

**BASIC MECHANISM OF ACCUMULATION AND RENEWAL
OF PHYSICAL DISTRIBUTION FACILITIES IN TOKYO**

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INTRODUCTION

Physical distribution is one of the vital functions supporting urban activities and lives. Occasionally, various conflicts such as traffic accidents, air pollution and other forms of environmental disruptions occur concerning physical distribution facilities and other urban facilities. From the view point of urban land use planning, it is important to grasp the locational tendency and to analyze the accumulation factors of physical distribution facilities.

The purpose of this study is to make clear the location factors of physical distribution facilities, and thereby clarify the basic mechanism of accumulation and renewal processes of these facilities.

1. NATURE OF PHYSICAL DISTRIBUTION AND ITS FACILITIES

1.1. Physical distribution and its facilities

Physical distribution, consisting of the physical supply and physical distribution, have six functions ; 1)transportation, 2)storage and deposit, 3) assembling and processing, 4)material handling, 5)packaging and wrapping, and 6)information. In these functions, the "transportation function" and the "storage and deposit function" need facilities such as truck terminals and warehouses, while other functions are generally annexed to the terminals, warehouses and other physical distribution facilities. (Table 1, Figure 1)

1.2. Physical distribution facilities in the city

In Japan, freight transportation pattern is divided into two broad types. The one is the intercity transportation and the other is the delivery service in the city. Accordingly, the truck terminals are divided into the intercity transportation terminal and the delivery terminal.

Therefore, the urban physical distribution facilities are composed of the intercity transportation terminals, the delivery terminals and the warehouses.

Table 1 Function of Physical Distribution and Facility

function	lot and space	facility
main function		
1) transpotation	truck platform parking lots handling space	intercity terminal delivery terminal
2) storage and deposit	warehouse storage lots handling space	warehouse

additional function		
3) assembling and processing	picking space assembling space labelling space and etc.	※ These functions are set up in truck terminal, warehouse, factory, wholsale, market and others.
4) material handling	handling space	
5) packaging and wrapping	packaging space wrapping space	
6) information	data processing	

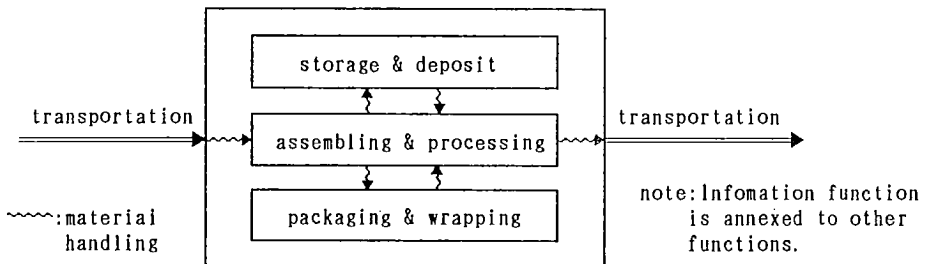


Figure 1 Physical Distribution Function in its Facility

2. POLICY FOR DISTRIBUTION BUSINESS CENTER IN JAPAN

2.1. Policy for physical distribution

The rapid economic growth of Japan which started since mid 1950's resulted in concentration of population and industries into major cities such as Tokyo and Osaka. In addition to this, the motorization caused seious urban problems during the same period. Truck trips have mainly generated from factories, wholesalers, warehouses, carriers and so forth which were usually located in the central area mixed with housing units. These physical distribution firms, most of which were small business enterprises, could hardly relocate their facilities for enlargement and modernization due to shortage of funds.

As it was urgent for the major cities to solve these problems, the concept of Distribution Business Center (DBC) was advocated during 1960's. The Act concerning Development of Distribution Business Center was enacted in 1966, and DBC's and Truck terminals have been widely developed in major cities under this Act. (2) (Figure 2)

2.2. Master plan of Distribution Business Center in Tokyo

The basic concept of DBC's in Tokyo was provided by the Act concerning Development of DBC. Up to present, four DBC's have been constructed in four regions i.e. southern, eastern, northern and north-western part on the fringe of the urbanized area of Tokyo. (Figure 3)

Each DBC has 100 ha of land area and has enough capacity to meet activities of distribution and storage. It is composed of a truck terminal, a railway station, a central wholesale market, a container depot, a wholesale trading center, warehouses, loading and unloading spaces, related processing factories, offices or shops for carriers and wholesalers.

2.3. Significance of physical distribution facilities in the city

Since mid 1970's (or since the oil crisis), the structure of the industry of Japan is said to have been transformed from the so-called heavy-thick-long-bulky type to the light-thin-short-compact type industry. In addition to this, demand of consumers has become sophisticated and diverse than ever, which is a consequence, among others, of the economic growth and income rise.

As the result of this tendency, JIT(Just-In-time) type transportation has become popular and transportation for delivery service has increased rapidly. At the same time, the role of physical distribution facilities other than DBC's in a central area of cities have become more important for delivery service.

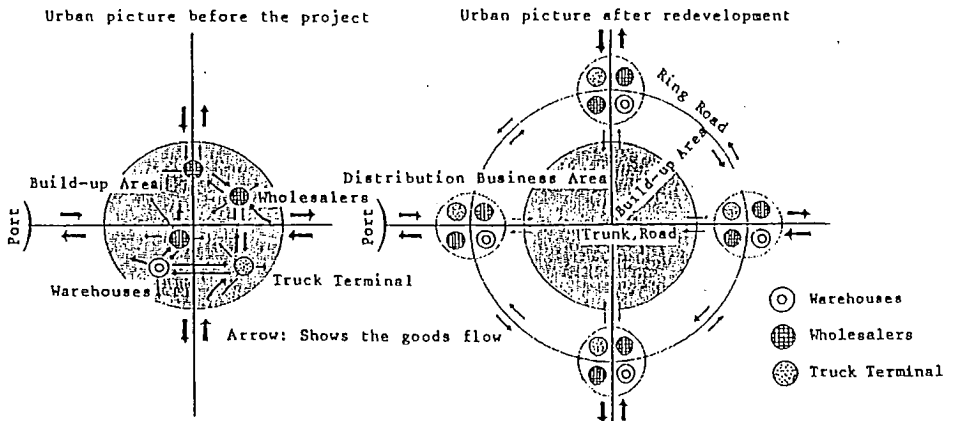


Figure 2 Concept of Distribution Business Center (2)

3. PHYSICAL DISTRIBUTION FACILITIES IN TOKYO

3.1. Characteristics of goods flow in Tokyo

The total volume of goods flow in the Tokyo metropolitan area was 3,270 thousand tons/day in 1972, and declined slightly to 3,000 thousand tons/day in 1982. The total number of freights, on the contrary, increased sharply from 1,580 thousand freights/day to 2,630 thousand freights/day.

While the share of truck-ridden loads to the freight transportation has increased about 10% in weight (from 49% to 59%) during these 10 years, while the share of railway-ridden loads has decreased from 6.5% to 2.7%. And the share of ship loads has also decreased from 38.3% to 34.2%. On the other hand, in terms of the number of freights, the share of truck was 84.5% and that of railway was only 0.2%, ship 0.1% and airplane 0.2% in 1982. (3)

3.2. Physical distribution facilities in the central area of Tokyo

In Tokyo, urban goods flow had mainly depended on railway and water transportation until trucks became popular after the World War II. Therefore many physical distribution facilities are concentrated in waterfront areas along Tokyo Bay, close to CBD (Central Business District). This area is

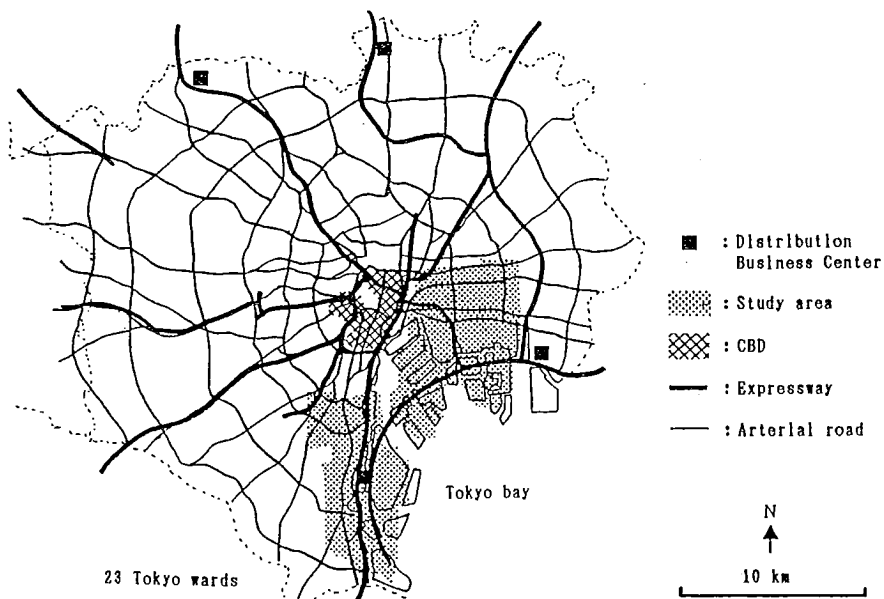


Figure 3 Distribution Business Centers and Study Area in Tokyo

important not only for delivery service to CBD but also as sites for intercity truck terminals and warehouses.

The Land Use Survey was carried out by the Tokyo Metropolitan Government concerning the land use pattern and the floor areas in 1970, 1981 and 1986. (4) According to data of this survey, ratio of the floor area of the physical distribution facilities to the total floor area was 2.99% on an average in the 23 Tokyo wards. The meshes where this ratio is over 3.0% are concentrated in the waterfront area. This tendency has become prominent from 1970, 1981 to 1986. (Figure 4)

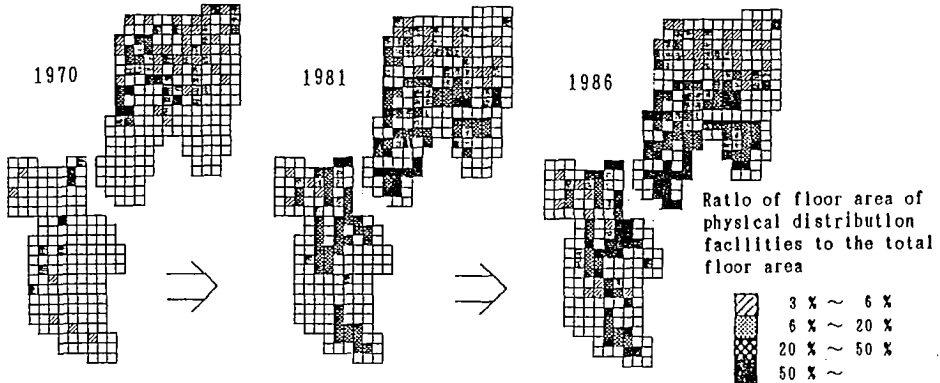


Figure 4 Changes in Pattern of Concentrated Area of Physical Distribution Facilities in Tokyo

3.3. Accumulation factors of physical distribution facilities

A multiple regression analysis shows that physical distribution floor area is positively correlated with industrial facilities floor area and daytime population. Resident population is negatively correlated to the physical distribution floor area. (Equation 1, Figure 5)

$$F_{pd} = 0.599 F_i - 0.362 P_r + 0.266 P_d \text{-----} (1)$$

(12.24) (-6.77) (4.44)

- where
- F_{pd} : floor area of physical distribution facility in each mesh
 - F_i : floor area of industrial facility in each mesh
 - P_r : population (resident population) in each mesh
 - P_d : daytime population in each mesh
 - N : 252 samples (meshes in the study area)
 - R : 0.887
 - F-value : 134.1
 - t-value : t-values are shown in ()

A discriminant analysis clarifies that location and expansion of these facilities are closely related to daytime population, floor area of industrial facilities and floor area of housing.

Table 2 Variables Chosen by Discriminant Analysis

variable name	F value	coefficient
Pd : daytime population	26.62 *	0.00057
Fi : floor area of industry	9.85 *	0.00001
Fh : floor area of housing	9.05 *	- 0.00003
Fpd: floor area of physical distribution facility	1.99	0.00001
Ae : access to expressway	1.66	- 0.00030
(* : significant variable)		
canonical correlation : 0.425 , hlt ratio : 75.8 %		

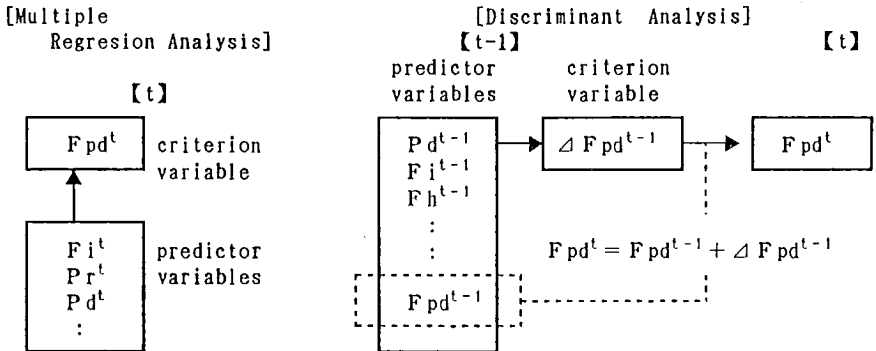


Figure 5 Multiple Regression Analysis and Discriminant Analysis in This Study

4. CHARACTERISTICS OF RENEWAL OF PHYSICAL DISTRIBUTION FACILITIES

4.1. Concept for renewal of physical distribution facilities

Activity of physical distribution facilities can be generally indicated by the volume of floor area. Increased floor area of physical distribution facilities consists of an area of newly founded facilities by new comers and an area of expanded facilities by existing firms. On the other hand, decreased area consists of an area of removed facilities and reduced facilities. (Figure 6)

Therefore, the change in the floor area of physical distribution facilities (PDF's) is shown as below;

$$F_{pd}^{t+1} = F_{pd}^t + \Delta F_{pd}^t \quad \text{-----} \quad (2)$$

$$\Delta F_{pd}^t = \Delta F_{pd}^{t,i} - \Delta F_{pd}^{t,d} \quad \text{-----} \quad (3)$$

- where F_{pd}^{t+1} : floor area of PDF's at t+1
- F_{pd}^t : floor area of PDF's at t
- ΔF_{pd}^t : change of floor area of PDF's from t to t+1
- $\Delta F_{pd}^{t,i}$: increased floor area of PDF's from t to t+1
- $\Delta F_{pd}^{t,d}$: decreased floor area of PDF's from t to t+1

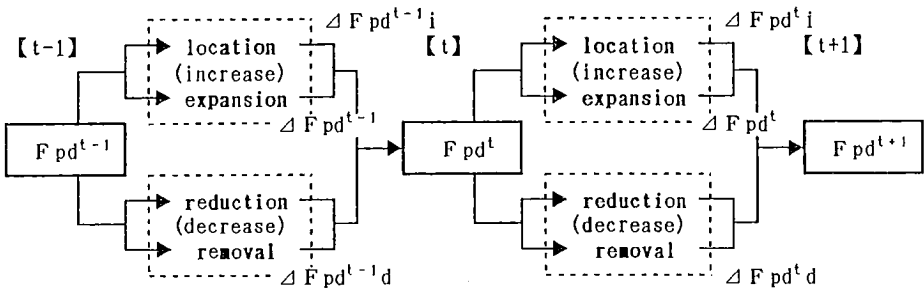


Figure 6 Concept for Renewal Mechanism of Physical Distribution Facilities

4.2. Physical distribution firms' intention for renewal in the questionnaire survey

A questionnaire survey was carried out on physical distribution firms in a concentrated area, in order to make clear the factors affecting location, expansion and removal of physical distribution facilities. The questionnaire was mailed to all the firms (478 firms) in the study area which belong to The Tokyo Society of Truck Firm or to The Tokyo Society of Warehousing. The number of firms which replied to the questionnaire was 161 (33.7 %).

4.1.1. Attractive factor for location

According to this survey, "distance to shippers or delivery areas" and "accessibility to arterial roads" can be said to be the most important factors (rank:1,2,1). And, "lot size" is second most important factor (rank: 2,1,3). "Characteristics of present land use" such as zoning, accumulation of similar firms and non-restriction for night-work are also found relevant.

(Table 3)

4.1.2. Change of locational condition

As the improvement of location factors, "improvement of expressway and

distributor road" are chosen. As the aggravation of location factors, "traffic congestion" is rated highest and "rising of land price" and "mixed land uses" are chosen. (Table 4) From this tendency, physical distribution firms are sensitive to the accessibility and the traffic problem.

4.1.3. Plan for renewal of facility

As for the expansion of facilities, "under study" is chosen by most firms. Concerning the removal to another site, "none" was rated highest. Therefore, it indicates that accumulation of physical distribution facilities is accelerated in specific districts. (Table 5)

4.1.4. Motivation of expansion and/or removal

Concerning the motivation for expansion of facilities, "enlargement business" is rated highest by all types of firms, and secondly "change of goods in amount or in quality" are rated the second highest. As the motivation for removal, "tightness of lot" is ranked highest and "redevelopment for other uses" is also chosen. (Table 6)

4.1.5. Attractive condition for Removal

Concerning the attractive condition for removal of facilities, "lot size" is ranked highest. "Cost of removal" and "convenience of commuting for employees" are chosen, and "traffic condition" is rarely chosen by firms of delivery service. This phenomenon is probably caused by high land price and shortage of workers. Other firms ranked "accessibility" high. (Table 7)

Table 3 Attractive Condition for Location

(Choices : 13) (% : Multiple Answer)

Rank	Firm of Delivery Service	Firm of Intercity Transport	Firm of Warehousing
1	Distance to Shippers (47.7%)	Lot Size (54.5%)	Access to Arterial Roads (51.9%)
2	Lot Size (33.0%)	Distance to Delivery Areas (45.5%)	Accumulation of Similar Firms(42.3%)
3	Zoning (30.7%)	Non-restriction for Night-work (45.5%)	Lot Size (40.4%)
4	Accumulation of Similar Firms(22.7%)	Accumulation of Similar Firms(36.4%)	Zoning (32.7%)
Samples	88	11	52

Table 4 Change in Locational Condition
(Choices : Improvement = 14, Aggravation = 9) (% : Multiple Answer)

Rank		Firm of Delivery Service	Firm of Intercity Transport	Firm of Warehousing
Improvement	1	Improvement of Expressway (38.7%)	Improvement of distributor Road (50.0%)	Improvement of distributor Road (33.3%)
	2	Improvement of distributor Road (29.3%)	Improvement of Expressway (50.0%)	Improvement of Expressway (31.3%)
	3	Improvement of Arterial Road(13.3%) Accumulation of Similar Firms(13.3%)	Accumulation of Similar Firms(20.0%) Change of Delivery Area (20.0%)	Accumulation of Similar Firms(29.2%)
	Samples	75	10	48
Aggravation	1	Traffic Congestion (61.0%)	Traffic Congestion (66.7%)	Traffic Congestion (85.7%)
	2	Rising of Land Price (35.6%)	Increasing of Dwellings (50.0%)	Rising of Land Price (40.5%)
	3	Increasing of Dwellings (18.6%)	Rising of Land Price (50.0%)	Increasing of Dwellings (21.4%)
	Samples	59	6	42

Table 5 Plan for Renewal of Facilities (% : Single Answer)

		Firm of Delivery Service	Firm of Intercity Transport	Firm of Warehousing
Expansion	In Planning	10 (10.8%)	0 (0.0%)	7 (13.5%)
	Under Study	64 (68.8%)	9 (81.8%)	38 (73.1%)
	None	16 (17.2%)	2 (18.2%)	6 (11.5%)
	Others	3 (3.2%)	0 (0.0%)	1 (1.9%)
	Samples	93	11	52
Renoval	In Planning	13 (14.1%)	1 (9.1%)	6 (12.0%)
	Under Study	38 (41.3%)	5 (45.5%)	16 (32.0%)
	None	41 (44.6%)	5 (45.5%)	28 (56.0%)
	Samples	92	11	50

Table 6 Motivation of Expansion and/or Renewal
(Choices : Expansion = 6, Removal = 8) (% : Multiple Answer)

	Rank	Firm of Delivery Service	Firm of Intercity Transport	Firm of Warehousing
Expansion	1	Enlargement Business (74.2%)	Enlargement Business (100.0%)	Enlargement Business (60.0%)
	2	Increasing of Goods (41.9%)	Change of Goods (66.7%)	Increasing of Goods (60.0%)
	3	Change of Goods (16.1%)	Increasing of Goods (33.3%)	Intorduction of InformationSystem (26.7%)
	Samples	31	3	15
Removal	1	Tightness of Lot (60.8%)	Tightness of Lot (66.7%)	Tightness of Lot (50.0%)
	2	Redevelopment for Other Uses (31.4%)	Traffic Congestion (33.3%)	Redevelopment for Other Uses (31.8%)
	3	Improvement for Customer Service(29.4%)	Conflict with Residents (33.3%)	Rising of Land Price (22.7%)
	Samples	51	6	22

Table 7 Attractive Condition for Removal
(Choices : 12) (% : Multiple Answer)

Rank	Firm of Delivery Service	Firm of Intercity Transport	Firm of Warehousing
1	Lot Size (52.4%)	Lot Size (75.0%)	Lot Size (47.6%)
2	Cost of Removal (45.2%)	Distance to delivery Areas (75.0%)	Access to Arterial Roads (28.6%)
3	Convenience of Commuting (21.4%)	Access to Arterial Roads (25.0%) Distance to Shippers (25.0%) Distance to CBD (25.0%) Non-restriction for Night-work (25.0%)	Distance to CBD (23.8%) Cost of Removal (23.8%)
Samples	42	4	21

5. BASIC MECHANISM OF ACCUMULATION AND RENEWAL OF PHYSICAL DISTRIBUTION FACILITIES

5.1. Characteristics of location, expansion and removal of facilities in the questionnaire survey

Characteristics of location, expansion and removal of physical distribution facilities in the questionnaire survey are as shown below:

[Location] : Location of the facilities is decided by the size of the lot and distance to shippers. If this area has already industrial facilities and business facilities, locational condition is considered better for siting physical distribution facilities.

[Expansion] : Each physical distribution firm tends to investigate rehabilitation or redevelopment of facilities in its present site to cope with the increased volume of goods and the change in the characteristics of goods.

[Removal] : Principal motivation for removal of facilities is tightness of the lot for continuing their business. Therefore, the most important removable condition is not the accessibility to arterial roads or CBD, but the size of the lot for their business.

5.2. Basic mechanism of accumulation and renewal

Basic mechanism of accumulation and renewal of physical distribution facilities for location, expansion and removal is as shown below;

Firstly, physical distribution facilities is located on the lot which has suitable size for business and accessibility(①). In spite of sensitiveness to accessibility, it is not a principal motivation for expansion and removal. Expansion, including "under study", is caused by enlargement business and change in the characteristics of goods(②). And, location and expansion cause the increasing of floor area of physical distribution facilities. For reasons of the tightness of the lot and redevelopment for other uses, removal is considered to continue its business(③). Then, removal causes the decreasing of floor areas. Few firms considered the reduction of floor area of physical distribution facilities. (Figure 7)

Accordingly, in the case of removal, the principal factor is the same as the location factor(①), and so a new cycle will start in this way.

Secondly, due to the result of the questionnaire survey, expansion is more general than removal for firms, and the accumulation of similar firms is an attractive factor for location. This tendency is also clarified by a multiple regression analysis.

Therefore, the accumulation of physical distribution facilities tends to be accelerated in specific districts. In Tokyo, these facilities have become accumulated in an area along Tokyo Bay, close to CBD.

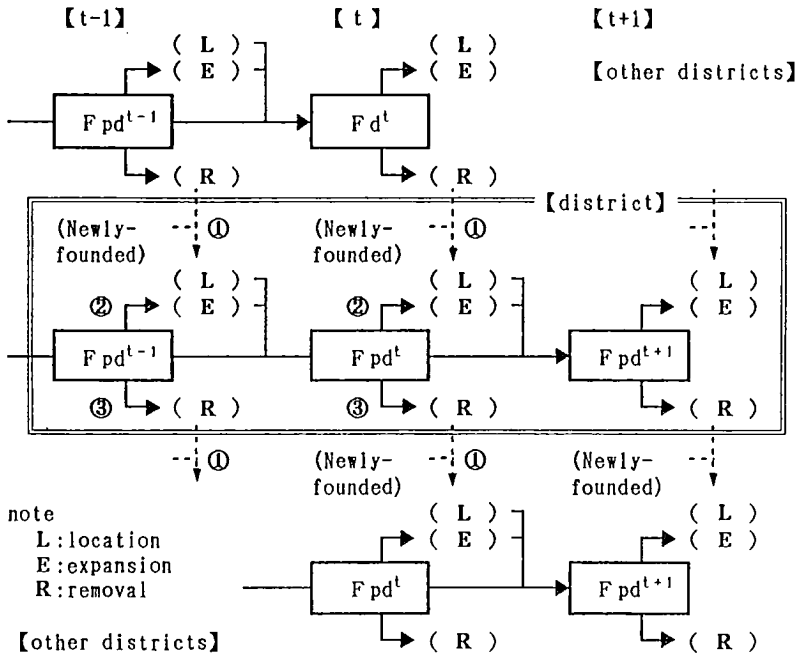


Figure 7 Basic Mechanism of Location, Expansion and Removal of Physical Distribution Facilities

CONCLUSION

In this paper, the relationship between physical distribution functions and physical distribution facilities was clarified first. Secondly, the policies of physical distribution in Japan and DBC in Tokyo were shown. Thirdly, accumulation factors of physical distribution facilities were presented by statistical analysis and questionnaire survey. And finally, the basic mechanism of accumulation and renewal of these facilities was made clear.

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