Logistics facility, road network and district planning: Establishing comprehensive planning for city logistics

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Abstract

Logistics, which support sustained and efficient freight transport in cities, is fundamental for economic development. Logistics has also been singled out to help in improving environmental conditions in cities. A city would therefore need comprehensive logistics planning, covering planning for infrastructure and transportation policies to maximise its impacts and benefits to society. The purpose of this paper is to propose a framework for city logistics planning. First, the paper describes the relationship between logistics and city formation through a historical review. Second, the paper discusses logistics concepts and clarifies the role of logistics infrastructure planning. Finally, three stages of logistics planning (i.e. large-scale logistics facility, road network, and district planning) are described considering the balanced role of the public and private sectors.

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Keywords: Logistics facility; road network; districts planning; logistics planning; logistics

1. Introduction

Sustained and efficient freight transport is fundamental for the economic development of a city. In the past, planning for person-trips was given more attention to improve traffic movements in the city. Little attention was given to freight transport due to the fact that freight transport is more concerned with the private sector that the public sector would not want to intrude. However, inefficient freight transport causes a number of problems, among which are traffic congestion, infrastructure deterioration and environmental pollution. Therefore, comprehensive logistics planning in a city is needed to achieve efficient freight transport for development.

The objective of this paper is to propose and clarify a framework for comprehensive logistics planning in a city. For this purpose, the paper aims to:

- clarify the relationship between logistics and city formation through a historical review of logistics in the Edo period,
discuss the definition and evolution of logistics,
present an overview of logistics infrastructure, and
propose a framework for comprehensive city logistics planning.

2. Relationship between Logistics and City Formation through Historical Review

2.1. Relationship between logistics and city formation during the Edo-Era

A number of major cities, such as London, Paris and Tokyo, were established near coastal areas or riversides because most economic activities were generated using water transport as the main mode of transport. During the Edo-era (1603-1863), the increase of population in Edo (former Tokyo) necessitated improved logistics infrastructure in the form of transport networks and logistics facilities to ensure efficient delivery of goods and commodities by riverboats. Transport network development involves the construction of canals and river routes while logistics facility development entails the construction of coastal shipping ports and river ports (kashi) (Figure 1).

![Figure 1 Bird’s Eye view of Edo Castle and rivers](Source: Noda-city; Edogawa-river Story, 2002)

2.2. Canals and river routes for short-distance delivery in Edo

To efficiently deliver goods and commodities to Edo by riverboats, canals and river routes were established and constructed in early 17th century after the foundation of the Edo-shogunate. A number of warehouses were constructed along these canals and river routes (Figures 2 to 4).

![Figure 2 Cart in Edo-Era beka-guruma](Source: Osaka city, Osaka Maritime Museum (Umi no Jikukan); Edo Famous Sights Drawings, 1996; Traffic History of Japan, 1994)  
![Figure 3 Warehouses along canals](Source: Osaka city, Osaka Maritime Museum (Umi no Jikukan); Edo Famous Sights Drawings, 1996; Traffic History of Japan, 1994)  
![Figure 4 Riverboats (takasebune)](Source: Osaka city, Osaka Maritime Museum (Umi no Jikukan); Edo Famous Sights Drawings, 1996; Traffic History of Japan, 1994)
2.3. Coastal ship ports and rivers ports (Kashi)

2.3.1. Coastal ship ports

A wharf called Hacchobori was constructed along Edo’s coast which became the base facility for long-distanced inter-city freight transport. The wharf played a major role similar to a ferry terminal or a container terminal in the present age. Several warehouses (kura) were subsequently constructed adjacent to this wharf (Figure 5).

2.3.2. River ports (Kashi)

Goods and commodities were unloaded at the coastal shipping ports, and then delivered to river ports (kashi) using the river routes in the inner areas of Edo. There were three main types of kashi. Kashi as terminal was used only for transhipment from big boats to small boats and/or from boats to carts. Kashi with housing was used for storing and residence, while kashi with market was used for loading commodities from boats and for selling. The latter type became commercial districts and were later transformed into the Central Business Districts (CBD) of Tokyo.

The Tokyo railway network was developed during the late Meiji-era (1868-1912) with connections between railway freight stations and ports. For example, the Sumida River Railway Freight Station was developed to transport commodity goods from the northern suburbs of Tokyo connected to Sumida River. Later, the railway extended its service to the central district of Tokyo.

A separation of commercial and logistics functions occurred due to these changes, after which commercial facilities expanded to the south-west direction such as Ginza, Kyobashi and Marunouchi. Logistics facilities then extended to the eastward direction such as Fukagawa nearby Sumida River (Figures 6 and 7). Now, the CBD of Tokyo includes not only Nihonbashi but also Ginza, Kyobashi and Marunouchi. The origin of the present CBD is the kashi and that the former logistics infrastructure influences the present structure of Tokyo.
2.4. Role of logistics in city development

Through a historical review of logistics from the Edo-period until the present, the improvement of the logistics infrastructure has contributed to the development of Tokyo’s CBD for more than 400 years. Development of the transport network, in the form of river route and canal construction, improved traffic movements by water which was the main mode of freight transport in Edo. In addition, the construction of coastal ship ports and river ports contributed to efficient freight transport movements in the inner areas of Edo. This finding is significant as it suggests that large cities need to improve its logistics infrastructure in order to attain a definite level of development.

3. Definition and Evolution of Logistics

3.1. Definition of logistics

Supply Chain Management is defined by the Council of Supply Chain Management Professionals (CSCMP) as，“the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities” (CSCMP, 2009). On the other hand, logistics is defined as, “the part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements” (CSCMP, 2009).

Logistics, therefore, includes several activities within the production, distribution and consumption processes. The distribution process can be split into the major processes of money flow and physical distribution (Kuse, 1999).
Physical distribution involves the structured integration of transport, storage, assembling, packaging, cargo handling and information to efficiently manage goods flow (Figure 8).

![Figure 8 Logistics definition (Source: Kuse, 1999)](image)

3.2. Evolution of the logistics concept

Originally, logistics was a military term used together with strategy and tactics. In the latter half of the twentieth century, it came to be used as a business term as well. The purpose of business logistics is to minimise costs and maximise value-added efforts. The concept of green and reverse logistics has also become necessary to achieve optimal conditions by eliminating collectively the adverse impacts of individuals and businesses. Individuals and businesses alike are required to make efforts to reduce waste materials in order to reduce the burden on the environment and to realize efficient resource utilisation. At the same time, it is necessary for the public sector to improve facilities and information infrastructure and legal systems to assist and promote private business activities (Table 1).

<table>
<thead>
<tr>
<th>Logistics</th>
<th>Aim</th>
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<th>Evaluation</th>
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<td>Army</td>
<td>National</td>
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<td>Reverse Logistics</td>
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<td>Reuse, Recycle, Energy, Saving</td>
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4. Logistics Infrastructure

4.1. Logistics system and logistics infrastructure

A logistics system is composed of several elements relating to finance, ordering, cargo, work and land use and traffic information (Figure 9). In order to integrate all these elements together and come up with an effective system, logistics infrastructure includes facility, technology, and institutional infrastructures must be able to provide support to the logistics system.
4.2. Role of logistics infrastructure

4.2.1. Facility infrastructure

Facility infrastructure includes physical aspects, such as transport route networks and logistics facilities, and software aspects, such as traffic management and control. Transport route network initiatives involve link type initiatives on roads, transportation, delivery, and conveyance networks. Logistics facility initiatives, on the other hand, include large-scale logistics facilities, delivery centres, loading/unloading facilities and origin/destination facilities, such as factories or offices (Figure 10).
4.2.2. Technology infrastructure

Technology infrastructure relates to human resources, information infrastructure, and industrial resources. Human infrastructure includes labour, education, and language among others. Information infrastructure involves hardware such as information and communications facilities and equipment, as well as software such as databases and rules for information use such as information sharing and standardization. In various aspects of logistics, it is necessary to eliminate information bottlenecks. Industrial resources infrastructure relates to electrical power, water supply, sewage and telecommunications, among others.

4.2.3. Institutional infrastructure

Institutional infrastructure involves social rules together with social consensus that support them. Institutional infrastructure focuses on law, taxes, and insurance. It is therefore necessary to develop institutional systems to keep up with the needs of the changing times, by including a re-examination of stakeholder’s vested interests. It will be also necessary to develop socially-accepted rules for solving problems on the environment.

4.3. Importance of nodes and links in the logistics system

The logistics system can be broken down into its basic network elements of nodes and links. For example, a Production-Logistics System and a Receiving System can be both associated with activities occurring at the nodes of the logistics facility (i.e. logistics centre or receiving facility). Ordering and Delivery Systems on the other hand relate to activities occurring at the links, such as the road network. Various measures can be applied to them to improve goods flow, such as mechanization, automation and commercial trade for the Production-Logistics System, separation of trade and goods flow, cooperation, and integration for the Ordering and Delivery Systems, and mechanization, automation and parking facility design for the Receiving System. (Table 2)

It should be noted that all the basic elements of nodes and links must be linked together when trying to introduce countermeasures to improve the logistics system. This is because logistics considers optimising the efficiency of the entire process from individual companies to the entire industry through inter-company collaboration.

| Table 2 Importance of nodes and links in the logistics system (Source: Kuse, 1999) |
|---|---|---|
| Node | Link | Node |
| Production-Logistics System | Ordering System | Receiving System |
| Facility | Logistics Center | Road Network | Receiving Facility |
| Logistics Function | storage/load/information/assemble/package and production | transport | loading and unloading |
| Counter-measure | mechanization automation commercial trade | separation of trade and goods flow cooperation/execution/integration | mechanization automation parking lot and facility |
5. Comprehensive City Logistics Planning

5.1. Logistics planning in coordination with public and private sectors

5.1.1. Relationship between public and private sector

The public and private sectors are capable of improving the logistics system through coordinative logistics planning efforts. The public sector (such as national, regional and local government) is responsible mostly for land use planning, architecture planning, traffic planning and road planning. The private sector, on the other hand, is mostly responsible for providing loading/unloading and transport services, and thus can be deeply involved in loading/unloading facility planning and transport planning.

In many cases, these planning decisions cannot be effective without collaborative work. For example, if road planning (F) does not adjust to the traffic demand that is decided by land use planning (E), traffic congestion and environmental pollution would occur \((E \leftrightarrow F)\). Therefore, the relationship between public and private should be collaborative (Figure 11).

![Figure 11 Relationships between public and private sectors (Source: Kuse and Iwao, 2007)](image)

5.1.2. Hard and soft countermeasures coordinated by public and private sectors

There are hard and soft countermeasures to improve the logistics system. Hard countermeasures refer to transportation facility and infrastructure development which are usually characterized by large amounts of capital investment, while soft countermeasures involve regulatory and policy measures that require fewer investments than hard countermeasures (Table 3).

The public and the private sectors have their own countermeasures to improve the logistics system. Hard countermeasures coordinated by the public sector involve facility infrastructures, such as establishment of logistics estates, night time delivery facilities, new freight transport systems such as pocket loading, and establishment of freight depots. Soft countermeasures by the public sector include truck routes, ITS, entry controls, truck time plans, high load factors, and road pricing. Soft countermeasures by the private sector relate to improving their logistics systems, such as separating commercial trade from freight transport, delivery time control, utilizing large trucks, and vehicle routing through cooperative delivery.
5.2. Stages of comprehensive city logistics planning

5.2.1. Logistics facility for inter and intra-city logistics

5.2.1.1. Present situation of large-scale logistics infrastructure in Tokyo:
As a result of the Tokyo Metropolitan Freight Survey Study, a policy for a comprehensive city logistics planning was proposed. There are three stages for comprehensive city logistics planning: large-scale logistics facility planning, road network planning, and district planning.

In the present situation, a number of large-scale logistics facilities are located near the seaside or highway interchanges of the Tokyo metropolitan region (Figure 12 and 13).

Figure 12 Locations of large-scale logistics facilities in Tokyo Metropolitan Region (Source: TMR Freight Survey, 2005)
5.2.1.2. Improvement policy for large-scale logistics facilities

The policy for establishing large-scale logistics facilities depends on geographic location and use, and is classified into: a) near the interchange (IC), b) logistics estate, c) intermodal, and d) near the seaside (Figure 14).

The policy for logistics facilities near the highway interchange regulates that they should be located away from existing housing clusters. This is due to the fact that they cause many environmental problems, such as noise and traffic congestion. For logistics facilities at industrial estates, the intention is to connect the various industrial estates through a road network to facilitate integration of the production and the distribution industry. For an intermodal logistics facility, the intention is to connect it to the railway network or the highway network. For logistics facilities near the seaside, the objective is to connect it to existing water routes or the highway network.
5.2.2. Road network planning

5.2.2.1. Present situation of road networks in Tokyo

A large number of trucks freely enter narrow streets located within the residential area and the Central Business District (CBD) of Tokyo. This is because there is no truck entry regulation in Tokyo which shows a lack of effective transport planning (Figure 15 and 16).

![Figure 15 Trucks in residential areas](image1)
![Figure 16 Trucks in the CBD of Tokyo](image2)

(Source: TMR Freight Survey, 2005)

5.2.2.2. Improvement policy for the road network

The existing road network can be improved through measures which include optimisation of traffic cells, truck routes, and separation of freight from person trips (Figure 17). The traffic cell system, introduced in many European countries, is a type of an entry regulation in the CBD or residential area to avoid traffic congestion or environmental pollution. Truck routes are designated travel ways for trucks to improve their transport by avoiding obstacles such as congested areas. The separation of freight from person trips aims to prohibit trucks entering particular routes on certain hours of the day in order to transfer the movement of trucks to non-congested roads or different time periods such as off-peak times.

![Figure 17 Road network planning](image3)

(Source: Kuse et al., 2006)
5.2.3. Loading facilities and district planning

5.2.3.1. Present situation of loading facilities

There are a number of on-street loading/unloading and parking vehicles in Tokyo’s busy districts. This is due to inadequate truck parking and loading/unloading facilities (Figures 18 and 19).

![Figure 18 Loading/Unloading on the Street in Ginza](image)

![Figure 19 Parking of trucks near a bus stop in Yokosuka](image)

(Source: TMR Freight Survey, 2005)

5.2.3.2. Improvement policy for loading facilities

District planning which often involves improvement of loading facilities can be supported by hard and soft countermeasures (Figure 20). Examples of planning for district logistics are land-use zoning and building planning. Examples of hard countermeasures are the provision or construction of parking and loading/unloading facilities, while examples of soft countermeasures are application of cooperative deliveries, and setting of parking regulations and speed limits.

![Figure 20 Improvement policy for loading facility and district planning (Source: Kuse et al., 2006)](image)
6. Conclusion

The paper has presented a framework for a comprehensive planning for city logistics. For this purpose, it clarified the:
- importance of logistics in the formation of a city through a historical review,
- definition and historical changes of logistics,
- role of logistics infrastructure to attain an efficient logistics system, and
- relevant stages of comprehensive city logistics planning, coordinated with the public and private sectors.

References