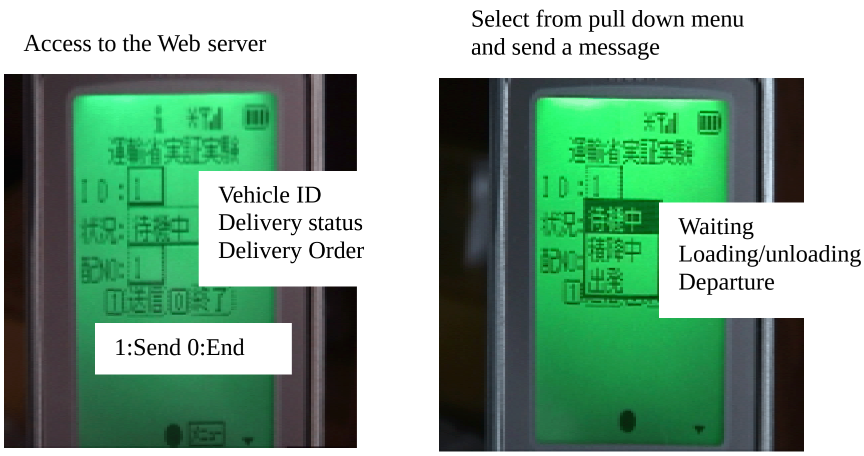


Figure 7. Interface of i-mode phone

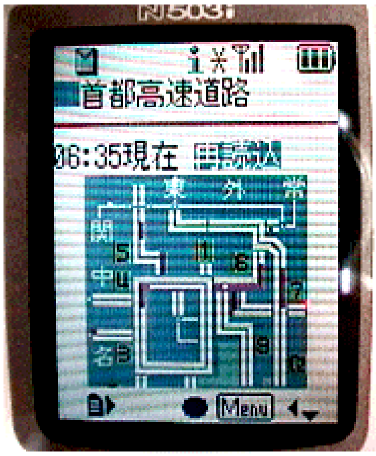
Table 4. Delivery status information in the Web

Delivery order	Route 1 Vehicle No. 1 Carrier X	Route 2 Vehicle No. 2 Carrier X	Route 3 Vehicle No. 3 Carrier Y	Route 4 Vehicle No. 4 Carrier Y	Route 5 Vehicle No. 5 Carrier Z
1	Shop 1A delivered at 4:00	Shop 2A delivered at 5:00	Factory 3A delivered at 5:00	Shop 4A loading at 4:00	Factory 5A loading at 7:30
2	Shop 1B delivered at 4:20	Shop 2B delivered at 4:20	Factory 3B delivered at 7:00	Shop 4B unloading at 8:00	Wholesaler 5B unloading at 7:00
3	Shop 1C delivered at 4:40	Shop 2C delivered at 6:00	Factory 3C waiting at 7:30	Shop 4C	Factory 5C
4	Shop 1D unloading at 7:20	Shop 2D delivered at 7:00	Factory 3D	Shop 4D	Factory 5D
5	Shop 1E	Shop 2E delivered at 8:00	Factory 3E	Shop 4E	***
6	Shop 1F	Shop 2F	***	Shop 4F	***
7	Shop 1G	Shop 2G	***	Shop 4G	***
8	***	***	***	Shop 4H	***
9	***	***	***	Shop 4I	***
10	***	***	***	***	***

Assumption 10: ITS will provide more opportunities to improve the efficiency of fleet management.

The application of ITS provides carriers a competitive edge in delivery efficiency and customer satisfaction. In Japan, couriers handling small parcel deliveries provide tracking information services via the IMPs. At present, time-sensitive shippers and consumers can check the position of 98 percent of 6.4 million parcels transported by 10 major couriers a day. Actually, the position is not real-time based on GPS data, but estimated based on bar-code records scanned at pick-up/delivery points and consolidation/de-consolidation terminals.

Real time traffic information is available to the drivers via the IMPs, as well as the dispatchers (Figure 8). In principle, it is desirable that the dispatchers control all the delivery orders and the routing. However, the drivers are expected to respond properly to the unscheduled events such as additional shipment order, diversion of the destination, and so on. The traffic information makes it possible for the drivers to estimate the travel time and to respond to the customer in a timely manner. Still, they need to consult with the dispatchers in order to confirm the change by phone or by e-mail.



(Source: ATIS, i-mode, 2001)

Figure 8. Traffic Information on Tokyo Metropolitan Expressway

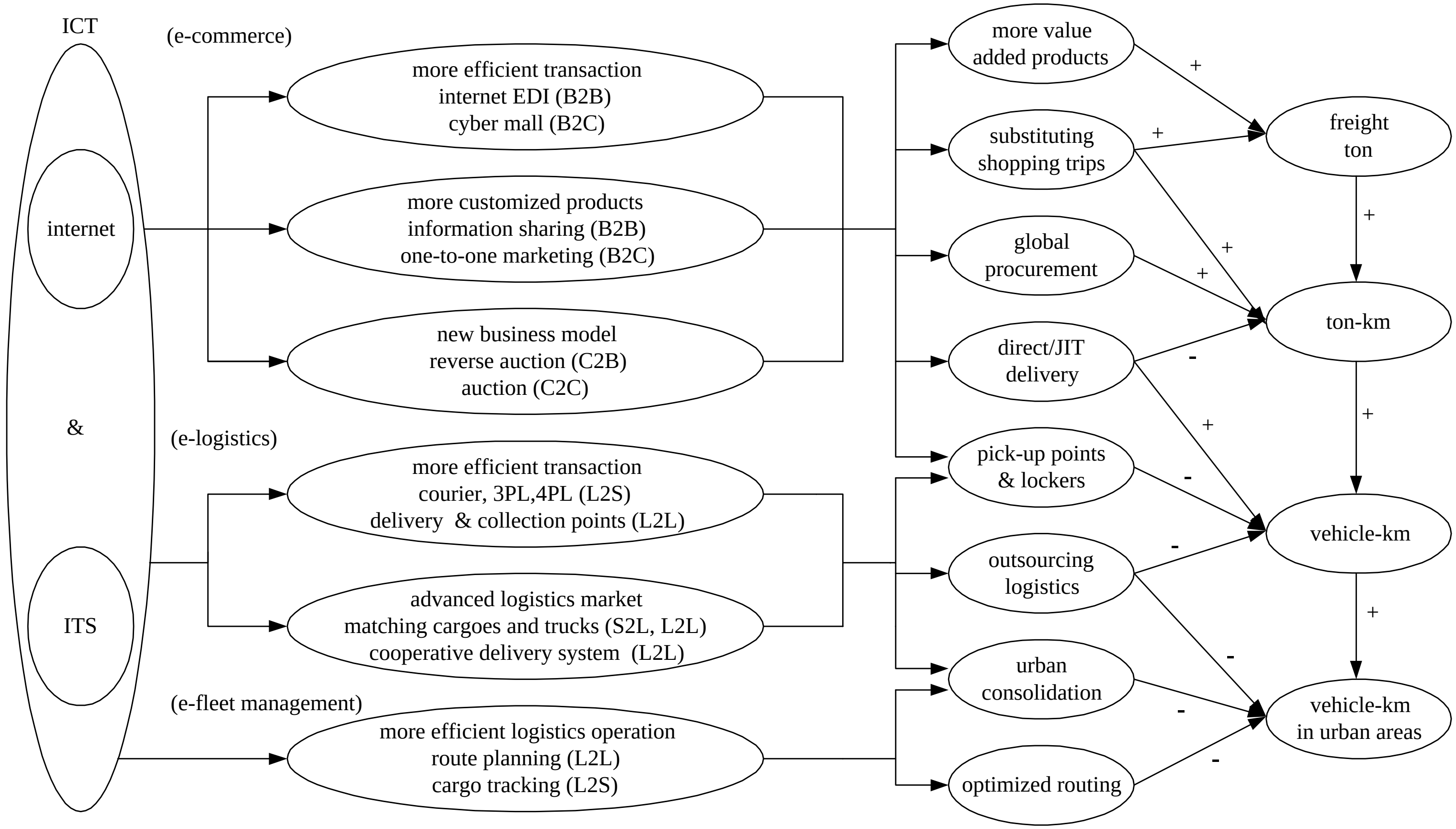


Figure 9 Impacts of ICT on urban logistics system

4. Policy implications

Recently, "city logistics", in contrast to "business logistics", has been initiated by the government in order to introduce social and environmental viewpoints in formulating logistics policies. The shippers and logistics service providers try to optimize their activities in the market, which often brings about negative external effects such as traffic congestion, air and noise pollution and so on. The government is expected to cope with these externalities and to make the allocation of resources efficient and fair.

The Internet and ITS provide the government more opportunities to effectively implement the policies on city logistics. The polices can be categorized into three (Table 5):

- Provision of transportation and information infrastructure,

- Regulations on city planning, logistics business, transportation demand, freight vehicles etc, and guidelines to standardize or harmonize private activities,

- Economic instruments including pricing to internalize externalities, and subsidies to facilitate environmentally friendly activities.

Concerning infrastructure provision, the fundamental databases (e.g. digital map, traffic information) should be built and maintained by the government. Though the information service providers in the private sector are better at identifying people's needs and supplying in a customized form, they cannot afford to build the original database by themselves. Although the private firms can build communication infrastructure as well, the government should properly manage the rules of the market. Unfortunately, in the auctions on radio spectrum for mobile phones, revenue-raising became a more important purpose for the government rather than controlling the market.

The schemes of Transportation Demand Management (TDM) can be smarter with ICT, as far as regulations/guidelines are concerned. Figure 10 shows the scenario of electronic placarding of hazardous materials/dangerous goods transportation developed by the Technical Committee 204 (TC 204) of the International Organization for Standardization (ISO). In this system, the vehicles are monitored whether they comply with the regulations on routes and time. In emergency situations, the information regarding the identification, the handling and condition of dangerous freight is relayed to the agencies concerned, resulting to the promotion of public safety.

ICT can make pricing schemes such as road pricing, and parking charge differentiation more feasible. We can design them to accommodate delicate requirements or to overcome practical barriers. Road pricing, for instance, becomes realistic with the Automatic Vehicle Identification (AVI), so that even large cities like London and Tokyo are considering its introduction seriously. Tokyo Metropolitan Government is planning o introduce cordon-type road pricing as one of coordinated TDM measures in 2003, charging 500 yen on a small vehicle and 1,000 yen on a large vehicle. Road pricing may not reduce the ton-km freight traffic but can reduce vehicle-km traffic by promoting consolidation, thus having positive effects on the urban environment.

Table 5. Policies on City Logistics

	Infrastructure provision		Regulations/guidelines		Economic instruments	
	Transportation	Information	Regulations	Standardization	Pricing	Subsidies
Land use		Digital map, GPS	Zoning for logistics activities		Property tax	
Transport networks	Ring roads, Direct links to ports & airports, Underground freight system	Road traffic information system, Electronic toll collection	Truck route control, Vehicle and time restriction		Road pricing	Subsidies for intermodal transport
Terminals	(Urban logistics platform)	(Berth guidance system)		Standards for intermodal terminals		Subsidies for cooperative facilities
Loading/Unloading	On-road parking space, (Off-road parking space)	(Reservation on parking space)	Compulsory loading spaces, Loading time		Parking charge differentiation	Subsidies for off-road parking facilities
Vehicles/Containers	(Electric vehicles, Vehicles with handling equipments)	(Fleet management system, Matching system between cargoes and vehicles)	Emission control, Loading ratio control, Compulsory use of low emission vehicles	Standardized containers, pallets, electronic tags, in-vehicle units	Vehicle weight tax, Fuel tax, Environmental tax	Subsidies for low emission vehicles, Vehicle sharing
Cargoes		(Cargo tracking, Order entry system)		(EDI, AIDC)		Subsidies for cooperative delivery

Note: ( ) expected to be introduced by the private sector

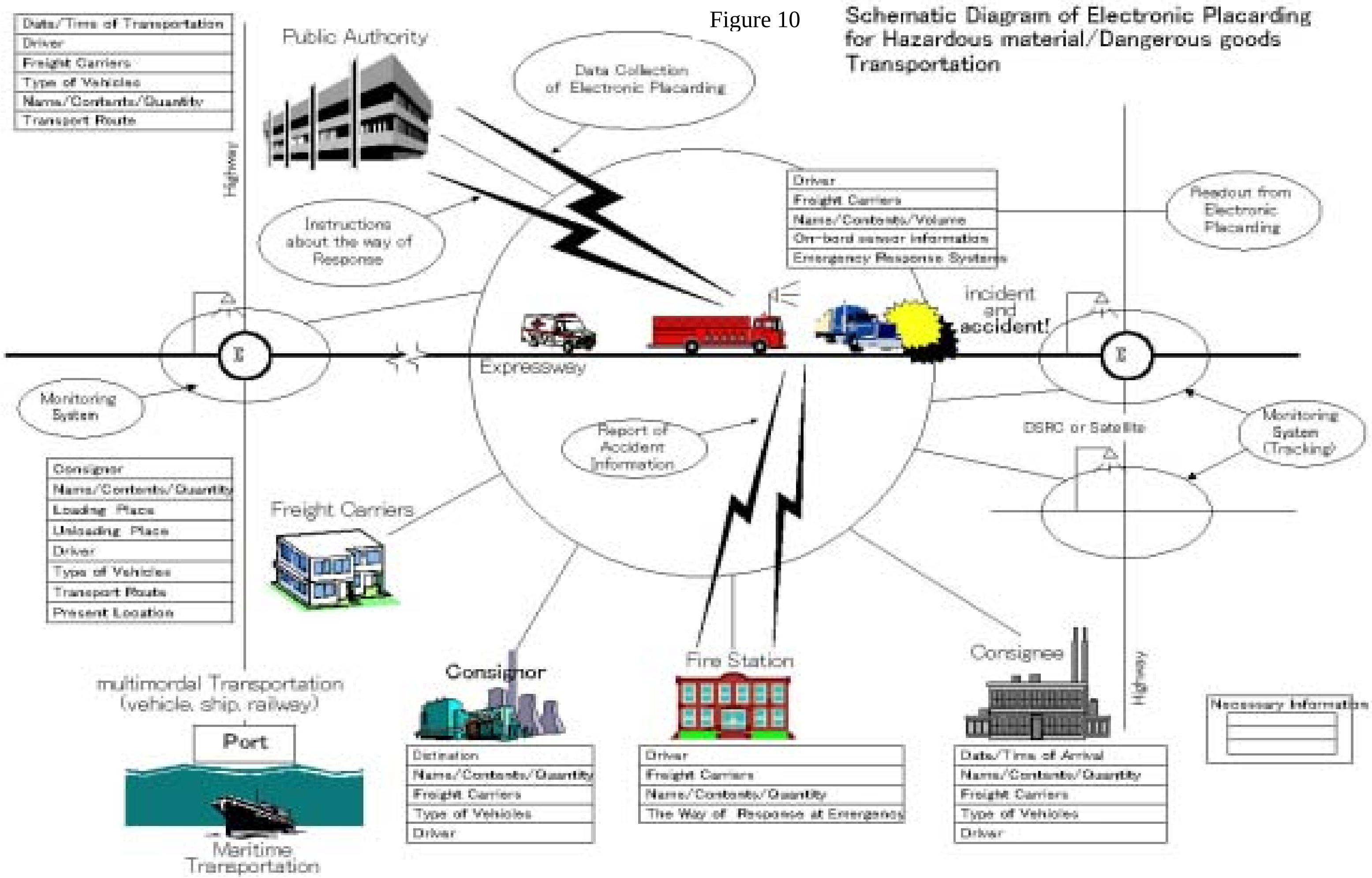

Schematic Diagram of Electronic Placarding for Hazardous material/Dangerous goods Transportation
Date/Time of Transportation
Driver
Freight Carriers
Type of Vehicles
Name/Contents/Quantity
Transport Route
Highway
Public Authority
Data Collection of Electronic Placarding
Instructions about the way of Response
Driver
Freight Carriers
Name/Contents/Volume
On-bord sensor information
Emergency Response Systems
Readout from Electronic Placarding
incident and accident!
Expressway
Monitoring System
Report of Accident Information
DSRC or Satellite
Monitoring System (Tracking)
Consignor
Name/Contents/Quantity
Loading Place
Unloading Place
Driver
Type of Vehicles
Transport Route
Present Location
Freight Carriers
multimordal Transportation (vehicle, ship, railway)
Port
Maritime Transportation
Consignor
Distination
Name/Contents/Quantity
Freight Carriers
Type of Vehicles
Driver
Fire Station
Driver
Freight Carriers
Name/Contents/Quantity
The Way of Response at Emergency
Consignee
Date/Time of Arrival
Name/Contents/Quantity
Freight Carriers
Type of Vehicles
Driver
Highway
Necessary Information

Figure 10

5. Conclusions

First, by examining the existing ICT, we found that the Internet and ITS, particularly their applications workable in the mobile environment, would influence the urban logistics system. In the evaluation framework, we proposed to analyze not only B2C and B2B e-commerce but also e-logistics and e-fleet management. This is because the Internet is changing the S2L and L2L market of logistics services, and improving the logistics operations of freight carriers together with ITS.

Second, we introduced ten assumptions concerning the likely impacts of ICT, and indicate major discussion points associated with the assumptions. However, since we do not have enough evidence or statistical data yet, we could not verify them. Nevertheless, the following tentative conclusions can be stated;

- It is likely that e-commerce and mobile commerce would continue to grow in the market, although we cannot judge whether the net amount of consumer spending would increase.
- The shift to direct home delivery by small trucks with low loading rates would increase freight traffic in terms of vehicle-km. However, the effect is marginal if small-sized frequent shipment is a common practice like in Japan.
- Freight traffic can be reduced by outsourcing logistics services to the couriers and 3PL, and by development of e-logistics and e-fleet management. Concerning marketplaces of logistics services, however, it is uncertain whether they would satisfy the risk-averting shipper’s strict requirements and have a large share in the market.
- Affordable and capable IMPs are believed to play an important role in e-fleet management in combination with GPS and other ITS applications.
- ICT will give the government more opportunities to effectively implement the policies on city logistics as well. In particular, the government expected to provide the fundamental transportation and information infrastructure, such as the databases of digital map and traffic information.

In order to access the impacts of ICT precisely, we need international cooperative research efforts. We faced many difficulties when comparing the data in different countries. If we define the key concepts and standardize the indicators, the comparative study brings us more fruits, resulting in better understanding of the relation between ICT and transport.

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