Food Control 21 (2010) 559–566

Contents lists available at ScienceDirect

Food Control

journal homepage: www.elsevier.com/locate/foodcont

Developing an advanced Multi-Temperature Joint Distribution System for the food cold chain

Ju-Chia Kuo [a], Mu-Chen Chen [b,*]

[a] Technology Center for Service Industries, Industrial Technology Research Institute, Taiwan, ROC
[b] Institute of Traffic and Transportation, National Chiao Tung University, Taiwan, ROC

ARTICLE INFO

Article history:
Received 17 February 2009
Received in revised form 13 August 2009
Accepted 18 August 2009

Keywords:
Supply chain management
Logistics
Food industry
Cold chain
Multi-Temperature Joint Distribution

ABSTRACT

For temperature sensitive and perishable products (TSPPs) logistics, a special type of supply chain management called Cold Chain Management (CCM), has been established. Temperature monitoring and control are essential mechanisms in CCM, because they are necessary for maintaining food safety and quality. However, they are costly to logistics service providers (LSPs). In this paper, a logistics service model based on the advancement of the Multi-Temperature Joint Distribution System, namely MTJD, is being proposed for the food cold chain. The proposed service model facilitates innovation in logistics services and gives the logistics sector a competitive advantage in the area of thermal protection for perishable shipments and temperature sensitive products. Smaller shipments and timely deliveries offer unique challenges when operating a cold chain. The MTJD-based model is designed with these challenges in mind. A case study is performed by using the regulative cycle. In this paper, an MTJD-based model is presented according to the requirements of the food chain and the operations of a 3PL in Taiwan. MTJD provides a new scheme for continuously temperature-controlled logistics, which can jointly deliver and store multi-temperature goods.

1. Introduction

As reported on the WHO website (http://www.who.int/foodsafety/en/), food and waterborne diarrhoeal diseases kill approximately 1.8 million people annually, most of whom are children, in less developed countries. The growing trends of global food production, processing, distribution and preparation create the need for food safety studies to improve the global food supply chain. Consumer awareness of food safety and government food safety regulations are the major driving forces behind cold chain development. Cold chain issues have continued to be seriously addressed in the food industry and academia in recent years. In temperature sensitive and perishable products (TSPPs) logistics, a special type of supply chain management has been established, named Cold Chain Management (CCM). Temperature monitoring and control are essential parts of CCM, because they are necessary for food safety. However, they are costly to logistics service providers (LSPs).

The term 'food chain' refers to the total supply process from agricultural production, harvest or slaughter, through primary production and/or manufacturing, to storage and distribution, to retail sale or use in catering and by consumers (Stringer, Hall, & The Breakdowns in Food Safety Group, 2007). The global trade in PTSPs such as refrigerated products and prepared meals is growing due to tariff reduction, continuous improvement in transportation efficiency, advances in communication and information technology, and enhancement of cold chain systems (Bogataj, Bogataj, & Vodopivec, 2005). The requirements and dynamics of the foodservice market differ noticeably from those of supermarket grocers. However, little research on the foodservice sector has been presented in the supply chain management literature (Francis, Simons, & Bourlakis, 2008). To protect the health of customers, public authorities must establish regulations on cold chains, and the related industries need to establish cold chain systems which not only meet the regulations but are also cost effective to operate.

In the food trade, consumer preferences in products are becoming increasingly diverse. The design of food supply chains should prevent loss in production improve sales efficiency, and reduce inventory by minimizing the order cycle time (Iijima, Komatsu, & Katoh, 1996). Effective logistics systems should not only deliver

Abbreviations: CCM, cold chain management; CLTL, cold less than truckload; DC, distribution center; ECR, efficient consumer response; ISO, International Organization of Standardization; LSP, logistics service provider; LTL, less than truckload; MTJD, Multi-Temperature Joint Distribution System; QR, quick response; RFID, radio frequency identification; TL, truckload; TSPP, temperature sensitive and perishable product.

* Corresponding author.
E-mail address: ittchen@mail.nctu.edu.tw (M.-C. Chen).

0956-7135/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.foodcont.2009.08.007

food products freshly and safely, but also be on time, which is an important concern of customers.

One of the particular attributes of the logistics systems for chilled and frozen goods is the maintenance of product quality, which is dependent on the duration of delivery time and variation of temperature in the cold chain (Zhang, Habenicht, & Spie, 2003). The physical logistics system of a cold chain is configured to minimize the cost of storage and transportation, and to meet the requirements of product quality. Although a cold chain can improve the maintenance of product quality, it requires more capital investment in storage and transportation facilities, and is more costly to operate. However, most food companies are SMEs, and most food products are produced by SMEs. For example, 62.2% of food companies are SMEs in Europe (Daives, 2004). These SMEs may outsource their food logistics to 3PLs in order to focus on their foodservice specialty and to reduce the logistics cost. The focus on logistics has shifted from manufacturer-oriented to consumer-oriented. The transportation cost is increasing because the number of deliveries to customers is greater than ever, while the shipment size and the delivery time continue to shrink. Therefore, it is necessary to develop cost effective and mass-customized logistics services in the food chain.

As aforementioned, this paper presents a Multi-Temperature Joint Distribution logistics model for the food chain. Implementing the MTJD-based food cold chain supported by the latest information technology and the advancement of cold chain equipment, LSPs can achieve operation cost reduction and performance improvement. This MTJD-based model facilitates innovation in logistics services and leads 3PLs to a competitive advantage in the area of thermal protection for perishable shipments and temperature sensitive products. A case study is presented in this paper by using the regulative cycle presented in van Strien (1997). The regulative cycle is a problem-solving methodology which consists of the following steps: problem identification, problem diagnosis, planning, intervention (implementation), and evaluation. In this paper, the MTJD-based model is proposed according to the requirements of the food chain and the operations of a 3PL in Taiwan. In addition, the proposed service model can be a valuable reference for the logistics industry.

The remainder of this paper is organized as follows. First, we will present the concepts of cold chain and food cold chain. Second, the as-is business model is introduced. Third, the basics of MTJD and the MTJD-based food cold chain for the case company are presented. Finally, we make a conclusion for this paper.

2. Food cold chains

The agri-food supply chain possesses several characteristics such as shelf life constraints for raw materials and perishability of products, long production throughput time, seasonality in production, necessity of conditioned transportation and storage, safety concerns, and so on (Aramyan, Oude Lansink, van der Vorst, & van Kooten, 2007). Due to the increasing food safety regulations and consumers' awareness regarding food safety, the study of the food chain or agri-food chain recently has capture more attention in the areas of food science and engineering, and supply chain management.

Food safety regulations include product temperature control along the supply chain, tracking of air and product temperature in refrigerated vehicles, production workcells and loading-reloading points, and verified standardized equipment (Bogataj et al., 2005). The International Organization of Standardization (ISO) provides the most popular definition on food quality, "the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs" (ISO 8402), on which virtually all of the communities coming from different backgrounds and working in different areas can agree (Becker, 2000). In cold chains, temperature conditions affect the risk potential, the shelf life and final quality of chilled products (Montanari, 2008). From Montanari, the progress of predictive microbiology enables researchers to model food safety and quality by considering the effect of temperature, intrinsic characteristics and packaging environment. The cold storage or low temperature of fresh products is essential because it can minimize the risk of food-borne illnesses, maintain optimal quality by reducing several physiological activities, and reduce the growth rate of spoilage microorganisms (Rediers, Claes, Peeters, & Willems, 2009). The quality and safety of fresh products can be determined by using the temperature profile along the supply chain (Giannakourou, Koutsoumanis, Nychas, & Taoukis, 2001).

In the past two decades, the major part of delivery and distribution of PTSPs was from the manufacturers or farms directly to the supermarkets. In more recent years, these PTSPs have been distributed and sold in a huge number of convenience stores (Iijima et al., 1996), as well as through online sales from wholesalers and retailers directly to customers. Customers expect that the products they order can be received safely, freshly and on time. Any temperature changes during the logistics process may cause loss of flavor or even spoilage. It is well known that temperature is an important parameter in food safety and quality (Montanari, 2008; Ovca & Jevšnik, 2009). Through collecting and analyzing more than 8000 breakdowns in food safety, The Breakdowns in Food Safety Group (Stringer et al., 2007) proposed a generic model of the integrated food supply chain, and identified 21 types of generic breakdown which could happen at any stage of the food chain. The temperature related breakdown is included in the 21 types as well. In the cold chain, any changes in time–distance or temperature may result in cost increase, while the added value in the supply chain shrinks (Bogataj et al., 2005). For food safety and quality, temperature needs to be carefully and continuously monitored and controlled in each stage of the supply chain because most food products are PTSPs (Montanari, 2008).

Responding to the expectation of customers requires proper cold chain management (CCM). Jackson, Blair, McDowell, Kennedy, and Bolton (2007) indicated that on average the shopping basket of European consumer mostly (say more than 60%) consists of chilled and frozen food, and food which can be consumed without heat treatment. Additionally, the globalization of the food supply, storage, distribution and processing increases the importance of the cold chain. The food supply chain typically includes all the activities in food production and food trade, which represents all the post-production activities such as storage, transport, distribution and retail of final products, their export and import (Likar & Jevšnik, 2006).

According to Bogataj et al. (2005), CCM is defined as "the process of planning, implementing and controlling efficient, effective flow and storage of perishable goods, related services and information from one or more points of origin to the points of production, distribution and consumption in order to meet customers' requirements on a worldwide scale." CCM integrates distinctive logistics activities for perishable goods into an existing business process to create customer value.

Jevšnik, Hlebec, and Raspor (2008) underlined several gaps in food safety knowledge and practices arising from shopping to eating. In their study, consumers do not understand their important role in maintaining a cold chain. Although temperature is a critical parameter to CCM, from the study by Jevšnik et al., temperature is the least important parameter for consumers in a retail cold chain. This might be because consumers trust shop managers or do not realize that they can influence temperature.

As proposed by LSPs, there are five major categories in the temperature control and monitoring for the food supply chain. They include hot food (above 60 °C constantly), fresh food (18 °C constantly), cold food (0 °C to +7 °C), chilled food (−2 °C to +2 °C), frozen food (below −18 °C), and deeply frozen food (below −30 °C). The MTJD system developed in this paper divides the temperature scope into three kinds including fresh goods (18 °C constant), chilled goods (−2 °C to +7 °C) and frozen goods (below −18 °C).

The food cold chain attempts to make sure that all kinds of perishable products with different temperature requirements can be maintained at the best quality condition, from the point of supply to the point of consumption, throughout the processes of storage and distribution. The freshness and safety of food have to be ensured in each stage in logistics service so as to maintain the value and quality to satisfy customers.

3. The current logistics service model

In the case of 3PL company which we study, the distribution and delivery services primarily include less than truckload (LTL) transportation, cold less than truckload (CLTL) transportation, express service, home delivery, cold distribution and ambient temperature distribution. In general, these logistics services are independently provided as shown in Fig. 1. With respect to various customers and distribution channels, the distribution and delivery services can primarily be categorized into four divisions: cold logistics, ambient temperature logistics, express and home delivery, and scheduled shuttle transportation.

These four divisions of the case 3PL are described as follows.

3.1. Cold logistics

This division provides logistics services of sorting, distribution and LTL transportation for cold, chilled, frozen and fresh goods to individual and enterprise consumers. Fig. 2 illustrates the service process of CLTL. The trucks dispatched by an LSP's agency transport goods from customers' warehouses or plants to a shipping refrigerated depot. After sorting, the refrigerated goods are transported to the destination depot by refrigerated shuttle trucks. Fig. 3 illustrates the existing service process of cold distribution for retailing. The refrigerated trucks transport goods from customers' warehouses or plants to a refrigerated depot. After sorting with respect to orders of retail stores, the refrigerated goods are transported to the convenience stores, supermarket and retail chain stores by refrigerated distribution trucks.

3.2. Ambient temperature logistics

This division mainly provides enterprise logistics services such as warehousing, distribution, order and invoice management, etc. The existing process of ambient temperature logistics service is

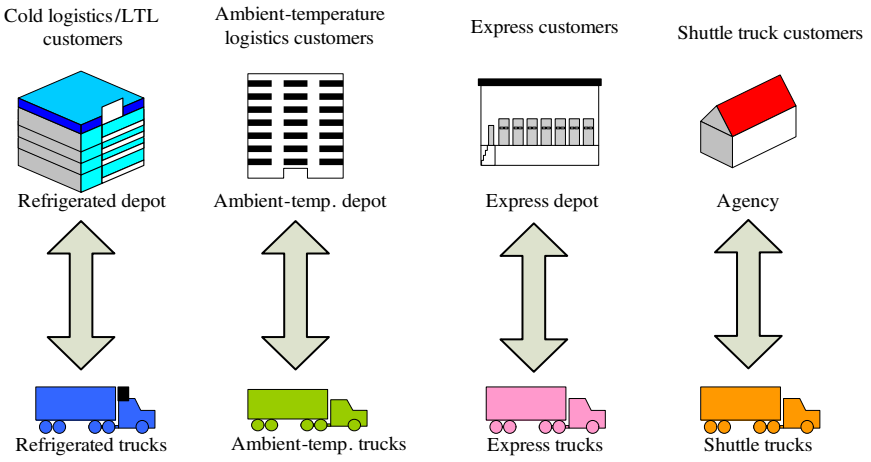

Fig. 1. Four divisions of logistics services.

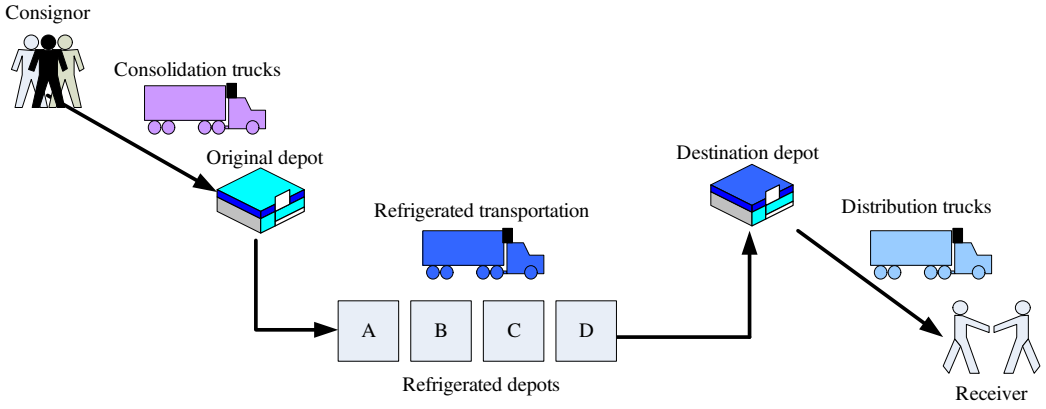

Fig. 2. The service process of CLTL.

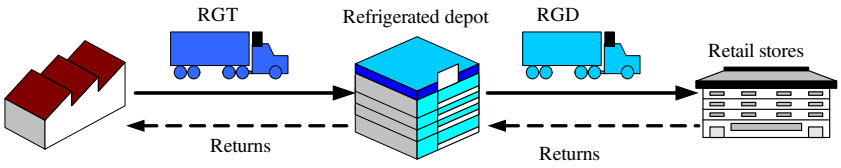

Fig. 3. The service process of cold distribution.

illustrated in Fig. 4. Goods can be transported from plants to a distribution center (DC) by trucks of suppliers (consignors) or LSPs. After sorting, the sorted goods are then transported by shuttle trucks to the destination depots. Finally, by using distribution trucks, the sorted goods are delivered to receivers such as supermarkets, department stores, and grocery stores.

3.3. Express and home delivery

These two logistics services are performed by the scheduled shuttle trucks. The express parcels may be distributed by domestic airlines if necessary to speed up the express delivery. In the service area of shuttle trucks, goods are transported between an express depot and shuttle depot by connecting trucks. Express consolidation trucks are responsible for consolidation and distribution. The service process of express and home delivery is illustrated in Fig. 5.

3.4. Scheduled shuttle transportation

The division of this kind provides LTL logistics services for manufacturing companies and SMEs. Fig. 6 shows the service process of scheduled shuttle transportation. Goods are transported between

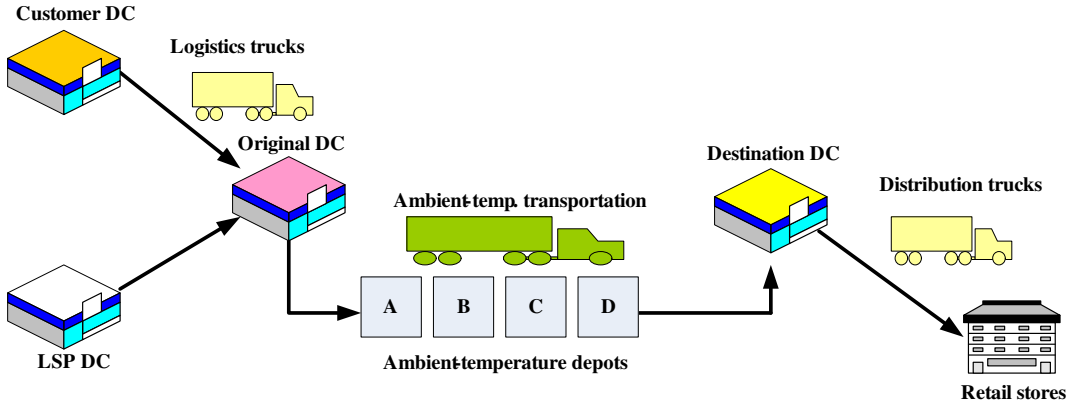

Fig. 4. The service process of ambient temperature logistics.

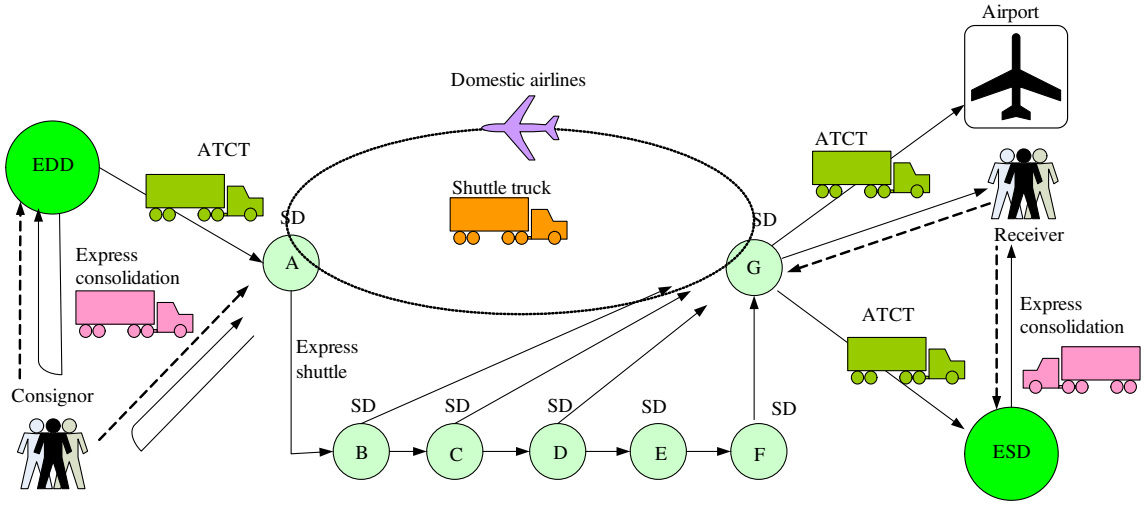

Fig. 5. The service process of express and home delivery.

original and destination hubs by transportation trucks. A transshipment hub directs several agencies, and each agency directs several consolidation depots. All hubs, agencies and consolidation depots can deal with goods receiving and shipping.

The characteristics of these four logistics service types are summarized in Table 1. The existing business model of logistics services has some difficulties, and they are discussed as follows.

3.5. Ambiguity in logistics service positioning

The four types of logistics services mentioned above are usually independently operated by the LSP. Customers are generally confused by the service contents, which are unclearly defined.

3.6. Disconnection in service window

Each service type has its own service window; customers, therefore, need to separately deal with the providers of these four service types. The back-office processes have difficulties in meeting various requirements of customers in a satisfactory manner in a one-stop logistics service.

3.7. Disorganization of transportation resources

The transportation resources such as depots, truck fleets, personnel, etc. are separated into four groups. This situation results in resource inefficiency, inadequate resource allocation and higher costs.

3.8. Inflexible transportation capability

Due to the independence of four logistics service types, the transportation services cannot flexibly respond to the diverse requirements of the customers.

3.9. Disconnected fresh service network

As mentioned above, temperature monitoring and control are the most critical parameters in food quality and food safety. However, the multi-temperature distribution service is not fully and conveniently provided in the service network since only refrigerated depots have the multi-temperature distribution capability.

4. The MTJD-based food cold chain

4.1. Basics of MTJD

As mentioned above, foodservice globalization and cold chains mutually reinforce each other for growth. Food globalization drives the need for a global cold chain; the advancement of the cold chain ensures the safety in the food chain. LSPs for continuously temperature-controlled delivery and distribution nowadays face stringent challenges such as cost effectiveness, smaller shipments and timely deliveries. In order to face such challenges and maintain competitive advantages, LSPs need to take the following issues into consideration:

- effective control and monitoring of temperature during delivery and storage;
- reduction in investment and delivery cost;

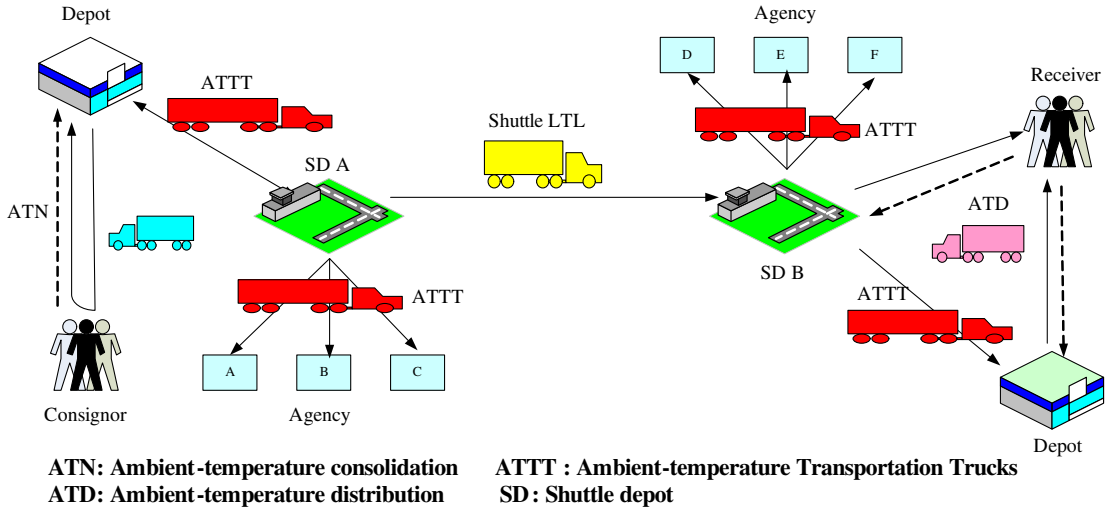

Fig. 6. The service process of scheduled shuttle transportation.

Table 1
Characteristics of four logistics services.

Service types	Scopes	Customer types	Services	Transportation types
Cold logistics	B2B, B2C	Food manufacturer, channel dealer	Cold logistics, cold LTL	Refrigerated transportation
Ambient temperature logistics	B2B	Manufacturer, channel dealer, franchisee, distributor	Ambient temperature logistics	Ambient temperature transportation
Express/home delivery	B2C, C2C	Consumer, direct mail dealer, enterprise	Express, home delivery	Shuttle trucks + connecting transportation
Scheduled shuttle transportation	B2B	SMEs	LTL	Hub and Spoke

- flexibility of truck usage;
- improvement of logistics operations.

Considering the difficulties the 3PL company is facing the above issues, the Multi-Temperature Joint Distribution (MTJD) system is built in such a way to minimize the investment and the cost for storage and transportation in the logistics system while maximizing truck usage and logistics performance. In addition, the requirements of product quality and delivery safety can be achieved through the proposed MTJD-based cold chain. The MTJD system with new cold chain equipment such as cold boxes, cold cabins and eutectic plates can balance quick delivery and increasingly diverse goods to ensure consumer satisfaction (Chu & Kuo, 2003; Kuo, Chung, & Lin, 2003). Fig. 7 illustrates an example of MTJD-based food logistics (Kuo et al., 2003). The goods with different temperature requirements can be distributed and stored in the same facilities such as trucks and warehouses to improve the facility utilization.

In 2001, the technology and service of home delivery were introduced to Taiwan from Japan, and the market of express and parcel deliveries has extensively grown to meet customers' requirements. This indicates escalating demand for innovative services and convenient consumer logistics in Taiwan. The home delivery market continues to expand due to the following reasons: the growth of TV/Internet shopping, daily life support in an aging society, and the direct sale model. The introduction of home delivery creates new business opportunities for MTJD. The MTJD system is expected to be a survival kit in the competitive market for express and home delivery services.

Goods delivered through home delivery are diversifying due to the advancement of logistics service technology. Different kinds of goods are generally delivered at temperature levels under control and monitoring. The refrigerated or frozen foods and agricultural commodities make up a large amount of home deliveries, and these goods necessitate strict control of temperature to ensure the quality and safety of these food products. By implementing MTJD, the conditioned foods and agricultural commodities can be delivered in a truck together with ambient temperature goods such as books, 3C products, and furniture. The MTJD system can satisfy the requirements of multi-temperature demand and one-stop logistics.

4.2. The proposed framework

To resolve the aforementioned difficulties in the 3PL which we study, the proposed MTJD-based model integrates the above four processes into two main modules, service integration module and resource integration module (refer to Fig. 8), and they are described as follows.

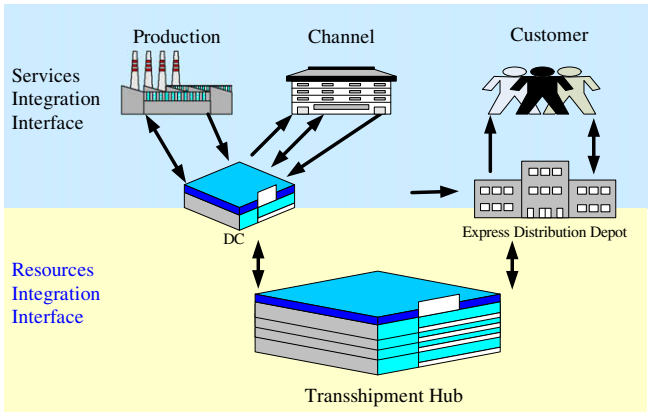

Fig. 8. Two modules for integrated logistics services.

4.2.1. Service integration module

This module standardizes the logistics service processes in an express depot, distribution depot, refrigerated depot and ambient temperature depot to meet the various customers' requirements. To balance between quick delivery and diversifying goods, the standardized service processes are designed to be not only mass customized, but also efficient and cost effective.

4.2.2. Resource integration module

This module integrates the resources of a back-office for logistics activities. It is primarily operated in transshipment hubs, and it aims to achieve resource integration with economic scale, efficiency and minimal cost.

Through service integration module and resource integration module, the proposed MTJD-based logistics service is an innovative Hub and Spoke model. The core engine of the proposed model is the transportation resource planning system, which further incorporates a multi-temperature management system and mobile technology to ensure food safety and quality in the cold chain, as well as to increase information visibility to improve transportation planning (refer to Fig. 9). The mobile technology system includes various functions such as real-time information, real-time tracing, order tracing, temperature monitoring, and so on. These functions can be primarily enabled by the emergence of radio frequency identification (RFID) technology. RFID can be used in a range of applications and industries. In a food chain, RFID can be used for tracking, identification, recall and so on. In particular, RFID has become an important technology in food sourcing because the government regulations of food traceability have increased extensively and stringently in the USA and EU beginning in 2005 (Attaran, 2007). From their study within the UK beef industry,

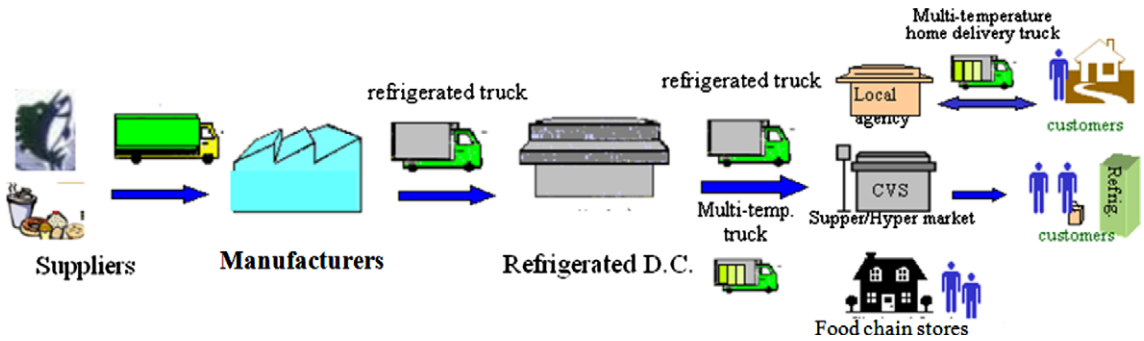

Fig. 7. An example of MTJD-based food logistics.

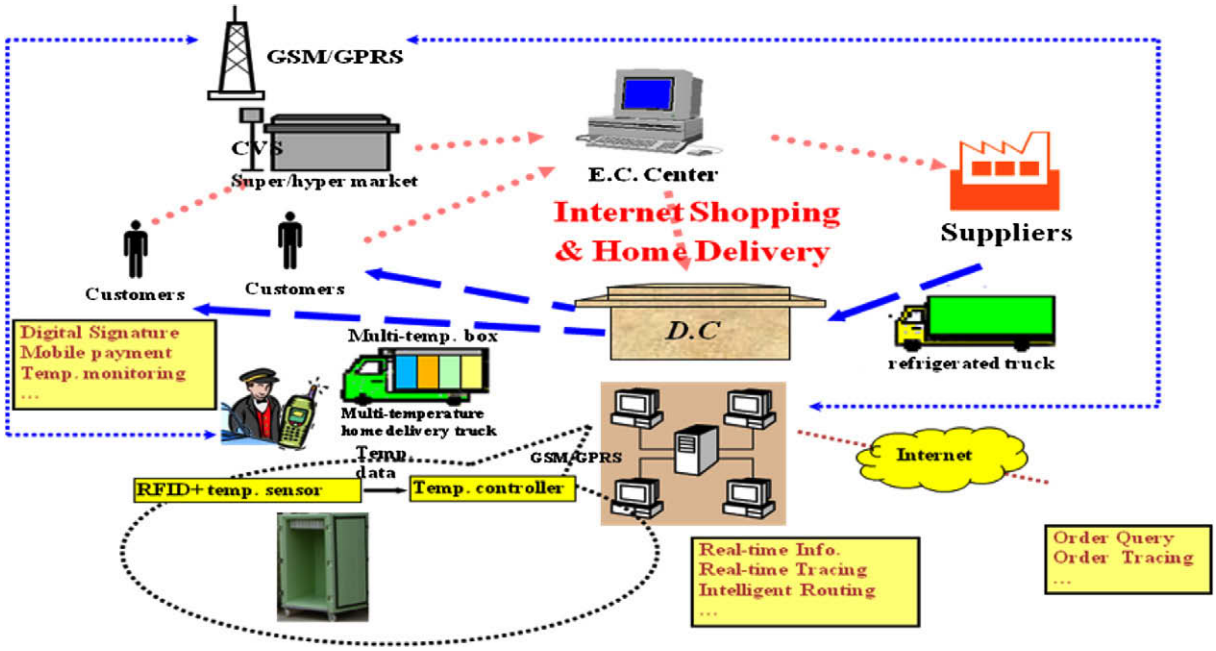

Fig. 9. The mobile information system of MTJD.

Cox, Chicksand, and Yang (2007) concluded that foodservice companies need to develop proactive upstream sourcing strategies which successfully ensure safe supply, so as to assist their more developed downstream marketing and branding strategies. Through advanced technology such as RFID, supply chain collaboration can be established to exchange real-time logistics information seamlessly (Chow, Choy, & Lee, 2007). Therefore, the supply chain partners can be correctly aggregated, managed, accessed and routed.

The proposed logistics service model integrates the abovementioned four types of services, viz. cold logistics, ambient temperature logistics, express and home delivery and scheduled shuttle transportation. In this model, the advanced equipment such as cold boxes, cold cabins and eutectic plates can improve the transportation performance better than a specialized refrigerated truck fleet.

The proposed MTJD-based logistics model has the following characteristics.

4.2.3. Integrated multi-temperature logistics

This can enhance the capability of multi-temperature logistics and provide an advantage in a competitive environment.

4.2.4. Single service window

Through the service integration module, customers can attain one-stop shopping for logistics in an agency, depot, website, call center, etc.

4.2.5. Fully connected multi-temperature cold distribution

Implementing the MTJD-based logistics system supported by the latest delivery device advancements such as cold boxes, cold cabins and eutectic plates, LSPs can achieve operation cost reduction, performance improvement and product safety and quality.

4.2.6. Rapid response to the varying needs of customers

The developed model of logistics service can speedily respond to the varying needs of customers by implementing a multi-temperature Hub and Spoke model incorporating a computerized transportation resource planning system.

4.2.7. Real-time logistics information

By incorporating mobile technology, the developed framework can provide real-time logistics information for transportation tracking and management, and food quality traceability along the supply chain.

The goods with multi-temperature requirements can be transported in a single truck by implementing the MTJD system. The efficiency, quality, convenience, flexibility and price competence of the cold chain are improved because of the MTJD system. The cold chain is generally designed for the requirements of enterprise logistics; it is not quite suitable for express and home delivery. By implementing the MTJD system, efficient express and home delivery services without huge capital investment in refrigerated equipment and trucks can be achieved.

The logistics cost of handling frequent delivery with small lots by LTL is much higher than the usual truckload (TL). Furthermore, PTSPs moved in a cold chain by refrigerated containers and trucks are more costly. The MTJD system can transport and temporarily store goods with various temperature requirements simultaneously in order to increase truck capacity utilization while not delaying delivery. The MTJD system can realize an innovative logistics model to minimize distribution cost while improving consumer satisfaction.

5. Conclusions

The achievement of efficient consumer response (ECR) and quick response (QR) is primarily based on first-class logistics. Nowadays, logistics plays a critical role in supporting the global supply chain strategy for enterprises. Recently, cold chain issues have continued to be seriously addressed in the foodservice industry due to increasing consumer awareness and government food safety regulations. The logistics of PTSPs such as foods necessitate advanced cold chain management which is more capital, technology and knowledge intensive. The MTJD-based logistics model is designed to cope with the broad scope of B2B, B2C and C2C. The system takes timely service as well as mass customization into consideration. The MTJD model transports and temporarily stores goods with different temperature requirements together in order to in-

crease the utilization of truck capacity and storage capacity while not delaying delivery. By using the MTJD model, the logistics cost of handling frequent delivery in small lots by LTL can be significantly reduced, while customer satisfaction can be attained. Furthermore, the safety and quality of perishable goods moved in the cold chain are guaranteed by information technology and advanced cold chain equipment. In view of the logistics advancements mentioned in this study, the innovative MTJD-based model can improve the logistics sector, particularly the cold chain. From the survey in Likar and Jevšnik (2006), consumers seem to have faith in the sellers' capability and willingness to maintain the cold chain for registered products. Growers, producers, distributors, retailers and 3PLs in a food chain, therefore, should be responsible for cold chain management to maintain food safety and quality. The proposed MTJD-based model is a potential alternative for preventing temperature problems in the food chain. The proposed MTJD model can be extended to the pharmaceutical cold chain, and it is a noteworthy direction for future work. Svensson (2007) pointed out that sustainable supply chain management has to simultaneously underline three aspects of business practices and theory, namely economic, ecological and social. Effective logistics additionally reduce CO_2 emissions and air pollution, which is becoming an important concern in logistics management and environmental policy. The impact of MTJD on CO_2 emission and air pollution also can be a future research direction. The MTJD-based model in this paper is developed according to the requirements of the food chain and the operations of a 3PL. Future work can additionally perform the evaluation stage of the regulative cycle to assess the performance of the proposed service model.

References

Aramyan, L. H., Oude Lansink, A. G. J. M., van der Vorst, J. G. A. J., & van Kooten, O. (2007). Performance measurement in agri-food supply chains: A case study. *Supply Chain Management: An International Journal, 12*(4), 304–315.

Attaran, M. (2007). RFID: An enabler of supply chain operations. *Supply Chain Management: An International Journal, 12*(4), 249–257.

Becker, T. (2000). Consumer perception of fresh meat quality: A framework for analysis. *British Food Journal, 102*(3), 158–176.

Bogataj, M., Bogataj, L., & Vodopivec, R. (2005). Stability of perishable goods in cold logistics chains. *International Journal of Production Economics, 93/94*(8), 345–356.

Chow, H. K. H., Choy, K. L., & Lee, W. B. (2007). Integration of web-based and RFID technology in visualizing logistics operations – A case study. *Supply Chain Management: An International Journal, 12*(3), 221–234.

Chu, H.-S., & Kuo, J.-C. (2003), Healthy logistics service, freshen Taiwan up, to be the No.1 of Asia. In *Proceedings of international conference on 2003 industrial science and technology innovation, policy issues and challenges in a critical era*, 13-1-7, Taipei, Taiwan, ROC.

Cox, A., Chicksand, D., & Yang, T. (2007). The proactive alignment of sourcing with marketing and branding strategies: A food service case. *Supply Chain Management: An International Journal, 12*(5), 321–333.

Daives, C. (2004). Preparing for new EU traceability laws. *Supply Chain Europe*, June.

Francis, M., Simons, D., & Bourlakis, M. (2008). Value chain analysis in the UK beef foodservice sector. *Supply Chain Management: An International Journal, 13*(1), 83–91.

Giannakourou, M. C., Koutsoumanis, K., Nychas, G. J., & Taoukis, P. S. (2001). Development and assessment of an intelligent shelf life decision system for quality optimization of the food chill chain. *Journal of Food Protection, 64*(7), 1051–1057.

Iijima, M., Komatsu, S., & Katoh, S. (1996). Hybrid just-in-time logistics systems and information networks for effective management in perishable food industries. *International Journal of Production Economics, 44*(1/2), 97–103.

Jackson, V., Blair, I. S., McDowell, D. A., Kennedy, J., & Bolton, D. J. (2007). The incidence of significant food borne pathogens in domestic refrigerators. *Food Control, 18*(4), 346–351.

Jevšnik, M., Hlebec, V., & Raspor, P. (2008). Consumers' awareness of food safety from shopping to eating. *Food Control, 19*(8), 737–745.

Kuo, J.-C., J.-C. Chung & Lin, C.-C. (2003), *Feasible Study for Healthy Logistics Service System*. Technical report. Industrial Technology and Research Institute, Taiwan, ROC.

Likar, K., & Jevšnik, M. (2006). Cold chain maintaining in food trade. *Food Control, 17*(2), 108–113.

Montanari, R. (2008). Cold chain tracking: A managerial perspective. *Trends in Food Science & Technology, 19*(8), 425–431.

Ovca, A., & Jevšnik, M. (2009). Maintaining a cold chain from purchase to the home and at home: Consumer opinions. *Food Control, 20*(2), 167–172.

Rediers, H., Claes, M., Peeters, L., & Willems, K. A. (2009). Evaluation of the cold chain of fresh-cut endive from farmer to plate. *Postharvest Biology and Technology, 51*(2), 257–262.

Stringer, M. F., Hall, M. N., & The Breakdowns in Food Safety Group (2007). A generic model of the integrated food supply chain to aid the investigation of food safety breakdowns. *Food Control, 18*(7), 755–765.

Svensson, G. (2007). Aspects of sustainable supply chain management (SSCM): Conceptual framework and empirical example. *Supply Chain Management: An International Journal, 12*(4), 262–266.

van Strien, P. J. (1997). Towards a methodology of psychological practice, the regulative cycle. *Theory and Psychology, 7*(5), 683–700.

Zhang, G., Habenicht, W., & Spie, W. E. L. (2003). Improving the structure of deep frozen and chilled food chain with tabu search procedure. *Journal of Food Engineering, 60*(1), 67–79.