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No. 9

Feasibility Study
for
the Bangkok Urban Truck Terminals Construction Project
in the Kingdom of Thailand

FINAL REPORT

March 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

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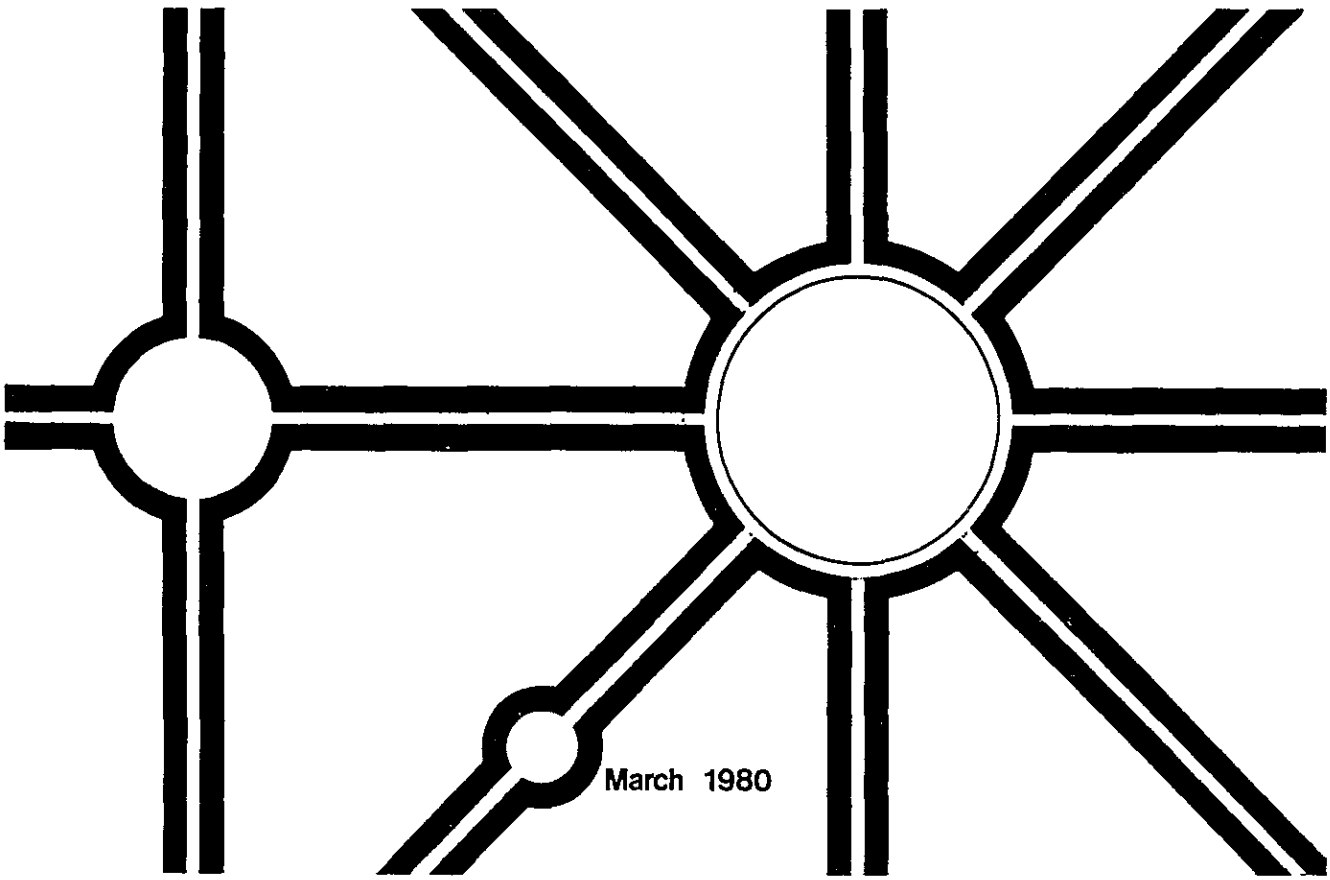


JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan has decided to conduct a feasibility study on the Bangkok Urban Truck Terminals Construction Project, and the Japan International Cooperation Agency (JICA), which is responsible for the implementation of technical cooperation programs of the Government of Japan, carried out the study.

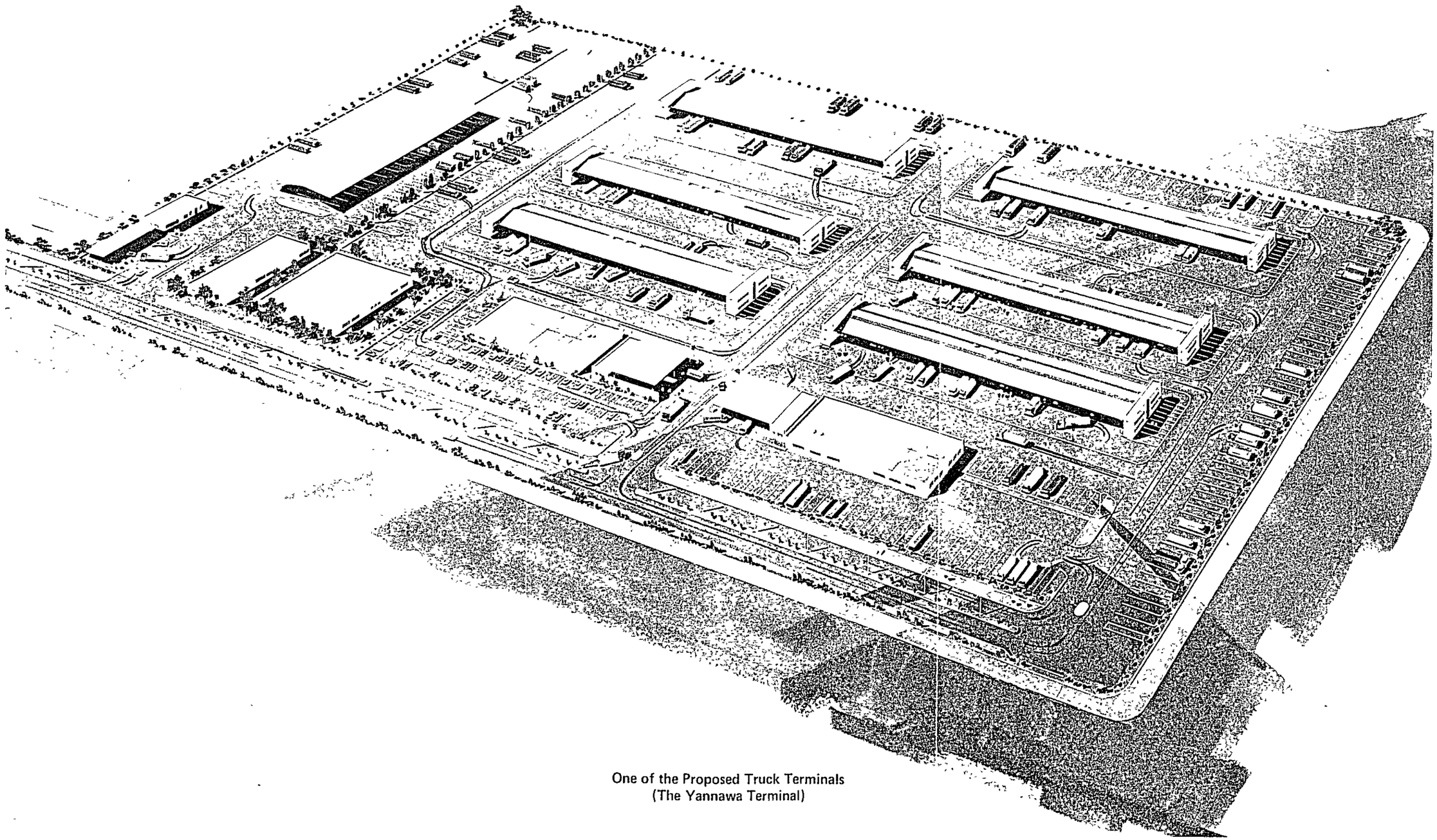
JICA dispatched to Thailand a preliminary survey team headed by Mr. Masahiko Yamamoto, Road Transport Bureau, Ministry of Transport in January 1979 and the feasibility study was started in August 1979. The present Report is based on the Draft Report of February 1980 as well as on the comments made thereon by the officials of the Government of Thailand and on the subsequent study made in Japan.

I hope that the report will prove to be useful for the development of the project and contribute to the economic and social development of Thailand as well as to the promotion of friendship between our two countries.

I wish to express my deep appreciation to the Royal Thai Government and the officials concerned for their valuable assistance and cooperation extended to our study team.

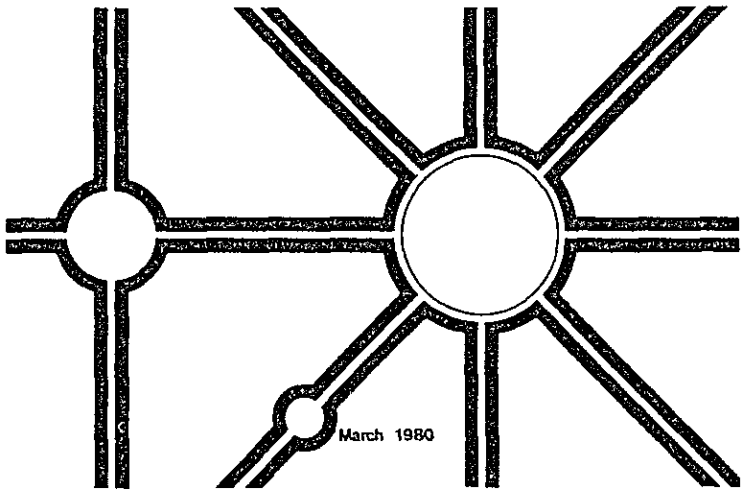
March, 1980

Keisuke Arita
President
Japan International Cooperation Agency



One of the Proposed Truck Terminals
(The Yannawa Terminal)

SUMMARY AND CONCLUSIONS



SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

The feasibility study to evaluate and recommend the location, design, and implementation program for the Bangkok Urban Truck Terminals Construction Project has been carried out by a consortium of consultants consisting of Pacific Consultants International and Nittu Research Center who were organized by the Japan International Cooperation Agency (JICA) during Aug. 1979.

The final report presents the findings of the study including the results of field investigation, demand forecasts, facility and evaluation of site locations, implementating organization and economic and financial feasibility of the project. This section summarizes the work and conclusions under the following headings:

I	The Concept of a Truck Terminal
II	Necessity and Demand for Truck Terminals
III	Truck Terminal Users
IV	Commodities Handled by Truck Terminals
V	Truck Terminal Study
VI	Truck Terminal Design
VII	Economic Evaluation of Benefits
VIII	Evaluation of Economic Cost and Feasibility
IX	Evaluation of Financial Cost and Feasibility
X	Organization for Truck Terminal Implementation
XI	Conclusions and Recommendations

I. The Concept of Truck Terminals

Truck Terminals are nodes between long-distance line-haul trucks and city pick-up and delivery trucks for efficient transport of non-bulk mixed cargo, of which about 70% are consumer goods used domestically by most businesses and people. Since the GBA is a population-concentrated city, traffic measures have a great impact on urban well-being, as well as on national growth.

The truck terminal is a facility to allow truck operators a place where they can link and rationalize truck road transport with collection and delivery operation (loading, unloading, sorting of goods according to destination and temporary storing) as described below:

1. Pick-up and delivery service into the GBA

Pick-up and delivery services within the GBA area will be served by small trucks (4-wheel) according to time-schedules. Unloaded cargoes from line-haul trucks will therefore be delivered within the GBA without necessitating entry of the large line-haul vehicles (6- and 10-wheel).

2. Materials handling on platform at the Terminals

Unloading from pickup trucks and sorting by shipping destination will be performed so that cargo is transferred onto a specific shipping block on the platform for loading to line-haul trucks.

Unloaded cargoes from line-haul truck will be sorted for transshipment to other line-haul trucks or for delivery by zone in delivery trucks.

3. Operation of line-haul service out of the GBA

Line-haul trucks on designated routes will be operated on time-schedules. The operation will be done exactly and promptly according to user requirements. Efficient loading, unloading and improvement of the load factor will be promoted by truck terminals.

With the establishment of a truck terminal system of cargo transportation for the inter- and intra-city, the following benefits can be expected:

1. The reduction of transport cost, total truck traffic volume and consumption of fuel can be expected based on increased loading factors, route simplification, increase vehicle size on line-haul routes and the rationalization of cargo transfer.

2. At the public truck terminals, the merits of scale for terminal users (truck operators) will be increased by the common use of various terminal facilities and land space.

3. The establishment of truck terminals will support GBA comprehensive land use planning to establish satellite towns on the periphery of the GBA and help improve the urban population overcentralization.

When the existing individual small-sized truck terminals which are located in the center of the city will be centralized and reorganized. When they move to the constructed terminal areas, their vacated land can be used as improved urban facilities.

4. By the establishment of terminals, the inhabitants who live in the surroundings of the terminal will have an opportunity to get jobs related to the terminal. Furthermore, working conditions for employees will improve with the provision of employee facilities.

II Necessity and Demand for Truck Terminals

Bangkok is a transport node for the country and all its modes of transport; however, the capacity of routes passing through this node are insufficient in relation to the traffic flowing through it and this situation causes the traffic congestion within the area giving adverse effect to the economy not only for Bangkok, but also for the whole country. There is a need to examine truck traffic apart from passenger traffic since the percentage of trucks in the network is large and problems related to the trucking industry are different by nature. In addition, the recent cargo handling patterns in the trucking industry prevents solution to the major problem of overcongestion in the central district because of illegal truck parking on roadsides within the city. Future substantial increases in the number of heavy trucks coming into the central area adds urgency to the problem.

The national costs of not having truck terminals are large since the present system of private cargo terminals is experiencing severe curtailment which is more than likely to increase in severity in the future.

The present cargo terminals in Bangkok mainly consist of two facilities:

(1) shophouses where storage and administrative funcitons are performed, and,

(2) roadside areas in the CBD where cargo handling and vehicle maintenance are performed.

Although the use of public roadways for business operations may at one time have been tollerable, the growth of this type of operation in the future is limited for the following reasons:

- Expansion within the CBD involves prohibitive land acquisition costs.

- Pressure for stricter enforcement of traffic regulations relating to the use of road space is growing.

- The leasable location at Suan Luan which handles an estimated 25% of the common truck business is likely to be withdrawn by its owner, Chulalongkorn University.

- As the growth of inflation continues, the cost of inefficiencies in the transport system (whether caused by location in congested area or lack of economics of scale) will become less acceptable.

The Government of the Kingdom of Thailand has recognized the importance of devising effective measures for the trucking situation, and has launched this project to improve the present cargo transport and distribution system to have it more effectively contribute to the economic development of the country.

1. Traffic importance of trucks

The effects of trucks on traffic flow and road capacity is large when one considers that trucks are slower, less maneuverable and larger than passenger cars. In terms of passenger car equivalents (P.C.E.), it is estimated that registered trucks totalled about 40% of registered passenger car units (P.C.U.) in 1976 as shown in the table below.

Vehicle Type	P.C.E.	1976 Vehicle Registration	Total P.C.U.	
Passenger car	1.0	220,550	220,550	
4-wheel truck	1.3	39,842	51,794	40%
6-wheel truck	1.5	17,194	25,791	
10-wheel truck	3.0	3,511	10,533	

In terms of actual traffic counts made on truck routes to/from the GBA by the DOH from 1972 to 1978 and by the Study Team in 1979, trucks are a major and increasing component of the traffic flow.

GBA Survey Station Location			Truck Composition Ratio (%)							
Name of Station	Route No.	Connecting Direction	1972	1973	1974	1975	1976	1977	1978	1979
Rangsit	1	North, NE	42.9	44.1	49.8	47.1	36.9	37.5	36.8	53.6
Srisamran	4	West	38.1	32.8	40.0	40.7	39.3	50.1	56.4	59.8
Ekachai	35	South	-	-	32.6	33.8	33.7	44.6	45.0	57.2
Chonburi	3	East	57.3	59.6	49.2	53.6	53.8	57.4	61.1	-
Bang Na	34	"	22.4	21.7	30.0	33.6	35.3	40.7	44.5	59.6
Minburi	304	"	35.0	46.4	32.6	30.1	27.6	29.7	40.0	-

Source: 1972-8, DOH. 1979 The Study Team
Ref. : Table 2-14

The summary results from all of the comparable survey stations, shown in the table below indicate that the total traffic volume has increased by an average of about 10.4 percent per year, and that the total truck volume has increased by an average of 14.0 percent per year.

TRUCK TRAFFIC VOLUME FOR GBA BY YEAR

		1972	1973	1974	1975	1976	1977	1978	1972-8 Average
Total Vehicles	Traffic Volume (Veh/day)	*39,116	50,569	50,897	54,028	60,853	71,465	70,635	-
	Annual (%) Growth Rate	-	29.2	0.6	6.2	12.6	17.4	-1.2	10.4
Trucks	Traffic Volume (Veh/day)	*14,490 (37)	*16,848 (33)	21,025 (41)	20,380 (38)	23,774 (39)	30,812 (43)	31,762 (45)	-
	Annual (%) Growth Rate	-	16.2	24.8	-3.1	16.7	29.6	3.0	14.0

Note: * Excluding the volume of Station No. 168 since the Thonburi-Pak-Tho highway was only constructed in 1973.
Ref.: Table 2-4

In terms of transport mode, the importance of trucks can be understood by comparison with other modes of transport; trucks carry about 60% on the majority of all cargo into and out from the GBA as shown below.

GBA Cargo Transport by Mode, 1977

(Unit: %)

Direction \ Mode	Truck	Rail	Water
Inbound	59.4	6.1	34.5
Outbound	63.4	27.9	8.5

Source: TMJS, 1977

The major origin and destination of the cargo for all modes of transport is the central region which accounts for about 80% of all cargo flows into and out from the GBA as shown below.

O-D of GBA Cargo Flows

(Unit: % veh/day)

O-D Direction	GBA	Central	South	North	Northeast
Inbound to GBA	5.2	82.1	1.6	7.7	3.4
Outbound from GBA	4.4	79.1	2.9	5.0	8.6

Source: AIT, 1979

2. The need for separation of truck routes

At present, almost all main roads even inside the CBD are used for commodity distribution. Even through traffic which has no relationship

with GBA, has to pass through the heavily congested CBD area.

The main origin and destination of line-haul cargoes without a truck terminal are concentrated in the central area. Cargoes which could be transfered to smaller vehicles at a truck terminal are carried directly to and from their origin and destination in the CBD by heavy trucks. The result is increased traffic congestion from two factors: the presence of large less-maneuverable line-haul trucks in the traffic flow and the obstruction to traffic from loading/unloading of line-haul trucks which consume more road space and for a longer time than do smaller 4-wheel trucks.

3. Restriction on truck movements: Productivity Loss

For the purpose of immediately reducing traffic congestion in GBA, the government has restricted the times medium and heavy trucks can operate in or enter the GBA as shown below:

Restricted Truck Operating Periods:

	Morning	Evening	Total Hours Restricted
6-wheel trucks	7- 9 a.m.	4-8 p.m.	6 hrs.
10-wheel trucks	6-10 a.m.	3-9 p.m.	10 hrs.

During these restricted periods, all of the trucks over 6 wheels are prohibited from operating in the GBA and as a result they are forced to park either at the GBA boundary or somewhere in the city. Although this restriction postpones the truck component of the traffic flow on limited road capacity, having trucks park on the roadsides causes diseconomies including the increase of distribution costs, slowdown in delivery time and the tie up of vehicles and personnel.

From the truckers viewpoint, the existing restricted period for 10-wheel trucks of 10 hours and 6-wheel trucks of 6 hours amounts to a loss of about 42 percent of a work day for 10-wheel trucks and 25 percent of a work day for 6-wheel trucks.

Although some kind of restriction for heavy trucks may be necessary to limit the volume of truck traffic until the progress of road construction can outpace the increase in the number of trucks on the road, the present restrictions on working time are indeed severe.

Truck terminals are one of the means to reduce the productivity loss from the operating restrictions for heavy trucks, especially with mixed cargoes, by allowing the time to be used for the purpose of cargo handling.

III Truck Terminal Users

The purpose of the truck terminal is to interface between two types of common carriers operators: short-distance intra-city operators and line-haul inter-city route operators. Both types of operators offer a public service, and therefore, it is the public who will benefit from the rationalization of the trucking industry which truck terminals will promote. The number of private operators and trucks is larger than the number of public operators and trucks, and yet, in Japan, their operating efficiency has been shown to be lower since they operate smaller tonnages over routes which can be serviced for joint benefits by public operators (i.e., common carrier operators).

The major users of a truck terminal will be outbound line-haul operators whose O-D ranges are large since without a truck terminal thier less-than-truckload (LTL) mixed cargoes have no economics of scale.

Inbound line-haul operators will profit from truck terminals, but not as much since they will have expended the major portion of overheads by the time they reach the terminals. Nonetheless, it must be noted that provincial truck terminals which are strategically located would greatly improve the efficiency and profitability of inbound LTL mixed cargo operators in the same way that truck terminals in the GBA will do.

An analysis of the composition of common carrier operators shown below, indicates that the size of most common carrier operators is much larger than private operators in terms of ownership of vehicles per firm. In terms of numbers of firms, the private operators have about 98% of the total, but in terms of vehicles, they own only 74% of the total. In terms of annual growth rate, the private operators are increasing more rapidly.

COMPARISON OF COMMON CARRIER AND PRIVATE TRUCK OPERATING FIRMS

Type of Carrier	1971			1976		
	No. of Firms	No. of Vehicles	Veh/ Firm	No. of Firms	No. of Vehicles	Veh/ Firm
Common	285(4)	8,090(37)	28.4	508(2)	22,436(26)	44.2
Private	6,538(96)	13,801(63)	2.1	23,541(98)	62,978(74)	2.7
Total	6,823(100)	21,891(100)	3.2	24,049(100)	85,414(100)	3.6

N.B. ( ) %
Ref.: Table 2-5

ANNUAL GROWTH RATES OF COMMONCARRIER AND PRIVATE TRUCK OPERATING FIRMS

Annual Growth Rates (%/yr)			
Type of Carrier	No. of Firms	No. of Vehicles	Veh/ Firm
Common	12.3	22.6	9.2
Private	29.2	35.5	5.1
Total	28.6	31.3	2.4

Continued

Sources: 1971: Report of the Working Group Concerning Truck Routing MOC, 1973.

1976: Number of Operators and Vehicles, DLT, 1977.

Ref. : Table 2-7

The Common Carrier operators in Thailand are highly concentrated with about 30% of the firms owning 75% of the vehicles as shown in the Table below.

DISTRIBUTION OF COMMON CARRIER TRUCK OPERATORS IN THAILAND, 1976

Firm Size	No. Veh/Firm	No. Firms Qty (%)	Total Veh Qty (%)
	1 - 5	49 (11.1)	118 (0.6)
Small	6 - 10	68 (15.3)	590 (3.2)
	11 - 15	65 (14.7)	860 (4.7)
Medium	16 - 20	55 (12.4)	1,008 (5.5)
	21 - 25	41 (9.3)	949 (5.2)
	26 - 30	33 (7.4)	951 (5.2)
Large	31 - 40	24 (5.4)	852 (4.6)
	41 - 50	32 (7.2)	1,535 (8.3)
	51 - 60	10 (2.3)	581 (3.2)
	61 - 70	10 (2.3)	653 (3.6)
	71 - 80	3 (0.7)	222 (1.2)
	81 - 90	10 (2.3)	808 (4.8)
	91 - 100	15 (3.4)	1,488 (8.1)
	101 - 200	18 (4.1)	2,581 (14.0)
	201 - 300	4 (0.9)	1,047 (5.7)
	301 - 400	1 (0.2)	302 (1.6)
	401 - 500	3 (0.7)	1,308 (7.1)
	501 - 600	1 (0.2)	523 (2.8)
	>600 1/	1 (0.2)	1,946 (10.6)
Total		443	18,394
Average Veh/Firm			41.5

Source DLT No. of Public Truck Operators in Thailand owning vehicles over 6-wheels, 1977

Note . 1/ LTO

Ref Table 2 9

It is estimated that the distribution of common carrier truck operators by region is concentrated in the central region as follows:

Regional Distribution of Common Carrier Truck Operators

Region	% of Firms	% of Vehicles
North	8.8	9.4
Northeast	22.9	24.9
Central	48.2	48.6
South	20.1	17.1

In terms of types of vehicles owned, 87% were over 6-wheel with some variation by region as shown below.

TYPES OF VEHICLES OWNED BY COMMON CARRIER TRUCK OPERATORS BY REGION

(Unit: %)

Vehicle Type	Total	North	East	Central	South
4-wheel	12	18	24	7	15
6-wheel	37	53	41	23	58
10-wheel	50	29	35	68	27
Others	1	-	-	-	-

Source: MOC, 1971.
Ref. : Table 2-10

IV Commodities Handled by Truck Terminals

The commodity amounts to be handled at the proposed terminals were calculated based on the following.

(1) Cargo tonnage to be handled at the proposed terminal are based on inter-zonal cargo flows for the year 2000 (table 3-31). Intra-zonal cargo will not in principle use the truck terminal since trip-ends are widely scattered.

(2) Public line-haul truck composition ratio

It was assumed that 20% of commodities which are suitable for truck terminals would be handled by line-haul vehicles since the ton-kms carried by public line-haul trucks in Japan against the total ton-kms carried by public trucks and that carried by all trucks was 28% and 16% respectively. The composition ratio of ton-kms carried by line-haul trucks in Japan has show a yearly increase, especially after the construction of truck terminals.

(3) Truck terminal use ratios of suitable commodities

The determination of commodity suitability was based on the JOC study results, the Suan Luang survey results, statistical data of Japanese truck terminals (see section 1.2.2) and commodity composition ratios obtained during the course of this study. The suitable inbound and outbound commodities selected are listed below.

Cargo Flow Direction	Category	Suitable Commodity Items	
Inbound	Forestry Prod.	Charcoal	
	Construction Materials	Piling Steel	
	Manufactured Goods	Highly Suitable	Medium Suitable
		Bottles	Canned Food
		Flour	Ice
		Noodles	Reels
		Salt	Sacks
		Tyres	Kerosine Cans
		Cloth	Pipes
		Jars	Tanks
		Leather	Matches
		Bowls	Syrup
		Animal Food	Bottled Ice
		Food	Manure
		Mats	Water
		Iron Scrap	Mosaic 1ile
		Miscellaneous	Silk Leaves
Outbound	Manufactured Goods	All mfg. goods such as: Appliances (Electric) Fuel Lubricants Fertilizer Soft Drinks & Tabacco Knitted Materials Grocery & Canned Food Raw Rubber, Vegetables Oils Jute	

V Truck Terminal Study

Terminal Location Considerations

In selecting suitable site locations for the truck terminals, the following criteria were examined.

1. Decongestion Criteria

Since even in the future, the difference in traffic congestion between areas inside the CBD and outside has been estimated at almost 40%, the truck terminal should be located outside the CBD since truck terminals do attract a great deal of vehicle traffic. Consequently, the high density mixed land use area of the central zone was excluded from consideration for truck terminal sites.

2. Land Use Criteria

In order to avoid conflict with the land use areas defined in the DTCP's Greater Bangkok Plan 2000, truck terminal site location should avoid areas designated for specific land uses such as industrial, institutional and high density mixed use. Consequently, attention for site location was forcused on areas designated as low density mixed use.

3. Accessibility Criteria

From the viewpoint of outbound inter-city truckers, it was considered that terminal locations should be near or on major provincial exit routes from Bangkok which are as follows:

Major Trunk Roads for the GBA

West/South - Route 4
East - Route 34
North/Northeast - Route 1 (alternately, Route 31)

From the viewpoint of the road network, it was considered that terminals should have access to the major 6-lane roadways which will include the following: Outer Ring Road, Middle Ring Road, First Stage Expressway and Routes 1 and 31.

Accessibility to airports and sea ports was considered desirable since both are major originating nodes for the trucking industry. On the other hand, too close a proximity was considered to represent a conflict. The major present and future ports and access routes are outlined as follows:

Type of Port		Port Name	Road Access to GBA
Airport	Present	Don Muang	Route 31
	Future	Nong Ngu Hao	Route 303
Sea Port	Present	Klong Toei	Expressway
	Future	Sattahip and Laem Chabong	Route 34

Consideration of access to railway terminals was considered as problematic since the major railway cargo terminals (Klong Toei, Thonburi and Paholyotin) are all located within the high density mixed-use area of the CBD. By eliminating the CBD from consideration, conflict with a major form of traffic, passenger traffic, was also eliminated since all major Passenger Bus and Railroad Stations are located within the CBD.

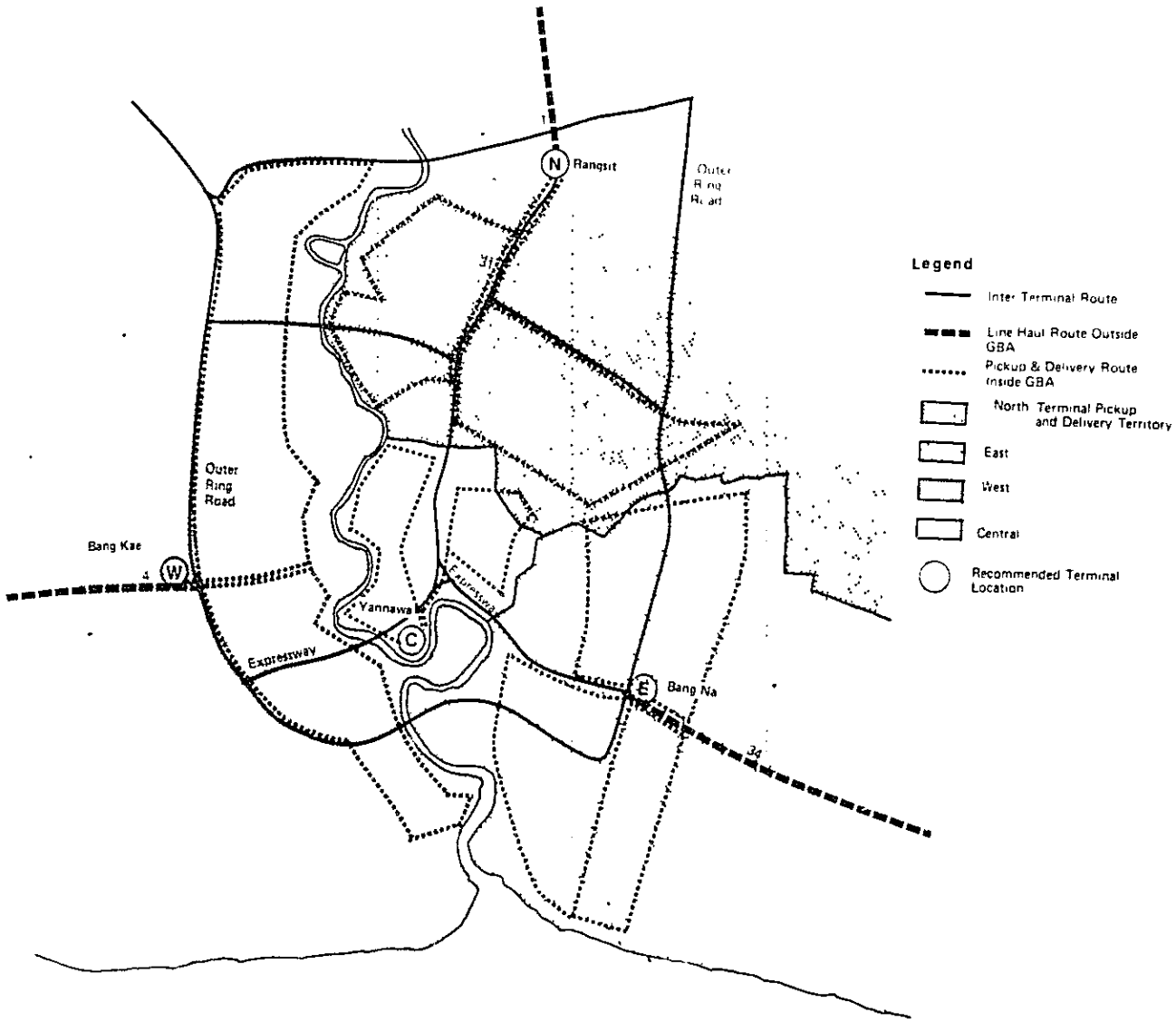
In conclusion, the following four terminal locations shown on the map below were recommended primarily from the access point of view although the locations also meet the decongestion and land use criteria mentioned before.

Summary of Terminal Site Accessibility

Symbol	Terminal	Location	Terminal User Access	6-Lane Road Network Access	Port Access
N	North	Rt. 1	Rt. 1	Rt. 1	Rt. 31 (Don Muang)
E	East	Rt. 34 and Outer Ring Road	Rt. 34	Outer Ring Road	Rt. 34 (Sattahip/ Laem Chabang)
W	West	Rt. 4	Rt. 4	Outer Ring Road	-
C	Central	Between Expressway and Middle Ring Road	Expressway	Expressway	Expressway (Klong Toei)

Ref.: P. 4-37

TRUCK TERMINAL NETWORK, 2000



4. Availability of Land

Although the terminal locations selected above are in low density land use areas, it is recommended that the government initiate zoning restrictions and land acquisition at the earliest possible date in order to keep land values from becoming inflated and to prevent the large land parcels required for truck terminals from disappearing from the market.

5. Single Transfer

The inbound and outbound cargo volume of the GBA was found to be relatively large based on comparison of single and double transfer systems (see section 4.1.3). Consequently, the single transfer system is recommended for terminal operation.

Functions of Each Truck Terminal

The location of the truck terminals are designed to benefit city traffic, facilitate implementation of the city development plan, modernize management for physical distribution operators and benefit users.

1. Central Truck Terminal

The Central Truck Terminal is proposed as a centrally integrated physical distribution base to handle about 50% of the total volumes of all truck terminals since the GBA is a source for LTL cargoes centered in specific areas where illegal parking of large-sized trucks and loading and unloading operations of individual trucks is done in the streets.

Truckers locate their bases of operation in the central area because the trucks of small-sized trucking enterprises are gathered there under control of freight forwarders.

Consequently, the terminal will have comprehensive facilities containing truck platforms, administrative building, parking area, garage, storage places, filling station, maintenance, checking and washing areas. A systematic operational liaison with the other three terminals will be maintained.

2. Eastern Truck Terminal

This main terminal is to be located at the key eastern traffic point about 20 km from the center of the GBA.

Functions of the facilities are mainly pickup and delivery services for LTL cargo within a 10 km radius. A container yard (including CFS) is to be located in the terminal complex as an auxiliary facility to connect systematically with the deep-sea port of Sattahip.

3. Northern Truck Terminal

This main terminal is to be established at the key northern traffic point about 28 km from the center of the GBA. The functions of the facili-

ties are also mainly pickup and delivery services for LTL cargo within a 10 km radius. The terminal will function to meet the expansion of the city and its development.

Demand for transport services of agricultural products and timber products destined for the GBA is high, and so, storage warehouses and silo are needed at this terminal.

Cargo storage for wholesalers in the GBA can transfer into the warehouses of the terminal and separation of sales channel apart from physical distribution will be possible.

4. Western Truck Terminal

This main terminal is to be established at the key western traffic point of about 12 km from the center of the GBA. The functions of the facilities are also mainly pickup and delivery services for LTL cargo

within the Thonburi area within a 10 km radius. The terminal facilities will also function to meet future expansion of the GBA and especially the area crossing Chaophraya River which presently experiencing traffic congestion due to lack of bridges, etc. The facilities in this terminal will meet such traffic conditions and still provide smooth pickup and delivery services in Thonburi.

The western terminal is designed to meet the increasing demand for vegetables and fruits in the GBA and the need for an efficient distribution system. It is designed to be equipped with the same facilities as the northern terminal.

VI Truck Terminal Design

Truck Terminal facilities for the consolidation and transshipment of freight between intra-city pick-up and delivery and inter-city line-haul truckers.

The main components of the truck terminal are the following.

- Cargo handling platforms for consolidation of cargoes into near truck-load lots and for transshipment between pick-up and delivery and line-haul vehicles.
- Apron area adjoining the platform area.
- Branch or field office of the terminal operators.
- Parking area for pick-up and delivery and line-haul vehicles and roadway throughout and surrounding the platform areas.

The determination of the scale of truck terminal facilities was primarily based on the projected volume of cargo to be handled composed of inbound, outbound and transshipment volumes as shown below.

The major design factor and areas of terminal components are shown in the subsequent Table.

MIXED CARGO VOLUMES FOR TRUCK TERMINALS

(Unit: tons/day)

Type of Cargo / Truck Terminal	Outbound Cargo Volume	Inbound Cargo Volume	Transshipment Volume	Total Volume
North	1,211	750	38	1,999
East	1,370	462	24	1,856
West	1,087	672	34	1,793
Central	3,098	2,938	147	6,183
Total	6,766	4,822	243	11,831

VII Economic Evaluation of Benefits

Economic Benefit Calculation

In this study, the benefit was calculated from the savings in vehicle operating costs and travel time costs which will accumulate as a direct result of truck terminal construction.

For the purpose of evaluating traffic assignment results, two cases were calculated: in the first case, the area of influence is only the GBA whereas in the second case, the area of influence is Thailand. The reasons these two cases were made is as follows:

a) The benefits of the truck terminal project will accrue to the whole nation, and so the whole of Thailand must be taken as the area of influence; however,

b) Focusing only on Thailand, will distort the difference between the alternatives in the GBA since the part of the road network outside the GBA is obviously much larger than the part inside the GBA.

According to the computer simulated commodity and vehicle traffic assignment to the road network, the total vehicle-hours and vehicle-kilometers results shown in the Table below indicate that alternative-33 is the best for the following reasons: (Note: the benefits for alternative-333 are the same; only the cost is different).

1. Vehicle-Hour Savings

The savings in vehicle-hours on the GBA account for 50-70% of the savings for Thailand or 6000 veh-hrs/day (see column C/D) although the size of the GBA road network in terms of vehicle-hours is only about 14% of the total Thailand road network (see column A/B) of the Table below.

By comparison with all the other alternatives which is only possible for the double transfer system, alternative-3 is most recommendable as producing the largest veh-hr. savings within the GBA. However, when the comparison is made between the single and double transfer system alternatives (Alt. 3 vs. 33 and 5 vs. 55), the single system is more recommendable. Hence, alternative 33 was chosen as producing the largest time-savings benefits for the nation.

SUMMARY OF VEHICLE-HOURS TRAFFIC ASSIGNMENT RESULTS

(Unit: veh-hrs/day)

Transfer System	Alt. (Terminals)	NETWORK COMPARISON A GBA Traffic Network	B Total Thailand Traffic Network	A/B GBA Percentage (%)	SAVINGS COMPARISON 1/ C Time Savings within GBA	Rank of Alt.	D Time Savings within Thailand	C/D GBA Percentage (%)
Double	1. (Null case)	107,134	767,339	14.0	-	-		
	2. (NEW)	103,128	761,532	13.5	-4,005	(2)	-5,807	69.0
	3. (NEWC)	102,881	761,090	13.5	-4,253	(1)	-6,249	68.1
	4. (NEWN')	103,128	761,320	13.5	-4,005	(2)	-6,019	66.5
	5. (EWN')	103,183	761,074	13.6	-3,951	(7)	-6,265	63.1
	6. (EWCN')	103,167	760,895	13.6	-3,967	(6)	-6,444	61.6
	7. (C)	103,124	760,574	13.6	-4,010	(4)	-6,765	59.3
	8. (CN')	103,125	760,782	13.6	-4,010	(4)	-6,557	61.1
Single	33. (NEWC)	102,661	758,188	12.4	-4,473		-9,151	48.9
	55. (EWN')	103,034	760,349	13.6	-4,101		-6,990	58.7

Note: 1/ The savings from construction of the terminals was defined as the difference between each alternative and the null case (the case in which no terminal is constructed: alternative-1).

Ref.: Table 4-11

2. Vehicle-Kilometer Savings

The savings in vehicle-kms in the GBA account for 60-95% f the savings for Thailand or 200,000 veh-km/day (see column C/D) although the size of the GBA road network in terms of vehicle-kilometers is small (only about 15% of the Total Thailand road network as shown in column A/B of the Table below.

By comparison with all the double transfer system alternatives, alternative-3 is again the most recommendable since it produces the largest veh-kms savings within the GBA. By comparison between comparable single and double transfer system alternatives, the single system is still

more recommendable. Hence, alternative-333 which produces the same benefits as alternative-33 is recommended for adoption as the best combination of truck terminals for the GBA and Thailand.

SUMMARY OF VEHICLE-KMS TRAFFIC ASSIGNMENT RESULTS

(Unit: veh-kms/day)

Transfer System	Alt. (Terminals)	NETWORK COMPARISON A GBA Traffic Network	B Total Thailand Traffic Network	A/B GBA Percentage (%)	SAVINGS COMPARISON 1/ C Distance Savings within GBA	Rank of Alt.	D Distance Savings within Thailand	C/D GBA Percentage (%)
Double	1. (Null case)	5,309,623	34,308,259	15.0	-		-	
	2. (NEW)	5,1 1,722	34,108,323	15.0	-197,907	(4)	-199,936	99.0
	3. (NEWC)	5,102,786	34,092,697	15.0	-206,843	(1)	-215,562	99.0
	4. (NEWN)	5,111,722	34,100,894	15.0	-197,907	(4)	-207,365	95.4
	5. (NEW')	5,114,585	34,092,269	15.0	-195,044	(7)	-215,990	90.3
	6. (EWCN')	5,113,075	34,085,803	15.0	-196,554	(6)	-2-2,456	88.4
	7. (C)	5,111,395	34,074,707	15.0	-198,234	(3)	-233,552	84.9
	8. (CN')	5,111,294	34,082,036	15.0	-198,335	(2)	-226,223	87.7
Single	33. (NEWC)	5,100,266	33,992,191	14.4	-209,363		-316,068	66.2
	55. (EWN')	5,111,116	33,992,191	15.0	-198,513		-316,068	62.8

Note: 1/ The savings from construction of the terminals was defined as the difference between each alternative and the null case (the case in which no terminal is constructed: alternative-1).

Ref.: Table 4-12

3. Total Economic Benefit

On the basis of total vehicle-hours and vehicle-kilometers benefits and the vehicle operating costs above (estimated in section 7.2), the total economic benefits of the major alternatives was calculated and is summarized below:

ECONOMIC BENEFIT, 2000

(Unit: 1,000 Bahr/yr)

Alt. No.	Terminals included	Recommendation	Total Benefit
33	NEWC	This study	537,448
55	EWN'	Thai Govt. proposal based on SEATAC Study.	432,185
7	C	E.T.A.	478,124

Ref.: Table 7-16

VIII Evaluation of Economic Cost and Feasibility

1. Staged Construction

To obtain maximum economic benefit, construction implementation was divided into stages to meet the demand levels at various stages instead of just completing all the elements of the terminals or all the terminals from the initial stage The priority of staging is as follows:

- Alternative 333

First priority - Terminal C
Second priority - Terminal N, E. and W

2. To minimize project costs, an alternative case to 33 (i.e. alternative-333) was considered based on the most economical design and layout of the project facilities. The cost of each project facility in the optimal case-333 including land acquisition cost is summarized below.

ECONOMIC COST BY FACILITY AND TERMINAL
(Alternative 333)

(Unit: 1000 Baht)

Facility 1/ \ Terminal		N	E	W	C	Total	(%)
Truck Terminal	Main Elements	67,148	60,474	66,807	290,562	484,991	(57.7)
	Supporting Elements: Main	15,744	14,882	16,189	67,656	114,471	(13.6)
	Supporting Elements: Other	15,190	14,394	15,170	52,144	96,898	(11.5)
Others		30,869	22,310	30,149	60,984	144,312	(17.2)
Total (%)		128,951 (15.3)	112,060 (13.3)	128,315 (15.3)	471,346 (56.1)	840,672 (100.0)	(100.0)

Note 1/ : Main Elements consist of : Platform, apron, roadway and administration building.

Main Supporting Elements : Platform office, truck parking, platform car park.

Other Supporting Elements : Employee facilities, petrol station, maintenance shop and other elements inside the terminal.

Others : Access roads and main drainage around the terminal complex.

Ref.: Table 7-21

The facilities were considered in various combinations to meet the minimum requirements of terminal function on the one hand (the "Main Elements") and to meet the full needs of terminal users by having additional supporting elements (the "All Elements") on the other. Economic internal rate of returns, B/C rations and net present values were calculated for the truck terminal project facilities as shown in the table below.

ECONOMIC EVALUATION OF PROJECT

Project Elements	EIRR (%)	B/C			Net Present Value (1000 Baht)		
		31%	26%	21%	31%	26%	21%
Main elements only	28.3	0.8	1.1	1.7	-37,306	36,804	183,452
Main elements + main supporting elements only	26.2	0.7	1.0	1.5	-67,285	3,216	144,967
All elements	25.0	0.6	0.9	1.3	-91,555	-24,404	112,796

Ref.: Table 7-23

According to this table, the Truck Terminal "Main Elements only" produces the highest economic return against the resources used for the project. The "All Elements" case, however, also shows a similarly high return in spite of a larger requirement of the investment cost. From the viewpoint of terminal users such facilities as petrol stations, maintenance shops, car park included in the "All Elements" are necessary and very convenient to have in the terminal area. Since the recently issued "Land Transport Act" requires truck terminals to set up vehicle inspection and weighing facilities, it is recommended that the truck terminal "All Elements" be implemented rather than confining the project to "Main Elements only".

To consider the effects of future unknown factors, the costs and benefits were varied by 20% in several combinations to examine best and worst scenarios which might result after adopting Alternative-333.

The results summarized below shown that even in the worst case (a 20% increase in cost plus a 20% decrease in benefits), the construction of the Truck Terminal "All Elements" is still very feasible since it will produce a minimum EIRR of 19.9%.

SENSITIVITY ANALYSIS OF RECOMMENDED ALTERNATIVE-333
(Truck Terminal Facility: All Elements)

		BENEFITS				
		+20%	+10%	0	-10%	-20%
COSTS	+20%	25.0	23.9	22.6	21.0	19.9
	+10%	26.0	25.0	23.8	22.4	20.7
	0	27.6	26.1	25.0	23.7	22.0
	-10%	29.1	27.8	26.3	25.0	23.5
	-20%	30.7	29.6	28.2	26.5	25.0

Ref.: Table 7-24

IX Evaluation of Financial Cost and Feasibility

Investment Costs

The construction costs estimated for the optimum designing of Alternative-333 are summarized below:

FINANCIAL COST BY FACILITY AND TERMINAL

(Unit: 1000 Baht)

Facility \ Terminal	N	E	W	C	Total	%
Main Elements	76,826	69,563	75,897	321,150	543,466	(70)
Supporting Main Elements: Other	18,092	17,199	18,506	74,919	128,716	(16)
	17,594	16,742	17,452	58,475	110,263	(14)
Total	112,512	103,504	111,855	453,574	782,445	(100)
(%)	(15)	(13)	(14)	(58)	(100)	-

Ref : Table 5-37

For the financial evaluation of the project, consideration of the investment cost was limited to the truck terminal facilities only since preliminary examination of the total complex found it not financeally feasible. Consequently 782.445 million Baht was estimated as the project construction cost (exclusing operation and maintenance cost). This accounts for about the 52% of the cost of total complex construction.

Revenue Projection

Each facility of the total truck terminal is supposed to be leased. The principles in determining the leasing fee are as follows:

i) The maximum fee should not exceed the financial benefit that facility users are able to anticipate.

ii) The facility users should amortize terminal construction costs during their operation time at the facility.

iii) The maximum fee should not exceed the existing financial payments of truck operators.

Based on the above principles, the leasing fees were determined as shown in the below table:

LEASING FEES OF TRUCK TERMINAL FACILITIES

Facility	Leasing Fee ($B/m^2/yr.$)	Notes
Platform	1600	The fee includes the operation and maintenance costs of the terminal.
Parking	240	Parking includes truck parking, platform car park and other car parks.
Other related Facilities	3200	The facilities include petrol station, maintenance shop, platform office and employee facilities such as restaurant, bank, post office and other accommodations.

Ref : Table 8-5

If the total revenue remains unchanged, the estimated financial internal rate of return (FIRR=10.3%) will also remain constant. Nonetheless, further investigation is recommended to determine the leasing fees of each respective facility mentioned above.

Financial Analysis Indicators

1. Assumptions on Financial Analysis were set as follows:

- Interest for long-term loans: As examples of consolidated average interest rate, 3.5% per annum for foreign loans and 15.5% per annum for local loans were adopted.

- Corporate income tax: The rate of corporate income tax was taken as 30% on the total net profit; however, this rate was applied to the semi-public corporation case only since a public corporation does not pay any tax.

2. Profitability, Internal Rate of Return (IRR) and Revenue/Cost Ratio

Average net profit over 25 years, average return on paid-up equity (ROE) and internal rate of return are as follows:

	Public Corp.	Semi-public Corp.
Average net profit (1,000 Baht)	30,202	21,157
ROE average (%)	8.99	6.30
ROE discounted base (%)	6.76	4.15
IRR (%)	10.30	8.34

3. Debt Service Coverage Ratio (DSR)

To denote capability of credit repayment, the profit to sales revenue and the Debt Service Coverage ratio (DSR) were calculated. The average values for 25 years are as follows:

	Public Corp.	Semi-public Corp.
Profit to revenue	0.40%	0.28%
DSR	4.28	3.54

(Reference)

DSR = (Depreciation amount + Net profit after tax + Interest payable)/(Principal repayable + Interest payable)

Sensitivity Analysis and Financial Evaluation

The sensitivity analysis below is based on the table which follows.

1. Leasing Fee

The rise of all leasing fees to the truck terminal user by 20% would raise IRR by 3.43% over that of the Base Case, producing an IRR of 13.73%.

2. Price Escalation

Introducing the price escalation on the Base Case (for example, 10% for investment cost and 7% for revenue) increases IRR by 6.27% over that of the Base Case, producing an IRR of 16.5%. The reason for the difference between constant price and escalating revenues is that the investment finishes by 1999 while the revenue continues to increase until 2010.

3. Interest Rate

Interest rate differences affect capital requirements, profitability and cash flow. The effects upon IRR with change of interest rate is quite small, because interest has very little relationship with process of IRR calculation; however, the average profit and other financial indicators showed improvement.

4. Land Acquisition

The amount of land acquisition cost accounts for about 24% of the total project cost. Since this investment is concentrated in the very beginning of the project period, it depresses the IRR accordingly. Deduction of land acquisition cost from the total project costs brings about the largest change in IRR. Since the project is justified for its valuable contribution to the economy, it is suggested that the government gives serious consideration to purchase the required land area at its expense as a separate project.

Conclusions

For Base Case (Alt. 333-1-1), it can be concluded that each financial indicator shows reasonably favorable results from the profitability, commercial soundness and cash flow points of view, assuming that this project is carried out by public corporation and land will be provided by the government as part of its public service role.

It is, therefore, concluded that Alt. 333-1-1 is commercially sound and feasible and deserves to be implemented as one of major development projects in Thailand.

RESULTS OF FINANCIAL SENSITIVITY ANALYSIS

(Alternative-333)

Case No.	Land Acq. Cost	Facilities	Fee (Baht/m^2/yr)	Public or Semi-public ownership	IRR (%)	Revenue/Cost Discount Rate 8%	10%	12%	15%	Average Profit (1,000Baht)	ROE (%)	DSR
333-1-1 (Base Case)	Deducted	All Truck Terminal Facilities	T.T. 1,600 Office 3,200 Parking 240 Rel.facil. 3,200	P	10.30	1.22	1.02	0.87	0.70	30,202	8.99	4.28
				S-P	8.34	1.03	0.87	0.74	0.60	21,157	6.30	3.54
333-1-2	Deducted	"	All fees 10% up	P	12.05	1.40	1.18	1.00	0.81	37,305	11.25	4.90
				S-P	9.72	1.15	0.98	0.84	0.68	26,393	7.87	3.97
333-1-3	Deducted	"	All fees 20% up	P	13.73	1.58	1.33	1.13	0.91	45,261	13,50	5.51
				S-P	11.01	1.28	1.08	0.93	0.75	31,683	9.45	4.91
333-1-4	Deducted	"	All fees 10% down	P	8.43	1.04	0.87	0.74	0.59	22.586	6.74	3.65
				S-P	6.87	0.90	0.76	0.65	0.53	15,810	4.72	3.10
333-1-5	Deducted	"	All fees 20% down	P	6.41	0.86	0.72	0.61	0.49	15,018	4.48	3.01
				S-P	5.32	0.77	0.65	0.56	0.45	10,513	3.14	2.65
333-1-6	Deducted	"	Price escalation All fees 7%/yr Investment 10%/yr.	P	16.57	1.95	1.64	1.40	1.12	168,380	16.08	7.49
				S-P	13.46	1.54	1.30	1.11	0.89	117,866	11.26	5.84
333-1-7	Included	"	"	P	12.22	1.51	1.23	1.02	0.78	149,868	10.97	4.35
				S-P	9.99	1.22	1.00	0.83	0.64	104,907	7.68	3.49
333-2-1	Included	"	Same as Base Case	P	6.49	0.83	0.67	0.55	0.43	21,708	4.75	2.20
				S-P	5.62	0.76	0.62	0.51	0.40	15,195	3.33	1.92
333-3-1	Deducted	Main Truck Terminal Elements only	T.T. 1,600	P	1.40	0.47	0.39	0.33	0.26	849	-	1.63
				S-P	1.40	0.47	0.39	0.33	0.26	849	-	1.63
333-4-1	Included	"	"	P	-	0.31	0.24	0.20	0.15	20,192	-	0.12
				S-P	-	0.31	0.24	0.20	0.15	20,192	-	0.12

Ref.: Table 8-11

X Organization for Truck Terminal Implementation

1. Promotion by Central Government

The central government is considered to be in the best position to promote the truck terminal development program with its broad perspective for the public interest, and ability to coordinate such a program with other public programs for transportation such as traffic, social, urban and regional developments. It can also provide the necessary legislative, legal and administrative support. Easier access through the central government to achieve cooperation with all governmental bodies for the Truck Terminal undertaking will also be a valuable asset and will facilitates program development. In addition, the possibility of raising funding internationally will be facilitated if the government rather than of semi-public organization is the owner and promoter.

The need of creating a large organization within its own administrative setup and the temporary nature of the need for such an organization are considerable disadvantages which the government must overcome.

2. Investment by the Central Government

Investment of the central government is justified by the benefits to the nation which can be derived from the development of truck terminals which are public service facilities.

3. Administration

A Joint Venture Corporation for administration between Public and Private Sectors is considered to be both realistic and practical.

All facilities should be equally administrated under one organization, with authority for the terminal
terminal managers, while the central administration office concentrates on overall management and centralized clerical work.

4. Plan for Utilization of Terminal Platform

The platforms will be leased for use to operators in lots. It is presumed that operation on the platform (loading, unloading, transshipment and sorting by destination) is to be done jointly among operators.

However, responsibility for cargo handling must be clearly defined especially, to prevent cargo losses and accidents.

5. Stages of Organization Development

The organization to implement the Truck Terminal Plan, tentatively designated as the Truck Terminal Corporation (TTC) will be developed essentially in three stages:

Stage 1: (Initial Transitional Stage)

Organization in the initial transitional stage will take the form of a provisional office, starting with a few selected personnel from the private sector who work

jointly with the governmental commission to establish the legal body of T.T.C. and operate until the organization is ready for full operation. The steps for establishing the G/C are outlined in section 6.2.2.

Stage 2: (Construction Stage)

The corporation will commence full operation after having mobilized a sufficient number of key staff members and established the basic work procedures for the organization. From then on it will continue to develop until the requirements for administrative personnel reaches its peak during the full scope of construction activities.

Stage 3: (Operation Stage)

After all terminals are opened for operations, the T.T.C. organization will begin to phase down for the normal operations; Land Acquisition and Engineering Divisions will be dissolved. Their functions will be absorbed by other administrative divisions, and each terminal office will become an independent sub-structure which reports to the general manager and cooperates in coordination with the central administrative divisions.

6. Implementation Program

Implementation is based on the estimated volume of demand as minimum time requirement for construction preparation, and the execution time of most projects is extended to avoid a concentration of similar operations for multiple projects at one time. (see the Figure below)

7. Construction Schedule

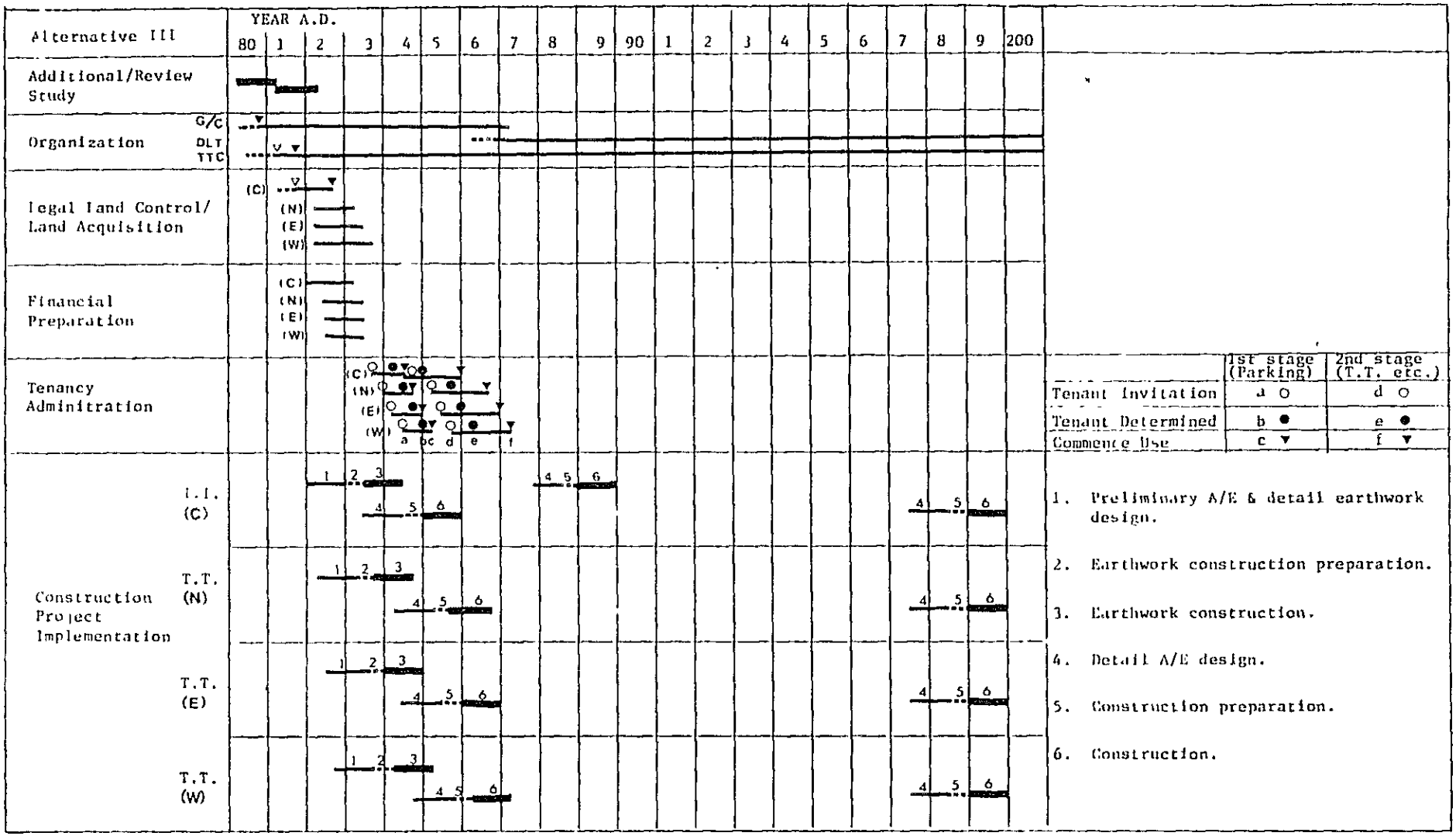
Before beginning construction, it will be necessary to carry out preconstruction preparatory works such as topographical survey, soils investigation, detailed design, land acquisition, and procurement of finance. The period required for such preparatory procedures is estimated to be about 24 months.

The detailed design will take about twelve months and assuming that at the same time, negotiations and financial procurement are successful, land acquisition can begin.

During the period required for land acquisition to be completed, the contract for construction can be approved and awarded. Mobilization for construction can begin after the contract is awarded.

The implementation and construction schedule outlined above is shown in the following Figure.

Implementation Program - Alternative 333



TT Truck Terminal
TTC Truck Terminal Corporation
DLT Dept of Land Transport
G/C Government Commission

N North
E East
W West
C Central

A/E Architectural Engineering Work

Ref.: Table 6-10

XI Conclusions and REcommendations

1. Truck terminals in Bangkok should be constructed at three locations on the periphery of the GBA on major truck roads in the north, east and west (Rangsit, Bang Na and Bang Kae respectively) and at one location near the central area of the GBA (Yannawa).

2. Construction of truck terminal facilities which includes the main and supporting elements is economically feasible since it produces an economic IRR of 25.0% and since it contributes to the economy of Thailand by promoting scheduled route transport and handling of most consumer goods which serves the public.

3. Construction of truck terminal facilities is financially feasible since it produces a financial IRR of 10.3% based on the assumptions that the project is carried out by a public corporation and that the land will be provided by the government as part of its public service role.

4. It is recommended that the Government acquire the land for the terminal sites within one year in order to finalize the location of the terminals which is the most important factor in finalization of the design and also to avoid inflationary pressures.

5. Interested trucking comparies should organized as an association or a formal organization through which the joint capital from trucking companies can be invested into this project as is done in the case of the Japanese public truck terminals. For the realization of such an investment system, further investigation about the desires and capabilities of the t_ucking companies is necessary.

6. According to the demand forecast of terminal cargoes and the case of establishment, the construction priority should be put on terminal-C. This will also make it possible to train the personnel to be assigned to the other peripheral terminals and also to establish management systems to organize the four terminals under the same administration.

   When terminals N, E and W start operation, it should be at the same time to permit uniform enforcement truck parking regulations in the vicinity of the GBA boarder. The construction of these peripheral terminals will contribute to the promotion of satellite town development and will enhance the realization of the urban decentralization scheme.

7. The existing traffic regulations for heavy trucks should be continued; however, in accordance with the progress of transportation infrastructure development, the regulations should be re-examined and kept flexible with due consideration to factors such as traffic safety, road congestion, air and noise pollution and influence on cargo movements.

   For the purpose of preventing heavy trucks from parking on the roadsides at the peripherv of the GBA during the truck operating restriction periods, the public parking area and petrol stations for the truck terminals N, E and W will be developed at an early stage.

8. Strict enforcement should be made of laws relating to trucks and particularly existing laws requiring truck operators to own and use their registered parking facilities. Laws prohibiting truck parking on the roadside of the central business district should accompany the establishment of the truck terminal in the central Bangkok area.

9. The establishment of truck terminals should be accompanied by strict enforcement prohibiting parking on the three radial trunk highways, (Routes 1, 4 and 34). At the same time, examination to eliminate all operating restrictions on these trunk highways and First Stage Expressway should be made.

10. It is desirable that a truck terminal include many truck related to functions, not only truck terminal facilities, but also a distribution center to decentralize the urban area. For this purpose, the design of terminal complexes should include warehouses, charter truck centers, public parking area, petrol stations, and facilities for drivers.

11. The settlement and determination of the forms and function of platforms should be made jointly with the tenants of the terminal. (This subject is recommended as a supplementary study described below.)

12. To determine the optimal system of pickup and delivery operation which is compatible with the objectives of truck terminal establishment and the introduction of a new truck operating system, study off the pickup and delivery system within the context of the current and future socio-economy, including the urban traffic situation, the practice of trucking business operation and the inter-relationship among commodity distribution related industries should be performed as a supplementary study.

13. The early construction of the segment of the Outer Ring Road between Phet Kasem Highway (Rt. 4) and the Thonburi Pak Tho Highway (Rt. 35) is highly recommended to keep truck terminal traffic out of the CBD by facilitating its use of the Expressway.

14. In order to make the necessary evaluation of truck terminal performance, it is essential that the Government statistical data related with trucks distinguish between types of registrations (common carrier or private). In addition, it is recommended that truck data relating to tonnages, distances and types of cargo carried should be collected on a regular basis.

15. The supplementary studies recommended for this project are listed below. These studies should be carried out in parallel with the review in the design stage.

    (1) Truck operator and user study to prevent insufficient cooperation and acceptance from users upon implementation which might threaten the terminals success.

    (2) Optimal truck route study in terms of new links, road capacity, maintenance costs and destinations to reduce the truck component of traffic and insure adequate terminal access even

if the Outer Ring Road construction is delayed.

(3) Development of rational cargo distribution zoning and system study to encourage terminal use.

(4) Truck terminal impact study especially on commerce, industry and land use to maximize the benefits in all these areas.

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TERMINOLOGY

Sizes of Trucks

Classification	No. of Wheels	Rated Cargo Capacity (ton)	Passenger Car Equivalents (pce)
Light	4	2	1.3
Medium	6	5	1.5
Heavy	10	10	3.0

Types of Trucks (see Section 2.2)

Pick-up and delivery:	Cover limited intra-city territory
Line-haul:	Cover wide fixed inter-city routes

Categories of Truck Operators

	Type of Business and Customers	Color of Licence Plate	Routes	Frequency
1. Private Carriers	Personal Carriage only	White (Bangkok) Black (Others)	Private	As desired
2. Common Carriers	Public Service	Yellow		
a. Japan "Line-haul" carriers	General public	Mixed Cargo	Fixed 1. National 2. Provincial 3. Local	Scheduled
b. Japan "district" carriers	Exclusive customers (Chartered Service) General public	Bulk Cargo	Not Fixed	Not Scheduled

Types of Terminals (see Section 1.1)

Private or Exclusive	Established as private businesses for private use
Public	Provided by law as public facilities

Truck Terminal Complex Facilities (see Chapter 5)

Truck Terminal	For non-bulk mixed cargo transshipment (see Sections 1.2.2 and 2.3)
Warehouses	For storage of bulk commodities not handled at truck terminal platforms
Chartered Truck Center	For centralizing the marketing of for-hire common carrier service
Public Parking	For trucks with 6 or more wheels which have restricted operating periods in the GBA (see Section 2.2.3)

FOREWARD

Background of the Study

On Nov. 2nd 1971, E.T.O. was authorized by the Thai Cabinet to pursue the planning and development of public truck terminal facilities in Bangkok. According to the "Report of the Working Group Concerning Truck Routing" (MOC, 1973), the economic and social benefits of truck terminals (which are still valid) were enumerated as follows:

a) Economic Benefits

- Better utilization of trucks and increased efficiency in trucking.
- Help alleviate traffic congestion by substituting 4-wheel delivery trucks in the city center for 6- and 10-wheel line-haul trucks which obstruct traffic in the course of their cargo handling operations.
- Facilitate control of truck weights to prevent overloading and thereby reduce road maintenance.
- Achieve greater efficiency through the use of cargo handling equipment.
- Provide easily accessible storage facilities with reduced tariffs due to construction economies of scale.
- Allow for the establishment of a Warehousing Center to lower transport costs and reduce unnecessary trip duplication.
- Produce statistical data and information useful in the process of urban planning.
- Facilitate integration of transport modes and rationalization of the physical distribution of goods.

b) Social Benefits

- Provide increased convenience to shippers with scheduled route service.
- Help reduce accidents through better facilities and welfare for drivers.
- Improve the inspection and maintenance of vehicles to allow for increasing their hours of use.
- Attract more workers to the transport industry.
- Facilitate expansion of the Bangkok business area to harmonize with the planned land use policy.

A preliminary feasibility study of the installation of the system of truck terminals was conducted by Thai University Research Associates in 1974, and another study for the establishment of truck terminal was carried out by JOC for SEATAC in 1978.

On the basis of the SEATAC study mentioned above, the Government of the Kingdom of Thailand asked the Japanese Government for assistance to prepare a detailed feasibility study and preliminary design study to advance the realization of Bangkok truck terminal construction.

In response to this request, Japanese Government, as part of its technical cooperation program, has undertaken to carry out this study. A preliminary mission organized by the Japan International Cooperation Agency (JICA) from January 22 to February 3, 1979 was dispatched for field reconnaissance and preparation of the scope of work in accordance with the Thai Counterparts. After a series of discussions with the Thai authorities concerned, the scope of the study was defined.

JICA appointed a consortium of consultants consisting of Pacific Consultnats International and Nittu Research Center, to perform the study and recommend effective and appropriate facilities for the truck terminal as one of the essential parts of the cargo distribution system in Thailand.

In the first phase, the consortium, working under the guidance of an advisory committee, dispatched an 8-member study team to Thailand for field work from 26th August to 9th October, 1979. A progress report was submitted in September, 1979, which contained the results of field work in Bangkok area. In the report, activities of the study team such as site reconnaissance, meeting with government authorities, data collection and discussions, traffic surveys and various efforts which largely concentrated on the investigation of the existing situation of the cargo transportation system in Thailand were presented. An overall policy for the following phase of the study as well as selected locations and numbers of project sites worked out by the team up to the end of the site survey period, were also incorporated.

On the basis of the policy outlined in the progress reports, further work was subsequently carried out by the consultants in Japan incorporating the Government comments, to identify the proposed alternative combination of sites including more possible alternative cases based on the general policy basically agreed upon in the site survey stage.

The results contained in this report were prepared after making necessary modifications which were raised in the panel discussion with the Thai Government on the progress report and in the thorough discussion in the plenary meetings on the draft final report held in the beginning of February, 1980, at the office of Department of Land Transport in Bangkok. Therefore, this report is a joint effort of Thai counterparts and the consultants in Japan, with the advisory committee providing the necessary advice and guidance during the decisive stages of the study.

Purpose of the Study

The purpose of the study is to examine the feasibility of the construction of the Bangkok Urban Truck Terminals as an essential part of the cargo distribution system of Thailand.

Premise

The long term planning objective in this study is based on the future road network of Bangkok to be completed by the year 2000. This network will include the urban planning roads, first stage Expressway, Middle Ring Road and Outer Ring Road. To base the truck terminal planning on any lesser configuration risks the preparation necessary to meet the demands of the future. On the other hand, the DOH has indicated that the implementation of the construction of the full Outer Ring Road is likely to involve at least a decade of delay. Consequently, for the initial period of operation, it is assumed that truck traffic will depend heavily on the Expressway for inter-terminal transport and the pickup and delivery traffic of intra-city commodity distribution. The early construction of the segment of the Outer Ring Road between the Phetkasem Highway (Rt. 4) and the Thonburi-Pak Tho Highway (Rt. 35) is highly desireable to minimize the truck component of city traffic.

Study Procedure

In order to insure that Truck Terminal System would contribute to the reformation and rationalization of the present physical distribution system in the GBA, alternatives of the location and numbers of the terminal were scrutinized based on recognition of the fundamental concept for the role of a truck terminal as a node of outbound mixed cargo as well as the characteristics of the economy and transportation in the country.

Traffic forecasts were made for passengers as well as commodities in the area to reflect the numbers and scale of the terminal facilities for refinement of the study concept.

Efforts to harmonize the conceptual study results of the terminal with that of the traffic forecasting, particularly of the freight demand characteristics were also maintained throughout the study course in order to obtain the most appropriate plan for the entire trucking industry.

The freight demand forecast made for economic and financial analysis of the project planning were conducted in the procedure outlined below:

1) The framework for the analysis was set up on the basis of collected data, study area zoning and the major commodities constituting cargo traffic flows.

2) Commodities were picked for the purpose of study and classified into groups. O-D matrices of the commodity volumes were developed based on the production, consumption, import and export of goods.

3) The results of the O-D matrices of itemized commodity tonnage were checked in the light of the control totals of the cargo volumes set up for the GBA, adjusted if necessary, and finally adopted.

4) The cargo O-D matrices in tonnage were then converted into the numbers of trucks for two alternative cases (with and without terminals system), and for each alternative case, traffic was comprehensively assigned again taking the person-trip demand into consideration.

5) Vehicle running costs were calculated on the assigned traffic and compared in order to figure out the project benefit. Other indirect benefits including time savings as the result of easing congestion, and various social benefits were also taken into account.

6) The above mentioned procedure was used as the basis for computer simulation of the alternative terminals plans expressed in terms of different locations, numbers and size. The results were then compared to select the one with the largest benefits for Bangkok and the nation.

The selected terminal facilities preliminary planned together with the costs were evaluated economically and financially in terms of benefit-cost ratios and internal rates of return. The details of the project study and the preliminary draft of its conclusions are presented in the chapters which follow as listed below.

Chapter

1 Truck Terminal Concept and Experience
2 Background of Cargo Traffic and Trucking
3 Forecast of Traffic Demand
4 Truck Terminal Study
5 Terminal Facilities Design
6 Organization and Implementation Program
7 Economic Evaluation
8 Financial Analysis

Team Formation: Advisory Committee, Study Team and Thai Counterparts

With the intention of effective completion of the project study, the advisory committee, the study team which participated in the field survey and the Thai counterparts who worked together with the consortium have been formed as follows:

a) Advisory Committee

1.	Chairman	Mr. H. Sagara	Ministry of Transportation
2.	Member	Mr. M. Yamamoto	Ministry of Transportation
3.	Member	Mr. O. Matsumoto	Ministry of Transportation
4.	Member	Mr. H. Ohkawa	Ministry of Transportation
5.	Alternate Member	Mr. H. Hiraishi	Ministry of Transportation

b)	Advisory	Mr. Y. Yoshitake	Japan Automobile Terminal Co., Ltd.
c)	Coordinator	Mr. K. Shiratori	Japan International Cooperation Agency

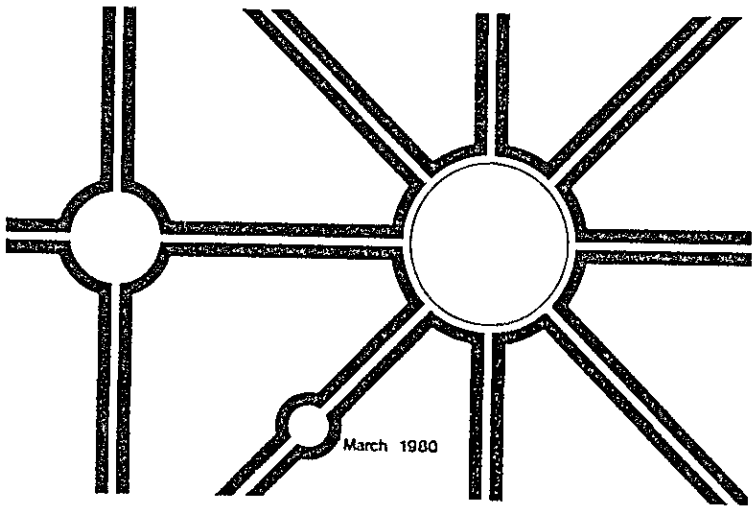
d) Study Team

1. Project Manager	Mr. H. Chiba	Pacific Consultants International (PCI)
2. Deputy Project Manager	Mr. S. Kohno	Nittu Research Center (NRC)
3. Truck Terminal Planner	Mr. K. Hirakata	NRC
4. Specialist of Terminal Administration and Operation	Mr. Y. Yamanobe	NRC
5. Senior Civil Engineer	Mr. K. Ueda	PCI
6. Transportation Planner	Mr. T. Matsumura	PCI
7. Transportation Economist	Mr. I. Gunji	PCI
8. Regional Planner	Mr. C. L. Fang	PCI
9. Senior Economist	Mr. Y. Nakao	PCI

e) Thai Officials and Counterparts

1. Senior Technical Planning Engineer	Mr. Anek Suriyavong	Dept. of Land Transport (DLT)
2. Senior Technical Planning Engineer	Mr. Pinyo Talaenoi	DLT
3. Technical Planning Engineer	Mr. Silpachai Jarukasemratana	DLT
4. Technical Planning Engineer	Mr. Chali Sukwat	DLT

CHAPTER 1 TRUCK TERMINAL INTRODUCTION



Chapter 1 TRUCK TERMINAL INTRODUCTION

1.1 Truck Terminal Concepts

1.1.1 The Necessity of Truck Terminals

When the cost of transport increases due to lack of economies of scale or wage and facility cost inflation, it in turn stimulates inflation since the distribution of most goods involves truck transport. An unorganized cargo distribution system further limits production and freezes capital. The transport causes of these problems are listed below.

1) Many small lots of commodities shipped at different times involve either repetitive scheduling or delays

2) Business area expansion increases the distribution territory causing long trips and duplication of routes

3) Some private trucking becomes inefficient due to route duplication

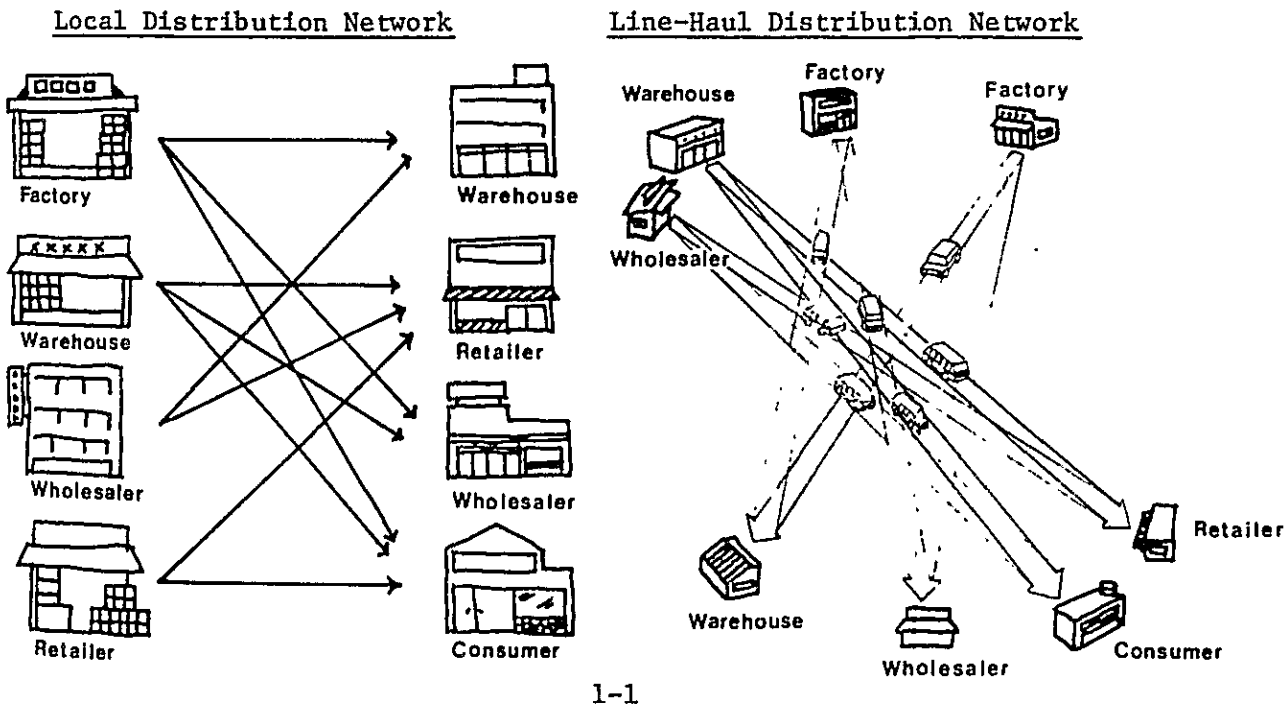
4) Wholesale area congestion increases transport time & costs, and parking areas there are harder to find

5) Areas to expand facilities for cargo distribution become more difficult to find and increasingly expensive

6) Employees for cargo transport become increasingly difficult to find

7) Employee work conditions worsen due to low trucking margins which cannot finance benefits.

Fig. 1–1 ROUTE DUPLICATION AND DELAYS IN LOCAL DISTRIBUTION AND LINE-HAUL BRING ABOUT THE CONDITIONS REQUIRING TRUCK TERMINALS



In the case of Thailand, the national costs of not having truck terminals are large since the present system of cargo terminals is experiencing severe curtailment which is more than likely to increase in severity in the future.

The present cargo terminals in Bangkok mainly consist of two facilities:

(1) shophouses where storage and administrative functions are performed, and

(2) roadside areas in the CBD where cargo handling and vehicle maintenance are performed.

Although the use of public CBD roadways for business operations may at one time have been tollerable, the growth of this type of operation in the future is limited for the following reasons:

- Expansion within the CBD involves prohibitive land acquisition costs.

- Pressure for stricter enforcement of traffic regulations relating to the use of road space is growing.

- The leasable location at Suan Luan which handles an estimated 25% of the common truck business is likely to be withdrawn by its owner, Chulalongkorn University.

- As the growth of inflation continues, the cost of inefficiencies in the transport system (whether caused by location in congested areas or lack of economies of scale) will becomes less acceptable.

1.1.2 Physical Distribution (PD)

In principle, the improvement of physical distribution is necessary because there is no other way but to rationalize transport business in order to reconcile two objectives: handling of the growing demand for cargo transport in big cities on one hand and the necessity to reduce transport frequency to conserve resources on the other. Physical distribution, is the flow of goods: that is, transporting, storing, handling and packaging. This chain of activities consists of two parts, "line part" which corresponds to means of transport and "nodal part" which connects these means of transport. These nodal points are called physical distribution facilities, functions of which can be summarized in the following way: (1) reloading, (2) mixed loading, (3) storing, (4) processing, (5) communication. Improvement of distribution facilities must be carried out along with the improvement of "line part" facilities.

Improvement of physical distribution facilities has the following effects:

(1) It rationalizes inter-district transport -- Centralization of goods and inventory control standardizes transport schedules thereby increasing volume of cargoes per unit

and promoting usage of large-sized trucks and other means of transport.

(2) It rationalizes collection and delivery service of inter-district transport -- Establishment of physical distribution facilities at appropriate places in the district makes it easy to set up distribution network and schedule for each destination.

(3) It provides stable supply of daily commodities - It becomes a stock point where demand and supply of daily commodities which are consumed regularly and in large quantity can be adjusted.

(4) It promotes containerization and palletization. As the cargoes in small lots are packed or sorted into a container, containerization becomes easy. Establishment of pallet depots promotes palletization thereby rationalizing loading and unloading operation.

(5) It provides merits of scale. Physical distribution facilities are an amlgamation of terminals owned by each enterprise. By efficiently allocating various facilities, operation costs can be saved and the volume of cargoes handled will be increased. Mechanization and joint operation become possible.

(6) It improves labour management. The establishment of wayside amenities such as rest room and room for taking a short sleep improves the working conditions of drivers.

1.1.3 Concept of Truck Terminals

(1) Objective of Truck Terminal Facilities

The GBA is a population-concentrated city and traffic measures have a great impact on urban well-being as well as national growth.

Especially, in order to have an efficient operation for LTL (less than truckload), commodities which include the main consumer goods used domestically by most people, the establishment of truck terminals which have node functions between intercity transport and intracity operation of pickup and delivery within GBA are required. The truck terminals perform for cargo similar functions as bus terminals perform for passengers as described below:

(2) Functions of Truck Terminals

The functions of truck terminals are as follows:

a) Function of transshipment and sorting

Loading, unloading and sorting by shipping destinations of collected and arrived cargoes.

b) Function of storage

Storage activities allow for timely adjustment of demand and supply through the transport industry.

c) Function of mode selection

In the intercity transport of LTL cargo, coordination with other modes (or intermodal transport service) such as rail, ship and air is required. Intermodal transport service is based on the unit load system for shipping destinations (by box-pallet and container, etc.)

d) Function of Distribution-Processing

Shipping of LTL Cargo requires packaging, labelling and collection of various goods.

(3) Related and Auxiliary Facilities

Truck terminals are the node facilities of LTL cargo where platforms are located. In order to promote more efficient (physical distribution), it is necessary to centralize physical distribution related facilities in a group such as chartered truck hiring, warehouses, container yards and transshipment platforms. Systematic tie-up among the facilities is desireable.

Other auxiliary facilities are also required such as maintenance and checking of vehicles, parts storage, garage, parking area and administration building, etc. which function to make the transport business more efficient. (See table 1-1).

(4) Kinds of Truck Terminal

Since the functions of truck terminals facilities mentioned above differ by size of city and traffic conditions, different kinds of terminals are employed. Generally, the main types of truck terminals are main-terminals, sub-terminals (touch-at-terminals), depots and transit-terminals.

Table 1-1 Functions of Truck Terminal Facilities

Function / Description	Transshipment	Storage	Distribution Processing	Mode Selection Coordinating	Auxiliary Function
Activity	Transshipment of cargo in the process of transport	Storage for the coordination of demand and supply	Processing and assembling to coordinate the change in quality to meet the change of customer demand	Coordination with other modes as appropriate	Supporting maintenance and operation activities
Contents	Loading, Unloading, Pick-up, Delivery, Sorting, Checking, Measuring	Storage Inbound and Outbound of Cargo, Sorting, Selecting, Checking	Processing, Assembling, Packing, sorting, Selecting, Checking	Vanning and De-vanning container (Rail, Ship) Transfers	Measures for vehicle maintenance and for Health and Welfare of Employees
Main Facilities	Truck Terminal Cargo Platforms Distribution Center Post Facilities Containers Yards	Warehouse Field Storage Facilities Silo	Processing, Assembling and Packing Facilities	Docking Yard Truck Terminal Distribution Warehouse Container Yard	Parking Area Petrol Station Maintenance Shop Cargo Checking Facilities Sleeping Room Dining Room Shower-bath Room Clinic, Bank, Post-Office

a) Main terminals

Main terminals are large-sized facilities located on the periphery of large cities where the demand for transport services has a high volume. Related and auxiliary facilities are located jointly with it.

b) Touch-at-Terminals (Sub-terminals)

Touch-at-terminals are needed for line-haul trucks in small cities and towns for transshipment of commodities on a route. The facilities focus on pickup and delivery services of LTL cargo and loading and unloading of line-haul trucks. Usually, related and auxiliary facilities are not required.

c) Depots

If pickup and delivery services from the main terminal around a large city are not operated efficiently or benefits of shippers are obstructed, depots are required. The area required for them is rather small and the main activities are to transship the transit cargoes from the main terminal for delivery to the area and to transship cargoes collected from the area to the main terminal. Alternatively, shippers and consignees can bring or receive their cargoes at the depots by themselves.

d) Transit Terminals

Transit terminals are established around traffic key cities to link shipping destinations. Transshipment service between line-haul trucks by destination is made at transit facilities. Main terminals also have a function as transit terminals.

(5) Operation Pattern of Truck Terminals

Truck Terminals are nodes between line-haul trucks and pickup and delivery trucks for efficient transport of mixed LTL cargo. Their major patterns of operations are listed below.

a) Pickup and delivery service

Pickup and delivery services within an area by small trucks (4-wheel) are made to the terminal according to schedules. Unloaded cargoes from line-haul trucks are therefore delivered within the territory of the service efficiently.

b) Materials handling on platform

Unloading from pickup trucks and sorting by shipping

destination are performed and cargo is transferred onto a specific shipping block on the platform for loading to line-haul trucks.

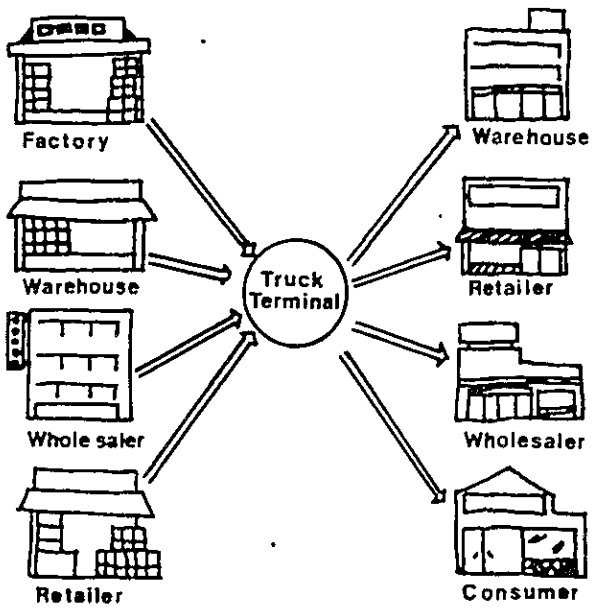
Unloaded cargoes from line-haul truck are sorted for transshipment to other line-haul trucks or for delivery by delivery zone in delivery trucks.

c) Operation of Line-haul trucks

Line-haul trucks on designated routes are operated on time-schedules. The operation is done exactly and promptly according to user requirements. Efficient loading, unloading and improvement of load factor are promoted by truck terminals.

For line-haul truck operators who transport mixed cargoes in small lots, it is necessary to have a facility where they can link and rationalize trunk road transport with collection and delivery operation (loading, unloading, sorting of goods according to destination and temporary storing). The facility called for is a truck terminal which offers separate service from that of chartered truck transport.

Local Distribution Network



1.1.4 Benefits of Truck Terminals

(1) Economies of scale

One of the economic justifications for truck terminals lies in the economies of scale it creates.

a) It is cheaper to transfer and breakup lots of goods bound for multiple destinations into smaller delivery vehicles rather than use partially loaded, more-expensively-operated large vehicles.

b) It is cheaper to transfer and consolidate goods bound for a single destination or along a single route into larger capacity line-haul vehicles rather than use 2 or 3 smaller vehicles.

These economics of scale are the rationale for the truck operators to offer a service to the public.

(2) Merits of establishing truck terminals

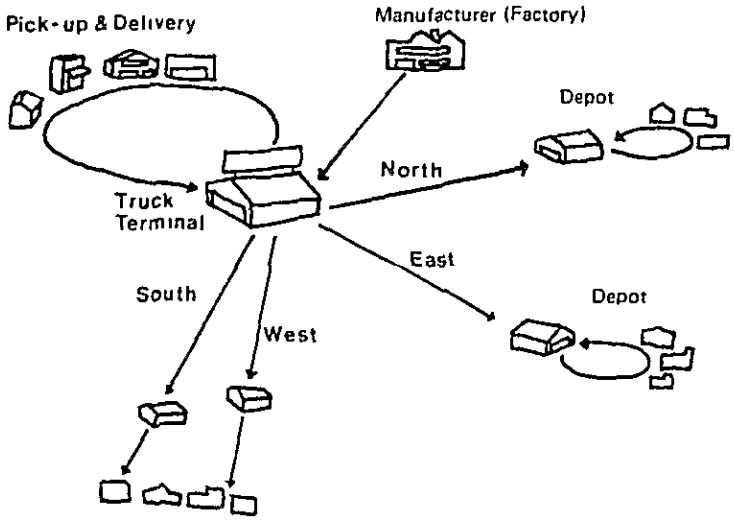
a) Improvement of inter-district transport efficiency

By concentrating cargoes and adjusting inventories, truck operation can be planned in advance and more cargoes can be transported as a large-scale operation.

b) Improvement of collection and delivery efficiency in intra-district transport

By establishing terminals at appropriate places, truck operators can organize the most suitable collection and delivery network and schedule for each destination (See Table 1-2).

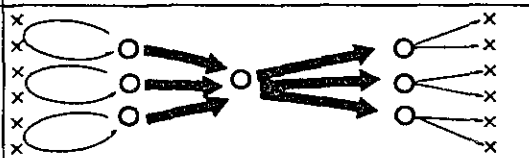
Line-Haul Distribution Network



c) Promotion of unit load system

Unit load system can be adopted by mobilizing containers which accommodate small-lot cargoes.

Table 1-2 Patterns of Transport and Terminals

			Details	o Merits * Demerits
Accompanied by collection/delivery	Centralization of cargoes at port of origin		Concentration of cargos collected from a number of shipping agents located in large city. Cargoes transferred from each shipping agent to the main terminal are to be put into the vehicle.	o Increase in loading factor of the vehicle o Cargoes arrive at port of destination in time (as opposed to the case of "concentration of cargoes at port of destination".) * Increase in cost for transfer operation * Time for collecting cargoes is limited to meet the departing time of the vehicle.
	Centralization of cargoes at port of destination		Concentration of cargoes to be delivered to shipping agents located in large city.	o Increase in loading factor of the vehicle o Decrease in the volume of sorting operation at port of origin and increase in operation efficiency. o Feasible to apply the direct transport system * Increase in cost for transfer operation * Increase in delivery time due to transfer operation.
	Centralization of cargoes at intermediate		In case it is difficult to transport cargoes directly from port of origin to that of destination, re-sorting operation has to be organized at intermediate port and cargoes thereafter are transported by different vehicles.	o Improvement of transport network and increase in transport efficiency o Decrease in overlapping transport of cargoes o Increase in loading factor.
Unaccompanied by Collection/delivery	Direct transport		Transport between main terminals which deal with large volume of cargoes (most efficient transport system).	o Minimum cost required o Minimum time of transport required o Minimum stay of cargoes at sorting platform o Improvement of services to customers
	Collection of cargoes from a number of shipping agents at port of origin		Collection of cargoes from only one shipping agents at port of origin to be delivered to the designated shipping agent at port of destination.	o Ample time for collecting cargoes o Cargo arrive at port of destination in time o Decrease in cost for transfer operation of cargoes o In case of volume of cargoes being increased or decreased at shipping agents, some cargoes would be left behind or additional vehicles may have to be arranged.
	Delivery of cargoes to a number of shipping agents at port of destination		Collection of cargoes from only one shipping agent at port of origin to be delivered to various shipping agents at port of destination.	o It is possible to select the number of shipping agents for delivery to suit the volume of cargoes handled and hence to organize optimum number of vehicles. o Improvement of loading factor o Decrease in cost due to the absence of transfer operation of cargoes.

Note: ○ Main terminal; ○ Sub-terminal; × Group of customers; ➡ Line-haul transport; —— Collection/delivery; ⟹ Transfer operation

(3) Benefits for the cargo owners

a) Terminals enable better matching of the demand for small lot and long distance cargo pickup and delivery.

b) Terminals can reduce the pickup and delivery time of low efficiency private trucks.

c) Terminals made it possible to offer regular pickup and delivery service, and as a result, rapid and secure transport service is also possible.

d) By the effective use of the space, reduction in the total size of the operation area is possible.

e) By the reduction in the number of pickup and delivery trips, the rationalization of cargo transport is possible.

f) By the rationalization of cargo handling work (fowarding), employee labour can be effective used.

g) Terminals make it possible to simplify the paperwork and business of tariff payment.

h) Terminals are expected to facilitate commercial by the reduction of traffic congestion such as in the wholesale area.

i) As a total effect of the benefits mentioned above, the reduction of cargo transport cost is expected.

(4) Benefits for freight fowarders and truck operators

a) Terminals will make it easier to combine small lot of cargoes and as a result, the loading factor of trucks will increase.

b) Truck operating effeciency will increase.

c) Terminals make it more attractive for cargo owners who regularly transport their cargoes using private trucks, to switch and use more efficient common carriers.

d) Terminals make it possible to use existing facility areas more efficiently and at the same time, make it possible to rationalize and mechanize the business.

e) By the concentration of the cargo transport industry, the working conditions for drivers will improve and their accident involvement will decline.

f) Business paperwork and transportation tariffs can be expected to undergo rationalization.

g) The effectiveness of the delivery and pickup service will increase.

h) The reduction of transport cost in expected as a total effect of the benefits mentioned above.

(5) National and Metropolitan Benefits

a) With the establishment of a truck terminal system for the inter- and intra-city, the following results can be expected.

i) The loading factor of line-haul and delivery and pickup trucks will be increased.

ii) The exclusion of double or mixed transport by trucks will be expected.

iii) The size of trucks used outside the city for line-haul will be increased.

iv) The rationalization of transfer cargo can be expected.

v) Based on the facts mentioned above, the reduction of transport cost, total truck traffic volume and consumption of fuel can be expected.

b) At the truck terminals, merits of scale for terminal users (truck operators) will be increased by the common use of various terminal facilities and land space.

c) The establishment of truck terminals will support GBA comprehensive land use planning to establish satellite towns on the periphery of the GBA and help improve the urban population overcentralization.

When the existing individual small-sized truck terminals which are located in the center of the city will move to the constructed terminal areas, their vacated land can be used as improved urban facilities.

d) By the establishment of terminals the inhabitants who live in the surroundings of the terminal will have an opportunity to get jobs related to the terminal. Furthermore, working conditions for trucking employees will improve with the provision of employee facilities.

1.2 Truck Terminal Experience in Japan

1.2.1 Background and Types of Truck Terminals

(1) The rapid growth of the commodity market in Japan during the past decades resulted in a heavy loading of commodity flows on all truck routes which called for the introduction of large capacity carriers for inter-regional freight hauling to improve the efficiency, both from public and private points of view, for the following benefits:

a) For private investors:

Saving of investment, operation and maintenance costs through reduction of equipment, personnel, fuel, and other requirements.

b) Socio-economically:

Saving of manpower (Japan has a shortage of manpower in the labour market), energy and other resources, and also road operation and maintenance costs,

c) Environmentally:

Reducing the cause of environmental pollution including air pollution, noise, vibration, etc., lowering of the probability of hazards on highways through reduction of the absolute volume of traffic on them, and releasing of public spaces better suited for the operation of smaller vehicles.

Truck terminals in Japan are classified, by law, into two types: "exclusive truck terminals" and "public truck terminals". "Exclusive truck terminals" are those built by line-haul trucking firms at strategic cities for use by their own trucks. "Public truck terminals" are defined as general public service facilities. Their functions are identical.

Because of low profitability and the need for large amounts of advance investment in running a truck terminal in addition to the large amount of capital required to establish truck terminal which goes beyond the financial capability of small trucking operators, more often than not, a public corporation intervenes to take care of planning and development stages including acquisition of land. The actual construction is left to the so-called third sector (combination of both public and private sector).

The government provides assistance in establishing truck terminals by way of the terms of such laws as Japan Automobile Terminal Company Law and the law regarding the provision have been initiated by local government offices with the government guidance and financial assistance, but

today, public terminals are built only by terminal operators obtaining support from public agencies.

In 1965 the Government promulgated the Japan Motor Terminal Company Act for setting up a company to undertake construction and management of public truck terminals in the outskirts of major cities with a view to relaxing urban traffic congestion and promoting urban redevelopment as well as rationalizing trucking operations between and within cities.

The number of truck terminals has increased every year since 1960. As shown in table 1-3 below, the total number of berths reached 15,714, as of September 1978 which represents more than a 3.4-fold increase since 1960. The increase in the number of public truck terminals is especially noticeable with a 13-fold increase.

Table 1-3 Growth and Development of Truck Terminals

(As of end of Sept., 1978)

Classification / Year	Public [1]		Exclusive		Total	
	No. of Terminals	No. of Berths	No. of Terminals	No. of Berths	No. of Terminals	No. of Berths
1960	71	266	1,051	4,306	1,122	4,572
1965	71	376	1,368	6,905	1,439	7,282
1970	68	1,561	1,607	8,826	1,675	10,387
1971	69	1,647	1,707	9,686	1,776	11,343
1972	69	1,647	1,741	10,024	1,810	11,671
1973	70	2,212	1,778	10,358	1,848	12,570
1974	72	2,880	1,828	10,971	1,900	13,851
1975	70	3,191	1,832	12,019	1,902	15,210
1976	71	3,233	1,818	12,044	1,889	15,277
1977	71	3,432	1,816	12,048	1,887	15,480
1978	73	3,502	1,829	12,212	1,902	15,714

Note[1]: Public terminals include those which are not yet in operation but to whom an operation license has already been given.

Source: Ministry of Transport Statistics

Regions having more than 1,000 berths are the Tokyo Metropolitan Area (2,131), Osaka Prefecture (2,195), and Mie Prefecture (1,215), symolizing the concentration of truck terminals in the three major metroplitan areas of Tokyo, Osaka, and Nagoya. In particular, the number of public terminals is exceptionally high in Tokyo and Osaka as compared with other regions. A list of terminals by prefecture is shown table 1-4.

Table 1-4 Truck Terminal Location by Prefecture

As of end of Dec. 1978

Location		No. of Terminals			No. of Berths		
Region	Prefecture	Public	Exclusive	Total	Public	Exclusive	Total
Sapporo	Hokkaido 1/	1	50	51	177	464	641
Sendai	Aomori	-	28	28	-	181	181
	Iwate 2/	1	20	21	84	73	157
	Miyagi 3/	3	62	65	150	415	565
	Fukushima 4/	1	43	44	45	226	271
	Total	5	153	158	279	895	1,174
Niigata	Akita		25	25		157	157
	Yamagata		28	28		208	208
	Niigata		53	53		442	442
	Nagano		56	56		358	358
	Total	-	162	162	-	1,165	1,165
Tokyo	Ibaraki	-	9	9	-	49	49
	Tochigi	1	24	25	3	132	135
	Gunma	-	17	17	-	102	102
	Saitama	-	25	25	-	233	233
	Chiba	-	15	15	-	87	87
	Tokyo 5-7/	24	98	122	1,146	985	2,131
	Kanagawa	1	45	46	2	319	321
	Yamanashi	-	16	16	-	83	83
	Total	26	249	275	1,151	1,990	3,141
Nagoya	Toyama	-	23	23	-	160	160
	Ishikawa	1	22	23	40	129	169
	Fukui	-	12	12	-	85	85
	Gifu	7	62	69	26	332	358
	Shizuoka	4	80	84	13	437	450
	Aichi	4	177	181	29	1,186	1,215
	Mie	6	42	48	17	233	250
	Total	27	418	440	125	2,562	2,687
Osaka	Shiga	-	25	25	-	110	110
	Kyoto	-	49	49	-	263	263
	Osaka 8-10/	3	168	171	916	1,279	2,195
	Hyogo	1	65	66	76	347	423
	Nara	-	6	6	-	25	25
	Wakayama	-	25	25	-	125	125
	Total	4	338	342	992	2,149	3,141
Hiroshima	Totori	-	17	17	-	90	90
	Shimane	-	12	12	-	89	89
	Okayama 12/	1	45	66	180	338	518
	Hiroshima 13/	1	68	69	72	455	527
	Yamaguchi	1	25	26	46	177	223
	Total	3	167	170	298	1,149	1,447
Takamatsu	Tokushima	1	11	12	67	55	122
	Kagawa 14/	1	9	10	84	119	203
	Ehime	1	17	18	34	121	155
	Kochi	-	4	4	-	53	53
	Total	3	41	44	185	348	533
Fukuoka	Fukuoka	5	82	87	65	670	735
	Saga	-	16	16	-	108	108
	Nagasaki	-	25	25	-	115	115
	Kumamoto 15/	1	29	30	70	215	285
	Ohita	1	30	31	3	167	170
	Miyazaki	-	30	30	-	156	156
	Kagoshima	2	45	47	157	193	350
	Total	9	257	266	295	1,624	1,919
Okinawa		-	-	-	-	-	-
Grand Total		73	1,835	1,908	3,502	12,346	15,848

N.B. Prefecture item numbers above have further particulars for individual terminals listed in Appendix 1.

As shown in Table 1-5 , most public and exclusive terminals have between 2-20 berths per terminal; however, only public terminals have take advantage of economies of scale over 100 berths.

Table 1-5 Size Distribution of Common Carrier Truck Terminals in Japan

(As of end of Dec. 1978)

Classification / No. of Berths	Number of Truck Terminals		
	Public (%)	Exclusive (%)	Total (%)
2	27 (37.5)	352 (19.2)	379 (19.9)
3 - 5	19 (26.4)	759 (41.7)	778 (41.2)
6 - 10	2 (2.8)	463 (25.2)	465 (24.3)
11 - 20	2 (2.8)	179 (9.7)	181 (9.4)
21 - 50	7 (8.3)	79 (4.0)	86 (4.2)
51 - 100	7 (9.7)	3 (0.2)	10 (0.5)
101 - 200	4 (5.6)	-	4 (0.2)
201 - 300	-	-	-
More than 301	5 (6.9)	-	5 (0.3)
Total	73 (100)	1,835 (100)	1,908 (100)

Source: Ministry of Transport Statistics

1.2.2 Operational Characteristics of Terminals

(1) Characteristics of commodities handled

The bulk of commodities handled at public truck terminals in Japan are shipments of products from manufacturing industries to be transferred to distribution business operators. This in fact is a major factor for the demand of transshipment operations as part of the transport operation since a manufacturer by nature requires regular distribution of his products. His shipments are bulky and can be classified by destinations. To offer quality service, it is up to the transport operator to arrange the channelling of the consignment efficiently.

Most mixed commodity items are handled at truck terminals, except perishables.

In 1977, the Japan Motor Terminal Co., Ltd. made a survey of the tonnages of truck cargoes handled in the Tokyo Metropolitan Area. The types of cargoes were classified into groups and for approximately 70% of the items, a comparison was made with the tonnages of the same cargo

items carried by rail and water transportation modes. The results shown in Table 1-6 listing commodity categories indicate that for most domestic consumer items, public line-haul truck transport are used.

Table 1-6 Modal Split of Major Inbound and Outbound 1/ Commodity Items Handled by Common Carriers in Tokyo, 1977

(Unit: 1,000 tons (%))

Mode / Commodity	Public line-haul trucks	Railroad	Waterways
Home appliances	3,860 (95)	-	214 (5)
Machines	1,730 (69)	13 (1)	756 (30)
Foodstuff	1,391 (59)	332 (14)	620 (27)
Chemical Products	1,164 (80)	71 (5)	217 (15)
Textile Products	949 (98)	16 (2)	-
Total	9,094 (80)	432 (4)	1,807 (16)

Note 1/: Line-haul trucks also include transfer cargo volumes.

Source : Cargo Movement Survey results. JMT, 1977

(2) Tonnage and Vehicles Handled Daily by Terminals

The number of vehicles passing through the Keihin, Itabashi, and Adachi Terminals in Tokyo are shown in Table 1-7. The total number of vehicles arriving and departing from Keihin Terminal is 7,687 vehicles per day, out of which 1,907 are line-haul trucks, 4,652 are local pick-up and delivery trucks (including privately-owned trucks), and the rest (1,128) are vans and passenger cars for shuttle transport, etc. At Adachi Terminal, the number of trucks is rather small compared to the freight handled. This reflects the fact that each truck has a higher load efficiency.

The total tonnage for the three public terminals is 26,367 tons per day, which represents roughly 50 per cent of all freight carried by trucks throughout the country to and from Tokyo.

Table 1-7 Freight and Vehicles Handled at Main Public Truck Terminals in Tokyo

(Data Collected on 22 March 1979)

Terminal Traffic by Tonnage and Vehicles						Keihin Truck Terminal	Itabashi Truck Terminal	Adachi Truck Terminal
Volume of Cargoes Handled (tons/day)	Outbound		Picked up by terminal cars dropped off by freight owners			3,658 (69.7)	3,345 (73.9)	3,609 (67.2)
			Relay	In-house	within premises	342 (6.5)	143 (3.2)	724 (13.5)
					outside premises	622 (11.9)	579 (12.8)	433 (8.1)
			Outside Companies		within premises	375 (7.1)	248 (5.5)	411 (7.7)
					outside premises	248 (4.7)	213 (4.7)	193 (3.6)
	Total Tonnage of Outbound Freight Handled					5,245 (100)	4,258 (100)	5,370 (100)
	Inbound		Delivered by terminal cars picked up by freight owners			2,382 (52.4)	1,568 (55.6)	2,198 (59.0)
			Relay	In-house	within premises	105 (2.3)	56 (2.0)	286 (7.4)
					outside premises	665 (14.6)	343 (12.2)	425 (11.0)
			Outside Companies		within premises	907 (26.0)	605 (21.4)	723 (18.7)
					outside premises	486 (10.7)	250 (8.9)	225 (5.8)
	Total Tonnage Inbound Freight Handled					4,545 (100)	2,822 (100)	3,857 (100)
Total Volume of Outbound and Inbound Freight Handled						9,790	7,350	9,227
Total Number of Vehicles Passing through Terminals (veh/day)	Outbound Vehicles	Commercial Vehicles	Line-haul Vehicle	In-house Vehicles	Line trucks	938 (24.5)	625 (24.6)	735 (32.5)
					Local truck	1,138 (29.7)	685 (27.0)	727 (32.2)
				Other company's trucks		315 (8.2)	117 (4.6)	119 (5.3)
			Other commercial trucks			540 (14.1)	335 (13.2)	183 (8.1)
			Private trucks			337 (8.8)	336 (13.2)	138 (6.1)
		Light trucks, private cars, etc.				559 (14.6)	443 (17.4)	357 (15.8)
	Total No. of Outbound Vehicles Handled					3,827 (100)	2,541 (100)	2,259 (100)
	Inbound Vehicles	Commercial Vehicles	Line-haul Vehicle	In-house Vehicles	Line trucks	969 (25.1)	639 (25.0)	753 (32.9)
					Local truck	1,163 (30.1)	686 (26.8)	733 (32.1)
				Other company's trucks		291 (7.5)	125 (4.9)	114 (5.0)
			Other commercial trucks			527 (13.7)	345 (13.5)	186 (8.1)
		Private trucks				341 (8.8)	325 (12.7)	144 (6.3)
		Light trucks, private cars, etc.				569 (14.7)	441 (17.2)	357 (15.6)
	Total No. of Inbound and Outbound Handled					3,860 (100)	2,561 (100)	2,287 (100)
Total Number of Inbound and Outbound Vehicles						7,687	5,102	4,546

Source: Truck Transport (Wayside Amenities). APO, 1979.

(3) Terminal Facilities

The public truck terminal in Japan is regulated by the "Automobile Terminal Law", under the jurisdiction of Ministry of Communication.

The facilities that make up a truck terminal can be categorized into three groups: facilities for handling freight, facilities necessary for arrival, departure, operation, and maintenance of vehicles, and, facilities for personnel (supervisors, employees, freight owners, etc. Table 1-8 is a listing of all of these facilities. These facilities are available at JMT truck terminals.

Table 1-8 List of Facilities of JMT Truck Terminals in Japan

Freight Facilities	Vehicle Facilities	Personnel Facilities
Freight Handling Area	Area for Line-Haul Trucks	Short-sleep Room
Distribution Centre	Area for Local Trucks	Overnight Lodging
Railway Container Depot	Space for Operation of Trucks	Bathroom
	Parking Lot	Dining Facilities
	Car-washing Area	Office
	Repair Shop	Clinic
	Petrol Station	Post Office
		Barber
		Conference Room

Supporting facilities provided in truck terminals produce about 25% of the terminal income in Tokyo and include fuel and vehicle service stations, vehicle maintenance workshops, workers welfare facilities such as canteen, lodging, medical services, etc.

In many cases (such as those operated in Tokyo by Japan Motor Terminal K.K.), a public truck terminal is located on a lot on a large parcel of land assigned for collective development of commodity distribution related facilities including warehouses, non-line-haul truck operation facility, wholesale market, etc. Such collectively located facilities generally do not have any substantial mutual connection functionally or in operation. The main benefit of collectively locating such facilities consists in protection of the urban environment which would otherwise be disturbed by the scattered distribution of these massive, heavy truck using facilities.

Freight transshipment platforms are generally designed as open sheds with elevated floors to the level of the standard height of a heavy truck for easy loading and unloading

operation, having neither internal partitions nor external walls except for platform offices which usually are located at both ends of the shed.

Platform tenants delineate their area of occupation by means of furniture, screens, etc.

In most cases in Japan, storage is not provided as an integral part of the platform facility. All freight delivered to the platform are in principle to be cleared for hauling operation within the same day.

Access roads to public truck terminals are guarded and are in principle closed to the public.

(4) Tenants

Almost all truck terminal tennants in Japan are large line-haul operating firms, and almost all line haul operators are legally authorized also for pick-up, delivery and other types of trucking operation.

Even though large trucking firms have extensive networks of operation, none of them maintain so densely branching a service network to be able to cover all areas of demand, both for hauling and distributing operations by themselves. Deficiency of coverage is supplemented by subcontracting small trucking operators, the number of which amounts to approximately 10 firms per tenant.

Except in the earliest cases where facilities were operated without being fully occupied during the initial few years, most tenants of public truck terminal in Japan were participants in the investment of the facility committed during early stage of promotion for the facility establishment.

Almost all the tenants of truck terminals in Japan have regular clients who are manufacturers in the distribution territory of the terminal, of about 10 km in radios.

Although business connections between individual tenants does exist, it is only on very limited basis and does not represent an important factor for either the justification or the effect of terminal facility establishment.

1.2.3 Impact of Truck Terminals

Since public agencies have provided funds for public truck terminals constructed and operated by JMT, these truck terminals must bring about social and economic impacts that justify the investments. To check on this, a study was made in 1976 by a professional surveying group specializing in transport affairs. In this report, a quantitative computation has been provided to prove that the effect is more than justified. Some of the

effects recognized listed below are quantified in the tables which follow.

i) Social impact

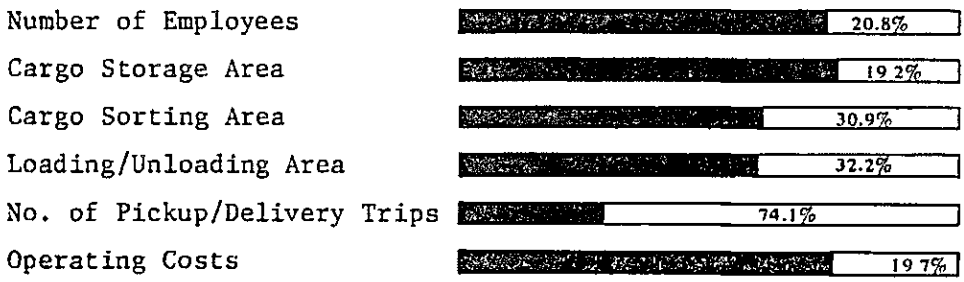
- Stable supply of goods
- Reduction of traffic volume
- Prevention of deterioration of biological environment
- Saving of energy
- Effective utilization of land
- Development and improvement of peripheral areas

ii) Economic impact (see Table 1-9 below)

- Benefits brought about by upgrading transport efficiency:
  * reducing truck operation cost by utilizing larger vehicles
  * reducing cost of local pick-up and delivery
  * reducing relay cost
  * reducing terminal cost

- Benefits brought about by increasing freight handling capacity

Table 1-9 Rates of Operation Reduced by Intra-City Truck Terminal



Source: Nihonbashi textile wholesale area survey results.

Table 1-10 shows the results of vehicle reduction which can occur when coordinated routes are established as a result of truck terminal establishment.

Table 1-10 Reduction in Trucks Required to Service Areas After the Establishment of Truck Terminals

(Unit: veh/day)

City	Area	Before Establishment	After Establishment	Percentage Reduced(%)
Tokyo	Ginza	80	12	185
Kyoto	Marunouchi*1/	187	111	41
Osaka	Housing Estate	23.6	15.8	33
Fukuoka	Tenjiin	16.3	6.1	63

Note 1/: Reduction in the distance travelled was also recorded as 5,478 Kms before and 3,480 Kms after establishment of truck terminals: a reduction of 37 percent.

An interview survey just prior to the establishment of the two public truck terminals in Tokyo in 1973 determined that about 54% of the private truck terminals in the area relocated to the public truck terminals as follows:

Type of Relocation/Change	No. of Operators
Sold previous terminal land	25
Substituted for accommodations, etc.	6
Substituted for their depot	36
Total private terminals affected	67] 54%
No. of private truck terminals in the interview area	124

The following table 1-11 shows the comparison of the public and private truck terminals in terms of the land use efficiency, which therefore lowers land acquisition costs. This data is also shown in Fig. 1-2 and 1-3.

Table 1-11 Land Use Efficiency of Inter-city Truck Terminals

Terminal Type and Size / Functional Area	Public Truck Terminal	Private Truck Terminal		
		Large size (30 Berths)	Medium size (10 Berths)	Small size (3 Berths)
Loading Space (m^2/berth)	333.3	455.0	558.2	921.3
Handling Space (m^2/ton)	16.2	20.2	24.8	40.6

Source: "Economic and Social Effect of Public Truck Terminal, 1976" conducted by the Transportation Economics Research Center, financed by the Japan Motor Terminal Co., Ltd.

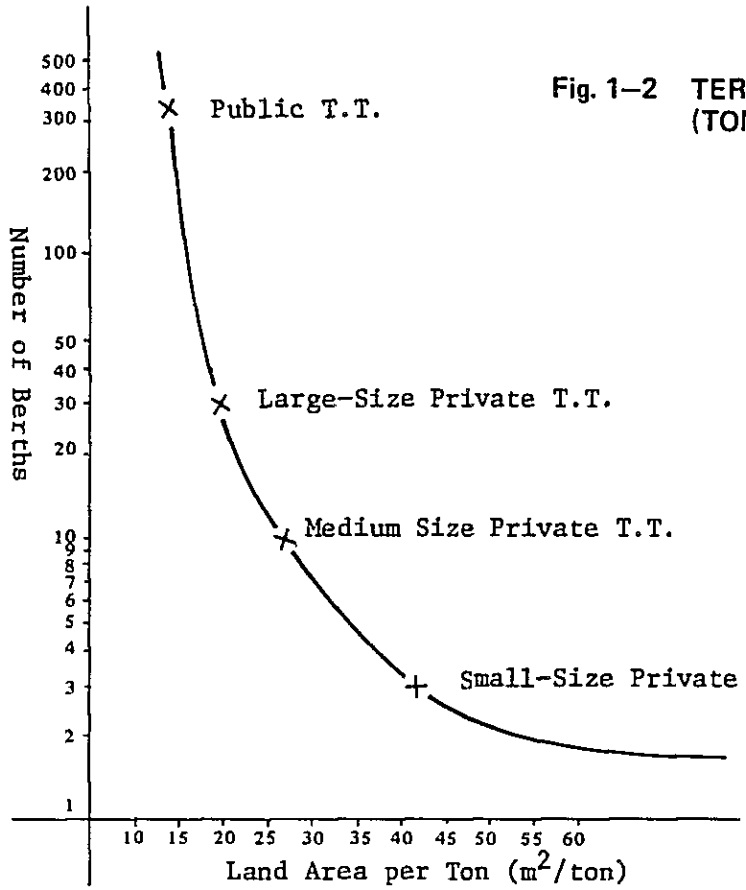


Fig. 1–2 TERMINAL EFFICIENCY (TONNAGE)

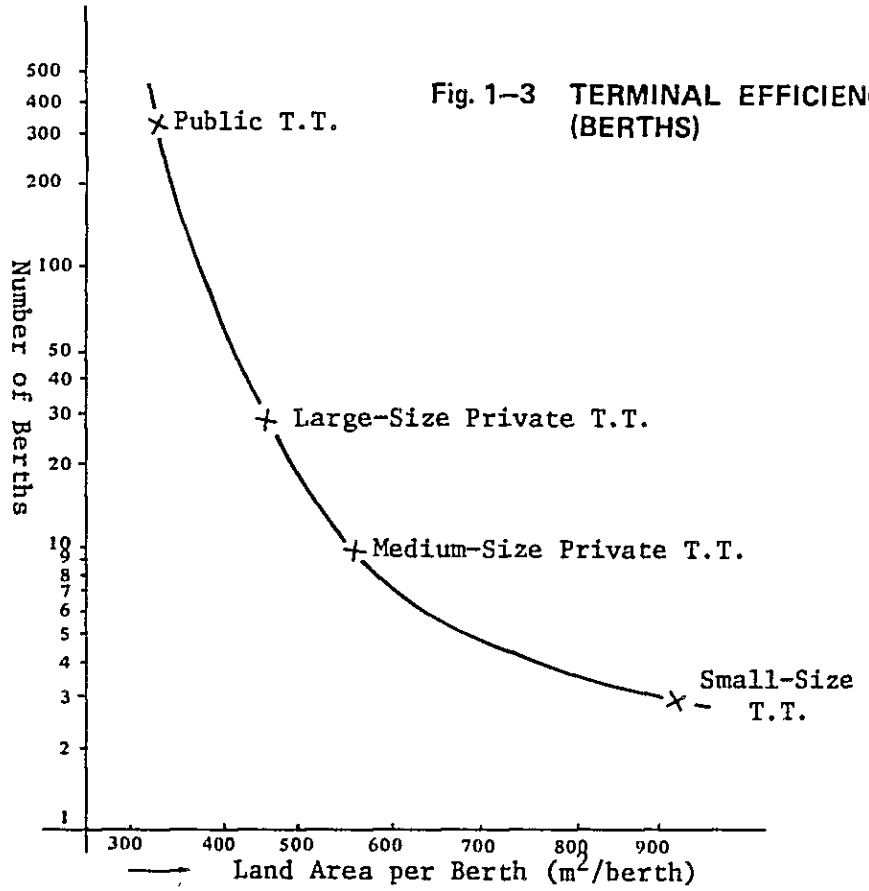
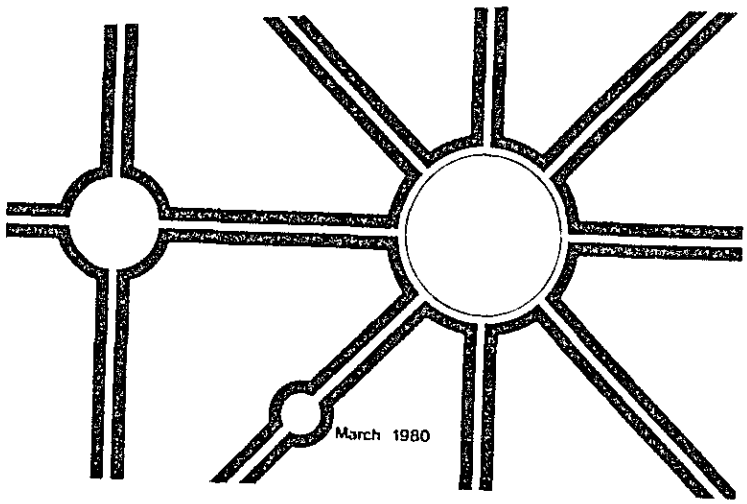


Fig. 1–3 TERMINAL EFFICIENCY (BERTHS)

CHAPTER 2

BACKGROUND OF CARGO MOVEMENTS AND TRUCKING



Chapter 2 BACKGROUND OF CARGO MOVEMENTS AND TRUCKING

2.1 Socio-Economic Background

2.1.1 Population Concentration

Thailand has a monocentric pattern of population concentration with 12.6% of the total population located in the GBA as shown below.

	GBA[1/]	Thailand	GBA/Thailand (%)
1947	1,475,641	17,442,689	8.5
1960	2,567,332	26,257,916	9.8
1970	3,675,832	34,397,374	10.7
1977	5,560,000	44,272,693	12.6

Note [1/]: GBA = Phra Nakhon, Thonburi, Nonthaburi, Samut Prakan

Sources: 1947-70: Statistical Yearbook, Thailand, 1974-75
1977: The Comprehensive Study for the Bangkok Suburban Transportation Project.

2.1.2 Economic Concentration

The economic functions of the Kingdom are concentrated in the G.B.A., such that the Bangkok metropolitan region alone accounts for 28% of the total of G.R.P. of the whole Kingdom as shown in Table 2-1 below.

Table 2-1 Estimated Regional and Per Capita G.D.P., 1977

	GDP (million Baht)	Population	Per Capita GDP (thousand Baht)
Thailand	370,445	44,272,693	8.4
Central Region	113,418	9,722,955	11.7
Bangkok	103,621	4,742,774	21.9

Source: "Gross Provincial Product, 2520"

Although the urban area has expanded and suburban areas increased, the old city core by and large remains the functional center of the urban distribution system.

In addition to the expansion of absolute size of the consumer market, the old city area has had to cope with the drastic demand for automobile space and the general growth of per capita commodity demand which is higher in the GBA than the average for the rest of the Central Region as shown below in Table 2-2.

Table 2-2 Average Monthly Household and Per Capita Consumption Expenditure, 1976

(unit: Baht)

	GBA	Central Region	
		Total	Municipal Areas
Average Monthly Household Consumption Expenditure	3,173	2,237	3,110
Average Monthly Per capita Consumption Expenditure	562	427	609
Average Household Size Consumption Expenditure	5.65	5.24	5.11
Estimated Av. monthly Household Income	3,442	2,251	3,527
Estimated Av. monthly Per Capita Income	609	430	690

Sources: Report Socio-Economic Survey, 1975-76, National Statistical Office

2.1.3 Commercial Patterns

Bangkok is the trade center of Thailand as shown in Table 2-3 below.

Table 2-3 Gross Regional Product Originating from Wholesale and Retail Trade, 1977

(unit: million Baht (%))

	Import Trade	Domestic Trade	Total Trade
(1) TOTAL			
All Regions	19,955 (100.0%)	43,609 (100.0%)	63,564 (100.0%)
Central Region	6,230 (31.2)	11,727 (26.9)	17,957 (28.3)
Bangkok	7,059 (35.4)	12,615 (28.9)	19,674 (31.0)
(2) PER CAPITA			
All Regions	451	985	1,436
Central Region	641	1,206	1,847
Bangkok	1,488	2,660	4,148

Source: "Gross Provincial Product, 2520"

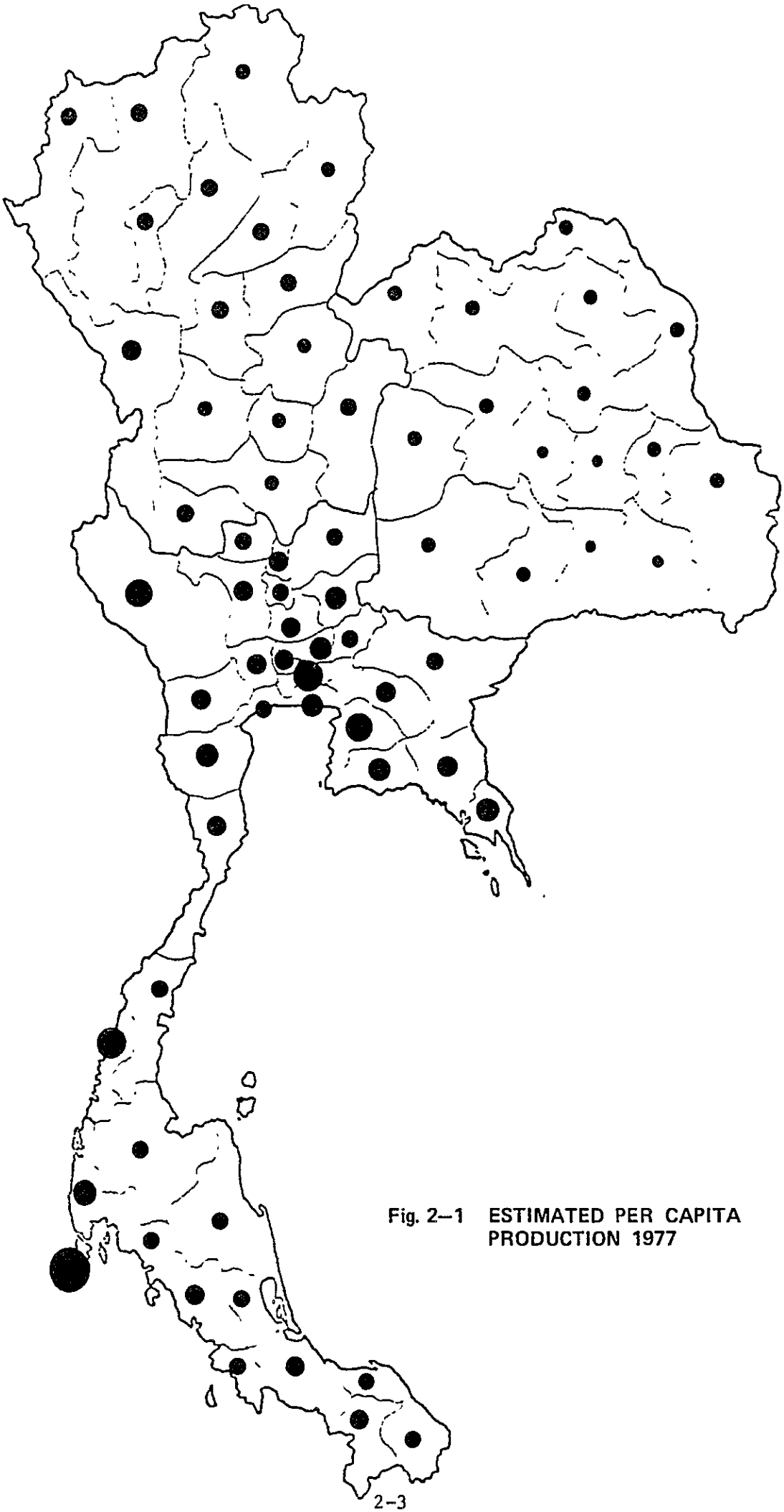


Fig. 2–1 ESTIMATED PER CAPITA PRODUCTION 1977

Transactions which take place in Bangkok not only include foreign trading, inter-regional trading between Bangkok and other areas of Thailand, but also a considerable percentage of transit trading within local areas in the Central region.

The volume of the transit trade is demonstrated by the fact that Bangkok's rate of per capita trade (Table 2-3) is greater than its rate of per capita consumption (Table 2-2) in the Central region as follows:

Transit Trade Through Bangkok (unit: Million Baht)

	A Bangkok	B Central Region	C A ÷ B
Per Capital Trade	4,148	1,847	2.2
Per Capital Consumption	690	430	1.4
Difference indicating Transit Trade			0.8

Due to the lack of a product standardizing system, where agricultural products are graded, packaged, and shipped with official indication of the grade of quality in accordance with Agricultural Standards which can be taken for granted, separation of commercial transactions and physical distribution flow is not practicable. For this reason bulk agricultural freight products purchased by a trader operating his business in the Central Bangkok area, requires it to be transported to the buyer for examination and transhipment, regardless of the eventual destination of the freight. This apparently adds to the many causes of traffic congestion within Central Bangkok area.

Interregional commodity flow generally follows a simple and concentric pattern, with GBA being the main importer of bulk commodity, including primary products, construction materials, etc. and the almost monopolizing exporter of manufactured products to all other regions in the Kingdom.

2.2 Trucking Industry

2.2.1 Truck Traffic

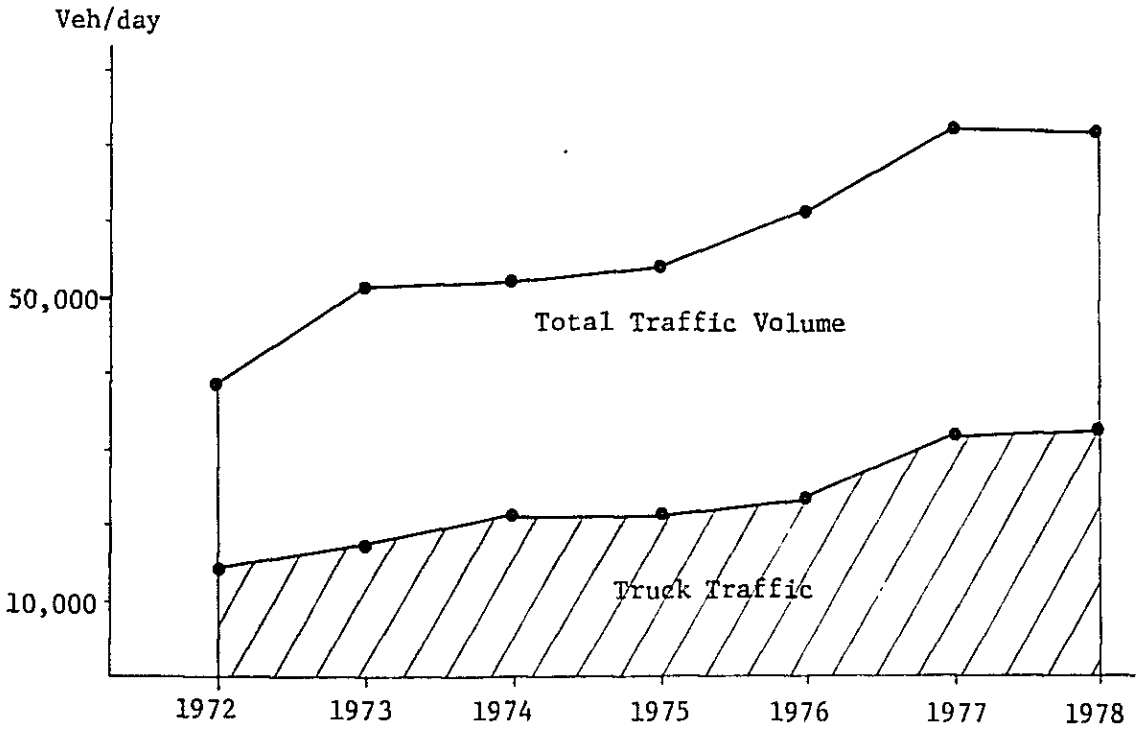
The number of trucks in the GBA has been estimated by the DOH to be 45% of the total traffic volume in 1978 as shown in Table 2-4 and Fig. 2-2. The data also indicates that trucks are increasing at a faster annual growth rate (14.0%) than the average for all types of vehicles (10.4%).

Table 2-4 Truck Traffic Volume for GBA by Year

		1972	1973	1974	1975	1976	1977	1978
Total Vehicles	Traffic Volume	*39,116	50,569	50,897	54,028	60,853	71,465	70,635
	Annual Growth Rate	-	29.2	0.6	6.2	12.6	17.4	-1.2
Trucks	Traffic Volume (% of total)	*14,490 (37)	*16,848 (33)	21,025 (41)	20,380 (38)	23,774 (39)	30,812 (43)	31,762 (45)
	Annual Growth Rate	-	16.2	24.8	-3.1	16.7	29.6	3.0

Note: * Excluding the volume of Station No. 168 since the Thonburi-Pak Tho highway was only constructed in 1973.

Fig. 2-2 TRUCK TRAFFIC VOLUME BY YEAR (GBA)



2.2.2 Truck Operators

Since truck ownership is not limited to one industry, the function of trucking cannot be discussed in terms of ownership of trucks. Instead, the main concept for differentiating types of carriers is in terms of the operating licence. In Thailand, two types of licences are issued common carrier licences and private carrier licences. Although common carriers are sometimes called "public carriers" since they are licenced to provide a public service, this term is not used in this study to avoid any implication of government ownership since common carriers in Thailand are all privately owned with the exception of E.T.O.

(1) Common Carrier

Operators are permitted to contract to provide transport services on the open market. Their vehicles have yellow licence plates. Common carrier operators are sub-divided in two main types: (a) pick-up and delivery operators who cover limited intra-city territory and usually transport small parcels of mixed cargoes, and (b) line-haul operators who cover large fixed inter-city, routes and usually transport cargo in package deals. The cargoes carried are mostly mixed commodities especially for domestic consumption. The average weight in Japan is 250 kg per lot.

(2) Private Carrier

Operators, on the other hand, are permitted only to operate transport service for their own benefit. They may utilize special vehicles such as is the case for bottling factories, oil refineries, etc. Their vehicles have white licence plates in Bangkok and black plates outside of Bangkok. The cargoes carried are often bulk cargoes because the private carrier operators are often producers of goods of some sort, particularly agricultural and industrial products and other commodities. Private truck operators are privately registered companies, but the essence of the term private lies in their transport licence limiting provision of transport service to themselves rather than for the public at-large.

According to the data presented in Tables 2-5, the fleet size of most private operators is much smaller than common carrier operators in terms of ownership of vehicles per firm. In terms of numbers of firms the private carriers constitute about 98% of the total, but in terms of vehicles, they own only 74% of the total. It is regretable that no data exists regarding tons carried as is the case in other countries.

Table 2-5 Comparison of Common Carrier and Private Truck Operating Firms

Type of Operator	1971			1976		
	No. of Firms	No. of Vehicles	Veh/Firm	No. of Firms	No. of Vehicles	Veh/Firm
Common	285 (4)	8,090 (37)	28.4	508 (2)	22,436 (26)	44.2
Private	6,538 (96)	13,801 (63)	2.1	23,541 (98)	62,978 (74)	2.7
Total	6,823(100)	21,891(100)	3.2	24,049(100)	85,414(100)	3.6

The cross sectional random traffic survey made during this report found the composition ratio of private and common trucks on major routes to be as shown in Table 2-6 below. About 90 percent of heavy trucks were found to be private trucks.

Table 2-6 Survey Results of Truck Registration Type

Station No.	Name of Station	Number of Trucks		
		Private	Common	Total
A	Rangsit	405 (83.5)	80 (16.5)	485 (100.0)
B	Chonburi	591 (94.8)	26 (4.2)	617 (100.0)
C	Srisamran	498 (85.0)	88 (15.0)	586 (100.0)
D	Ekachai	221 (73.7)	79 (16.5)	300 (100.0)
Total		1,715 (86.3)	273 (13.7)	1,988 (100.0)

In terms of annual growth rate, the number of private truck operators and the number of vehicles they own is increasing more rapidly than common carriers. Based on the annual growth rate between 1971-1976, shown in Table 2-7, 17,000 more private trucks are registered in Thailand per year than common carriers. This fact poses a problem for Thailand if, as in Japan, the common carrier line-haul vehicles are more efficient (see Appendix 2).

Table 2-7 Comparison of Truck Operator and Vehicle Growth Rates, 1971 to 1976

Type of Carrier	Annual Growth Rates (%/yr)		
	No. of Firms	No. of Vehicles	Veh/Firm
Common	12.3	22.6	9.2
Private	29.2	35.5	5.1
Total	28.6	31.3	2.4

Sources: 1971: Report of the Working Group Concerning Truck Routing, MOC, 1973

1976: Number of Operators and Vehicles, DLT, 1977

The common carrier trucking industry in Thailand is highly concentrated with about 30% of the firms owning 75% of the vehicles as shown in Table 2-8 below.

Table 2-8 Common Carrier Truck Operating Industry Concentration, 1976

	No. of Firms No. (%)	Total Vehicles No. (%)	Average Veh./Firm
Small (1-15 veh.)	182 (41)	1,719 (9)	9
Medium (16-30 veh.)	129 (29)	2,908 (16)	23
Large (>30 veh.)	132 (30)	13,767 (75)	104
Total	443 (100)	18,394 (100)	42

Source: DLT. No. of Public Truck Operators in Thailand owning vehicles over 6-wheels, 1977. (ie, Line-haul operators).

The division of firm size into three categories (small, medium and large) is arbitrary; however, it is necessary in order to visualize the nature of the whole industry. A more complete and detailed distribution of the same data is shown in Table 2-9. It is estimated that the list covers about 87% of the registered common carrier truck operators.

Table 2-9 Distribution of Common Carrier Truck Operating Firms in Thailand, 1976

Firm Size	No. Veh/Firm	No. Firms Q'ty	(%)	Total Veh Q'ty	(%)
Small	1 - 5	49	(11.1)	118	(0.6)
	6 - 10	68	(15.3)	590	(3.2)
	11 - 15	65	(14.7)	860	(4.7)
Medium	16 - 20	55	(12.4)	1,008	(5.5)
	21 - 25	41	(9.3)	949	(5.2)
	26 - 30	33	(7.4)	951	(5.2)
Large	31 - 40	24	(5.4)	852	(4.6)
	41 - 50	32	(7.2)	1,535	(8.3)
	51 - 60	10	(2.3)	581	(3.2)
	61 - 70	10	(2.3)	653	(3.6)
	71 - 80	3	(0.7)	222	(1.2)
	81 - 90	10	(2.3)	880	(4.8)
	91 - 100	15	(3.4)	1,488	(8.1)
	101 - 200	18	(4.1)	2,581	(14.0)
	201 - 300	4	(0.9)	1,047	(5.7)
	301 - 400	1	(0.2)	302	(1.6)
	401 - 500	3	(0.7)	1,308	(7.1)
	501 - 600	1	(0.2)	523	(2.8)
	>600 1/	1	(0.2)	1,946	(10.6)
Total		443		18,394	
Average Veh/Firm				41.5	

Source: DLT No. of Public Truck Operators in Thailand owning vehicles over 6-wheels, 1977

Note : 1/ E.T.O.

Based on the previously used MOC data for 1971, it is estimated that the distribution of common carrier truck operators by region is concentrated in the central region as follows:

Regional Distribution of Common Carrier Truck Operators

Region	% of Firms	% of Vehicles
North	8.8	9.4
Northeast	22.9	24.9
Central	48.2	48.6
South	20.1	17.1

In terms of types of vehicles owned, 87% were over 6-wheel with some variation by region as shown below in Table 2-10 based on the 1971 MOC data.

Table 2-10 Types of Truck Owned by Common Carrier Operators by Region

(unit: %)

Vehicle Type	Total	North	East	Central	South
4-wheel	12	18	24	9	15
6-wheel	37	53	41	23	58
10-wheel	50	29	35	68	27
Others	1	-	-	-	-
Total	100	100	100	100	100

The Transportation Association in Thailand (for truck operators) had 124 members and 28 ex-members as of Dec. 1978, representing 28% (or 34% with ex-member included) of the trucking industry at shown in Table 2-11.

Table 2-11 Percentage Distribution of the Transportation Association Members by Listed Region and Area of Operation

Region	No. of Members No. (%)	Territories of Operation Listed No. (%)	No. of local Offices	Percentage of local operation area with office
Eastern	9 (7.3)	57 (15.9)	8	14 %
Southern	30 (24.2)	76 (21.2)	46	61
Northern	52 (41.9)	131 (36.6)	89	68
North-Eastern	33 (26.6)	94 (26.3)	68	72
Total	124 (100.0)	358 (100.0)	211	59

- All members have their individual offices in Bangkok with the exception of one who has his office in Chiengmai.

- The distribution of Bangkok offices of the members shown in Fig. 2-3 indicates that practically all members are located in the high density commercial area in the city core.

Fig. 2-3 OFFICE LOCATIONS OF TRANSPORTATION ASSOCIATION MEMBERS

District	No. of Members	(%)
Pathumwan	54	(43.9)
Pomprab	35	(28.5)
Pra Nakhon	21	(17.1)
Sam Panthawong	11	(8.9)
Bangkapi	2	(1.6)
Total CBD	123	(100.0)

The distribution of members by Changwats indicates that the majority of members have single routes of handling operation, with only 14% exceptions as shown in Table 2-12.

Table 2-12 Distribution of the Transportation Association Members by Type of Route of Operation

Type of route	Distribution of members No.	(%)
1. Single Route with Branches <100km	97	(85.9)
2. Single Route with Branches >100km	12	(10.6)
3. Multiple Routes	4	(3.5)
Total	113	(100.0)

The schematic routes of members, omitting all approach routes from Bangkok are shown in Fig. 2-4. These figures indicate the following:

1) Most member have local territories of operation outside the Central Region

2) Very few of the members operating within Central Region have local business offices.

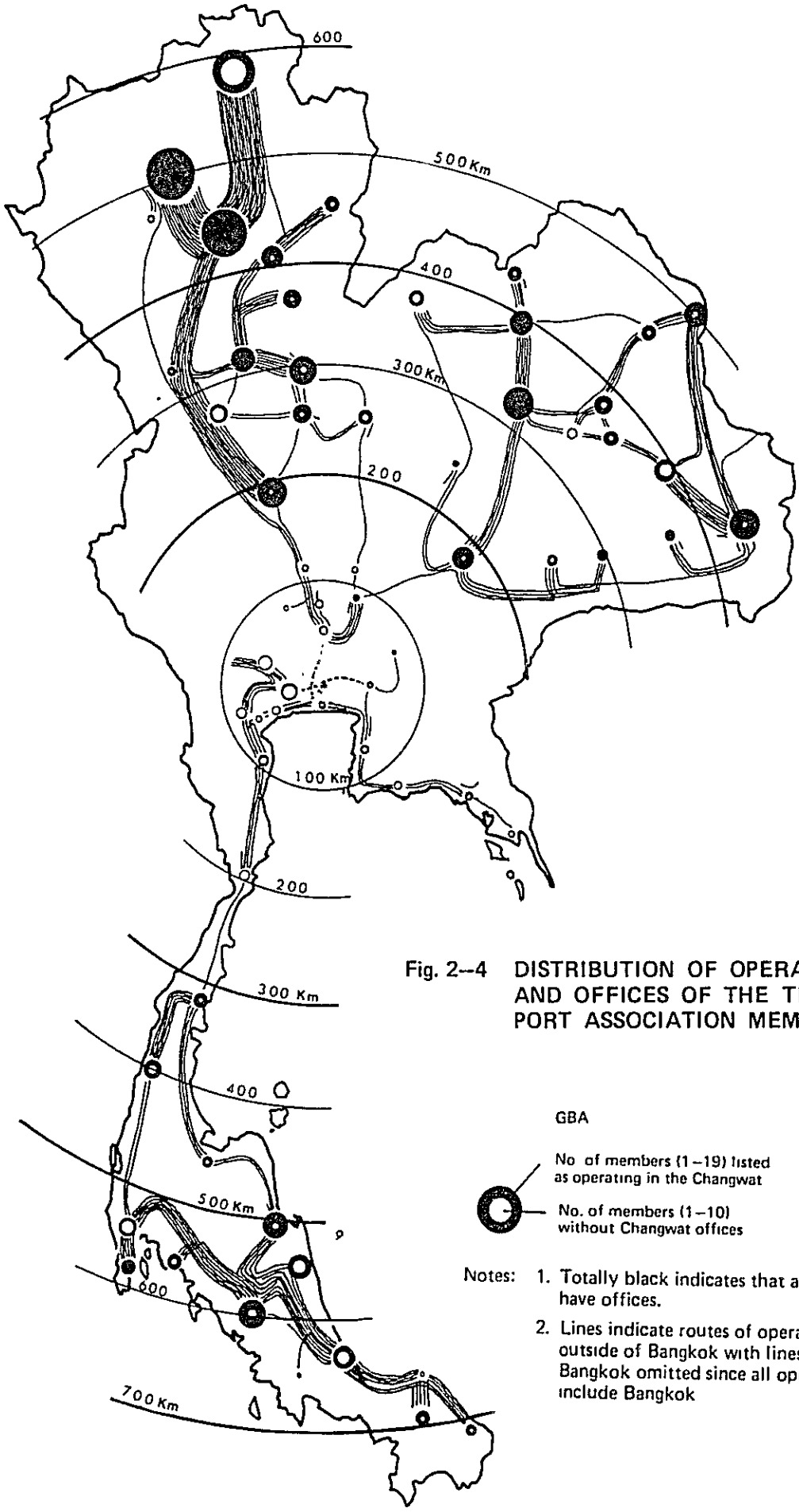


Fig. 2–4 DISTRIBUTION OF OPERATIONS AND OFFICES OF THE TRANSPORT ASSOCIATION MEMBERS

Notes:
1. Totally black indicates that all members have offices.
2. Lines indicate routes of operations outside of Bangkok with lines to Bangkok omitted since all operations include Bangkok

3) Concentration in the number of operation routes varies according to distance from Bangkok. Conspicuously in approximately 200km intervals beyond Central Region. E.T.O. routes are shown in Fig. 2-5 for comparison.

2.2.3 Restricted Truck Operating Periods

For the purpose of immediately reducing traffic congestion in GBA, the government has restricted the times truck may operate or enter the GBA since Dec., 1969. According to the highway police, the present restricted times of medium and heavy truck operation in the GBA are as shown below:

Restricted Truck Operating Periods

	Morning	Evening	Total Hours Restricted
6-wheel trucks	7 - 9 a.m.	4 - 8 p.m.	6 hrs.
10-wheel trucks	6 - 10 a.m.	3 - 9 p.m.	10 hrs.

During these restricted periods, all of the trucks over 6 wheels are prohibited from operating in the GBA and as a result they are forced to park either at the GBA boundary or somewhere in the city. Although this restriction postpones the truck component of the traffic flow on limited road capacity, having trucks parked on the roadsides is also a cause of traffic congestion on the road.

Establishment public parking areas at the truck terminals will help to solve this problem.

From the truckers viewpoint, the existing restricted period for 10-wheel trucks of 10 hours and 6-wheel trucks of 6 hours amounts to a loss of about 42 percent of a work day for 10-wheel trucks and 25 percent of a work day for 6-wheel trucks.

Although some kind of restriction for heavy trucks may be necessary to limit the volume of truck traffic until the progress of road construction can outpace the increase in the number of trucks on the road, the present restrictions on working time are indeed severe.

Truck terminals are one of the means to reduce the productive loss from the operating restrictions for heavy trucks, especially with mixed cargoes by allowing the time to be used for the purpose of cargo handling.

The number of trucks parking on the roadsides near the boundary of the GBA were checked by field survey. Items such as the number of trucks parking on the roadsides, the parking period and the number of accumulated trucks parking were counted in parallel with the cross-sectional traffic volume count survey and origin-destination survey every fifteen minutes during the truck restriction period at the following three major entry points.

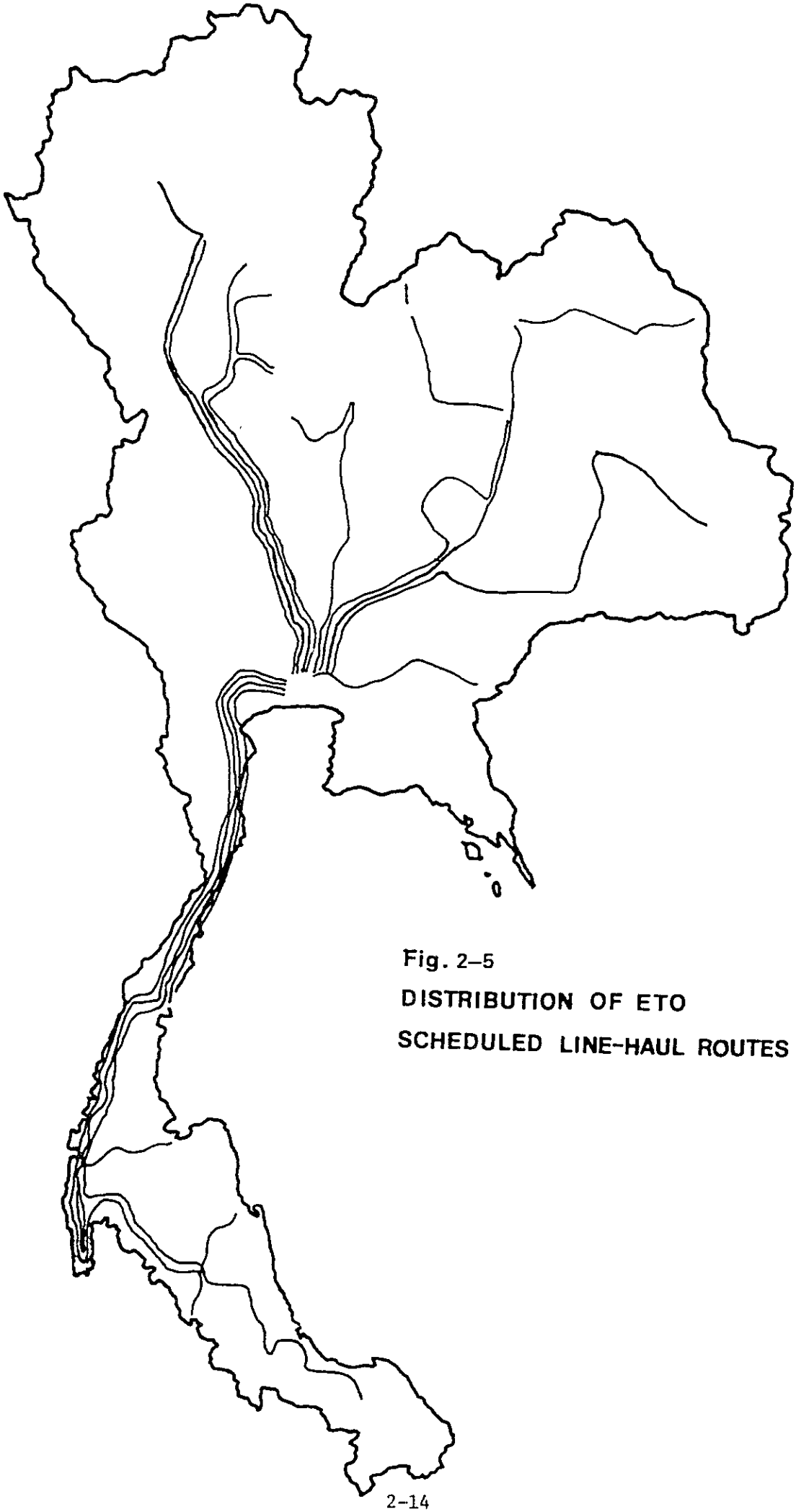


Fig. 2–5
DISTRIBUTION OF ETO
SCHEDULED LINE-HAUL ROUTES

	Location	Route No.	Direction	Maximum Parked Trucks Surveyed
1.	Rangsit	Rt. 1	North	187
2.	Bang Na	Rt. 3	East	159
3.	Srisamran	Rt. 4	West	95

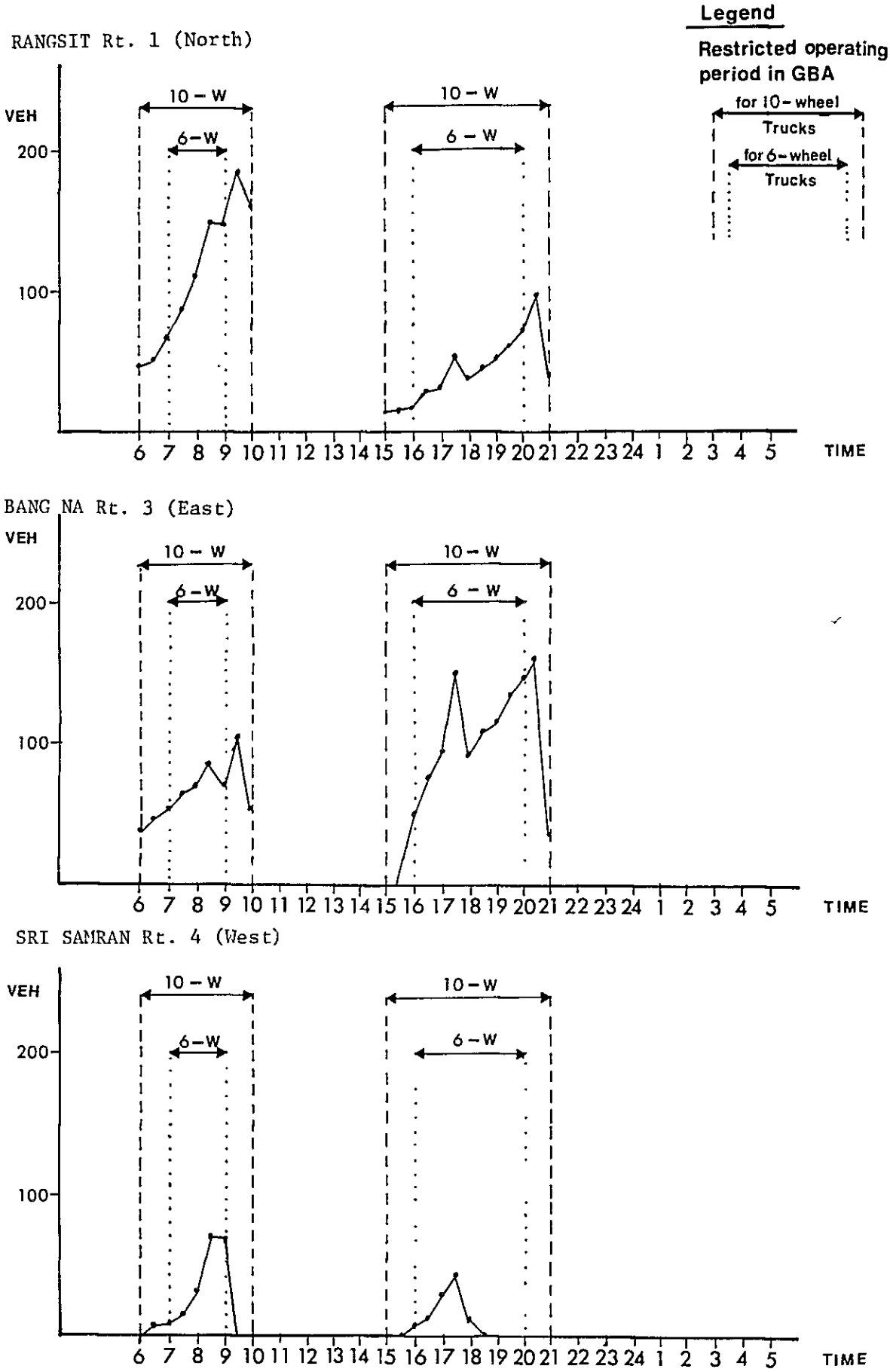
Since there is a vehicle parking restriction on the Thonburi - Pak Tho Highway (Rt. 35), no vehicles were parked on the roadside, so this survey was held only at three stations.

Fig. 2-6 shows the number of surveyed parked trucks on the roadside. According to this figure, the number of parked trucks increases to its maximum in the last hour of restriction. Since the restricted period for 6-wheel trucks ends one hour before that of 10-wheel trucks, it is reasonable to conclude that the maximum number or trucks are all 10-wheel vehicles.

Compared with the surveyed cross-sectional inbound traffic volume the ratio of the maximum number of parked trucks is approximately 5 percent.

In terms of timing, there is a remarkable difference between the survey results at Rangsit and Bang Na. At Rangsit, the peak appears during the morning restricted period, whereas at Bang Na, the peak is in afternoon restricted period. The reason for this difference is that the origin of trucks at Rangsit is far from the GBA such as Chieng Mai whereas the origins of trucks which pass the Bang Na Station are limited to the Eastern Region. Both results provide O-D information used in this report.

Fig. 2–6 RESTRICTED GBA OPERATING HOURS AND TRUCKS PARKING AWAITING ENTRY



2.2.4 Road Network and Truck Routes

Thailand has a radial road network pattern centered in Bangkok. The total length of roads in Thailand is 30,331 km with a load density of 59 km/km^2. The outline of the national road network is shown in Fig. 2-7.

Based on a survey of the commodity distribution routes carried out in parallel with the travel speed survey, it was determined that almost all the main roads even inside the CBD are used for commodity distribution as shown in Fig. 2-8. Since actually travelling all of the routes for every commodity is a very difficult task, some of the commodity distribution routes were checked by utilizing statistical data.

The main origin and destination of cargoes at present without a truck terminal are concentrated in the central area. Therefore, even cargoes which could be handled at the truck terminal are carried directly to and from their origin and destination in the CBD by heavy trucks. By delaying the establishment of a complete road network, even through traffic which has no relationship with GBA, has to pass through the heavily congested CBD although some of the through traffic which passes from the westside to eastside of Bangkok is using the ferry boat on the Chao Phraya River at Phra Pradaeng in the south. From this point of view the completion of Outer Ring Road is the very near future is desirable both in the western portion and the southern portion for reducing traffic congestion in the central area not only due to truck restrictions but also since the use of the Outer Ring Road by trucks is efficient and necessary for inter-terminal trips.

For the purpose of checking the truck composition of inbound and outbound traffic volume on the trunk routes of the Greater Bangkok Area (GBA), a 24-hour continuous cross-sectional traffic volume count was carried out at four survey stations on the major highways at the outskirts of the GBA on 17th and 18th of September 1979. The names of the survey stations are listed below and their locations are shown in Fig. 2-9.

Survey Station Name	Trunk Route Location	Region Linked
A - Rangsit	Super Highway Rt. 1	North/Northeast
B - Chonburi	Bang Na-Trad Rt. 34	East
C - Srisamran	Phet Kasem Rt. 4	Southwest
D - Ekachai	Thonburi-Pak Tho Highway Rt. 35	South

The summary of the cross-sectional traffic count survey results shown in Table 2-13 indicate that trucks compose the major part (57%) of vehicle traffic and that modal split between light and heavy trucks is 1:1.2.

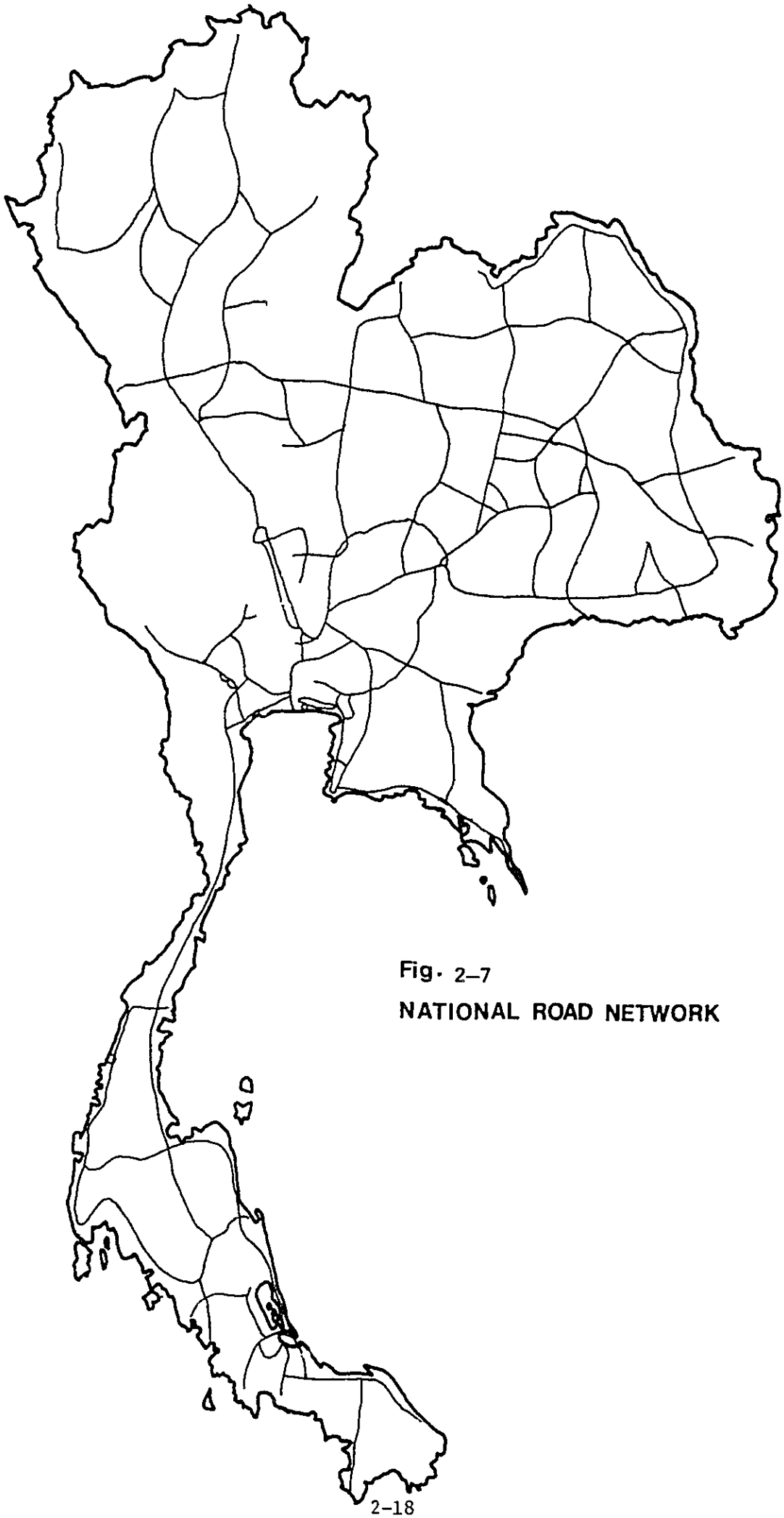


Fig. 2–7
NATIONAL ROAD NETWORK

Fig. 2–8 MAIN TRUCK COMMODITY DISTRIBUTION ROUTES IN THE GBA

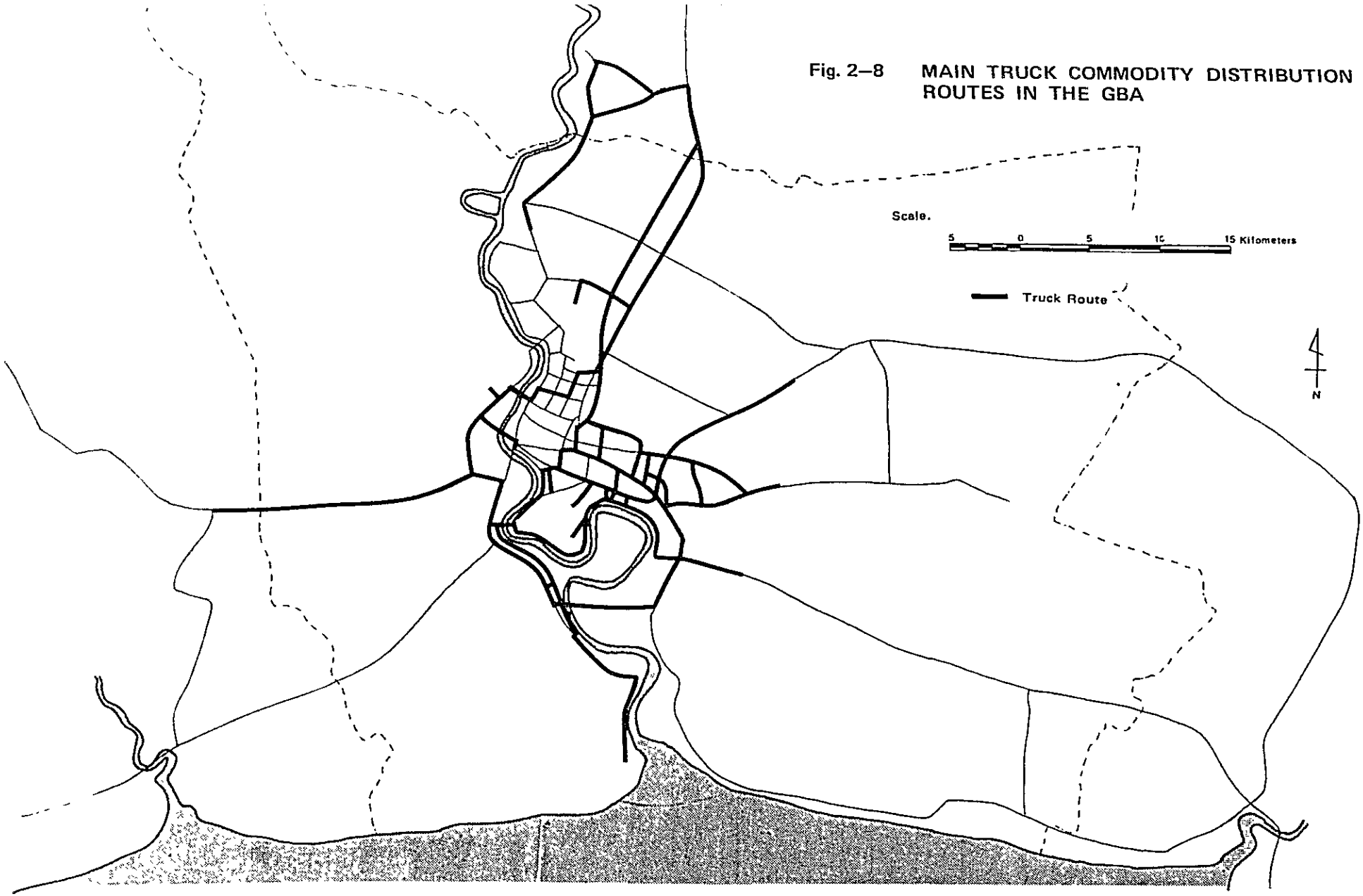


Table 2-13 Summary of Cross-sectionl Traffic Volume Survey, 1979
(Total of Inbound and Outbound traffic)

(unit: Veh/day)

Station No.	Name of Survey Station	Light Truck (4-Wheel)	Heavy Truck (6/10-Wheel)	Trucks over 10-wheels	Total all Veh.	Percent of Trucks
A	Rangsit	6,921 (26.2)	7,052 (26.7)	174 (0.7)	26,414 (100.0)	53.6
B	Chonburi	2,671 (25.0)	3,626 (33.9)	70 (0.7)	10,681 (100.0)	59.6
C	Srisamran	4,906 (24.9)	6,784 (34.5)	80 (0.4)	19,682 (100.0)	59.8
D	Ekachai	2,211 (26.7)	2,505 (30.2)	25 (0.3)	8,287 (100.0)	57.2
	Total	16,709 (25.7)	19,967 (30.7)	349 (0.5)	65,064 (100.0)	56.9

The results found in the field survey seem consistent with the yearly survey results from the DOH made at similar survey points. A comparison of survey points is presented below making reference to locations also shown in Fig. 2-9. The results of the DOH survey are shown in Table 2-14.

Equivalent Survey Locations:

Field Survey Station	DOH Survey Station
A - Rangsit	2
B - Chonburi	63, 167, 303
C - Sri Samran	76
D - Ekachai	168

2.2.5 Truck Loading Factor

One of the reasons for considering establishment of truck terminals is to improve the loading factor of trucks outbound from the GBA. Two of the surveys made to quantify the opportunity cost of empty vehicle traffic are summarized in the paragraphs which follow.

The first survey made at four provincial check points in the north, northeast, east and south during 1976 and 1977 found that an average of 40% of the trucks passing the check points were empty. (See Fig. 2-10).

Fig. 2–9 CROSS SECTIONAL SURVEY LOCATIONS

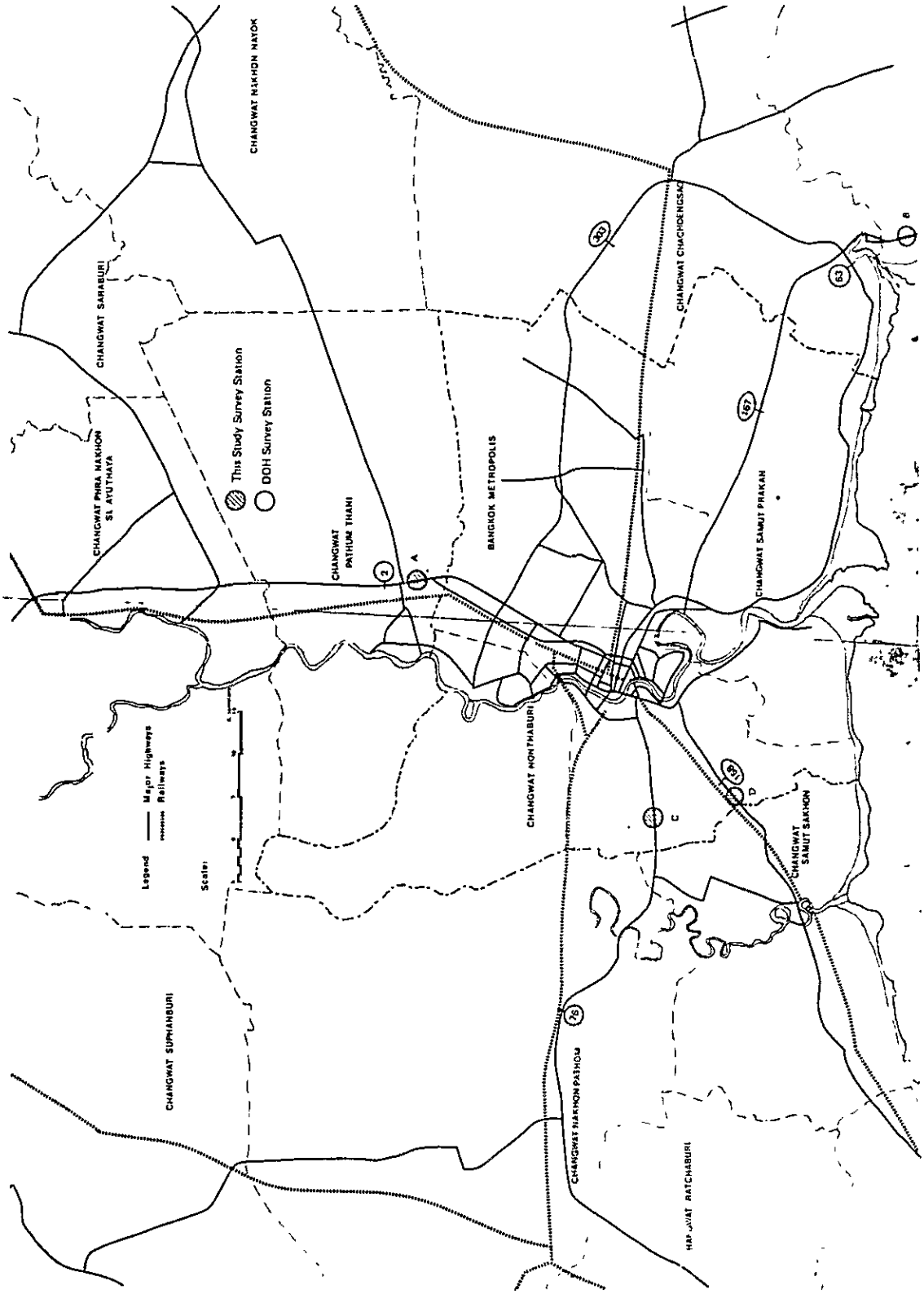


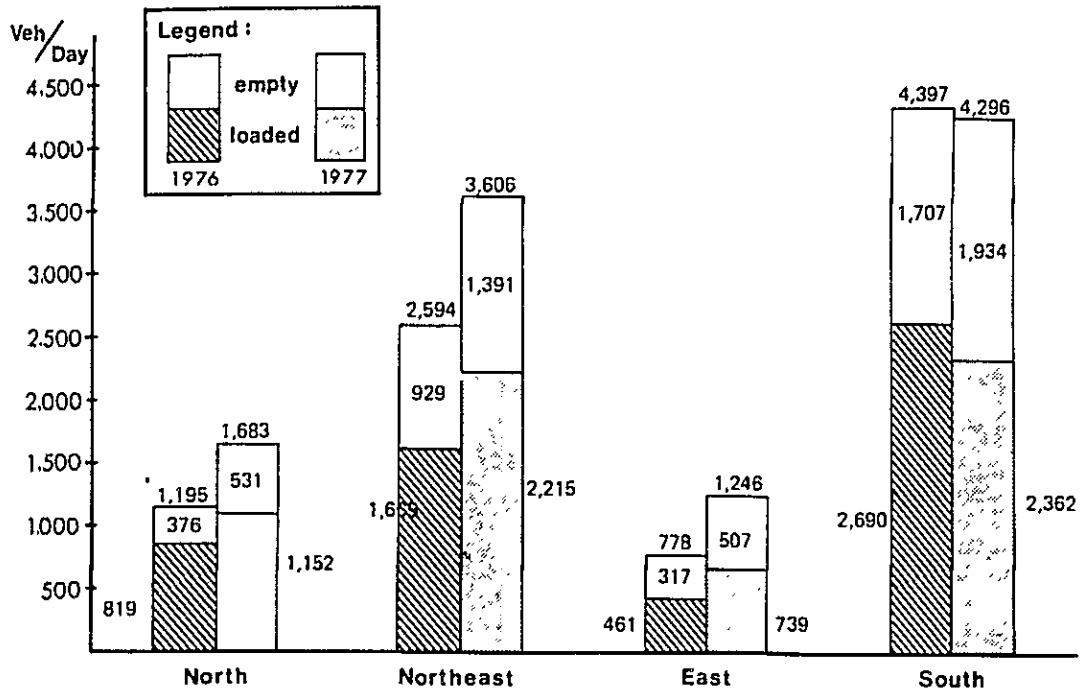
Table 2-14 Average Daily Traffic by Truck Type 1972/78

Station No.	Route No.	Terminal	Year	Light Trucks	Heavy Truck	Trucks Over 2 Axles	Total all veh.1/	Percentage of Trucks
2	1	Don Muang	1972	2,513	2,049	1,137	13,299	42.9
			1973	3,504	2,934	1,887	18,870	44.1
			1974	3,702	2,632	2,971	18,691	49.8
		Wang Noi	1975	1,861	2,029	2,831	18,140	37.1
			1976	2,299	2,440	3,180	21,485	36.9
			1977	2,412	1,789	4,715	26,478	17.5
			1978	2,525	2,389	4,369	24,474	36.8
63	3	Samutprakan	1972	264	145	986	2,434	57.3
			1973	375	146	1,311	3,074	59.6
			1974	234	214	738	2,413	49.2
		Bangpakong	1975	538	915	22	2,754	53.6
			1976	572	823	22	2,635	53.8
			1977	625	1,158	12	3,129	57.4
			1978	644	1,606	9	3,697	61.1
76	4	Bangkok	1972	1,328	1,465	2,110	12,878	38.1
			1973	1,340	1,440	1,309	12,460	32.8
			1974	1,170	1,559	2,947	14,193	40.0
		Nakhonpathom	1975	1,162	1,907	3,241	15,512	40.7
			1976	1,346	2,464	3,234	17,931	39.3
			1977	1,845	1,821	5,797	18,893	50.1
			1978	1,670	1,716	6,695	17,869	56.4
167	34	Bang Na	1972	975	1,085	61	9,384	22.4
			1973	922	964	193	9,573	21.7
			1974	841	966	807	8,714	30.0
		Bang Pakong	1975	874	989	1,173	9,048	33.6
			1976	1,268	1,009	1,367	10,309	35.3
			1977	1,597	2,682	1,327	33,777	40.7
			1978	1,762	2,004	2,501	14,081	44.5
168	35	Thonburi	1972	–	–	–	–	–
			1973	N.A.	–	–	–	–
			1974	598	690	492	5,051	–
		Pak Tho	1975	791	886	645	6,869	33.8
			1976	856	734	638	8,602	33.7
			1977	982	998	1,029	6,753	44.6
			1978	1,088	980	1,386	7,677	45.0
303	304	Minburi	1972	122	105	165	1,121	35.0
			1973	200	71	252	1,541	46.4
			1974	183	109	172	1,424	32.6
		Chachoeng Sao	1975	187	136	191	1,705	30.1
			1976	235	219	68	1,891	27.6
			1977	279	199	245	2,435	29.7
			1978	392	305	439	2,842	40.0

Source: DOH, 1972–8.

Note: 1/ including cars, taxis and buses.

Fig. 2-10 AVERAGE DAILY AMOUNT OF EMPTY AND LOADED TRUCK TRAFFIC TO/FROM GBA



Source: Commodity Movements In and Out of Bangkok. DLT, 1977

The study then quantified the daily loss in terms of operating costs and opportunity loss at about 4 million Baht per day as shown in Table 2-15. On a yearly basis this would amount to 1.2 billion Baht which is approximately 80% of the estimated truck terminal complex cost in Chapter 5.

Loading factors have significance in terms of increasing or economizing cost, the size of vehicle used is of even greater importance in realizing economics of scale. As shown below, the financial cost of operating different size vehicles (see Chapter 7), decreases when payloads and size of vehicle both become larger.

(฿/ton-km)

Size of Payload	Size of Vehicle		
	Light	Medium	Heavy
2 tons	1.3	2.1	2.5
5 tons	1.3	0.9	1.0
10 tons	1.3	0.9	0.5

The other study made by AIT of origins and destinations of line-haul trucks identified the percentage of outbound vehicles by type of truck. The results presented in Table 2-15 and 2-16 which are summarized below indicate the greatest need to improve loading factors for 10-wheel trucks.

Type of Vehicle	Percentage of Empty Outbound Vehicles
6-wheel	41.2
10-wheel	65.5
semi-trailers	38.0

Table 2-15 Assessment of Daily Losses from Empty Inbound and Outbound GBA Traffic

(Unit: Baht/day)

Check Point (Region)	(1) No. of Empty Trucks*	(2) Empty Trucks Route Length (km)	(3) Ton-km	(4) Average Route Length/-Empty Vehicle	(5) Operating Loss [item(2)x 3.00฿]	(6) Opportunity Loss [item(3)x 0.40฿]	(7) Total Loss (5)+(6)
Ayuthaya Interchange (North)	531(32%)	94,559	849,240	178	283,677	339,696	623,373
Nong Khae weighing Sta. Saraburi (Northeast)	1,391(39%)	328,184	2,484,801	236	984,552	993,920	1,978,472
Chonburi (East)	507(41%)	48,574	391,712	96	145,722	156,685	302,407
Amphoe Muang and Amphoe Kratumban (South)	1,934(45%)	168,529	1,438,655	87	505,587	575,462	1,081,049
TOTAL	4,363(40%)	639,846	5,164,408	597	1,919,538	2,065,763	3,985,301

Source Commodity Movements In and Out of Bangkok, DLT, 1977.
Note: * (%) indicate ratio of empty to loaded trucks

Table 2-16 Degree of Truck Loading by Direction and Type of Truck

(Unit: veh(%))

Type of Vehicle	Direction	Degree of Loading			Total
		Empty	Partially Loaded	Fully Loaded	
6-wheel	Inbound	32 (30.2)	62 (58.5)	12 (11.3)	106 (100.0)
	Outbound	47 (41.2)	59 (57.8)	1 (1.0)	102 (100.0)
	Total (Average)	74 (35.6)	121 (58.2)	13 (6.2)	208 (150.0)
10-wheel	Inbound	11 (3.7)	24 (12.4)	159 (81.9)	194 (100.0)
	Outbound	144 (65.5)	37 (16.8)	39 (17.7)	220 (100.0)
	Total (Average)	155 (37.5)	61 (14.7)	198 (47.8)	414 (100.0)
Truck Trailers	Inbound	5 (15.6)	7 (21.9)	20 (62.5)	32 (100.0)
	Outbound	19 (38.0)	16 (32.0)	15 (30.0)	50 (100.0)
	Total (Average)	24 (29.3)	23 (28.0)	35 * (42.7)	82 (100.0)

Source: Distribution of Origins and Destinations in BKK of Long Distance Trucks AIT, 1979.

2.2.6 Travel Speed of Trucks

In order to grasp the actual situation of truck operating speed in and out of GBA, a survey was carried out to follow trucks as they made their way through the GBA to determine their average travelling speed. Using a trip meter and stop-watch riding in a car, the accumulated distance and required transit time of trucks was checked.

The survey results shown in Table 2-17 indicate that the average truck speed in GBA was about 27 km/h. The survey was made only for trucks which were fully or partially loaded and therefore, the travelling speed is low.

There was no significant difference between 6-wheel trucks and 10-wheel trucks.

Comparisons with the survey results for passenger cars conducted in "The Comprehensive Study for Bangkok Suburban Transportation Project" are shown in Table 2-18.

Table 2-18 Comparison of the Travel Speed Survey Results

		Travel Speed (km/h)
Passenger Cars 1/	Central City Area	28.3
	Suburban Area	55.9
	Average	48.1
Trucks 2/		26.9

Source: 1/ BSTP: Bangkok Suburban Transportation Project
2/ BTTP: Bangkok Truck Terminal Construction Project

Especially in the city area, the travel speed of passenger cars and trucks is almost the same indicating that it is very difficult to drive at their desired travel speed due to the heavy road traffic congestion.

The travel speed survey results were adopted as a basis for the definition of travel speed on each road of the network which used in the traffic assignment.

Table 2-17 Travel Speed by Type of Truck

6-Wheel Vehicles

Sampling No.	Travel Distance (km)	Travel Time	Travel Speed (km/h)
4	23.7	37'44"	37.6
9	8.7	34'51"	15.0
11	10.45	40'12"	12.7
13	25.3	41'06"	36.9
16	16.1	34'18"	28.2
20	16.0	50'00"	27.3
21	9.0	16'18"	33.1
22	19.0	37'00"	29.3
25	16.8	55'38"	18.3
TOTAL	145.05	$5^{h}47'06"$	26.5

10-Wheel Vehicles

Sampling No.	Travel Distance (km)	Travel Time	Travel Speed (km/h)
1	34.4	49'08"	40.4
2	12.3	20'07"	36.7
3	25.3	59'17"	25.6
5	37.7	$1^{h}41'51"$	22.2
6	53.8	$2^{h}00'28"$	26.8
7	29.9	$1^{h}28'28"$	20.3
8	39.3	$1^{h}11'17"$	33.1
10	6.4	14'46"	26.0
12	29.8	$1^{h}15'53"$	23.6
14	15.6	45'34"	20.5
15	19.4	35'50"	32.5
17	39.1	$1^{h}47'11"$	21.9
18	33.4	$1^{h}27'25"$	22.9
19	13.0	$1^{h}26'00"$	24.5
23	36.6	$1^{h}23'28"$	25.4
24	32.2	$1^{h}09'30"$	31.9
TOTAL	458.2	$18^{h}36'12"$	27.1