COMPARATIVE STUDY ON URBAN STRUCTURE AND TRANSPORT IN TOKYO AND LONDON

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1. INTRODUCTION

Tokyo and London are both metropolitan cities and capital cities of their country, but both have many differences in urban structure and transport. Population and population density of the Tokyo Metropolitan Region are much higher than that of the London Metropolitan Region. Road system and railway system are different from each other. Mainly because of these, transport situation in the Tokyo Metropolitan Region is generally much worse than that in the London Metropolitan Region.

This paper investigates the differences in urban structure (population distribution, emoployment distribution, commuting area to the central area), road and railway system, and transport situation between these two big metropolitan regions, in order to obtain some hints to reduce transport problems in Tokyo. Through these fact finding, this paper can provide some suggestions which may be helpful in tackling transport problems in other cities in the world.

So far, some papers dealt with transport problems in Tokyo and in London but most of them dealt with each city separately, using measures which were not identical for both cities, therefore the differences have not been clear(1)(2) However, Kakumoto R.(3), compared Tokyo with london and New York in terms of population and transport using macro-data. This paper investigates the differences in population and transport in detail through applying identical measures to both cities.

In this paper, Tokyo and London stand for the Tokyo Metropolitan Region and the London Metropolitan Region respectively.

2. BASIC COMPARISON

Zones dealt with in this paper are shown in Table 1 and Fig 1. In Tokyo, "Tokyo Metropolitan Region" is used for the area which covers Greater Tokyo (Tokyo-to) and three surrounding prefectures. The boundary of greater Tokyo is not concentric but extends partially westwards from the city centre. Inner Tokyo is an eastern part of Greater Tokyo including the CBD of Tokyo. The are of Inner tokyo is approximately 1.8 times as

large as that of Inner London, while the area of Greater Tokyo is almost equal to that of Greater London. The area of the Tokyo Metropolitan Region is slightly larger than that of the London Metropolitan Region.

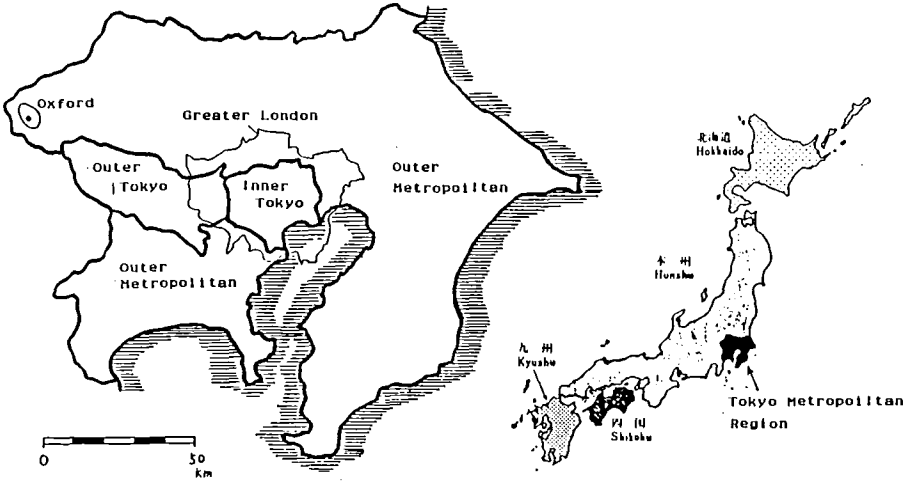
The population of Greater Tokyo in about 12 million, while the population of Greater London is about 7 million. The population of Inner London decreased rapidly from 1971 to 1981 and that of G. L. decreased less rapidly than that of Inner London. Only in Outer Metropolitan Region did the population increase, and the population in whole metropolitan region decreased from 1970 to 1980 as well, but the decreasing ratio is less than that of Inner London. The population of Outer Tokyo and Outer Metropolitan Region increased rapidly during these 10 years, and the whole population of Tokyo Metropolitan Region increased.

The number of people working in Tokyo and its density are much higher than those in London. It is interesting that, despite the higher density of people working in Tokyo, the numbers of people working in Inner Tokyo, Grater Tokyo and Outer Metropolitan Region are increasing. However, the number of people working in G. L. and the London Metropolitan Region is slightly decreasing.

Magnifications of density -- density in Inner Tokyo divided by density in Inner London -- are as follows;

Density of resident population	1.86
Density of people working in the area	1.75
Density of person trips	2.15

Fig.1 Scale Comparison between Tokyo and London



The magnification of density of person trips is the highest among these. Therefore, one can say that Inner Tokyo is a higher density city compared to Inner London, particularly in terms of traffic. The reason for higher density of person trips is that the intensity of activity in the central area depends on the population of the whole hinterland and the population of the Tokyo Metropolitan Region is much larger than that of the London Metropolitan Region. Number of trips made by one person in Tokyo is 2.530, this is smaller than that of 2.924 in London, therefore, trip rates are not the reason for high density of person trips in Tokyo.

Table 1 Basic Comparison

	TOKYO						LONDON					
	YEAR	INNER TOKYO	OUTER TOKYO	GREATER TOKYO	OUTER METRO	METRO	YEAR	INNER LONDON	OUTER LONDON	GL	OUTER METRO	METRO
AREA (Km²)		577	1,175	1,752	12,501	13,078		321	1,259	1,580	9,042	10,621
POPURATION (THOUSAND)	1980	8,352	3,266	11,618	20,346	28,698	1981	2,498	4,215	6,713	5,400	12,113
	1970	8,841	2,567	11,408	15,272	24,113	1971	3,032	4,420	7,452	5,152	12,604
DENSITY (PERSONS/ha)	1980	144.7	27.8	66.3	16.3	21.9	1981	77.8	33.5	42.5	6.0	11.4
INCREASE (% A YEAR)	'80/70	-0.55	2.72	0.18	3.32	1.90	'81/71	-1.76	-0.46	-0.99	0.48	-0.39
	'80/75	-0.11	-0.05	-0.10	1.83	1.22						
	'75/70	-1.00	5.51	0.47	4.41	2.43						
PEOPLE WORKING IN THE AREA (THOUSAND)	1980	6,234	1,083	7,317	7,280	13,514	1981	1,984	1,616	3,600	2,153	5,753
DENSITY (PERSONS/ha)	1980	108.0	9.2	41.76	5.8	10.3	1981	61.8	12.8	22.8	2.4	5.4
INCREASE (% A YEAR)	'80/70	0.58	2.60	0.84	2.05	1.32	'81/71			-0.6	1.0	-0.1
	'80/75	0.38	2.90	0.72	2.34	1.39						
	'75/70	0.77	2.01	0.93	1.57	1.18						
PERSON TRIP (THOUSAND)	1978	27,642		33,710			1981	7,157		19,407		
DENSITY (TRIPS/ha)	1978	479		192			1981	223		123		

Figure of the Outer Metropolitan Region in Tokyo, includes figures of outer Tokyo.

3. Distribution of population and employment

Fig.2 shows the distribution of resident population in Tokyo and in London. The data is based on cities and towns in Tokyo and districts in London and the average population densities in this figure are a weighted values by administrative areas. In most rings, population density in Tokyo is much higher than that in London, in other words, within the big umbrella of population of Tokyo, there is a smaller umbrella of population of London. Near the city centre in Tokyo -- within 5 kilometres from the city centre -- population density is much lower than that of 5-10 km ring. On the other hand in London, population density of 0-5 km area is higher than that of 5-10 km ring and the value is close to that of Tokyo.

Population density in Tokyo decreases rapidly from 10 km ring upto 50 km, however in 30-40 km ring, the decrease is

Fig.2 Density of Resident Population

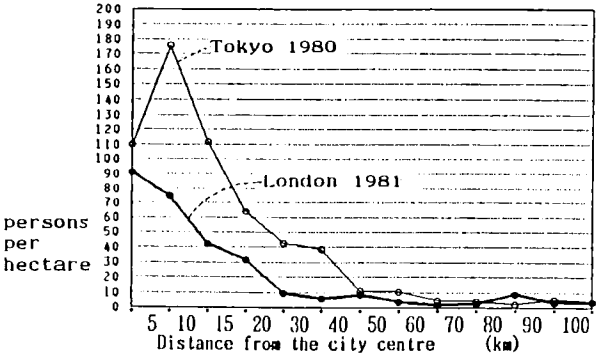
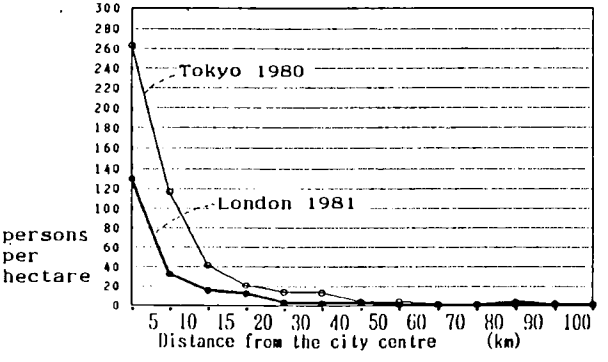


Fig.3 Density of People Working in a Area



smaller. The reason for this is that in this ring, there are big satellite cities such as Yokohama city (2.8 million people) the city of the second largest population in Japan, Chiba city (750 thousand people), Tachikawa city and so on. However, in case of London, there are no such big satellite cities as above. The slope of population density in Tokyo is almost flat outside 50 km and in case of london it is 30 km.

Fig.3 shows the distribution of density of people working in areas. Density of it in Tokyo is much higher than that in London, like density of resident population. The density of people working in 0-5 km area in Tokyo is 260 persons per hectare and it is twice as high as that in London. The magnification in 5-10 km ring is larger than that in 0-5 km area. This is reflected by the existence of some big subcentres in Tokyo, such as Shinjuku, shibuya, Ikebukuroisi and by the fact that there are no such big subcentres in London.

In Tokyo, density of people working in 30-40 km ring shows an increase similar to that of population density, due to big satellite towns

4. DIFFERENCE BETWEEN RESIDENT AND PEOPLE WORKING IN A AREA

Balance between resident in employment and people working in an area is a measure which indicates how much each area is self-contained. In other words, this measure shows the extent of a city's efficiency, in terms of commuting. The closer to one this ratio is, the more efficient the city is in terms of commuting.

Fig.4 shows ratio of resident in employment to people working in each area. The ratio in 0-10 km area in Tokyo are lower than those corresponding in London, namely central area in Tokyo is less self-contained than in the central area in London. In 10-50 km ring in Tokyo, the measure is higher than in London. Almost all value of this ratio in London are more close to one than in Tokyo, Therefore, one can say that London is more efficient than Tokyo in terns of commuting.

Fig.5 shows the density of differences between resident in employment and people working in each area. This measure indicates the same characteristics of areas as the last measure but this shows the amount of people who should commute. The lower this ratio is, the more people should commute to the area. The higher this ratio is, the more people should commute to other areas such as to the city centre, and the less self-contained the area is. Fig.5 shows that central area in Tokyo requires huge amount of commuting which is not clear in Fig.4. Central area in Tokyo excluded more resident population than in London and this situation reflects longer distance of commuting.

The reason why there are large differences in resident in employment and people working in each area in Tokyo are as follows;

1. Particularly in the central part of Tokyo, land price is too high for people to live. Land price within 5 km radius in Tokyo, is more than 5 million yen per m² (22,000 pounds), when compared to one million yen within 10-20 km ring (4,400 pounds) in 1987. In London, average land price is 13,300 yen per m² (579 pounds) in 1984.
2. In the suburban area of Tokyo, there has not been effort to provide working places, like new towns with industry in London. So far, because of big shortage of housing in Tokyo, the effort of the government is mainly focused on providing housing in suburban area.

Fig.4 Ratio of resident in Employment to People Working in a Area

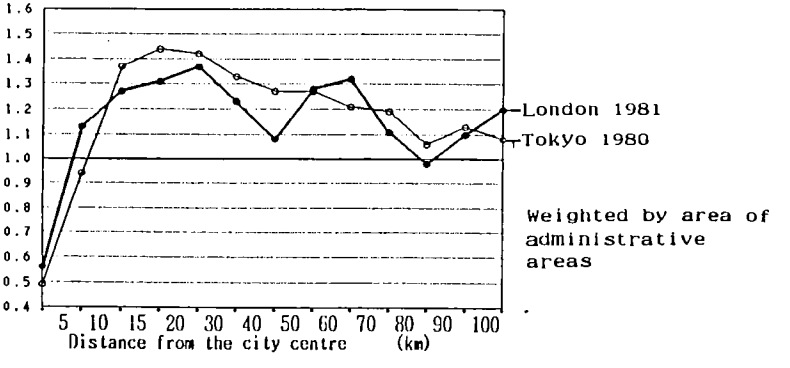
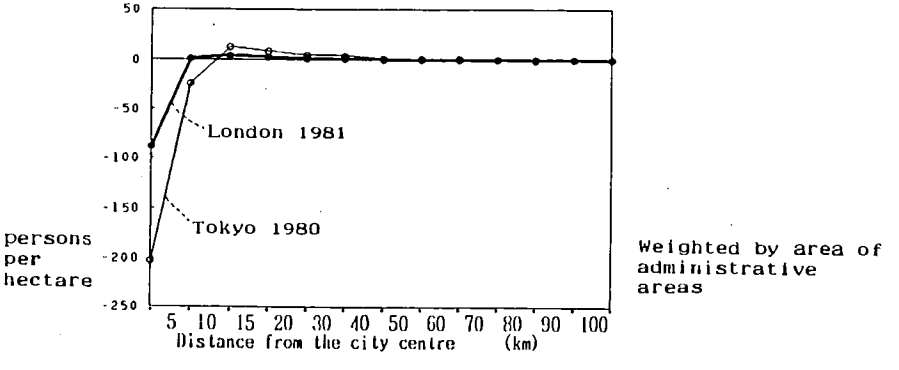


Fig.5 Density of Difference between Resident in Employment and People Working in a Area



5. COMMUTING POPULATION TO THE CENTRAL AREAS

Speed of Inter-City Trains and Motorways

Speed of inter-city trains in London is much higher than that in Tokyo. Fig.6 shows speed of the fastest trains including express trains from the city centre to the suburbs. Speed shown in this figure is average speed including stopping time at stations, based on time tables.

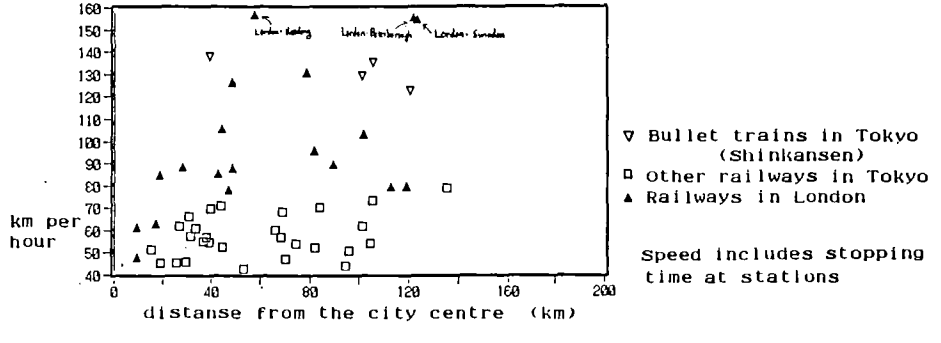
Average speed of some of the fastest trains in London is more than 150 km per hour, faster than the Bullet Train (Shinkansen) in Tokyo. Speed of most trains in London is more than 80 km per hour, on the other hand in Tokyo, it is mostly less than 70 km per hour. Incidentally, fare of trains in London is almost the same as in Tokyo. In London, passengers do not need to pay special fare for express trains, in contrary to Japan's case that passengers need to pay special fare for express trains.

The reasons why speed of trains in London is much faster than in Tokyo are as follows;

1. Railway construction stndard and railway operation stndard in the U. K. is set to allow trains to go at higher speed than in Japan.
2. Number of level crossing in London is much smaller than in Tokyo, that is, the number in Greater London is 20, in Tokyo -- within Ring Road 8 of which area is slightly larger than Inner London -- it is 403.
3. Tight land use control system in London is controlling urban sprawl rigidly. Owing to this, there are less houses along railways and trains can go faster between stations than in Japan.

Speed limits on roads in the U. K. were generally higher than those in Japan. A speed limit on motorways is 113 km per

Fig.6 Average Speed of Trains



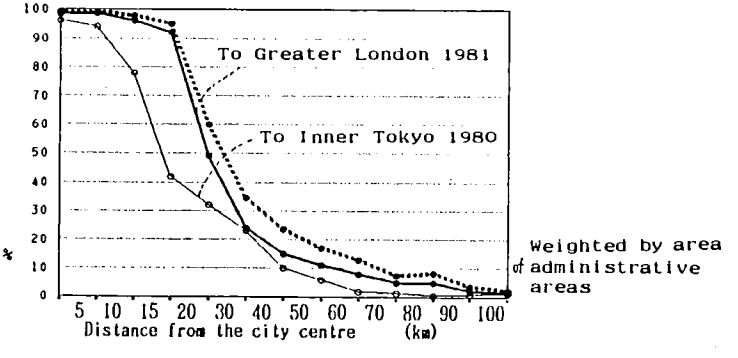
hour, compared to 80 km or 100 km per hour in Japan. Even on non-motorway standard roads, as in the case of dual carriageways, a speed limit is 113 km per hour in the U. K., compared to 40-50 km per hour in Japan.

Commuting Area

Because of high speed of trains as well as high speed motorways in London, people commute to the central area from farther area than in Tokyo. Fig.7 shows the ratio of people commuting to Greater London to resident in employment. Fig.8 shows the ratio of people commting to Inner London. In London even in the area 80 km away from the city centre, 5 % of resident in employment commute to Greater London. This ratio is affected by the number of people working in the central area, therefore, in order to compare these two cities at the same condition, the assumed ratios are calculated on the asumption that there are the same number of people working in Grater London as in Inner Tokyo and the assumed ratio is shown with a dotted line. In the assumed case, commuting distance extended to 90 km from the city centre, for 5 % of resident in employment. These distances are longer than Tokyo's case, that is 60 km. Fig. 8 shows the ratio of people commuting to Inner London. Corresponding commuting distance for 5 % of resident population is 70 km from the city centre and in the assumed case it is 100 km, much farther than Tokyo.

Long commuting distance in London must be the result of higher speed of inter-city trains and higher speed of roads in London. If speed of inter city traffic in Tokyo is as fast as in London,

Fig.7 Ratio of People Commuting to the Central Area to Resident in Employment



Assumed ratio of commuting people, on the assumption that number of people working in Greater London is the same as that of Inner Tokyo. The number of people commuting to Greater London is multiplied by 1.73.

people can live farther than that in present situation and can obtain cheaper lands. Consequently land price in inner suburbs will decrease.

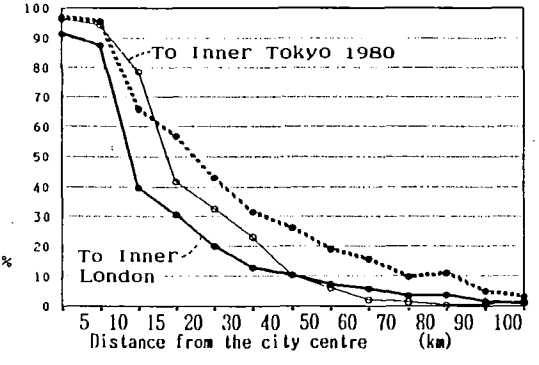
Number of People Commuting to the Central Area

Fig.9 shows number of people commuting to Inner Tokyo or Inner London. A dotted line indicates the number of people commuting to Inner London based on the assumption that there are the same number of people working in Inner London as in Inner Tokyo. People working in Inner Tokyo live farther than those of Inner London, reflected by the fact shown in Fig.5 that there is larger differences between resident in employment and people working in the central area of Tokyo than that in Inner London.

Assumed commuting population in 40-80 km ring in London is slightly larger than that in Tokyo. This is reflected by high speed of intercity traffic in London.

The dotted line shows that many people working in Inner London live nearer to the city centre than in Tokyo and also live in farther area than in Tokyo. That is to say, the dotted line is flatter than the line in Tokyo. This means that people live more uniformly in London than in Tokyo, in other words, people in London have more flexibility to choose their location of houses than in Tokyo.

Fig.8 Ratio of People Commuting to Inner London to Resident in Employment



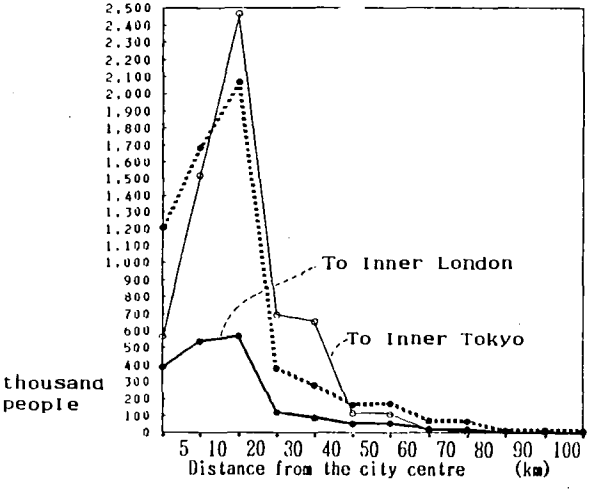
Assumed ratio of commuting people on the assumption that number of people working in Inner London is the same as that of Inner Tokyo. The number of people commuting to Inner London is multiplied by 3.14.

Journey Time to Work

Despite long distance of commuting, owing to high speed of inter city traffic, journey time to work in London is much less than in Tokyo as is shown in Table 2. In Tokyo, 51.8 % of people commute for 60-120 minutes. People who commute more than 60 minutes is 56.3 %, compared to 15 % of people living in G. L. and 8 % of people living in the rest of South East.

Reflected by the fact that larger number of people live near the city centre in London shown in Fig. 5, ratio of people with very short commuting time is much larger than in Tokyo.

Fig.9 People Commuting to Inner Tokyo or Inner London



•••••• Assumed number of people commuting to Inner London, on the assumption that number of people working in Inner London is the same as that of Inner Tokyo. Each value is multiplied original value by 3.142.

Table 2 Journey Time to Work

	minutes	0 ~15	15~30	30~60	60~120	120 ~
Tokyo 1985	Commuting Area (Radius of 50 km)	5.4 %		38.3 %	51.8 %	4.5 %
London 1993	Greater London	23 %	26 %	36 %	15 %	
	Rest of South East	38 %	34 %	20 %	8 %	

Source:(5)(11)

6. EFFICIENSY OF ROADS

Table 3 shows that proportions of road area to total land aera in both Tokyo and London are similar, on the other hand, road density -- road length per area -- in Inner Tokyo is much higher than in Greater London. The latter fact does not necessarily mean that Tokyo has an efficient road system. These two facts means that in Tokyo there are many narrow roads. The average width of roads which is an area of roads divided by total road length is 7.4 m in Tokyo and 14.1 m in London.

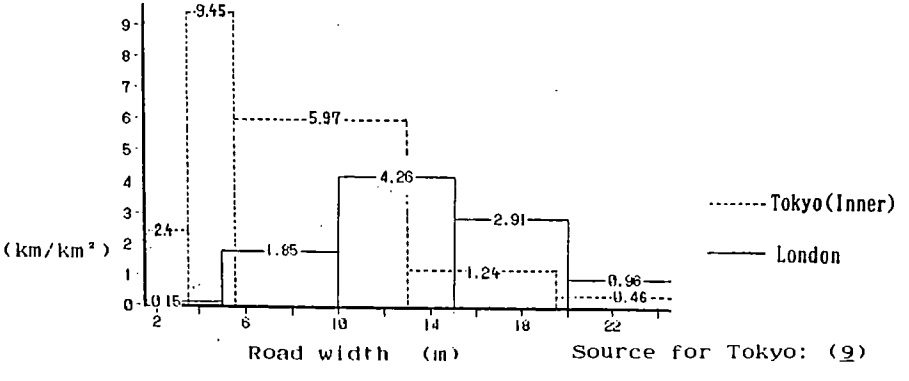
Fig.10 shows road length per square km by a rank of road width. Data for Tokyo is based on all roads in Inner Tokyo.

Table 3 Road

	TOKYO			LONDON	
	CENTRAL 15 WARDS	INNER TOKYO	GREATER TOKYO	INNER LONDON	GL
AREA (Km^2)	302	577	1,752	321	1,580
PROPORTION OF ROAD AREA TO TOTAL LAND AREA (%)	(1973) 14.5	(1979) 14.1	—	(1966) 16.9	(1966) 10.9
ROAD LENGTH (Km)	—	(1978) 10,926	(1978) 21,895	—	(1970) 12,690
ROAD DENSITY (Km/Km^2)	—	18.9	12.5	—	8.0
MEAN WIDTH OF ROADS (m)	—	7.4	—	—	14.1

Source: (5)

Fig.10 Road Length per Square Kilometre by Road Width



Source for Tokyo: (9)

Data for London is measured on some maps which cover some parts of Greater London from the city centre to the suburbs. According to Fig.9, width of most roads in Inner Tokyo is less than 10 m and in Greater London there are more wide roads than in Inner Tokyo. This means, in London the road system is more efficient than in Tokyo in terms of function of traffic.

Because of narrow roads and high density of person trips, there is much congestion on roads in Inner Tokyo. Fig.11 shows average travel time to and from the city centre by car. The area surrounded by 30 min. line in Tokyo, is much smaller than that in London. Magnification between these two areas is about 4 and this shows clealy how congested roads are in Tokyo. In case of Tokyo, the time is average travel time for whole day, on the contrary, in London, the time is during morning peak hours, therefore, in Tokyo during morning peak hours, the area of 30 min. should be smaller than the area shown in Fig.11.

Number of population which can be accessed in the same travel time is a good measure to evaluate the accessibility. Table 4 shows the resident population and number of people working in the area accessible in 30 min. by car from the city centre. The number of resident population in the area in Tokyo is much smaller than in London and the numbers of people working in the area are nearly the same.

Table 4 Population in the Area Accessible in 30 nim by Car (million)

	Resident population	People working in the area
London	2.12	1.86
Tokyo	0.94	2.19

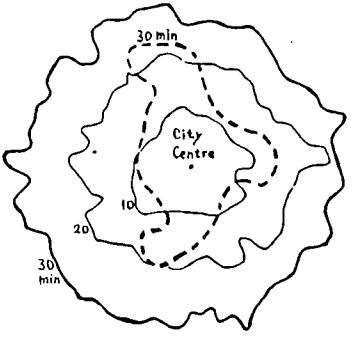


Fig.11 Travel Time by Car

0 10Km

------ 30 min line from Tokyo station. Average time in 24 hours. 1978
——— Travel time to Charing Cross during mornig peak hour 1981
Source:(4)(10)

In Tokyo, people gather for better accessibility but this causes serious congestion, which in turn leads to less accessibility of person trips to resident population than that in London and nearly the same accessibility of person trips to people working in the area as that in London. One can say that people who live and work in Tokyo suffer from high land price and congestion on roads, but can not obtain much benefit corresponding to these hardships.

7. EFFICIENCY OF RAILWAYS

Table 5 shows the mode of transport. Because of lack in arterial roads in Tokyo and high density of person trips as is shown in Table 1, ratio of car trips is much less than that in Greater London. Also because of congestion on roads, ratio of bus trips is much less than London. On the other hand, because of the same reason, ratio of rail trips in Tokyo is much larger than that in Greater London.

Table 5 Mode of Transport

	ALL PURPOSES			WORK		
	INNER TOKYO	GREATER TOKYO	GL	INNER TOKYO	GREATER TOKYO	GL
AREA (Km^2)	577	1,752	1,580	577	1,752	1,580
MODE (%)						
RAIL	33.6	30.7	8.0	55.4	54.1	20.5
BUS	3.5	3.6	11.4	5.5	4.9	14.5
CAR	17.8	18.9	41.6	13.0	16.1	45.3
WALK,CYCLE	45.1	46.8	38.6	26.1	24.9	19.7
OTHER			0.3			

Source: (4) (10)

Fig. Underground in Tokyo and London (1986)

			Tokyo	London
Passenger journeys	(millions)	A	2,383	769
Passenger kilometres	(millions)	B	17,459	6,218
Route length	(kilometres)	C	203	394
Train kilometres	(millions)	D	31.8	49.3
Average waiting time	(minutes)	*	6.7	8.4
Passenger per route rength	(millions/km)	B/C	85.75	15.78
Average passenger load per train		B/D	549	126

*60min/(D/C)/(365*24*2)

Source: (7) (8)

This results in efficiency of running railways in inner suburbs of Tokyo, as is shown in Table 6. In inner Tokyo, besides undergrounds (subways) there are many private railways but the Table shows the comparison of undergrounds only. Passenger per route length in Tokyo is 85.75 million per km per year, this is much higher than 15.78 million in London. Despite the fact that average waiting time in Tokyo is shorter than that in London, average passenger load per train in Tokyo is 549 people, which is much larger than that of 126 people in London. This efficiency of underground in Tokyo must lead the finance of undergrounds to good balance.

High ratio of railway trips in Tokyo leads to develop big subcentres around big stations such as Shinjuku, Shibuya, Ikebukuro and so on mentioned before, which are very useful in reducing congestion in the city centre.

8. CONCLUSION

The characteristics of urban structure of Tokyo compared with London are summarized as follows;

1. Large number of population and people working in the metropolitan region, as are shown in Fig.2 and Fig.3.

2. High population density and high density of working population, as are shown in Fig.2 and Fig.3.

3. Existence of some big satellite towns and some big subcentres. Big subcentres have been formed around big stations, through high ratio of railway trips.

4. Larger separation between residence and working places, caused by high land price in the central area.

5. Smaller commuting area caused by slower speed of inter-city trains.

6. As a result of 4 and 5, there is large number of people commuting to Inner Tokyo from the area 10-40 km from the city centre. It results in high land price in 10-40 km area.

Characteristics of transport in Tokyo affected by characteristics of urban structure listed above and other conditions, are as follows;

1. Density of person trips is much higher than that in London. The ratio of person trip density of Inner Tokyo to Greater London is larger than that of population density, due to larger number of population in the Tokyo Metropolitan Region.
2. Long journey time to work caused by slower speed of inter-

city trains and greater separation of residences and work places.

3. Population accessible by car within 30 min. is much smaller than in London, because of serious congestion on roads caused by high density of trips and lack of arterial roads. Excessive gathering in high density to obtain good accessibility result in less accessibility.

4. Because of high density and shortage of arterial roads, underground system operates efficiently.

Two of the most serious problems in Tokyo are high price of land and long time of commuting, caused by high density. In order to improve these problems, Improvement of speed of railways must be adopted as a priority in the list of urban policy of Tokyo. If speed of trains becomes as fast as that in London, people will be able to live farther than today. This will lead to lower density and less congestion in inner suburbs and land price might hopefully decrease, as well as commuting time will decrease.

In order to make trains as fast as in london, it is not necessarily needed to build new bullet trains. From London's experience, to improve existing railways is enough to obtain very high speed, and the means to obtain high speed can be as follows;

1. Tight land-use cotrol to obtain high speed between stations.
2. To improve geometric standard of railways.
3. To reduce level crossings.

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