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The integrated logistics management system: a framework and case study

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Introduction

In recent years, the heightened intensity of retail competition has drastically changed the way distribution companies operate their distribution systems. These changes include the application of the integrated logistics management concept to the analysis and design of their supply chains and, what is most important, extensive use of information technology to gain a competitive edge. Five major information technologies which have become increasingly common in practice are:

(1) point-of-sale (POS) systems;

(2) barcoding;

(3) electronic data interchange (EDI);

(4) value-added networks (VANs); and

(5) electronic ordering systems (EOSs).

In addition, distribution firms should maintain close relationships and effective communications with their channel/trading partners, render necessary support to them and provide customers with satisfactory service. These have been deemed the key factors for distributors' success in managing their logistics systems.

The purpose of this article is to formulate an integrated framework for distribution firms to establish and so improve their distribution systems. Since information technology is an important prerequisite to good logistics management, integration of information technology with the logistics management concept is presented. In the presentation, relevant Taiwanese practices are covered. Because few Taiwanese papers[1-3] discuss logistics management, a referenced summary of logistics' treatment refers almost exclusively to the USA/UK literature. To illustrate further the pragmatic operations of an integrated logistics management system, a case study of a large Taiwanese food processor is included. This study also investigated situations where Taiwanese retailers have engaged in some aspects of logistics management through a survey of the case company and another 44 retailers.

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Background

Logistics definitions

Daskin[4] defined logistics as "the design and operation of the physical, managerial, and informational systems needed to allow goods to overcome time and space". Another definition promulgated by the Council of Logistics Management[5] is:

> the process of planning, implementing, and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods and related information from point of origin to point of consumption for the purpose of conforming to customer requirements.

In the past, logistics had a variety of names such as "physical distribution", "business logistics", "supply chain", and so forth. However, "logistics management" is the most widely accepted term among professionals[6].

Logistics management is vital not only to manufacturing and assembly industries, which are goods-oriented, but also to retailing, transport and other distribution or service-oriented industries. Today's retail businesses have diversified into commodity supplies, restaurants, travel services, rental and leasing services, agriculture, education and culture. Ellram *et al.*[7] explored the way in which retailers were using logistics to respond to the challenges of increased competition and the threat of takeovers. Transportation is also very important, because logistics involves the movement of products (raw materials, parts, supplies, finished goods) from a point-of-origin to a point-of-consumption. Davis[8] showed that in terms of $/cwt, physical distribution costs had increased by 12 per cent between 1980 and 1988 and, on the average, represented 7.53 per cent of sales. Barks[9] further reported distribution costs in the Davis Database that, in 1989, transport costs represented 2.9 per cent of sales, 1.91 per cent of inventory carrying costs, 1.83 per cent of warehousing costs, and 0.5 per cent each of customer service and distribution administrative costs roughly amounting to a total distribution cost of 7.46 per cent of sales. The 1989 distribution ratio of 7.46 per cent was close to the average figure per cent during this period of 7.53. However, distribution costs may continue to rise[10]. In order to alleviate the possible impact of rising costs in the future, companies should improve distribution efficiency and effectiveness through logistics improvements with cost justifications.

The above definitions imply that there exist four flows in a logistics system. First, *material flow* is a flow of goods from their sources through the necessary processes, including storage, retrieval and delivery, then on to the customer with no unnecessary delays or costs. Second, *merchandise flow* contains marketing flows in the channel of distribution. It represents a transfer process of goods from manufacturers through wholesalers and/or retailers to customers. The difference between material flow and merchandise flow is that the former is only to move goods from producers or suppliers to customers without considering the paths through which the ownership of goods passes on the way from suppliers to customers. Third, *money flow* involves pay in advance and

funds' transfer, which can be handled by electronic fund transfer (EFT). Fourth, the linking of the desired information communicated among the members in the logistics channel constitutes *information flow*. This creates the need for the installation of a logistics information network. The aforementioned information technologies can be extensively used to enhance the manipulation of information flow.

Despite the different strategies distribution firms have formulated, their logistics systems have various common features including:

- diversified products;
- short order cycle times;
- shipping in small quantities;
- high frequency and reliability of deliveries;
- customer service orientation;
- low stock level and rapid inventory turnover; and
- timely and accurate information requirements.

It is widely recognized that the four flows and all components involved in the logistics system should be integrated to achieve synergy. Bowersox and Morash[11], Shah[12] and Shapiro[13] have emphasized the great importance of integrated logistics management.

Important issues in logistics management

Although human activities have been recorded for thousands of years, the earliest research on logistics management in the US can be traced back to the early 1900s. After the Second World War, corporations began to emphasize customer satisfaction, and logistics was further developed. Later, with the development of information and management technologies, the revolutionary change in managing logistics systems was termed the "distribution revolution" in contrast to the Industrial Revolution which occurred in the eighteenth century in Great Britain.

Today, governments and all members in supply chains need to work together to resolve several important issues in an attempt to create a good operating environment. For example, in Taiwan considerable time and effort have been spent to:

(1) Enact/modify laws and regulations relating to practical operations in logistics. For instance, the law with the widest impact on Taiwanese distribution companies is the Distribution Industry Regulation, which sets the criteria and standards for distribution companies to build and operate their distribution centres. The provisions of providing distribution companies with low-interest funds and reducing tax payments in installing automatic logistics equipment are also covered by this law. This law was passed in 1992 and amended once since then.

(2) Encourage member companies to increase their use of the *universal product code* (UPC).

(3) Establish EDI standards[14-16] for specific distribution industries.

(4) Develop nationwide merchandise databases for member companies to carry out on-line enquiries and necessary analyses as well as prepare performance, design, operating and test specifications for each logistics information subsystem. For instance, a pilot supermarket merchandise database is developed and contained in a nationwide supermarket VAN pilot system (see (6) below). It is expected that the pilot database will be expanded to cover more merchandise. Also, Chinese EDI, EOS and POS system specifications are prepared for documentation and standardization.

(5) Standardize the containers, racks and pallets that can be interchangeably re-used by member companies in the supply chain.

(6) Develop a pilot logistics system by designating a committee composed of logistics professionals from government agencies, business organizations and academic/research institutions. For example, a nationwide supermarket VAN pilot system in Taiwan was installed in this way on 30 November 1993. The system included merchandise and supplier management, EDI management, EOS, EFT, card service and POS subsystems. Figure 1 shows the pilot logistics system framework. It was estimated that the total cost savings approximated US$0.44 million in the first operating year. The benefits will be even more substantial in the future, as many new users join the system and the system's technology transfers to other industries.

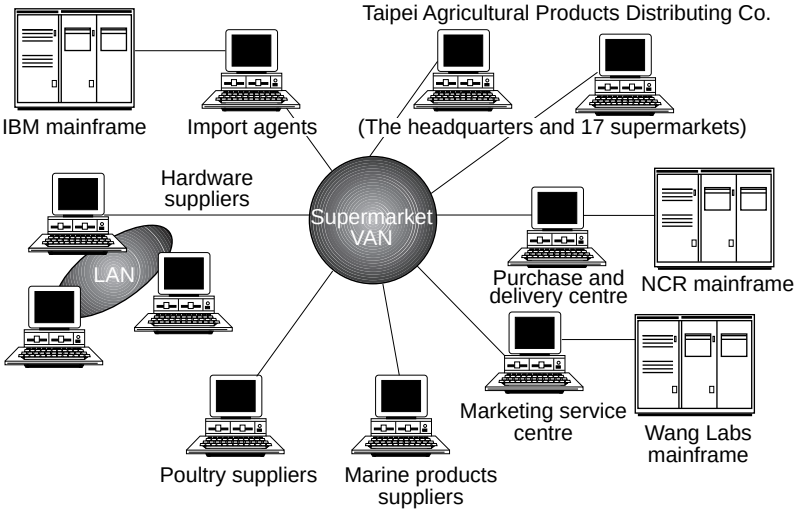


Figure 1.
The pilot logistics system framework

(7) Develop long-term formal courses and short-term intensive training programmes for logistics personnel of member companies to improve their managerial abilities and technical skills in logistics.

The philosophy of JIT (see Sohal *et al.*[17] and Golhar and Stamm[18]), which is currently prevalent in manufacturing, can be applied to logistics management. By applying the concepts of (JIT) information processing, purchasing, delivery and service, distribution firms can more easily accomplish the goals of paperless transactions, quick response, low logistics cost and customer satisfaction.

Overview of the logistics management system

Generally, a logistics system comprises a variety of components: corporate headquarters; retail stores; distribution centres (DCs); suppliers; manufacturers; distributors; carriers; networks; information service providers; insurers; and bankers. Figure 2 presents a typical logistics system.

As shown in Figure 2, a large general merchandiser with geographically dispersed DCs and retail outlets may need a dedicated satellite network. For example, Wal-Mart's use of satellite communications has been a key factor in its success in distributing goods to their stores[19]. The POS terminals in each store are connected to an in-store micro or mini computer. The store computer is then connected to the satellite network and can be accessed directly by the corporate mainframe. However, for a local, medium-sized company, using standard telephone lines or leased lines may be enough.

The mainframe in the headquarters maintains all records of the current stock levels at each DC. Thus, purchase orders can be transmitted directly and accurately from the mainframe to the computers of the vendors. By 1993, it was

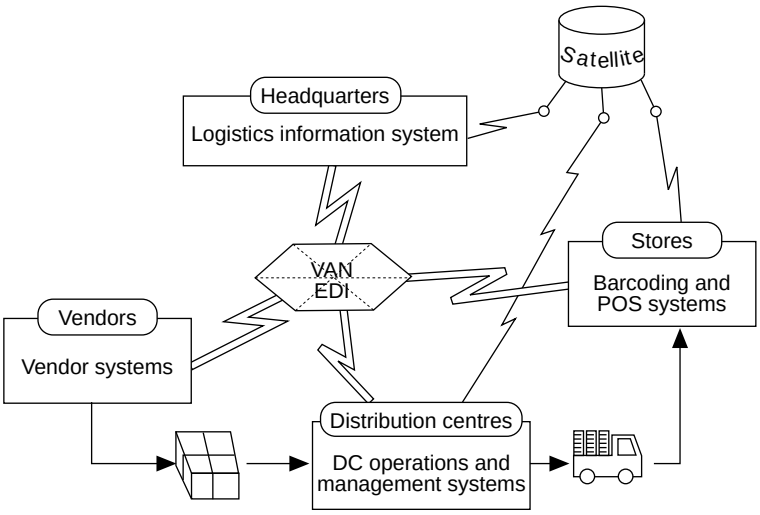


Figure 2.
A typical logistics system

estimated that over 90 per cent of Kmart's purchase orders were transmitted via EDI. The deliveries of goods from DCs to retail stores are pursuant to the vehicle routing schedules. This is a typical vehicle routeing problem[20,21]. Figure 3 shows major subsystems and flows in the logistics information system.

Distribution centres in the logistic system

Types of distribution centre

In order to realize economies of scale, a distribution company may build its own DCs, or several companies may share one DC. Generally, distribution centres can be classified into the following six categories:

(1) distribution centres built by manufacturers (MDC);

(2) distribution centres built by wholesalers;

(3) distribution centres built by truckers;

(4) distribution centres built by retailers (ReDC);

(5) regional distribution centres – serving retail stores or outlets within a particular (small) area; and

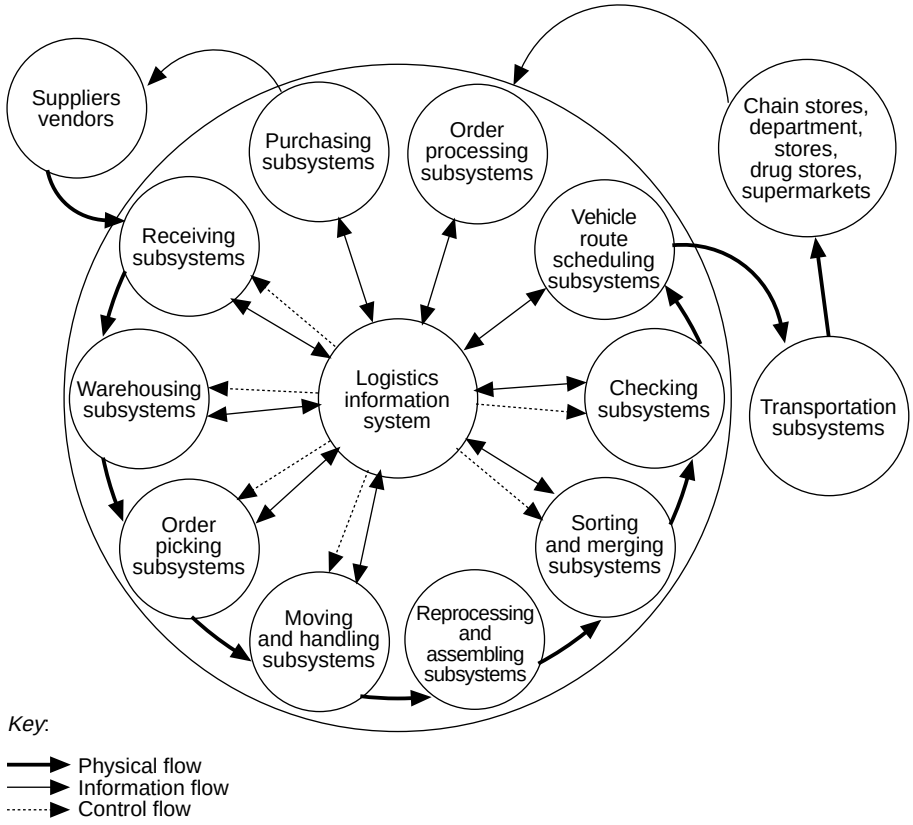


Figure 3.
Subsystems and flows in a logistics information system

(6) frontier distribution centres – equivalent to transfer or depot centres.

The major differences among the six categories are obvious because of their different missions. For example, a MDC built by the manufacturer through forward integration is much closer to the final consumers. On the other hand, a ReDC is built by the retailer through backward integration to ensure that low price, high quality and stable supply of goods can be achieved. However, the basic functions of these two types of DC can be identical.

Basic functions of the distribution centre

In this article, the distribution centre is referred to as the MDC or the ReDC. There are eight primary functions of the DC: receiving; warehousing; order picking; moving and handling; reprocessing and assembling; sorting and merging; checking; and vehicle route scheduling, as depicted in Figure 3. The function of order picking is very important. According to the general manager of the Retail Support Corporation in Taiwan, the manual order picking time was generally about 30 per cent of the total DC operation time. In addition, the order picking cost approximated 15 per cent of the total DC operation cost for a manual picking DC. Ottjes and Hoogenes[22] formulated a DC simulation model in The Netherlands to describe order picking and traffic operations. Ntuen *et al.*[23] studied ways of increasing storage capacity and improving inventory turnover efficiency for a kind of distribution centre. Of course, using automatic picking equipment or a computer-assisted picking system (CAPS) can increase the efficiency of picking operations, but the underlying premiss is to be able to achieve economies of scale.

Possibly, certain goods received frequently and in bulk from suppliers should be reprocessed, assorted and packed into saleable packages before delivery to retail stores. In such a case, the DC has to have efficient equipment for performing the function of reprocessing/assembling.

The objectives that the DC manager must make strenuous efforts to reach are to:

- reduce the time spent in handling each product;
- persistently lower DC operation costs through continuous improvement;
- decrease the rate of order picking error;
- shorten the time that elapses from the receipt of an electronic order to the completion of the shipment;
- decrease the rate of delivery delay; and
- respond quickly to any abnormal events such as incorrect shipments of regular orders, emergency shipments of rush orders, the filling of very small orders, returns of defective goods and various operational mistakes.

Use of information technology

With increasing global competition, many distribution companies are beginning to realize that they and their trading partners are indivisible parts of the supply chain. The use of information technology to form a consolidated logistics network has become an inevitable trend. Five major information technologies used are barcoding, POS, EDI, EOS and VAN.

Barcoding and POS systems

Barcoding of products is the first step towards store automation. Store automation led by POS systems has become indispensable in the logistics management strategies of distribution firms. In some developing countries, the percentage of use of the UPC is not high because most retail stores conventionally have used the company-specific in-store codes. This situation has been an impediment to the widespread use of POS systems. According to the Taiwan Institute of Information Industry (Triple I), by 1993 over 3,300 companies and 130,000 products had UPC tags attached or printed on the packages of goods. It is expected that by 1995 the proportion of stores applying UPC to the food products, groceries and commodities will reach 90 per cent, as compared with 70 per cent at the end of 1993.

The UPC data and price list are regularly (usually nightly) provided by the mainframe in the corporate headquarters. In each store, a super-micro or mini computer that monitors the POS terminals maintains the UPC database and price list. Almost all sales information can be gathered by the front POS (FPOS) system in a more timely and accurate way. The rear POS (RPOS) system analyses sales information from the FPOS system, prints out the UPC barcodes, manages goods by product and places electronic orders. In addition, the RPOS system handles merchandise receiving and inspection, inventory control, physical counting, accounting and vendor management. In Taiwan, most POS systems consist of the FPOS system and the RPOS system. One benefit of POS systems is that the results from sales analysis can show which product is the best seller and which is the sticker.

Electronic data interchange

EDI refers to the direct transfer of information between computers of trading partners. To achieve the goal of paperless transactions, the exigent need for a common standard for recognizing interflow information is encouraging. The document forms that trading partners send each other, such as purchase orders, order confirmations, bills of lading, invoices, advanced shipment notices and remittance advices, are formatted and converted to standard messages during the transaction process. The standard messages can be interpreted, processed and transmitted directly, using the same data communication protocols via a communications network, usually a direct link network or third-party network, to the destination without incurring the delay of mail delivery. Solis[24] pointed out that about 15 per cent of logistics expenses were derived from order

processing, administrative and related costs, so savings from EDI in these areas are substantial.

EDI formats differ not only from industry to industry, but also among firms in the same industry. A variety of industry-specific standards have been developed. Some popular examples are: UCS (uniform communication standard) for the retailing industry; WINS (warehouse information network standard) for the warehousing industry; TDCC (transportation data co-ordinating committee) for the transportation industry, CIDX (chemical industry data exchange) for the chemical industry; VICS (voluntary inter-industry communication standard) for general merchandisers, and EDX (electrical data exchange) for the electrical industry. According to the marketing information centre at the Triple I, there was no sign of the application of EDI in Taiwan before 1992. Now its application is making good progress. The results include: 220 trading companies connected to a tariffs and trade EDI network; 119 car makers/part suppliers added to an automobile EDI; 38 supermarkets/suppliers linked to a supermarket VAN pilot system, as mentioned earlier; and another 49 EDI users selling EDI software packages and providing information services. On the other hand, the Japan Information Processing Development Centre reported that, at the end of 1993, at least 50,000 companies were EDI users. Undoubtedly, EDI application will become extensively pervasive in the future.

With an increasing number of global trading partners, many companies realize that they need international EDI standards. Most US companies subscribe to the ANSI X.12 standard, while most companies in Europe and Asia subscribe to UN/EDIFACT. As a result, there is an increasing demand for EDI software packages with the flexibility to be able to transform one standard message into another. The success of EDI application depends on the creation of industry-wide standards, high EDI technical levels, reliable VANs and thorough EDI regulations. Once the standards are developed, trading partners will become more willing to use EDI.

Electronic ordering systems and value-added networks

After POS data have been processed by the RPOS system, electronic orders are automatically placed when certain stock levels of products in the retail store are reached. Also, the store manager can use a hand-held terminal to enter his orders if required. Orders from all retail stores are received over the VAN by the mainframe at the headquarters. Then they are recorded, approved and forwarded electronically to the appropriate distribution centres or suppliers. Triple I reported that network service businesses in Taiwan had sales of US$116.12 million in 1993, US$100.10 million in 1992, and US$88 million in 1991. The sales growth of 16 per cent in 1993 over 1992 was far higher than the economic growth of 6.3 per cent in 1993. Figure 4 depicts the growth of network services in more detail. The sales growth in 1994 over 1993 is expected to be 20 per cent.

In the next section, a case is presented of one large food distribution company in Taiwan to illustrate how to apply the framework of the logistics management system presented in previous sections. This framework delineates some special

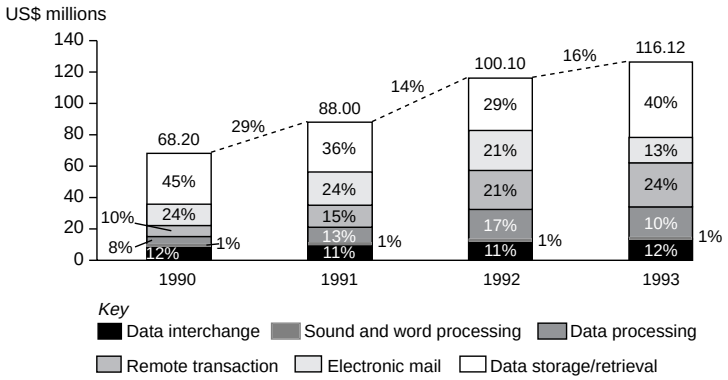


Figure 4.
The growth of network services in Taiwan

characteristics and several important issues existing in the logistics management system, the system's major components and their integrative operations, and the use of information technology. This case is pragmatic in nature and will present performance analysis and improvement suggestions that are helpful to logistics practitioners.

A logistics management case

Case description

The PST Enterprises Corporation, founded in April 1978, is one of the biggest food processors and retailers in Taiwan. The company serves an island-wide market with a variety of products ranging from food items to consumer sundries. Their product lines include breads, Chinese fast foods, beverages, toys, newspapers, magazines, cigarettes, wines and many other consumer goods. The company has its own plants to produce breads, some kinds of Chinese fast foods and various beverages under the brand of PST. The Chung-Li plant, located about 40 miles south of Taipei, is the largest PST plant producing PST breads and fast foods for the northern Taiwan market. Another ten plants located in the suburbs of the major cities manufacture various kinds of beverages. Most of the vendor-made products from over 400 suppliers or manufacturers and all company-made products are shipped to the DCs and then delivered to the appropriate chain stores according to the vehicle routeing schedules. Under 20 per cent of vendor-supplied products such as ice creams are delivered to the chain stores directly because of low transport costs and the lack of refrigerators in the DCs.

By 1993, PST had opened 777 chain stores, including 640 regular (company-owned) chain stores and 137 franchise arrangements. No voluntary store involvement is the company's policy for management and service quality considerations. These chain stores are almost all located in densely populated areas throughout the island. They had total sales of approximately US$420 million in 1991, US$500 million in 1992, and US$600 million in 1993. Consequently the company achieved, on the average, a 20 per cent growth in annual sales. Each chain store provided the customer with round-the-clock service. The

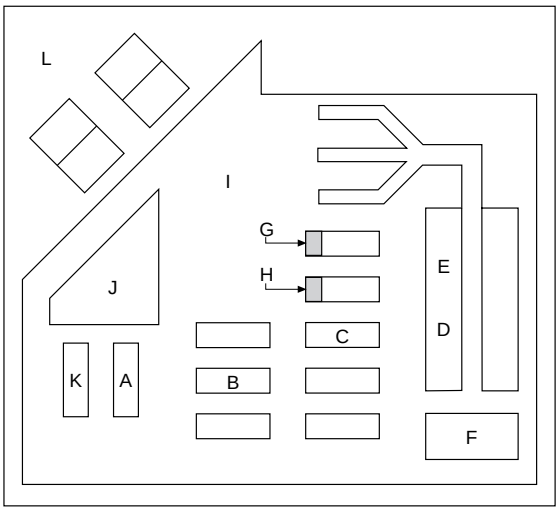
company also actively participated in various benevolent activities, such as enhancing environmental protection, helping police officers in search of missing children, and donating money or food to aid many charity institutions, which helped PST to earn a fairly good reputation in Taiwan. Over the last few years, PST was ranked as an *Excellence Magazine* top ten reputable corporation.

The floor space of each chain store was generally less than 2,000 square feet because of the high land price and costly rent. Therefore, each store was limited to cramming no more than 2,000 product items (or stock-keeping units (SKUs)[19, p. 197]) onto the shelves. Laser scanners could scan most of the company's products because of the high percentage of barcoding. It represented over 90 per cent of the source marking (i.e. the UPC) and less than 10 per cent of the instore marking. Each store allocated a small space to a stock room for storing the best-selling products. These products needed additional space besides the shelves to maintain the required service level. The stocking requirement for each best-selling product was determined according to a two-day normal demand level because the average order cycle time was two days. Top management felt that it was necessary to maintain at least a 95 per cent service level in such a drastically competitive market. The company's major competitor, the Wei-Chuan Foods Corporation, also operated a formidable distribution system and did the same things as did PST. Each store installed a FPOS system and a RPOS system in an attempt to improve responsiveness and consumer service further. It has been five years since the company successfully carried out the EOS in both types of chain store. Store clerks could use hand-held terminals to enter replenishment orders. Almost all replenishment orders and business documents were transmitted between chain stores and corporate headquarters via a VAN. PST had organized a store automation committee composed of technical and logistical experts and staff from both the marketing and distribution services departments. A project manager was fully responsible for accomplishing the objectives of store automation.

The fact was that less than 20 per cent of a chain store's orders were not electronic orders, which were allowed to be filled by the vendors directly. However, the electronic orders emanating from chain stores in northern Taiwan areas were filled by the northern DC of the Retail Support Corporation. Another DC, in Tainan, a city in southern Taiwan, served the southern Taiwan market. The Retail Support Corporation is one related business of PST which owned 51 per cent of the subsidiary company's stock.

Each DC had approximately 50,000 square feet of floor space with about 100 employees. PST's headquarters purchased goods centrally from over 400 suppliers. The close relationships with these suppliers and the long-term purchasing contracts made it possible to buy goods at low prices. Also, it could be ensured that the DCs would receive the ordered goods at the right time. Each DC could handle not more than 2,500 product items (or SKUs) because of limited space. A simplified view of the DC layout is presented in Figure 5.

PST's headquarters recorded, approved and forwarded chain stores' electronic orders to the computers at the DCs. Each DC then processed every



Key:
A— Area for high unit price products (i.e. cigarettes and wines)
B— Area for large volume, but light products (i.e. instant noodles and toilet tissue)
C— Area for small volume, but heavy products (i.e. beverages and canned goods)
D— Area by the two sides of the order-picking conveyor for storing piece commodities on the picking racks
E— Area by the two sides of the order-picking conveyor for storing piece foods on the
F picking racks
G— Area for materials and tools used by chain stores
H— Delivery kanbans
I— Performance rating kanbans
J— Area for temporarily storing outbound goods
K— DC office
L— Area for product returns
— Inbound and outbound docks

Figure 5.
A view of the simplified DC layout

arriving order and prepared a picking list for each storage area. The goods picked from the storage areas of A, B, C, D, E and F, as shown in Figure 5, were merged into a batch that contained all the orders placed by a chain store. Then several batches were put together for delivery to a particular set of chain stores according to the delivery *kanbans*. These aggregate batches were loaded onto designated trucks. The DC immediately sent the picking and shipping information to corporate headquarters.

By the end of 1993, each storage cell and picking rack had been equipped with a liquid crystal display, coupled with a well-designed CAPS and the DC afterwards could handle order-picking operations in a more efficient and effective way. Any product, no matter whether it was PST-made or vendor-supplied, was charged a distribution cost of 4 per cent of the sales price before 1992. After the beginning of 1993, this figure increased to 6 per cent in order to maintain a gross profit margin of about 10 per cent. Each DC reported an estimated value of outbound goods at US$200 million for 1993. Meanwhile, each DC often held the average inventory at a level of US$4 million.

The RS Corporation owned two truck fleets, each with 20 trucks for one DC to ship goods by a vehicle-routing schedule developed manually. To keep away from traffic jams during rush hours, the delivery times were usually late at night. Each chain store received ordered goods every two days. Unfortunately, the major disadvantage was that the industry-specific EDI standard had not yet been established. Thus, effective communication was a problem because communications with suppliers still relied heavily on facsimile transmission machines (fax), telephone or mail.

Analysis

Several performance indicators were used by the RS Corporation in measuring the operation performance of the DCs. A control standard – revised annually for each performance indicator – was figured out by the top RS managers after referring to historical performance data and considering relevant situational factors. The yearly revised standards were the major source of progressive impetus pushing the RS Corporation to improve continually. These performance indicators and their associated performance in 1993 were analysed as follows:

- *Inventory turnover rate*. The DCs achieved a rate of 4.2 per month, which was slightly lower than the standard, 4.5 per month. This fact could be attributed to the company's policy of maintaining a higher service level that would inevitably result in a higher average inventory level.
- *Picking error rate*. There were occasional errors in picking and filling chain stores' orders. The order picking error rate was 0.3 per cent, while the standard was set at 0.2 per cent. However, the percentage was relatively low as compared with other companies in the distribution industry.
- *The stockout rate*. The DCs reported a 1.0 per cent stockout rate, which was lower than the standard rate of 2.0 per cent. The standard stockout rate virtually amounted to a 98 per cent service level. Moreover, the rate had decreased by 1.5 per cent as compared with 1992.
- *The spoilage rate*. This rate could be figured out by dividing the spoiled goods value by the outbound goods' value a given period of time. The year's spoilage rate was 0.5 per cent, which was identical to the established standard.
- *Cost ratios*. The total operation cost of the DCs was about 88 per cent of the year's gross revenue, which compared unfavourably with the target of 85 per cent. The order-picking cost, which was over 15 per cent of the total operation cost, also reflected unfavourable performance.
- *Employee productivity*. Productivity was measured in terms of the value of outbound goods. It was estimated that employee productivity averaged US$160,000 per employee per month. This figure essentially matched the standard and had increased at least US$10,000 when compared with the previous year.

Improvement directions and expectations

Ten constructive suggestions can be offered the PST and RS Corporations to improve their conjointly integrated logistics system:

(1) The expected sales in 1994 are US$720 million, which suggests 20 per cent growth over the 1993 sales value. This growth can be accomplished primarily by opening many more chain stores. At the end of 1994, PST will operate 900 chain stores. By 1995, the company expects to have over 1,000 chain stores operating in its distribution system.

(2) The surprisingly continuous increase of the number of chain stores will begin to exceed the capacity of the DCs. Building of another DC and expansion of the existing DCs should be planned to support future sales' growth and the store expansion programme. For instance, a new DC can be built in the central part of the island so that the overload of the existing two DCs can be alleviated.

(3) Furthermore, a procedure should be developed and decision criteria specified on which the fast replacement of slow-selling goods can be based. It is expected that every month 50 product items will be eliminated and replaced with those which are potentially best-selling.

(4) It is extremely important to re-examine PST's distribution policies and implement a cost reduction programme in order to maintain competitive superiority over its major competitor, the Wei-Chuan Foods Corporation. Additionally, in the last few years, many new competitors have emerged in the form of large chain stores, supermarkets and discount stores.

(5) Establish an industry-specific EDI standard as soon as possible to achieve the goals of paperless transactions and effective communications with suppliers and other trading partners.

(6) It is important to improve existing DC layouts, to get more efficient machines such as automatic order-picking equipment and an automatic sort/merge system, and advanced logistics management techniques involved. These are considered by top management as the right ways to increase productivity and survive in such a fiercely competitive environment.

(7) The percentage of in-store marking is expected to be further decreased to a reasonable level, say 2 or 3 per cent, because it is unreasonable to ask store clerks to attach UPC tags, for example, to marinaded eggs which are soaked in a pot of boiled Chinese tea.

(8) Although there are infrequent errors in recording, picking and filling orders, continuous improvement is something that all the members in the distribution system must pursue. In addition, success in store automation, reduction of order cycle times and avoidance of delays in delivering orders should also be the focus of further efforts.

(9) Two fundamental issues in improving the reliability of the CAPS, the communications network and the computer systems are: how to reduce operating errors that can be attributed to human factors; and how to prevent these systems from being attacked by viruses or from discontinuing operation after a power failure. Conducting intensive employee training and installation of a stand-by uninterrupted power system (UPS) would be necessary steps to reduce possible errors and failures.

(10) Replace the manual truck-assignment and route-scheduling system with a tailor-made, computer-assisted vehicle-routing system (CAVRS) or an appropriate CAVRS package[25].

Survey and analysis

A survey was conducted to investigate the extent to which logistics management was being carried out in Taiwan. The analysis of the survey covered basic operating data, logistics management barriers, logistics services and the use of information technology. Chief executive officers (CEOs) of 45 retail companies were asked to respond to a series of questions on the four areas of analysis. The CEO of the PST Corporation is one survey participant. All survey participants were asked to provide demographic data, including sources of capital, the number of chain stores, annual gross revenues and distribution costs. Respondents were provided with a list of logistics management barriers (see Table I) and were asked to indicate five important barrier items about which they were most concerned. Similarly, respondents were provided another list of logistics' services (see Table II). The responses were measured on a five-point scale, where 5 was most important and 1 was least important among the five items. If any item was not chosen by the respondent, then zero was assigned to it. Further, each respondent was asked to rate 22 performance items in terms of satisfaction with information technology used. Another five-point

Barrier item	Overall mean
Lack of advanced logistics management know-how and talent	2.911
Inadequate elaboration of existing logistics laws and regulations	2.800
Delivery delay caused by constant traffic jam	2.644
Insufficiently high percentage of universal product code usage	2.356
Industry-specific electronic data interchange standard unavailable	2.133
High costs in acquiring and installing automatic logistics equipment	1.689
Imperfect logistics information system	1.267
Poor relationships with suppliers and other trading partners	0.778
Employee resistance to changes to logistics management processes	0.644
Unobtainable logistics economies of scale because of limited Taiwan market	0.489

Table I.
Analysis of logistics management barriers

Service item	Overall mean
Shorter order cycle time	3.298
Higher frequency of delivery	2.622
Lower spoilage and delivery delay rates	2.133
Shorter customer checkout waiting time	1.756
Lower stockout rate	1.556
JIT delivery regardless of small or large quantity ordered by any chain store	1.378
Quick response to rush orders	1.267
Easier manipulation of electronic ordering systems	0.889
Lower order picking error rate	0.667
Each product with universal product code and price tags attached to packaging	0.422

Table II.
Analysis of logistics services

scale (2 = very satisfactory; 0 = no comment; and –2 = very unsatisfactory) was used. Table III shows the top ten (satisfactory) items.

The statistics of the demographic data reveal the fact that 22 companies (48.9 per cent) raised their funds from Taiwanese entrepreneurs and domestic capital markets. The remaining companies (51.1 per cent) used joint ventures in alliance with foreign companies. Approximately 37.8 per cent of the 45 retailers had developed alliances with Japanese companies. For example, the PST Enterprises Corporation and Mitsubishi Foods Corporation had entered a joint venture. Logistics managers had recognized the positive synergy created by co-operative partnerships between companies in sharing technology, logistics management techniques, financial resources and marketing channels. In addition, the results of the survey show that average sales' growth in 1993 was

Performance item	Overall mean
Good business image	1.585
Short checkout waiting time	1.439
Quick response and stockout decrease	1.424
Transaction simplification	1.202
Product mix reinforcement	1.189
Economies of scale of the supply chain	0.972
Fewer employees due to service automation	0.867
Enhanced communication with customers	0.855
Accelerated merchandise turnover	0.736
Short order cycle time	0.698

Notes: 2 = very satisfactory
0 = no comment
–2 = very unsatisfactory

Table III.
Satisfaction with using information technology

23.62 per cent, which was about 4 per cent higher than in 1992. In 1993, average distribution cost was 7.24 per cent of sales, which was up by 1 per cent as compared with the previous year. Such a small percentage of cost increase may simply reflect that the increment of distribution costs was diluted by higher product prices.

Table I presents the analysis of logistics management barriers. The lack of advanced logistics management know-how and talent was rated by the respondents as the most important barrier. This is the reason why over 50 per cent of the 45 retailers had resorted to joint ventures with foreign companies advanced. Inadequate elaboration of existing logistics' laws and regulations, such as restrictions on the location of DCs and on the operation of chain stores, also had a tremendous impact on retailers. In an effort to resolve the problem of traffic jams in the daytime, the alternative of late-night delivery seemed to be the best transport policy. Undoubtedly the insufficiently high percentage of UPC usage had been an obstruction to the use of the POS system. Table I also shows the importance of an available EDI standard.

An analysis of those logistics' services in which the respondents were interested is provided in Table II. Shorter order cycle time was ranked as the most important service item from the standpoint of the retailers. The lower stock-out rate and shorter customer check-out waiting time were also ranked as important service items by the respondents who represented their customers.

Table III indicates that when using information technology, top managers preferred to promote their business image and provide customers with satisfactory services, such as short check-out waiting time, quick response and a decrease of the stock-out rate. Surprisingly, some technical merits, such as accelerated merchandise turnover and short order cycle time, did not obtain high overall means, even though they were extremely important service items, as shown in Table II.

Finally, each respondent was asked to assess the extent to which his company used information technology. The results are summarized in Figure 6.

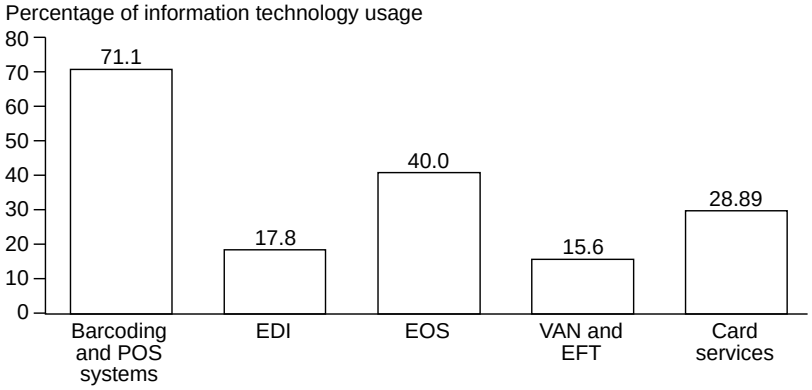


Figure 6.
Use of information technology expressed as percentages

Approximately 70 per cent of the 45 retail companies had installed some form of POS system. However, the percentage of EOS usage was 40. Only 17.8 per cent and 15.6 per cent of retail companies used EDI and VAN, respectively. This is because successful implementation of EDI and VAN requires the creation of industry-wide or company-specific EDI standards. Compromise between retailers and their trading partners on an agreement to standardize the formats of business transaction documents is usually very difficult to achieve and time-consuming.

Conclusions

The integrated logistics system is especially important for distribution-oriented companies when they face heightened domestic and global competition. The survival of distribution companies has become an underlying issue for the so-called "distribution revolution". The framework of the integrated logistics system presented in this article involves the system's major components, their relationships and operating philosophies. Since most companies have a small portion of the whole supply chain, linking closely with trading partners to achieve synergy is essential. In addition, working with channel partners helps them to overcome common logistics management barriers and provides them with satisfactory logistics' services, as found through a survey of 45 retailers.

An inevitable trend in the future will be more intensive use of new information technology to increase logistics' productivity in the distribution industry. Today, those retailers who remain labour-intensive and tardy in the use of technology will have to change their strategies and provide customers with convenient automated services. Store automation systems built around POS and EOS systems can be instrumental in improving logistic efficiency and supporting improved customer service levels. To improve service levels further, integration of information technology and logistics management is becoming increasingly important. Such integrated systems enable retailers to save on labour, increase accuracy, to quicken services, and cut costs.

This article has also illustrated Taiwanese logistics management practices by covering the case of the PST Corporation and presenting much Taiwanese experience. After all, the keys to success lie in good logistics system's planning, well-designed distribution organization, prudent selection of allied companies, close relationships with trading partners, good logistics investment analysis, logistics management barriers elimination, top management commitment and continuous improvement in logistics.

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