

THE ROLE OF INFORMATION SYSTEMS IN ESTABLISHING THE JUST-IN-TIME (JIT) TYPE TRANSPORTATION

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abstract: The use of information systems increasingly play an important role in establishing Just-In-Time (JIT) by shortening the lead-time thereby achieving higher efficiency. This paper introduces the basic concepts of advanced logistics, marketing and transportation as related to logistics, and more particularly, the relationship of information systems and JIT. This is done by conducting a survey of 26 companies and their use of information systems for JIT. It presents the effects of the information systems on the four elements of marketing: product, price, promotion and physical distribution. However, the utilization of information systems concentrate on the physical distribution element of marketing alone. Hence, it is more appropriate to focus on the problems of physical distribution when using information systems in JIT.

1. INTRODUCTION

Just-In-Time (JIT) system is a philosophy which aims to achieve higher productivity without losses and inventory excesses. Advanced logistics like JIT integrates information flow and synchronizes logistics activities by fully utilizing information technology.

Because of its wide success and applications, the Just-In-Time (JIT) type transportation has become popular in many companies. However, the role that information systems has played in establishing the JIT type transportation, in particular, and their effects on logistics, in general, has not been clarified yet.

The purpose of this paper is to define the role and the effects of information systems on JIT as applied to transportation, and then to show how to establish JIT in companies using information systems.

2. BACKGROUND ON THE SPREAD OF ADVANCED LOGISTICS

2.1 Social Background

2.1.1 The Industrial and Structural Change of Logistics

Industries have shifted from producing heavy and bulky commodities to lighter and more sophisticated ones. As a result of this structural change of industries, goods flow in urban areas has greatly increased and frequent delivery service has become common.

Companies have increased their efficiency of production and minimized their inventory level. In addition to this, companies also require their raw material and intermediate product suppliers to make smaller lots and more frequent delivery services.

2.1.2 Globalization and Structural Change of Logistics

With the high growth of the economy in developing countries, movement of commercial trade and goods between them and the developed countries has increased, as well as between the developed countries. More importantly, goods movement between developed and developing countries has changed from raw material flow to flow of semi- finished products and/or finished products. The industrial trade was developed to be globally competitive along with the transportation system, particularly the pick-up and delivery services.

2.1.3 Consumer Behavior and Logistics

As the standard of living improved, more and more people demand various goods depending upon their preferences. Technological innovation also made it possible to produce and supply a greater variety of goods and commodities.

Hence, most companies would choose suppliers who can deliver high quality goods in smaller lots and with more frequent delivery services, and provide services flexible enough to meet demand fluctuation. The life cycle of goods and commodities are shorter; lot sizes are smaller; and the number of items higher. Thus, the functions of assembling, processing, and packaging has become more important than ever before.

- Industrialization : high quality materials and finished products
- Globalization : spread effects or trickling down
- Consumer Behavior : change of life cycle time of goods and commodity

2.2 Change of Logistics by the Information Technology

2.2.1 Information Technology

Advances in integrated circuits, display screens and process miniaturization technologies have made possible the development of smaller, more powerful types of computers such as portable laptop and notebook computers. Development in information, networking and database technologies have given rise to integrated systems of pick-up and delivery service, processing service, and on-line access to worldwide information.

These advances have changed the ways of commercial trade and logistics activity, and created new businesses based upon logistic service.

2.2.2 Shortening of Lead-Time

Lead-time is composed of a sequence of time-related events such as order transmittal time, order processing time, order assembling time, stock availability and delivery time. Order transmittal and processing time could be shortened extremely by information systems. The lead time could therefore become shorter in accordance with progress of information systems.

2.2.3 Separation of Commercial Trade and Logistics

Commercial trade and goods flow is closely related to each other. But it is possible to separate trade flow and goods flow, with sending-ordering-information quickly and precisely to logistics information systems. Hence, progress of information technology is necessary to separate commercial trade and logistics.

For example, a retailer orders a certain commodity from a wholesaler, and the wholesaler would then order from a manufacturer, if the wholesaler does not have the stock of the commodity. Trade flow is described as the chain of retailer-wholesaler-manufacturer, but the commodity can sometimes be delivered directly from a manufacturer to a retailer.

2.2.4 Substitution/Multiplication/Supplementation Effects of Information Systems

Information has substitution, multiplication and supplementation effects on both logistics and traffic. These effects are described as follows:

- Substitution : the effect of decreasing logistics activities by means of information systems
- Multiplication : the effect of increasing logistics activities by means of information systems
- Supplement : no change on the amount of logistics activities, but logistics activities are done more quickly and accurately by means of information systems

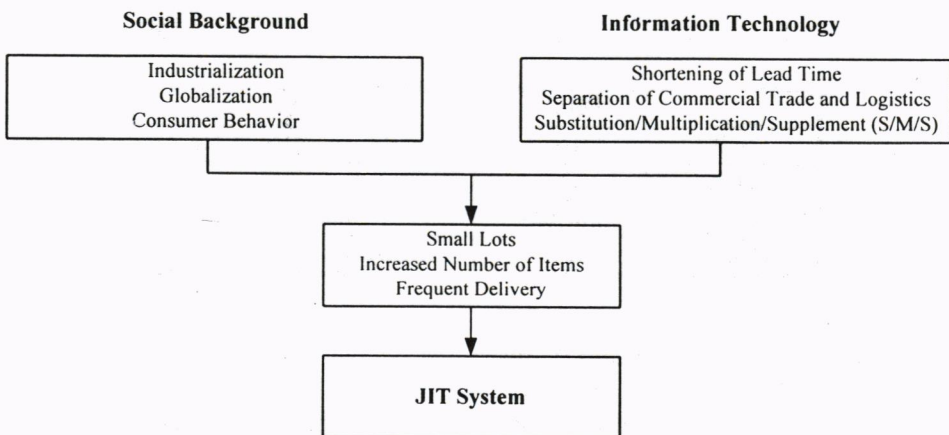


Figure 1. JIT System Resulting from Change in Social Background and Information Technology

3. LOGISTICS AND TRANSPORTATION

3.1 Characteristics of Transportation

3.1.1 Comparison of Person Trip and Goods Movement

Transportation planning has six elements:

- Node : terminal, railway, station, port, airport
- Link : road, railroad, shipping route, flying route
- Mode : car, train, ship, aircraft
- Operation : interval, capacity, etc.
- Control : speed control, safety control, etc.
- Market : price, tax regulation, etc.

The elements of transportation planning has been designed according to its use. Mechanical systems include operation and control, transportation planning and market economic activities.

However, industries and/or firms and the consumers should make a compromise on certain policies of the transportation system. Given the six elements of goods movement, planners have been biased on physical distribution as their linkage for business transactions.

Goods movement are counted in number of items and units, while trips are counted in number of cycle like hour, day, week, month, year, etc.

In packaging and processing, the shape, weight and size of goods changes while person movement remains the same.

Table 1. Difference between Person Trip and Goods Movement

	Person	Goods
unit	person	ton, kg, m ³ , case, piece, etc.
item	one	many
cycle	one day	many pattern
change	never	shape, weight, length, etc.

3.1.2 Pick-up, Transport and Delivery

Transportation of goods is divided into three parts: pick-up, transport and delivery. Pick-up and delivery occurs within an area or a city by using light vehicles like jeepneys, tricycles, pedicabs, etc. and comes from different points to one point of an area and vice versa. On the other hand, transport occurs from one point to another by using large vehicles like ships, airplanes, etc.

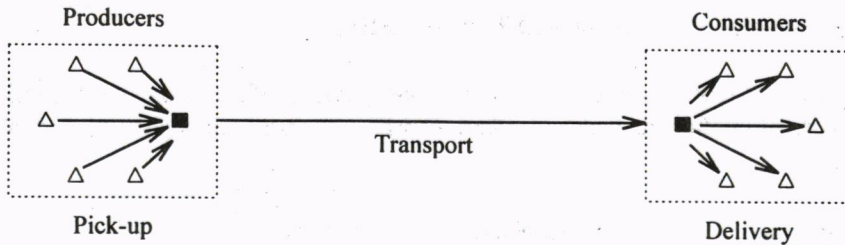


Fig. 2. Pick-up, Transport and Delivery

3.2 Marketing and Transportation

3.2.1 Characteristics of Goods Movement

Transportation is divided into two elements, person trips and goods movement while logistics is composed of commercial trade and goods movement.

In distribution, logistics has two phases, physical supply and physical distribution. In marketing, logistics consists of trade and goods movement.

The characteristics of goods movement is usually misunderstood because it has two aspects, transportation and logistics. However, goods movement should be considered as a part of logistics and not as a part of transportation because the private companies are the ones which introduce information systems to make their own activities be more efficient.

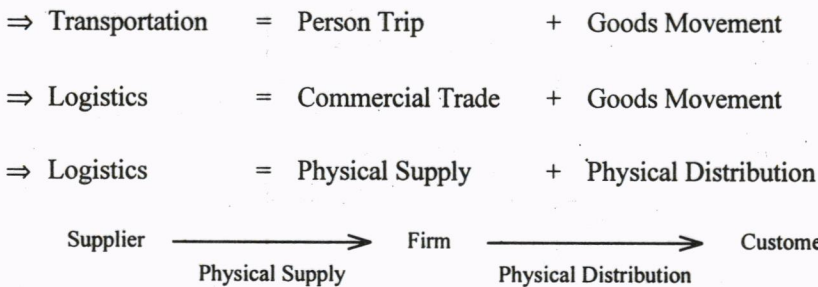


Figure 3. Logistics on Physical Supply and Physical Distribution

Table 2. Comparison of Commercial Trade and Goods Movement

	Commercial Trade	Goods Movement
transfer	money	space & time
firm	commercial firm	trucking firm, warehouse, etc.
function	wholesale retail information	transport, storage processing, packaging handling, information

3.2.2 Relationship of Marketing and Transportation

Marketing is a vital tool for the private sectors. The elements of marketing are the following: product, price, promotion and place. Place consists of distribution channel and physical distribution.

- product : product planning, market research, etc.
- price : costing, pricing
- promotion : advertisement strategy
- place : distribution channel, physical distribution

Physical distribution is part of business management and has six major functions: transportation, storage and deposit, assembling and processing, material handling, packaging and wrapping, and information. Physical distribution functions are annexed to physical distribution facilities, such as terminal, distribution center, warehouse, and so on.

Usually, private sectors tend to design an effective physical distribution system for their own interest and not for the realization of an effective urban goods movement.

Table 3. Physical Distribution Functions

Function	Lot and Space	Facility
<i>main function</i>		
1. Transportation	truck platform parking lots handling space	intercity terminal delivery terminals
2. Storage and deposit	warehouse storage lots handling space	warehouse
<i>additional function</i>		
3. Assembling and processing	picking space assembling space labelling space and etc.	⇒ These functions are set up in:
4. Material handling	handling space	truck terminal, warehouse, factory, wholesale, market, and others
5. Packaging and wrapping	packaging space wrapping space	
6. Information	data processing	

The comparison between the two elements is shown in Figure 4. This figure shows that the private sector believes that goods movement is just a small part of marketing while the public

sector tends to consider transportation planning as planning for person trips. However, goods movement has two aspects, transportation and marketing. Therefore, if planning for goods movement shall be made, planners should consider both sides.

3.2.3 Marketing Channel, Facility Channel and Transportation Channel

Marketing channel is used as a marketing tool for the distribution of products from one industry to another whether for manufacturing of products, wholesale or retail. Facility channel is used in city planning to facilitate the flow of goods from the factory to distribution centers, and from the distribution centers to commercial stores and shops. Transportation channel is used in transportation planning to monitor the vehicular flow in different zones. Transportation network consists of road, railway, sea and air routes.

The flow in channels is not fixed. For example, manufacturing firms do not only have factories but also distribution centers while retailers do not only have stores and shops but also distribution centers.

Transportation flow depends on the market location and is also necessary in considering the other channels.

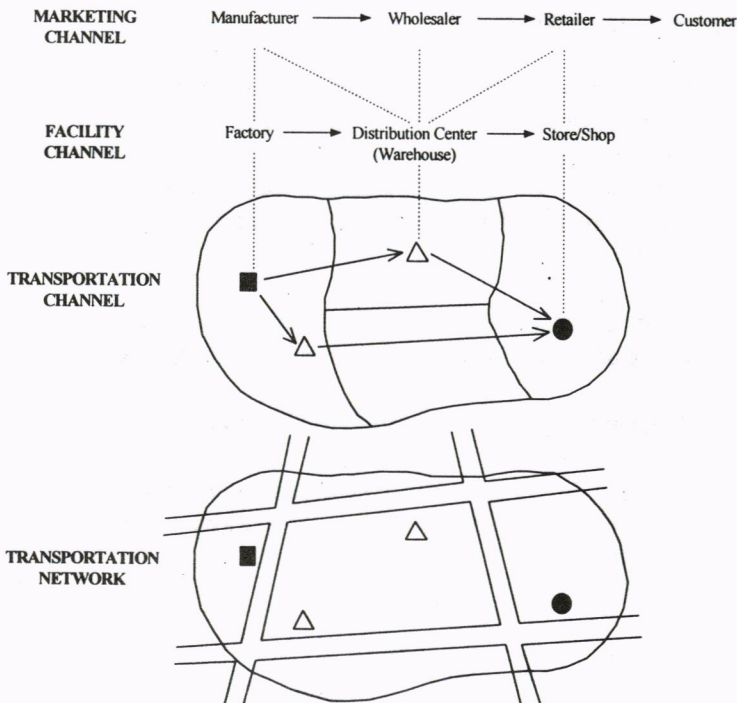


Figure 4. Marketing, Facility and Transportation Channels

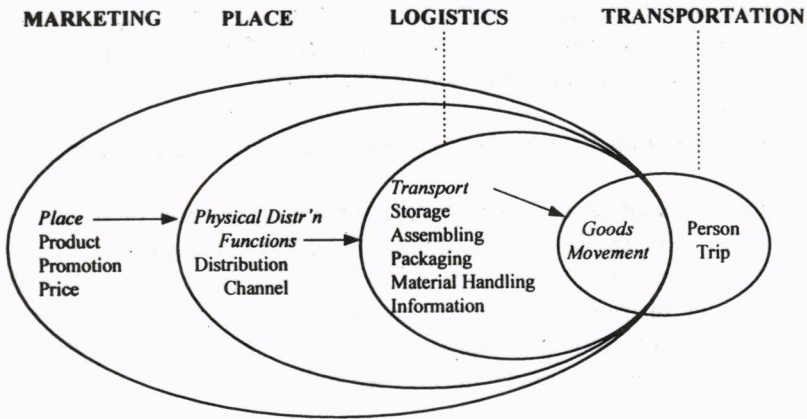


Figure 5. Two Aspects of Goods Movement

4. JIT AND INFORMATION SYSTEM

4.1 JIT and the Effects of Information System

4.1.1 Objectives and Definition of JIT

Just-In-Time, as it refers to production, means maintaining minimal inventory while producing what is needed, when it is needed, in exactly the quantity needed, with as little surplus output as possible. Just-In-Time in transportation and logistics is the same; conveyance of items from parts suppliers, to production line, to the dealers through each process with the timing volume that the market demands. This means shorter delivery lead-times, lower inventories and ultimately lower costs.

Keeping lead-time short and cost low requires the elimination of waste. Waste is defined as any part of the process or activities that does not add value to the product or services.

4.1.2 JIT and Information System to Keep Lead-Time Short

One of the key objectives of the JIT system is to keep lead-time as short as possible. There are three ways to achieve this purpose, through: 1) *computerized system*, 2) *automated system*, and 3) *non-computerized system*.

Table 4. Information Systems and Components of Lead-Time

	Components of Lead-Time		
	ORDERING- INFORMATION	LOGISTICS - INFORMATION	TRANSPORTATION - INFORMATION
Computerized System	POS EOS VAN	POS, EOS, VAN Cargo Tracing System	Multi-Channel Access Vehicle Routing System Truck Tracing System
Automated System		Digital Picking System Automated Packaging System Inventory Control	Automated Material- Handling
Non- Computerized System		KANBAN (Commodity Identification) Small Lot Production	Insertive Pick-up

4.2 Components of Lead Time and Information System

4.2.1 Components of Lead-Time

Lead-time is the total time from the point of placing the order to the point of receiving the goods. Lead-time is composed of the following: 1) *Order Transmittal Time*: time from the point of placing the order by the customer to the point of receiving the order by the supplier, the information system adapted depends on the customer and the supplier; 2) *Order Processing, Assembling with Stock Availability Time*: time from the point of receiving the order by the supplier to the point of dispatching the goods by the supplier, the information system adapted depends on the supplier; 3) *Delivery time*: time from the point of dispatching the goods by the supplier to the point of receiving the goods by the customer, the information system adapted depends only on the supplier. In reducing these times, various information systems are introduced.

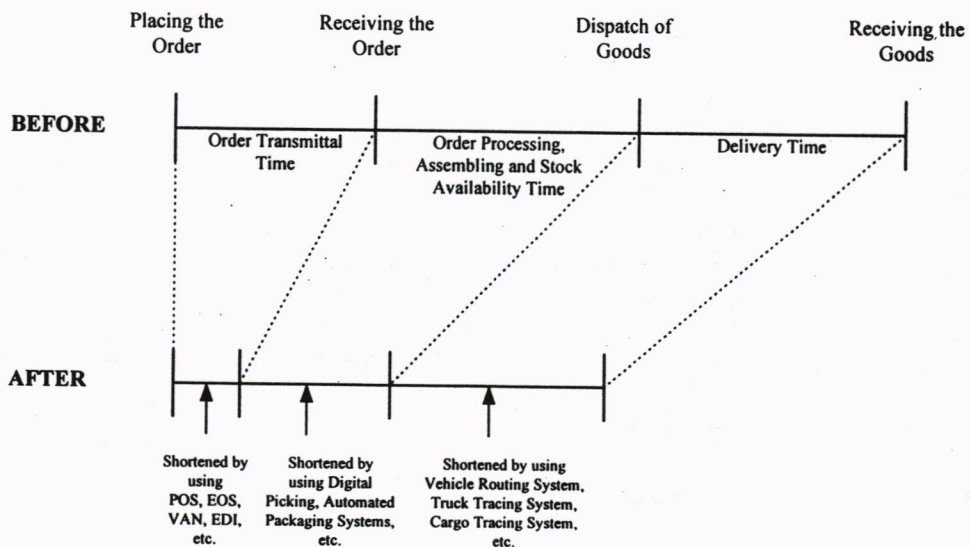


Figure 6. Components of JIT and its change due to Information System

4.2.2 Ordering - Information System

Information system in relation to commercial trade can be divided into two types. The first type is the system for ordering goods and the other is the system for settling accounts.

Order Transmittal Systems, such as POS (Point of Sales), EOS (Electronic Ordering Systems), VAN (Value Added Network) and EDI (Electronic Data Interchange), has been introduced in many companies for shortening the order transmittal time and for avoiding errors.

On-line banking system is an example of accounting-information systems.

4.2.3 Logistics - Information System

Technological innovation has changed logistics dramatically. More particularly, the cold-chain system, unit load system and information system are introduced for the purpose of quality and safety control in transport, storage and other services related to logistics.

Logistics information related to transport, storage and logistics service can be divided into three types: 1) *information on quantity*, 2) *information on quality*, 3) *information on operation*. For example, delivery control and automated-checking systems are information systems on quantity. Inventory management and automated-packaging systems are information systems on quality. Space location and digital-picking systems are examples of information systems on operation.

4.2.4 Transportation - Information System

Delivery time of goods and commodities has increased because of serious traffic congestion and the ever increasing amount of goods to be distributed. To shorten delivery time, Vehicle Routing System, Truck and Cargo Tracing System, etc. are introduced.

5. EFFECT OF INFORMATION SYSTEM ON JIT

5.1 Outline of the Survey

The survey was done by private firms which used the JIT system to see the effects of introducing information system. The data were gathered from special articles of two Japanese magazines, *Nikkei Logistics* (1990 October-1993 October) and *Distribution Design* (1988 April-1993 October). Twenty six (26) companies which employed the JIT system were selected as samples. The breakdown are as follows: 10 manufacturers, 3 food industries, 6 service industries and 7 shipping companies. Some of the companies employed 2 or 3 types of information systems. Hence, a total of 57 information systems were used for analysis.

5.2 Information System for JIT

5.2.1 Aim of Information System

Companies have introduced JIT system primarily to reduce lead-time. As earlier mentioned, lead-time is composed of ordering time, processing time and delivery time.

Based on the survey, majority of the companies have focused on reducing either one or two components of the lead-time. More than 80% of the companies tried to reduce the processing time, and about 50% of the companies aimed at reducing the delivery time (refer to Table 5).

Table 5. Main Aim of 26 Companies for Reducing Lead-Time

	Ordering Time	Processing Time	Delivery Time
No. of Companies	6/26 (23.1%)	22/26 (84.6%)	12/26 (46.2%)

Note: Multi-answered by 26 companies

5.2.2 Characteristics of Information System

Twenty-six (26) companies introduced a total of fifty-seven (57) types of information systems. The information systems has three basic types: computerized, automated and non-computerized system.

More than half use the computerized information systems. A major part of computerization focuses on reducing the processing and delivery components of lead-time (refer to Table 6).

Table 6. Characteristics of Information Systems

Type of Info. System	No. of Information System			Total
	Ordering	Processing	Delivery	
Computerized	4	10	18	32 (56.1%)
Automated	0	9	0	9 (15.8%)
Non-Computerized	0	7	9	16 (28.1%)
Total	4 (7.0%)	24 (42.1%)	27 (50.8%)	57(100.0%)

Note: Multi-answered by 26 companies

From Table 5 and 6, it can be said that for the majority of the companies, reducing processing time played a major role in the introduction of information systems.

5.3 Effects of Introducing Information Systems

5.3.1 Marketing Effects Due to JIT

The method of introducing information systems is shown in Fig. 7. The company's Background determines what type of information system is to be used.

As already mentioned, marketing has four (4) elements “product, price, place (which includes physical distribution), and promotion. Correspondingly, introduction of the JIT system can also be grouped into these four elements “Product, Price, Physical Distribution and others.

Typically, companies introduce JIT system to solve their marketing problems. The introduction of the JIT system then results to an Effect related to marketing. These effects, in turn, influence the marketing elements.

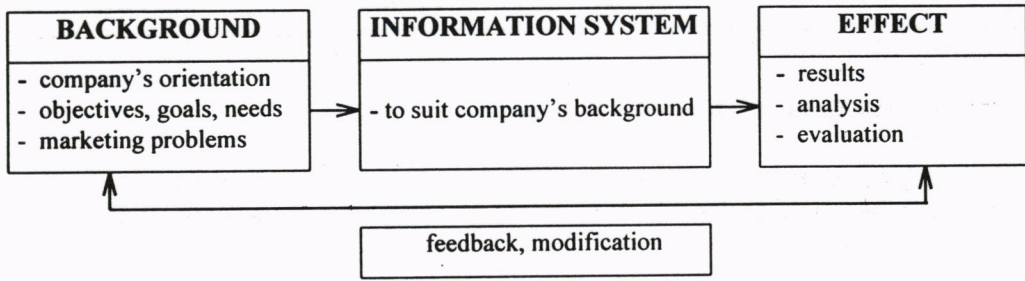


Fig. 7. Introduction of Information System Cycle

Based on the survey, majority of the JIT system employed usually have product and physical distribution backgrounds. These systems mainly focus on reducing processing and delivery time (refer to Table 7).

Table 7. Background of Information System

Background	No. of Information System			Total
	Ordering	Processing	Delivery	
Product	3	13	16	32 (39.5%)
Price	1	6	3	10 (12.3%)
P.D.	2	13	11	26 (32.1%)
Others	0	6	7	13 (16.0%)
Total	6 (7.4%)	38 (46.9%)	37 (45.7%)	81(100.0%)

Note: Multi-answered by 26 companies

However, majority or about half of the effects resulting from the utilization of information systems is in *physical distribution*. This means that almost all information systems were designed to make physical distribution more efficient, irrelevant of the company's background (refer to Table 8).

Table 8. Information System and Their Effects

Effect	No. of Information System			Total
	Ordering	Processing	Delivery	
Product	0	4	5	9 (12.7%)
Price	1	2	2	5 (7.0%)
P.D.	2	16	17	35 (49.3%)
Others	2	8	12	22 (31.0%)
Total	5 (7.0%)	30 (42.3%)	36 (50.7%)	71(100.0%)

Note: Multi-answered by 26 companies

5.3.2 Comparison between Background and Effect of the JIT System

Most of the time, companies acquire some effects which are not the same as its background. This is because it is quite difficult to estimate what will be the outcome of introducing the JIT system. The results of the survey suggest that the backgrounds of the companies are focused mainly for product and physical distribution reasons, but the effects are mainly for physical distribution.

Table 9. Comparison between Background and Effects of Information System

Background	No. of Information System				Total
	Effect of Information System				
	Product	Price	P.D.	Others	
Product	4	2	14	10	30 (34.9%)
Price	2	1	6	2	11 (12.8%)
P.D.	3	2	15	8	28 (32.6%)
Others	3	1	8	6	17 (19.8%)
Total	11 (12.8%)	6 (7.0%)	43 (50.0%)	26 (30.2%)	86 (100.0%)

Note: Multi-answered by 26 companies

Table 9 shows the diagonal boxes which represents unity between the background and its effect. This unity accounts for only 30.2% (26/86). Furthermore, the effects obtained for physical distribution has the highest percentage (50%).

From this analysis, it is clear that most of the companies introduce JIT system because of product (34.9%) and physical distribution (32.6%) backgrounds. However, the system mainly have effects on physical distribution (50%).

5.4 Relationship of Background, Information System and its Effects

Private companies employ information systems to make their marketing activities more efficient and thus, increase profit. In spite of this situation, the acquired benefits of the system concentrates mainly on physical distribution. This means that the JIT System using information systems is not an effective means of addressing Product Planning and Price Planning. On the other hand, it can be concluded that the information system on JIT is most effective in addressing Physical Distribution Planning.

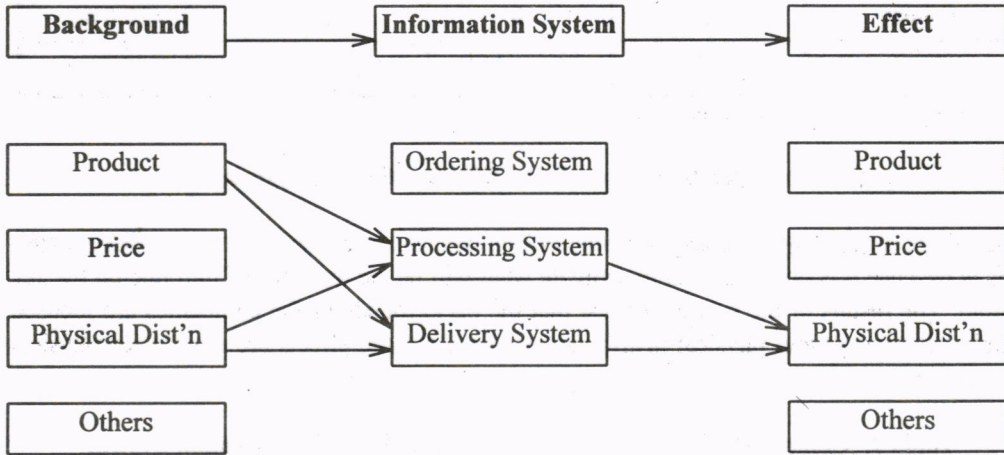


Fig. 8. Relationship of Background, Information System and its Effects

6. CONCLUSION

In summary, the effect of information systems on JIT can be shown in two aspects: 1) through the reduction of lead-time, and 2) through the planning of the four marketing elements.

JIT information systems can be classified into three types: computerized, automated and non-computerized. The majority of the companies studied, specifically 56%, used computerized information systems while only 16% employed automated, and 28% employed non-computerized systems. It has also been shown that for companies reducing the three components of lead-time, information systems for processing and delivery are used more often than for ordering.

Many companies also introduce information systems with the aim of solving their marketing problems and in the process, realize the efficiency of the JIT system of transportation. Marketing can be classified into four elements: product, price, promotion and place, which includes physical distribution. These elements usually dictate what type of information systems are to be adapted by the company.

From the survey, 39.5% introduced information systems to aid in product planning, while 32.1% used it for physical distribution planning, 12.3% for price planning and 16.0% for

others. However, results of the study reveal that the bulk of the effects of information systems concentrate on the physical distribution element of marketing. In particular, 49.3% of the information systems had beneficial effects for physical distribution, while only 12.7% had effects for product, 7.0% for price and 31.0% for others.

In comparing the background of the introduction of information systems with its resulting effect, it has been shown that only 30.2% had achieved their primary objective while the rest only achieved secondary goals. While most company backgrounds focused on product and physical distribution, the effects were mainly felt for physical distribution alone with an overwhelming 50%. Only 12.8% had effect for product, 7.0% for price and 30.2% for others.

Therefore, in establishing JIT, the introduction of information systems for companies is most effective when used for physical distribution planning. Also, it can be said that the most benefit may be achieved by introducing information systems in reducing processing time and delivery time.

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