Proceedings of the Eastern Asia Society for Transportation Studies, Vol. 5, pp. 1657 - 1672, 2005

THE ROLE OF TRANSPORTATION IN LOGISTICS CHAIN

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Abstract: The operation of transportation determines the efficiency of moving products. The progress in techniques and management principles improves the moving load, delivery speed, service quality, operation costs, the usage of facilities and energy saving. Transportation takes a crucial part in the manipulation of logistic. Reviewing the current condition, a strong system needs a clear frame of logistics and a proper transport implements and techniques to link the producing procedures. The objective of the paper is to define the role of transportation in logistics for the reference of further improvement. The research was undertaken to assist logistics managers, researchers and transportation planners to define and comprehend the basic views of logistics and its various applications and the relationships between logistics and transportation.

Key Words: Logistics, Transportation, City Logistics

1. INTRODUCTION

Since logistics advanced from 1950s, there were numerous researches focused on this area in different applications. Due to the trend of nationalisation and globalisation in recent decades, the importance of logistics management has been growing in various areas. For industries, logistics helps to optimise the existing production and distribution processes based on the same resources through management techniques for promoting the efficiency and competitiveness of enterprises. The key element in a logistics chain is transportation system, which joints the separated activities. Transportation occupies one-third of the amount in the logistics costs and transportation systems influence the performance of logistics system hugely. Transporting is required in the whole production procedures, from manufacturing to delivery to the final consumers and returns. Only a good coordination between each component would bring the benefits to a maximum.

The purpose of this paper is to re-clarify and redefine the position relationship between transportation and logistics systems through collecting and analysing various application

cases and practices in logistics from literatures. It is to provide a general framework and expect to be referred for further development and researches. The paper started from introducing the development of logistics and transport-related sectors based on a historical review. Afterwards it discussed the interrelationships of transportation and logistics. It expresses the benefits that transportation brings to logistics activities and vice versa. For instance the increase of the efficiency of logistics also would bestead to release traffic load in the urban areas. Furthermore, some major logistics activities and concepts were also discussed in this paper. It especially presents City Logistics independently due to it is considered as a main tendency and an available method of future integration of transport and logistics in the urban areas. Finally, this paper will discuss and conclude the potential further development of logistics systems.

2. OVERVIEW OF LOGISTICS

2.1 Definitions

Council of Logistics Management (1991) defined that logistics is '*part of the supply chain process 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'*. Johnson and Wood's definition (cited in Tilanus, 1997) uses 'five important key terms', which are logistics, inbound logistics, materials management, physical distribution, and supply-chain management, to interpret. *Logistics describes the entire process of materials and products moving into, through, and out of firm. Inbound logistics covers the movement of material received from suppliers. Materials management describes the movement of materials and components within a firm. Physical distribution refers to the movement of goods outward from the end of the assembly line to the customer. Finally, supply-chain management is somewhat larger than logistics, and it links logistics more directly with the user's total communications network and with the firm's engineering staff.*

The commonality of the recent definitions is that logistics is a process of moving and handling goods and materials, from the beginning to the end of the production, sale process and waste disposal, to satisfy customers and add business competitiveness. It is '*the process of anticipating customer needs and wants; acquiring the capital, materials, people, technologies, and information necessary to meet those needs and wants; optimising the goods- or service-producing network to fulfil customer requests; and utilizing the network to fulfil customer requests in a timely way*' (Tilanus, 1997). Simply to say, 'logistics is customer-oriented operation management'.

2.2 Components of Logistics System

Figure 1 provides an overview of the logistics system. Logistics services, information systems and infrastructure/resources are the three components of this system and closely linked. The interaction of the three main components in the logistics system is interpreted as follows. Logistics services support the movement of materials and products from inputs through production to consumers, as well as associated waste disposal and reverse flows. They include activities undertaken in-house by the users of the services (e.g. storage or inventory control at a manufacturer's plant) and the operations of external service providers.

Logistics services comprise physical activities (e.g. transport, storage) as well as non-physical activities (e.g. supply chain design, selection of contractors, freightage negotiations). Most activities of logistics services are bi-direction. Information systems include modelling and management of decision making, and more important issues are tracking and tracing. It provides essential data and consultation in each step of the interaction among logistics services and the target stations. Infrastructure comprises human resources, financial resources, packaging materials, warehouses, transport and communications. Most fixed capital is for building those infrastructures. They are concrete foundations and basements within logistics systems.

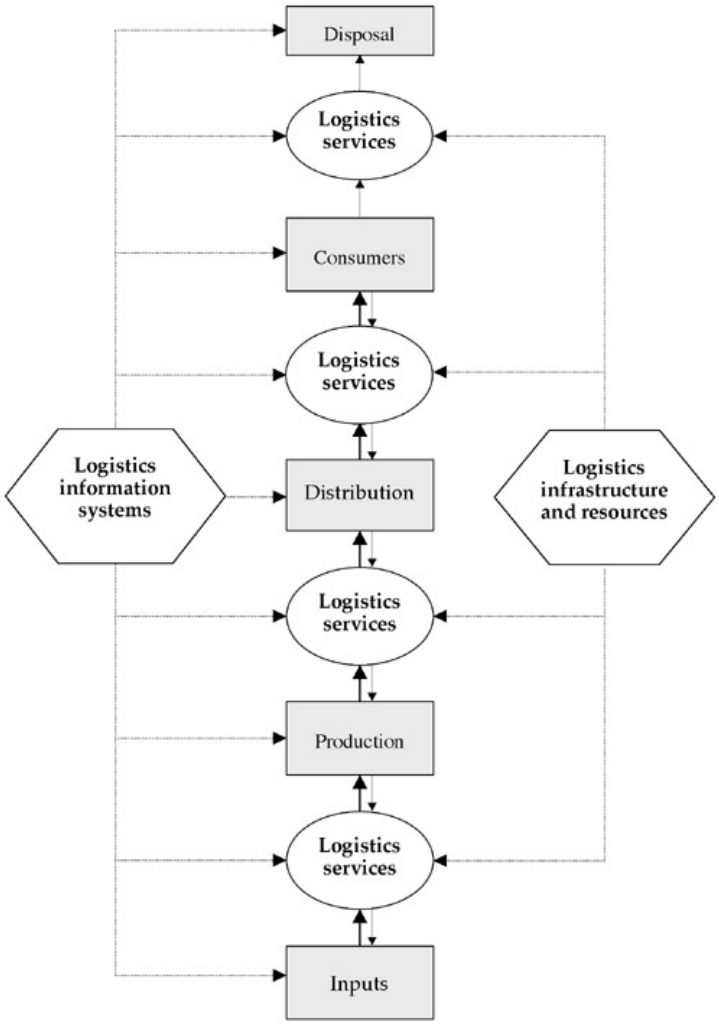

Figure 1. Overview of Logistics System (source: BTRE, 2001)

2.3 History and Advancement of Logistics

Logistics was initially a military activity concerned with getting soldiers and munitions to the battlefront in time for flight, but it is now seen as an integral part of the modern production process. The main background of its development is that the recession of America in the 1950s caused the industrial to place importance on goods circulations. The term, logistics, was initially developed in the context of military activities in the late 18th and early 19th centuries and it launched from the military logistics of World War II. The probable origin of the term is the Greek *logistikos*, meaning 'skilled in calculating'. (BTRE, 2001) Military definitions typically incorporate the supply, movement and quartering of troops in a set. And now, a number of researches were taken and made logistics applications from military

activities to business activities.

Business logistics was not an academic subject until the 1960s. A key element of logistics, the trade-off between transport and inventory costs, was formally recognized in economics at least as early as the mid-1880s. (BTRE, 2001) Based on the American experience, the development of logistics could be divided into four periods (Chang, 1998), which are represented as Figure 2.

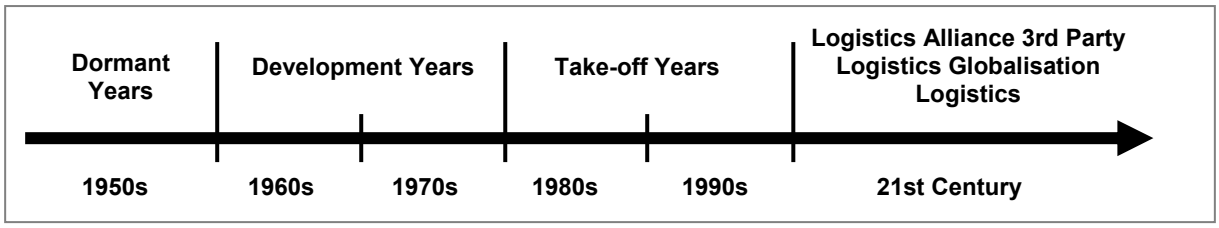

Figure 2. Logistics historical development

Before the 1950s, logistics was under the dormant condition. Production was the main part of the managers concerned, and industry logistics was once regarded as "necessary evil" in this period. During the 1950s to and 1960s, applying new ideas of administration on business was a tendency. Drucker (2001), who thought *Logistics* was *The Economy's Dark Continent*, regarded the procedure of physical distribution after producing products as the most possible development area in American businesses but also the most neglected area. Lewis's study (cited in Chang, 1998) in 1956 on the role of air transportation in physical distribution was the application of "total cost concept" and it pointed out the notions of trade-off between inventory and transportation. From the 1970s onwards, more and more applications and researches of logistics appeared. Due to petroleum price rise in 1973, the effects of logistics activities on enterprises grew. Slow growth of market, pressure of high stagflation, release of transportation control, and competitions of the third world on products and materials all increased the significance of logistics system on planning and business at that time.

The further tendency of logistics in the early 21st century is logistics alliance, Third Party Logistics (TPL) and globalised logistics. Logistics circulation is an essential of business activities and sustaining competitiveness, however, to conduct and manage a large company is cost consuming and not economic. Therefore, alliance of international industries could save working costs and cooperation with TPL could specialize in logistics area.

3. INTERRELATIONSHIPS BETWEEN TRANSPORTATION AND LOGISTICS

Without well developed transportation systems, logistics could not bring its advantages into full play. Besides, a good transport system in logistics activities could provide better logistics efficiency, reduce operation cost, and promote service quality. The improvement of transportation systems needs the effort from both public and private sectors. A well-operated logistics system could increase both the competitiveness of the government and enterprises.

3.1 Transport Costs and Goods Characters in Logistics

Transport system is the most important economic activity among the components of business logistics systems. Around one third to two thirds of the expenses of enterprises' logistics costs are spent on transportation. According to the investigation of National Council of Physical

Distribution Management (NCPDM) in 1982 (Chang, 1988), the cost of transportation, on average, accounted for 6.5% of market revenue and 44% of logistics costs.

BTRE (2001) indicated that Australian gross value added of the transport and storage sector was $34,496 million in 1999-2000, or 5.6% of GDP. Figure 3 shows the components of logistics costs based on the estimation from Air Transportation Association (Chang, 1988). This analysis shows transportation is the highest cost, which occupies 29.4% of logistics costs, and then in order by inventory, warehousing cost, packing cost, management cost, movement cost and ordering cost. The ratio is almost one-third of the total logistics costs. The transportation cost here includes the means of transportation, corridors, containers, pallets, terminals, labours, and time. This figure signifies not only the cost structure of logistics systems but also the importance order in improvement processing. It occupies an important ratio in logistics activities. The improvement of the item of higher operation costs can get better effects. Hence, logistics managers must comprehend transport system operation thoroughly.

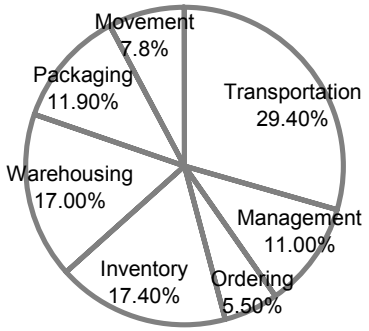

Figure 3. Cost ratio of logistics items (modified: Chang, 1998)

Transport system makes goods and products movable and provides timely and regional efficacy to promote value-added under the least cost principle. Transport affects the results of logistics activities and, of course, it influences production and sale. In the logistics system, transportation cost could be regarded as a restriction of the objective market. Value of transportation varies with different industries. For those products with small volume, low weight and high value, transportation cost simply occupies a very small part of sale and is less regarded; for those big, heavy and low-valued products, transportation occupies a very big part of sale and affects profits more, and therefore it is more regarded.

3.2 The Effects of Transportation on Logistics Activities

Transportation plays a connective role among the several steps that result in the conversion of resources into useful goods in the name of the ultimate consumer. It is the planning of all these functions and sub-functions into a system of goods movement in order to minimize cost maximize service to the customers that constitutes the concept of business logistics. The system, once put in place, must be effectively managed. (Fair *et al.*, 1981)

Traditionally these steps involved separate companies for production, storage, transportation, wholesaling, and retail sale, however basically, production/manufacturing plants, warehousing services, merchandising establishments are all about doing transportation. Production or manufacturing plants required the assembly of materials, components, and supplies, with or without storage, processing and material handling within the plant and plant inventory.

Warehousing services between plants and marketing outlets involved separate transport. Merchandising establishments completed the chain with delivery to the consumers. The manufacturers limited themselves to the production of goods, leaving marketing and distribution to other firms. Warehousing and storage can be considered in terms of services for the production process and for product distribution. There have been major changes in the number and location of facilities with the closure of many single-user warehouses and an expansion of consolidation facilities and distribution centres. These developments reflect factors such as better transport services and pressures to improve logistics performance.

3.3 The Role of Transportation in Service Quality

The role that transportation plays in logistics system is more complex than carrying goods for the proprietors. Its complexity can take effect only through highly quality management. By means of well-handled transport system, goods could be sent to the right place at right time in order to satisfy customers' demands. It brings efficacy, and also it builds a bridge between producers and consumers. Therefore, transportation is the base of efficiency and economy in business logistics and expands other functions of logistics system. In addition, a good transport system performing in logistics activities brings benefits not only to service quality but also to company competitiveness.

4. FORMS OF LOGISTICS OPERATION

4.1 Supply Chain Management

Supply Chain Management (SCM) is the concept for handling the production procedures in broad sense. An effective SCM application could promote the industry to satisfy the demand of new business environment. Ross (1998) defined SCM as '*a continuously evolving management philosophy that seeks to unify the collective productive competencies and resources of the business functions found both within the enterprise and outside in the firm's allied business partners located along intersecting supply channels into a highly competitive, customer-enriching supply system focused on developing innovative solutions and synchronizing the flow of marketplace products, services, and information to create unique, individualized sources of customer value.*'

SCM can be divided into three main activities – purchase, manufacture and transport (Thomas *et al.*, 1996). Cooper *et al.* (1997) analyzed the three elements of SCM – supply chain business processes, supply chain management components, and supply chain network structure. Figure 4 shows the entire elements in SCM frame. It displays the details of the whole processes from purchasing, management, production, and distribution to customers. The information flow is like an individual system to link the whole supply chain from supplier and manufacturer to consumer. Unimpeded information flow could increase the operation accuracy for costs saving and promote the competitiveness of firms. The product flow proceeds through the whole production processes from material supply via manufactories till providing the finished products to consumers. The items in vertical direction show the various management tasks within the supply chain. Particularly, the return flow, or reverse logistic, is one of the elements in the system but with converse direction from the others.

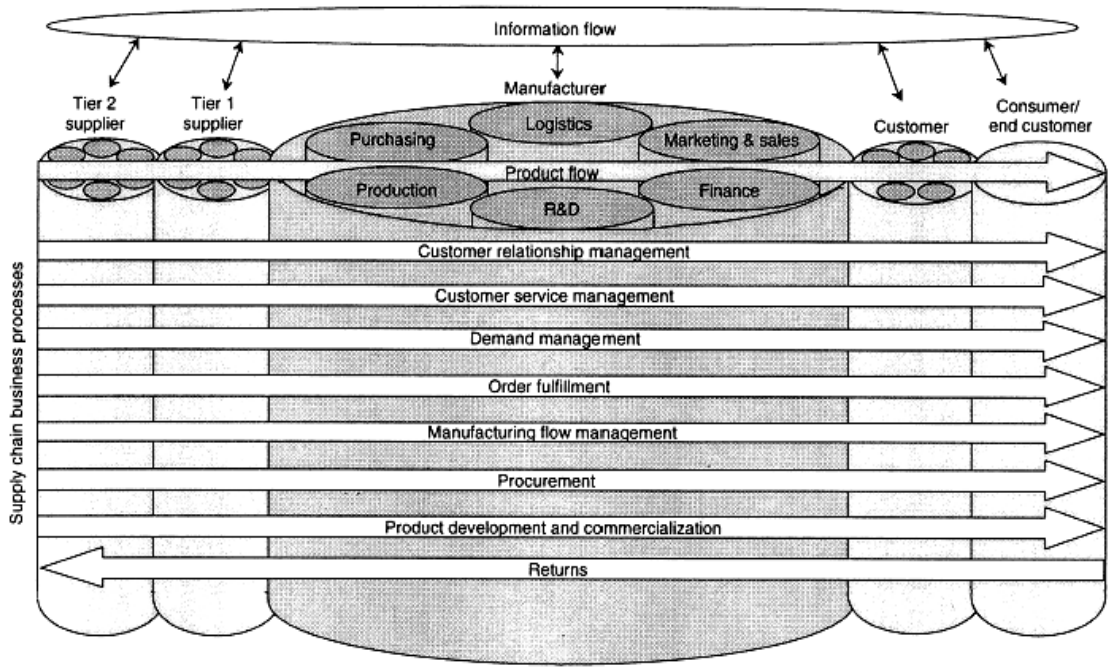

Figure 4. Interaction of business processes and supply chain (source: Cooper *et al.*, 1997)

4.2 Reverse Logistics

The concept of reverse logistics has been applied in promoting costumer service and resources recycling. Concerning quality control, the defective components and finished products will be returned to their producers through reverse logistics systems. Nowadays, reverse logistics has been developed rapidly for increasing industries' competitiveness, promoting customer service level, and recycling the reusable material. Meanwhile, the demand of reverse logistics brings out a new market for the third-party logistics industries.

Rogers *et al.* (1998) defined reverse logistics as '*the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal*'. Figure 5 shows the structure of logistics systems, which includes forward logistics, backward logistics and information flow. The flow in black arrows presents the direction of reverse logistics, whose direction is counter to the ordinary logistics represented in hollow arrows. The information flow interlaces between different stakeholders within the system. Each stakeholder can communicate with the others directly to maximum their profitability. Reverse logistics will be adopted in various modes and applications in the future due to its efficiency and benefits in environment protection.

The two main reasons behind the rise of reverse logistics are the globalisation of markets and policies for environment protection. A successful reverse logistics could help to increase the service level of companies and reduce the costs of producing processes. More and more companies want to build their reverse logistics system, however the system needs professional knowledge in logistics management and particular facilities. Thus the third-party logistics service provides another option for small to middle size companies to have their reverse logistics system. Figure 6 shows a system of reverse logistics service on how FedEx, a third-party logistics provider, serves Acer computer, the customer company. At the first step of the system, the customer applies a request for returning the product through the Internet, and then FedEx builds the data of the products; meanwhile the system organizes the route of the

delivery trips of the product. The customer can check the processing condition and wait for sending back at the right time.

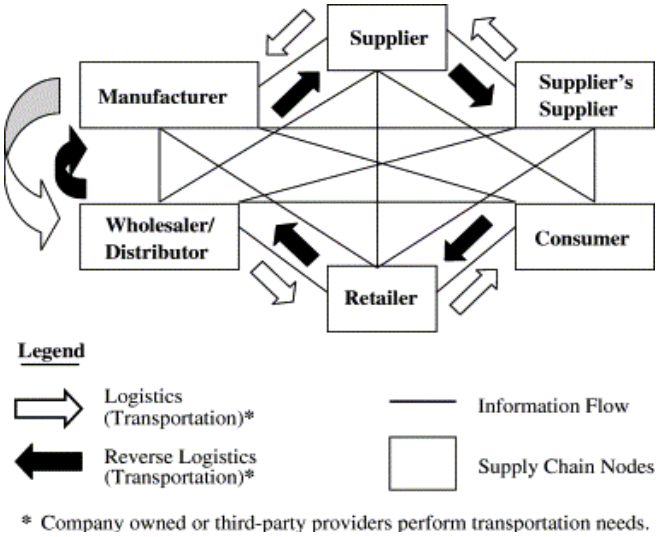

Figure 5. Consumer supply chain (source: Krumwiede *et al.*, 2002)

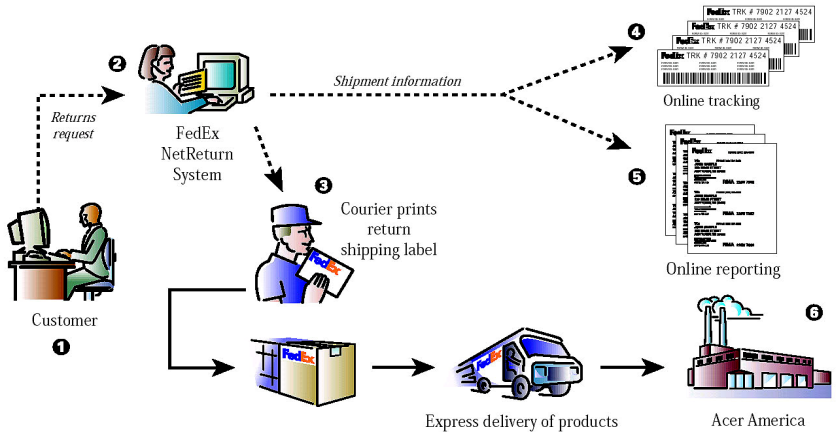

Figure 6. Third-party reverse logistics
(source: http://www.fedex.com/us/solutions/downloads/acer.pdf)

4.3 Maritime Logistics

Maritime industry plays an important role in international freight. It can provide a cheap and high carrying capacity conveyance for consumers. Therefore, it has a vital position in the transportation of particular goods, such as crude oil and grains. Its disadvantage is that it needs longer transport time and its schedule is strongly affected by the weather factors. To save costs and enhance competitiveness, current maritime logistics firms tend to use large-scaled ships and cooperative operation techniques. Moreover, current maritime customers care about service quality more than the delivery price. Thus, it is necessary to build new logistics concepts in order to increase service satisfaction, e.g. real-time information, accurate time windows and goods tracking systems. The operation of maritime transport industry can be divided into three main types: (1) *Liner Shipping*: The business is based on the same ships, routes, price, and regular voyages. (2) *Tramp Shipping*: The characters of this kind of shipping are irregular transport price, unsteady transport routes, and schedule. It usually delivers particular goods, such as Dry Bulk Cargo and crude oil. (3) *Industry Shipping*: The

main purpose of industry shipping is to ensure the supply of raw materials. This sometimes needs specialized containers, such as the high-pressure containers for natural gas.

4.4 Air Freight Logistics

Air freight logistics is necessary for many industries and services to complete their supply chain and functions. It provides the delivery with speed, lower risk of damage, security, flexibility, accessibility and good frequency for regular destinations, yet the disadvantage is high delivery fee. Reynolds-Feighan (2001) said air freight logistics is selected '*when the value per unit weight of shipments is relatively high and the speed of delivery is an important factor*'. The characteristics of air freight logistics are that: (1) airplanes and airports are separated. Therefore, the industries only need to prepare planes for operation; (2) it allows to speed delivery at far destinations; (3) air freight transport is not affected by landforms.

Research data show that the freight transport market keeps growing. Given the trend of global markets, air freight logistics also has to change their services. The future tendencies of air freight development are integration with other transport modes and internationalisation and alliance and merger between air transport companies The future pattern of air freight logistics is cooperative with other transport modes, such as maritime and land transport, to provide a service base on Just-In-Time, and door-to-door.

4.5 Land Logistics

Land logistics is a very important link in logistics activities. It extends the delivery services for air and maritime transport from airports and seaports. The most positive characteristic of land logistics is the high accessibility level in land areas. The main transport modes of land logistics are railway transport, road freight transport and pipeline transport.

Railway transport has advantages like high carrying capacity, lower influence by weather conditions, and lower energy consumption while disadvantages as high cost of essential facilities, difficult and expensive maintenance, lack of elasticity of urgent demands, and time consumption in organizing railway carriages. Road freight transport has advantages as cheaper investment funds, high accessibility, mobility and availability. Its disadvantages are low capacity, lower safety, and slow speed. The advantages of pipeline transport are high capacity, less effect by weather conditions, cheaper operation fee, and continuous conveyance; the disadvantages are expensive infrastructures, harder supervision, goods specialization, and regular maintenance needs.

The excessive usage of land transport also brings many problems, such as traffic jams, pollution and traffic crashes. In the future, to improve the land transport in transport efficiency and reliability, a revolution of transport policies and management is required, e.g. pricing.

4.6 Express Delivery

As the increasing demand of time accuracy and decentralization of production, the need to reduce stock costs has led to the Just-In-Time (JIT) delivery principle, which involves more frequent delivery of materials at the right time and at the right place in the production process. The characteristics of express delivery are: (1) door-to-door service; (2) efficiency; (3) traceability; (4) Just-In-Time (JIT); (5) growing various delivery demands.

The trend toward increasingly compact products is expected to improve the cost-benefit ratio of express delivery by decreasing the transportation cost share. Smaller products will enlarge the market for express delivery services. Also, the increasing value of products requires rapid transportation, because companies want to reduce the interest costs bound up in stock and inventories. For future development, the industries should consider integrating the services with 24-hour stores so that customers could choose a certain shop as the pick-up station. Meanwhile, the services would become more efficient and controlled due to more regular routes to those shops instead of personal houses.

4.7 E-commerce

E-commerce is the future trend of business style. It brings many benefits for both companies and consumers: (1) E-commerce expands the market area from regional to global; (2) E-commerce uses electronic techniques instead of traditional paper works, which promotes the industries' efficiency and competitiveness; (3) The number of trips is increased. On the other hand the average load of single trip is reduced, which means it needs higher carriage if using the same means of transportation; (4) E-commerce will impact on transport system due to the increased trips; (5) E-commerce might reduce the number of warehouses and the stock cost. Therefore the prices could be lowered. Figure 7 and Figure 8 express the differences between the transport patterns of traditional trade and e-commerce. However other new topics, of course, accompany with the system and need to be concerned, such as Internet security, transport impacts and door-to-door services. A healthy and successful e-commerce environment is determined by the optimal logistics operation.

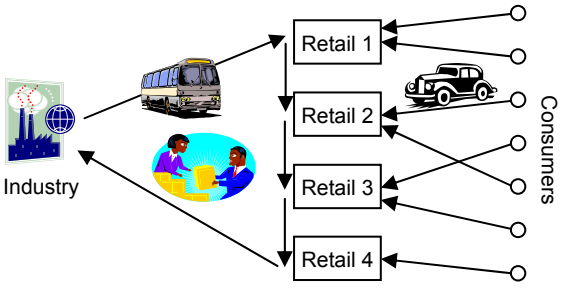

Figure 7. The transport pattern of traditional business

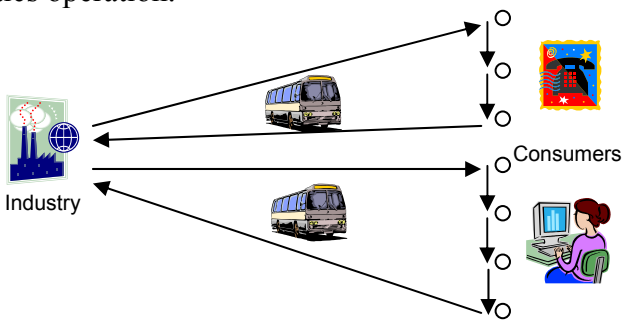

Figure 8. The transport pattern of e-commerce

5. CITY LOGISTICS

City Logistics is a concept trying to integrate the existing resources to solve the difficulties caused by the impacts of increasing population and vehicle ownerships in the urban area. Many cities, such as Bangkok, London, and Tokyo, have suffered from these problems due to traffic congestions, environment impact, low transport efficiency, and consequently the competitiveness of business decreased. This kind of condition not only reduces the quality of life in urban areas but also the future city development. *City Logistics provides an opportunity for innovative solutions to be developed for improving the quality of life in urban areas.* (Taniguchi *et al.,* 2001a) It contains several advanced techniques, such as Geographic Information System (GIS), Global Positioning System (GPS), logistics knowledge, Intelligent Transport System (ITS) and modelling, to optimise the city environment. Moreover, it helps to reduce both transport cost and negative environment impact.

5.1 Definitions of City Logistics

> *City Logistics is the process for totally optimising the logistics and transport activities by private companies with the support of advanced information systems in urban areas considering the traffic environment, its congestion, safety and energy savings within the framework of a market economy. (Taniguchi et al., 2001b)*

Cities are the main locations of business activities. Hence they play an important role in economic development. However given the high concentrated development in urban areas, many cities have serious traffic problems and negative environmental impacts, such as noise and air pollution, this is the cost in both developing and developed countries. These negative factors reduce the economic competitiveness of a city and make its life quality declined. The residents become the victims in the highly developed cities. The way to solve and balance the condition became a demanding issue in the recent years. City Logistics is a new and innovative concept which aims to solve this complex problem.

Urban freight logistics can be broken down in many elements, such as storage, transport and handling. Conventional improvement of the logistics process is usually only focused on single element. However, from a macro-viewpoint, the improvement can help bring the best profit to the society. Figure 9 shows the principle of the cost matters with different transport modes. Airfreight might be more expensive than land transport but the storage cost might be less. Thus in terms of total cost, airfreight might be the most reasonable transport mode for a particular transport purpose, for example, transport of fresh seafood.

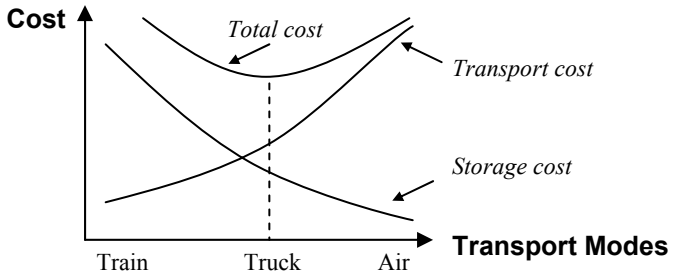

Figure 9. Transport patterns and total costs (source: Chang, 1998)

Before planning a City Logistics system, it is important to understand its elements. According to Thompson *et al.* (2001), there are four key stakeholders involved in urban freight transport: (1) shippers; (2) freight carriers; (3) residents; (4) administrators/governments. Each group has its own specific objectives and tends to behave in a different manner and needs to be considered. The interlaced relationships among those groups and different conflicts within the system are shown as Figure 10. Basically, the origination of the journey is from shippers and to the consumers. Freight carriers and administrators are the media of the delivery tasks. The characteristic of their relationships is that a slight move in one part may affect the whole situation. For instance, a freight carrier with lower efficiency would impact on the service quality of the system and hence increase the difficulties of management for administrators. Besides, it would also reduce the satisfaction level of consumers and the reliability of firms and increase the operation cost.

Taniguchi *et al.* (2003) consider that there are three necessary targets that could be achieved by applying City Logistics: (1) mobility; (2) sustainability; (3) liveability. Mobility is ease of movement, which is the basic requirement for transport of commodities in urban areas. Goods are supposed to be delivered Just-In-Time. Therefore, the balance between sufficient road

network capacity and reduced traffic congestion is a main issue. Concerning sustainability, which is more and more important, environmental issues and energy conservation would need to be taken into account. Liveability should be thought of for the residents. It involves an assessment of the conditions that are experienced and interpreted within an individual's life area, such as safety, peacefulness, attractiveness and charm.

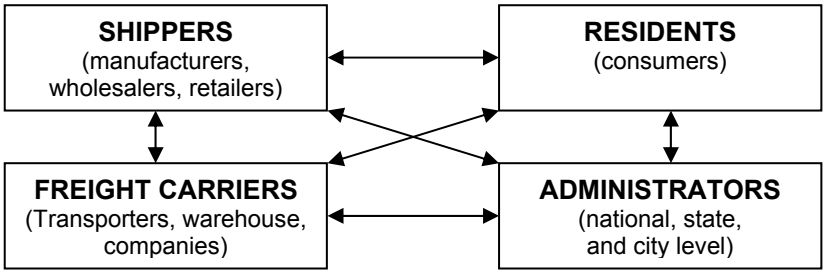

Figure 10. Key stakeholders in City Logistics (modified: Taniguchi *et al.*, 2001a)

5.2 The Applied Techniques in City Logistics

Common techniques integrated in the procedures of City Logistics include cooperative freight systems, freight villages (terminals), controlling transport load factors, new freight transport systems, and intelligent transport systems (ITS).

5.2.1 Cooperative freight systems

The traditional delivery pattern of freight is fewer trips and more loads. The delivery companies usually maintained their business independently. It means two carriers might serve in the same area. Nowadays, the trends of urban freight transport towards to deliver "Just-in-time" and "door-to-door". The operation of freight transport changes to have more trips but fewer loads in order to increase the efficiency differently. Without improvement, the transport costs will increase hugely to satisfy the current requirements. Cooperative freight systems are the ways which could be expected to solve this problem.

Cooperative freight systems integrate the resources of the cooperating companies to optimise the economic benefits. The main benefits of the techniques are (1) properly increasing delivery trip loads; (2) reducing unnecessary trips, as well as pollution and costs; (3) reducing service area overlaps; (4) increasing service quality and company profits.

5.2.2 Freight villages (terminals)

The concept of freight villages (terminals) has been applied in several cities, such as Monaco. The goods are reorganised in the freight village before being delivered to the urban areas. This system can reduce the required number of trucks used for delivery and handling.

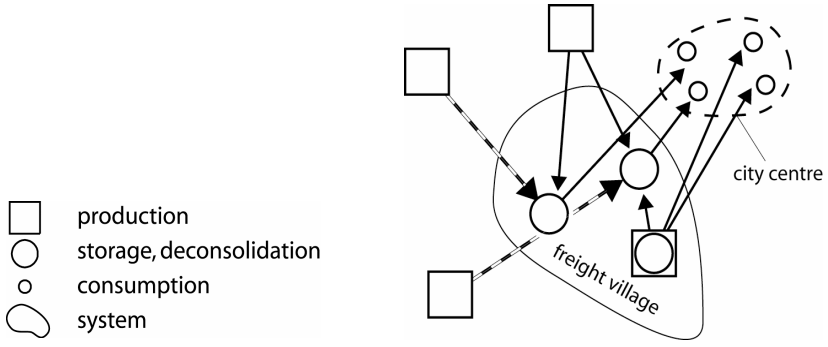

Figure 11. The structure of freight villages (source: Potrol, 2003)

Figure 11 shows the model of freight villages. The freight from outside of a city is sent to the freight village in order to classify and prepare for delivering to city area. This could increase the carrying load of vehicles and reduce unnecessary trips in the urban area. In addition, this integration benefits the private sector by reducing costs, and also the public environment by decreasing trips and air pollution.

5.2.3 Controlling transport load factors

In Europe, some cities implement the limitation of load factors in urban freight transport. Companies allowed to deliver freight in urban area must have high loading rates, and the vehicles have to conform to the environmental standards. The method of regulation is through publishing special certificates and giving the right for the companies to use particular transport infrastructure in the urban area, so reducing the complexity of urban transport.

5.2.4 New freight transport systems

New freight transport systems range from the design of new vehicles to the underground freight transport systems. The former can be used to adjust the current resource to satisfy the short-term requirements. The latter is for the long term, bringing a new era to city freight transport.

5.2.5 Intelligent Transport Systems (ITS)

Applications of ITS in transport systems are widespread. The most common techniques for logistics include Global Positioning System (GPS), Geographic Information Systems (GIS) and advanced information systems. GPS provides the service of vehicles positioning. It could help the control centres to monitor and dispatch trucks. GIS provides the basic geographic database for the deliverers to enable to organise their routes easier and faster. Advanced information systems provide the real-time information for both managers and deliverymen to adjust their paths as new demands occur. The integration of GPS, GIS and advanced information systems provides a high manoeuvrability of transport systems. The benefits of the integrations are better service quality, reduced unnecessary trips, and increased loading rate.

6. FUTURE PROSPECTS OF LOGISTICS

Facing the worldwide competition, the improvement of logistics system should be advanced by both private companies and government. Weeld and Roszemeijer (Ho, 1997) discerned three revolutions in business that have substantial impacts on the purchasing and supply strategies of the manufacturing sectors. These three revolutions are: (1) the globalisation of trade; (2) the coming of the information era; (3) more demanding consumers and continuously changing consumer preferences. The main characteristics of future logistics development are:

- ***Government role:*** To keep competitiveness of industries, the government has to lead the way to assist the logistics industries. For instance, the idea of freight village of city logistics provides the environment to promote logistics efficiency and to reduce operation costs. However it involves large of investments and some problems relating laws and national policies. Without the lead and support of government, achieving the plan is difficult.
- ***Growth of international goods transport:*** The up-growth of international freight transport is contributed by several factors. Firstly, the blossoming of E-commerce pushes ahead the international business activities. Secondly, the change of production strategy needs international cooperation, e.g. importing the semi-finished products from countries with

cheaper human resources to those with higher technology to assemble the final goods. Thirdly, the pressure of globalised market, such as World Trade Organization (WTO), pushes local industries to promote themselves to reach an international standard and face the worldwide competition.

- ***Improvement of services:*** Providing a good customer service becomes a necessary requirement of business operation with the intense competition of global market. The quality of services is the main factor to affect consuming behaviour among the enterprises with high similarity. The service systems involve several developed techniques now, such as Efficient Consumer Response (ECR) and Quick Response (QR). In the near future, more new techniques would be applied in providing better services for customers.
- ***Revolution of logistics operation:*** IT techniques and its products bring efficiency and fluency to the logistics systems. Radio Frequency ID (RFID) is one of these techniques. The main difference between the bar-code system and RFID is that RFID does not need the action of scanning the barcode on goods. RFID could save manual operation time dramatically. RFID systems could sense the amount of goods input in the tags automatically and immediately when the costumers push their trolley through the exit (Carroll, 2004).
- ***Shorter product life cycle:*** With the current trend, the merchandise design is changing day by day, and therefore, the product life cycle is shorter and shorter, especially in computer science. To confront the impacts, logistics system must improve its efficiency and reliability of goods delivery. Otherwise an inappropriate logistics system would hinder the competitiveness of new products and the business profits.
- ***Improvement of logistics facilities:*** The advancement and development of logistics are based on several techniques and complete theories. High-tech facilities and systems, e.g. ITS, could bring more possibilities and advantages to logistics. For example, the improvement of related facilities, e.g. Forklift Trucks, is necessary for transport efficiency. In the future, factory automation is the main target for the whole supply-chain procedures. It could help to improve efficiency and also reduce the operation costs.
- ***Channel cooperation between companies:*** In order to save the logistics costs, a key concept is to maximize the usage of available transport capacity. Integrating the logistics demands between numerous departments helps achieve this purpose. In practice, a conglomerate could develop its own logistics service for the branches. For some medium size companies, they could cooperate transport channels with others.
- ***Specialized logistics delivery:*** One of the notable trends of logistics industries is specialized delivery service. For instance, delivering fresh food from the place of origin needs low-temperature containers. Compute chips, gases and petroleum need particular conveyances to carry. These demands are rising since the products became more and more delicate.
- ***Logistics centres:*** The development of logistics centres is good for industry promotion and the development of national economic system. Logistics centres could successfully shorten the distance between production and marketing vertically and also integrate various industries horizontally, and thus decrease the costs. Governments can propose special areas for storehouses and logistics to reduce land acquisition. The future logistics will cooperate e-commerce, the Internet and the newly door-to-door service to create new business prospects.
- ***Freight transport:*** The alliance between middle-small size delivery companies is an important trend in the future. The strategy could help to expand service areas and increase service quality, and meanwhile raise the loads of single trips to reduce delivery costs.

7. DISCUSSIONS AND CONCLUSIONS

7.1 Discussions

How to speedily deliver products to consumers' hands is a common consensus of operators. Integration of logistics and e-business is the future trend. In order to get more advantageous position and build a complementary and dependent relationship, networking industries, such as Yahoo and e-Bay, usually cooperate with logistics industries. The integration could reduce the middle-level procedures. The producers could immediately give the products over to the terminal customers. This could reduce expenses and also administer sources more efficiently. Besides, the companies do not have to take the costs of inventory and warehouse, and therefore they become modernized industries of low cost, more efficiency and division of specialty. For example, customers could get ordered goods from convenience stores. Through e-logistics, the competition condition of industries could be promoted in knowledge economics.

Based on the discussions of previous paragraphs, the integration and promotion of business activities have to involve transportation systems at various stages. The integration of various applications brings the convenience through promoting the system of information flow and business operations. Customers and firms could make business more efficient and easier through the help of e-commerce and the Internet. However physical delivery still relies on the transportation system to finish the operations. The cost of transportation operation may be one-third of logistics costs. Meanwhile, transportation systems and techniques are needed in almost every logistics activity. Thus the reform of business patterns has to consider transportation systems.

7.2 Conclusions

This paper covers broadly from logistics activities to transportation systems and attempts to determine the role of transportation in logistics systems through extensive review. The main contents of the research include a review of logistics development, the characters of various transport operations in logistics activities, the applications of logistics in various fields, city logistics, future direction in logistics development, and its cooperation with transport systems. To sum up, logistics and transportation have some relevance. (1) Logistics system has a more and more important position in our society activities. (2) Transportation and logistics systems have interdependent relationships that logistics management needs transportation to perform its activities and meanwhile, a successful logistics system could help to improve traffic environment and transportation development. (3) Since transportation contributes the highest cost among the related elements in logistics systems, the improvement of transport efficiency could change the overall performance of a logistics system. (4) Transportation plays an important role in logistics system and its activities appear in various sections of logistics processes. Without the linking of transportation, a powerful logistics strategy cannot bring its capacity into full play.

The review of logistics system in a broad sense might help to integrate the advantages from different application cases to overcome their current disadvantage. On the other hand, the review of transport systems provides a clearer notion on transport applications in logistics activities. The development of logistics will be still vigorous in the following decades and the logistics concepts might be applied in more fields.

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