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Concepts of city logistics for sustainable and liveable cities

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Abstract

This paper presents concepts of city logistics for sustainable and liveable cities. City logistics can contribute to create more efficient and environmentally friendly urban freight transport systems. The application of innovative technologies of ICT (Information and Communication Technology) and ITS (Intelligent Transport Systems), the change in mind-sets of logistics managers, and public-private partnerships can promote city logistics policy measures. The procedure of urban freight transport management is described, which is an adaptive management system that uses the PDCA (Plan, Do, Check, and Act) cycle. Joint delivery systems with urban consolidation centres are also highlighted in particular focusing on the benefits and problems, the success factors, the role of municipalities and the transferability to other areas.

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Keywords: city logistics; urban freight transport; environment; sustainability, liveability;

1. Introduction

There have been increasing concerns about the rapid urbanisation and aging of population. About a half of total world's population of 7 billion people lived in urban areas in 2010 according to the survey of United Nations and this is predicted to become over 60% by 2030. Globally, the proportion of persons over 65 years old was 7.6% in 2010 and is predicted to become 18.3% in 2060.

Under such demographic conditions urban freight transport issues have become more important for supporting a better life for people as well as a better environment in urban areas. Urban freight transport is not only essential for economic growth but also for better urban environment. However, logistics activities sometimes generates traffic

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congestion, air pollution, noise and crashes in urban areas. Therefore, balancing smart economic growth and cleaner, quieter, and safer communities are needed. In addition, as we face higher risks of disasters due to global climate change and aging societies, urban freight transport should incorporate these risks for creating more sustainable and liveable cities (Taniguchi et al. 2013).

To address these complicated problems the concept of city logistics has been proposed (Taniguchi et al., 2001). A number of policy measures of city logistics have been implemented in cities throughout the world. As well, modelling techniques have been developed for planning and evaluating the city logistics policy measures. This paper describes overview of city logistics and urban freight transport management for creating more efficient and environmentally friendly urban freight transport systems.

2. Concepts of city logistics

What is city logistics? Taniguchi et al. (2001) defined city logistics as "*the process for totally optimising the logistics and transport activities by private companies with support of advanced information systems in urban areas considering the traffic environment, the traffic congestion, the traffic safety and the energy savings within the framework of a market economy.*" This definition highlights the total optimisation of logistics activities of private companies rather than local optimisation. It also incorporates the social issues of the environment, congestion and energy savings as well as economic issues relating to urban freight transport within the framework of a market economy.

There are four major stakeholders, i.e. shippers, freight carriers, administrators, and residents who are involved in city logistics. Since these stakeholders have different objectives and different perspectives on urban freight transport, coordination amongst the stakeholders is required to make progress towards more sustainable and liveable cities.

Three elements are essential for promoting city logistics; (a) Application of innovative technologies of ICT (Information and Communication Technology) and ITS (Intelligent Transport Systems), (b) Change in mind-sets of logistics managers, and (c) Public-private partnerships. First, the application of innovative technologies of ICT and ITS in urban freight transport allow the collection of precise data of pickup-delivery truck movements on urban road networks with lower costs. Digital data can be fully used to optimise the vehicle routing and scheduling planning in a dynamic and stochastic manner (Taniguchi and Shimamoto, 2004; Ando and Taniguchi, 2006). This type of optimisation of vehicle operations can contribute towards reducing logistics costs, decreasing CO2, NOx and SPM emissions as well as alleviating traffic congestion. Therefore, both private companies and society at large can benefit from the application of innovative ICT and ITS technologies in terms of the efficiency of logistics as well as the reduction of negative environmental impacts.

Secondly a change in the mind-set of logistics managers is critical for city logistics, since logistics managers are key players in urban freight transport operations. A number of transport and logistics companies have obtained ISO9001 certification (quality management) and ISO14001 certification (environment management). This certification provides logistics companies with a good opportunity to educate employees about actions for developing greener logistics systems. For example eco-driving of pickup-delivery trucks is beneficial in reducing fuel costs and crashes by milder driving manner. The green image of companies may help them to obtain a good reputation in market. For small and medium size enterprises, a similar but less expensive certificate for green management is issued by the Foundation for Personal Mobility and Ecological Transportation in Japan.

Thirdly, public-private partnerships (Browne et al., 2004) is a core element for city logistics. In traditional transport planning, administrators mainly develop transport plans based on their own surveys and data and then sometimes listen to voices of the public authority and residents. However, public-private partnerships allow all stakeholders to take part in developing urban freight transport plans from the initial stage. Sharing data between private companies and the public sector is quite helpful to understand the situation of goods distribution and related problems. During discussion administrators can understand the expected reaction of logistics companies to city logistics policy measures. This procedure is effective to avoid any unexpected side effects of policy measures.

3. Urban freight transport management

The procedure of urban freight transport management (World Road Association, 2012) can be divided into four stages, i.e. (a) Design stage, (b) Assessment stage, (c) Implementation stage, and (d) Evaluation stage. The design and assessment stages corresponds to the "plan" and the implementation stage corresponds to the "do" and the evaluation stage corresponds to the "check" and "act" procedures. The "plan, do, check, and act" (PDCA) cycle is adopted.

The design stage includes identifying problems, finding the cause of problems, setting goals, describing freight vehicle movements, and combining approaches and measures. In this stage, we need to listen to public voices and identify problems in the target urban areas to find the cause of problems. This process is important to understand the relationship between problems and urban freight transport issues. The goals should be clearly and simply stated. Then we can describe vehicle movements in urban areas using available traffic data. Several approaches are listed such as: (a) Infrastructure, (b) Regulatory, (c) Logistical, (d) Co-operative, (e) Technical, (f) Behavioural approaches. A number of measures are also given, including traffic flow management, parking management, time management, vehicle management, better transport method (joint delivery and intermodal transport), harmony with urban structures in terms of land use planning, improvement of vehicle movement using ICT and ITS, and organizational activities such as freight quality partnerships. Combining these approaches and measures are required to solve complicated urban freight transport issues.

In the assessment stage, a pilot project is usually planned to determine if a project may cause any side effects. Typical side effects can be seen in such cases that implementing truck bans for large trucks in urban areas increases the number of small trucks instead of large trucks which leads to higher level of traffic congestion and negative environmental impacts. To avoid such side effects, we need to carefully design projects.

In the implementation stage, collaboration between public authorities and private companies is essential, since the success of any measures of urban freight transport management depends on the mutual understanding and cooperation of stakeholders. The wise use of subsidies from municipalities is required, as the project cannot be sustainable if it depends too much on subsidies.

In the evaluation stage, multiple criteria are needed for evaluating policy measures, including costs for freight carriers, environmental impacts, traffic safety and energy consumption. Key performance indicators (KPI) in terms of life quality, economic development, accessibility, and transport efficiency play an important role for evaluating policy measures. If the results are not good, they can feedback and the procedure re-started from the beginning. This feedback system is the key to achieving goals in the PDCA cycle.

Throughout the procedure, public-private partnerships (PPP) among stakeholders are important, since meeting together and discussing in the open manner is required to find smarter solutions and implement them in real situations. In general shippers and freight carriers are reluctant to open any business data to outside people. However, recently some data, for example truck movements using GPS (Global Positioning Systems) are available to analyse truck traffic flows and parking behaviour. Precise data of truck traffic is critical for understanding the current situation of traffic and finding better solutions.

4. Joint delivery systems (JDS)

Let us take a typical city logistics policy measure of joint delivery systems (JDS). JDS involve freight carriers cooperating to jointly deliver and/or collect goods to and from customers using urban consolidation centres (UCC) for minimising the logistics costs and social and environmental impacts. The purpose of JDS is to increase the efficiency of urban goods distribution by consolidating goods of competitive freight carriers as well as reducing the negative environmental impacts, alleviating congestion, improving safety and security conditions in urban areas. JDS has been introduced in Japan, The Netherlands, UK, France (Taniguchi and van der Hijden, 2000; Browne et al., 2011;van Duin et al., 2010; Gonzalez-Feliu et al., 2012 and Browne et al., 2012) and other countries. JDS are operated by private companies with some support by municipalities needed, which is not necessarily financial, since JDS deals with social issues in an area.

In Japan, a JDS was initiated early in 1978 in Tenjin, which is the central business district of Fukuoka city. The UCC was set up in the suburb and a new joint delivery company was established in 1994. This project has been successful and still operating at the present with the support of the Ministry of Transport. Another type of JDS involving 11 department stores in Osaka started in 1990s based on the initiative of private companies only. This system allowed department stores to exchange their goods to cooperatively deliver to customers. It successfully resulted in the reduction of working hours of employees at peak times as well as increasing the frequency of visiting to customers. Customers also benefited by receiving their goods at once from different department stores. An area type JDS started in Shinjuku, Tokyo for high rise buildings in 1992, and in Motomachi shopping streets, Yokohama in 2004, Otemachi, Marunouchi, and Yurakucho, Tokyo for chilled foods in 2012. These JDS are similar in terms of aiming at efficient and environmentally friendly delivery systems in a target area using UCC. These JDS are examples of good practices of city logistics measures, since these systems have been successful in reducing the number of vehicles used for delivery and resulted in improving the environment based on the public-private collaboration and also receivers are satisfied with the better delivery service and improved environment with a smaller number of trucks in the area.

A more advanced JDS was introduced at a building complex in Tokyo Midtown in 2007 and Tokyo Sky Tree Town (Soramachi) in 2012. The new feature of these JDS is the participation of developers of area type JDS. Developers are very interested in improving the traffic environment around their building complex as well as providing better services of pickup and delivery to tenants. The involvement of developers was effective to plan and design goods distribution systems from the beginning of designing building, including the UCC, the number of elevators for goods, parking space for trucks, and information systems for operating JDS. Actually the developer and the responsible operator of JDS discussed and worked together on the goods distribution systems as well as passenger movements from the beginning of designing the building.

The benefits of JDS are:

- Reduced costs, number of vehicles, number of drivers,
- Improved environment,
- Reduced level of congestion and crashes, and
- Increased frequency of visits to customers.

Freight carriers can benefit from reduced costs, number of vehicles and number of drivers and increasing the frequency of visits at customers, while society or the community can also benefit by the improved environment, reduced level of congestion and crashes. Receivers of goods may also be happy to receive their commodities without delay. On the other hand, common problems associated with JDS include:

- Confidentiality of customers' information,
- Limited delivery time,
- Responsibility of transport, and
- Additional costs of urban consolidation centres and unified information and management systems.

Freight carriers usually have confidential customers' information and they do not hope to disclose such information to competitive companies. The delivery time within JDS is not as flexible as in the direct delivery cases, since pickup-delivery trucks visit customers at designated times in a JDS. Sometimes receivers worry about the responsibility of transporting goods in cases where there are delayed arrivals of vehicles or damage to goods. Additional costs are required for building or leasing space for a UCC as well as creating unified information and management systems for freight carriers in the JDS. These items can be obstacles for establishing and operating JDS. However, in successful cases of introducing JDS in reality these problems have been overcome by the efforts of reducing costs and increasing the service level in a public-private collaboration environment.

Let us look at the success factors of JDS in case of Motomachi, Yokohama (Figure 1). The JDS in Motomachi started in 2004 after pilot project in 1999-2001 with the financial support by Yokohama city. After the subsidy was ended in 2001, the Motomachi Shopping Street Association (MSSA) started activities to find a neutral freight carrier who would be responsible for delivering goods from the UCC (Figure 1) to customers and collecting goods from

customers to the UCC as well as the appropriate location of the UCC and parking spaces. Another important point for the MSSA was to create the business model to sustain the JDS by using profits of the operation of the car park and so on. The MASS is the core organization for the JDS and they have set clear and simple goals of reducing CO2 emissions by pickup-delivery trucks and providing a good atmosphere in the shopping street by reducing pickup-delivery trucks. Although no subsidies were given by Yokohama city, other support was provided that involved preparing parking spaces for pickup-delivery trucks nearby the shopping street. Around 85% of the goods are transported by the JDS in Motomachi area, excluding furniture and fresh food. Both pickup and delivery of goods are carried out by the JDS in Motomachi, whereas there are some cases where only delivery is done by the JDS in other areas. Whole area of Motomachi is covered by the JDS including about 500 shops in the shopping street and about 850 individual homes surrounding the shopping street. A number of freight carriers drop off their goods at the UCC and the neutral freight carrier delivers goods to customers using CNG (Compressed Natural Gas) trucks (Figure 2) to three parking spaces and then delivers goods to the final destinations by cart (Figure 3).

Figure 1. UCC for Motomachi JDS.

Figure 2. CNG truck for JDS.

Figure 3. Parking space for JDS behind the shopping street.

The MSSA financially supports the neutral freight carrier using the profits from car park operations. Therefore, the self-financing systems are established within the JDS consortium. Freight carriers who use the UCC need to pay 150 Japanese Yen (about 1.1 Euro) per parcel and the price is same all the time. The UCC handles 1,000 -1,200 parcels per day. The results of introducing the JDS was that the number of trucks was substantially reduced and also the environment on the shopping street was improved.

The success factors for the Matomachi JDS are:

- Good leadership and enthusiasm towards achieving goals,
- Collaboration in stakeholders --- Public-private partnerships, and
- Business model to maintain joint delivery systems.

Good leadership by the manager of the MSSA was essential for the success of the JDS for more than decade and also the enthusiasm of members of the MSSA was helpful to maintain the JDS for a long time. A number of shop owners are eager to promote the brand of the shopping street by operating JDS. Collaboration among stakeholders was also important for the success of the JDS, since theJDS cannot be operated by private sectors only. Coordination and collaboration between private and public entities are required in many stages of planning, designing, implementing JDS. The business model plays an important role for successfully operating the JDS. Although some financial support is needed for operating the JDS but depending too much on the subsidies by municipality holds a risk of failure of the JDS after the subsidies end. Therefore self-funding schemes with a business model is critical for maintaining a JDS for a long time. In this sense Motomachi case provides us with a good insights.

The role of municipality is an important subject and it can be summarized in case of Motomachi:

- Not giving money, but coordinating stakeholders by finding smart solutions,
- Keeping continuous support for the project, preferably not changing personnel during the project,
- Preparing some facilities, including the dedicated parking space,
- Advising stakeholders on legal issues, including traffic regulations, and
- Encouraging shop owners and residents to take part in the joint delivery systems.

The main role of municipality was not to provide money to the JDS consortium, but coordinate stakeholders to find smart solutions. Municipal officials need to provide opportunities to discuss issues relating to JDS and urban freight transport with all stakeholders. People in public and private sectors usually have different perspectives and objectives. For example, the urban planning period for public sector is 10-20 years, whereas the planning period for

businesses is 3-6 months. The technical terms are also different in public and private sectors. Therefore, coordination by the municipality includes narrowing these gaps amongst stakeholders.

The municipality should continuously support JDS and preferably the same person should be in charge of the project throughout the whole project. Preparing some facilities can only be done by municipalities including dedicated parking space. As well advising stakeholders on legal issues including traffic regulation are very helpful for the smooth operation of pickup-delivery trucks. For example dedicated truck parking for JDS trucks on urban streets is legally difficult and so giving priority for the JDS trucks to park may be a solution. Municipalities can encourage shop owners and residents to take part in the JDS. Since the penetration rate of a JDS is a key issue for their successful operation, efforts by municipalities for disseminating the idea of city logistics and benefits of JDS would substantially enhance the project.

Regarding the transferability of good practice of JDS to different cities in different countries, it is quite possible to transfer JDS to other cities but some conditions should be satisfied. The required conditions are:

- Mind-set of balancing the economic vitality and the environment,
- Core organisation (not necessarily public sector) for managing joint delivery systems,
- Some amount of goods delivered (over 1,000 parcels per day),
- Appropriate location of urban consolidation centre near the target area,
- Neutral carrier for operating joint delivery systems, and
- Branding the area with joint delivery systems

Changing the mind-set into balancing the economic vitality and environment is required to introduce city logistics measures. Only focusing on economic efficiency cannot guarantee the successful application of JDS. This is a basic requirement for people who are involved in city logistics projects. The core organisation, which is not necessarily public sector for managing the JDS is required. This organisation will make plan and implement the JDS together with other entities but the core organisation is responsible for the results of the JDS project. Some amount of goods over the threshold of approximately 1,000 parcels per day is needed to maintain a JDS. Keeping as many goods as possible over the threshold is essential for the sustainable operation of a JDS. The appropriate location of the UCC near the target area affects the results of JDS. So finding a good location of the UCC is important. A neutral carrier is needed for the JDS, since many carriers do not want an existing large carrier to take a lead in the JDS. Branding the area with the JDS is another important element for promoting a JDS, as the participation of many shop owners and residents are needed for successful operation of a JDS.

5. Conclusion

This paper presented the concept of city logistics for sustainable and liveable cities. As multiple stakeholders are involved in urban freight transport and these stakeholders have different objectives and different perspectives on urban freight transport, coordinating the stakeholders are needed to make progress for establishing efficient and environmentally friendly urban freight transport systems. We have discussed that three elements are essential for promoting city logistics; (a) Application of innovative technologies of ICT and ITS, (b) Change in mind-sets of logistics managers, and (c) Public-private partnerships.

Urban freight transport management can be divided into four stages, (a) Design stage, (b) Assessment stage, (c) Implementation stage, and (d) Evaluation stage, based on the PDCA cycle. Several approaches are given such as: (a) Infrastructure, (b) Regulatory, (c) Logistical, (d) Co-operative, (e) Technical, (f) Behavioural approaches and some specific policy measures are highlighted including traffic flow management, parking management, time management, vehicle management, better transport method (joint delivery and intermodal transport), harmony with urban structures in terms of land use planning, improvement of vehicle movement using ICT and ITS, and organizational activities such as freight quality partnerships. Combining these approaches and measures are required to solve complicated urban freight transport issues. Feedback after evaluating policy measures with multiple criteria is essential for improving the management of urban freight transport.

Joint delivery systems (JDS) was highlighted as a typical city logistics measure. The benefits and problems of JDS and the success factors for JDS based on the cases in Motomachi, Yokohama were discussed. Three success factors were identified, (a) good leadership and enthusiasm towards achieving goals, (b) collaboration in stakeholders - public-private partnerships, and (c) business model to maintain joint delivery systems. These factors are key elements for promoting JDS. The role of municipality and transferability to other cities were also discussed.

City logistics can contribute towards balancing economic vitality and improving the environment in urban areas. Therefore, city logistics schemes can be used to establish increase efficiency and improve the environmental performance of urban freight transport systems by providing a platform for creating more sustainable and liveable cities.

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