ANALYSIS OF TRAFFIC IMPACTS OF DEPARTMENT STORES ADJOINING MAJOR RAILWAY STATIONS IN JAPAN

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abstract: Large department stores adjoining major railway stations have been functioning as active city centers where trains have played important roles as urban transportation modes. But, in recent years, many shoppers use private vehicles to go to these departments particularly those in suburban areas. As a result, streets around the major stations suffer severe traffic congestion on every weekend. This paper aims at investigating the actual conditions by choosing Ohmiya station as case area. Through various surveys including traffic count survey, video survey, interview survey, questionnaire survey to the shoppers, etc. We found out that queuing traffic obstruct intersections and deteriorating the level-of-service of buses and taxis.

1.INTRODUCTION

In Japan, Large department stores usually locate at city centers adjoining major railway stations. On every holidays, a large number of private vehicles concentrate in such area. As a result, various problems occur not only as the disadvantages of shopping vehicles themselves but also as deterioration of access vehicles to the station such as buses. Although such situation is well recognized, there is little study, which investigated detailed situation.

Such station-oriented department store is the unique in Japan that is not problem in European countries and U.S.A. Historically speaking, station-oriented department store was first built at Umeda station, Osaka in 1929 aiming at catching a lot of potential customers who are changing trains at Umeda terminal. Following the success of Hanshin department, a name of Umeda first station-oriented department store, most traditional department stores were relocated at terminal station until 1970's in most Japanese cities

including suburban cities of Tokyo. Although such department stores originally expected their customers to come by train and/or buses, the number of customers who use private vehicles to come to chopping has rapidly increased in the progress of motorization. The unbalance between the demand of private vehicles and the supply, i.e. parking capacity and network capacity, is the fundamental reason of the problem.

The purpose of this paper is to analyze the traffic problem around the major station on holidays as mentioned before. The Ohmiya station in Saitama Pref. was chosen as the case study.

2.CURRENT STATE OF THE OHMIYA STASION

The Ohmiya station has 7 railway lines (Jouetsu Shinkansen, Saikyou line, Takasaki line, Utsunomiya line, Keihin northeast line, and Tobu Noda line), the new transportation system and about 10 bus routes (in the western exit side) functioning as the key point of regional land transportation. In this paper, the western side of Ohmiya station was dealt with, where five large department stores are located. These facilities are linked by pedestrian deck at the second floor level and the pedestrian can use each facilities without going down to the ground level. There are some ticket parking in several streets and two small parking besides a large-scale parking attached in the department. The map of the western side of Ohmiya station in September 1993 is shown in Figure-1. There is the "Bus Street" which is four-lane road from the rotary around station toward in the east, and there is the right turn lane in the all signalized intersection. Pedestrians cannot cross the “Bus Street” because there are medial strips. On holidays, chronic congestion occurs in "Main Street" which run through from south to north and is the two-lane road.

The subject area is surrounded by arterial streets such as "Route 17(The 17th national road)" from south to north and " Ohmiya-Iwatsuki line (Prefectural highway) from east to west. Also, there is a comparatively narrow one-way road from the “N3” intersection toward the Ohmiya station. In this area, various retail shops and preschools, etc. are randomly located besides large department stores.

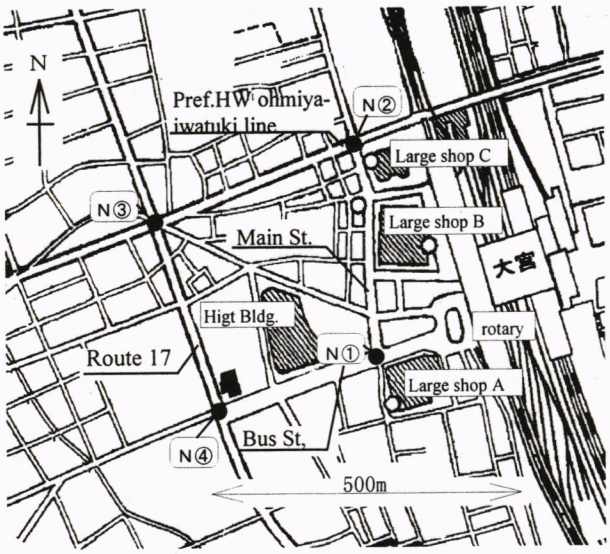

Figure-1 Western side of the Ohmiya station

3.OUTLINE OF SURVEY AND RESULT

3.1.Outline of Survey

"The Ohmiya station Holiday Traffic Study (OHTS)" was Conducted to understand the current state around the station on holidays and to collect basic traffic data on Sunday of September 5, 1993 as shown in table-1. "Questionnaire Survey in Catchment area of the department store (QS)" aiming at grasping trip characteristic bath of shopping and daily trip, was conducted in the end of November 1993 by targeting those who are used to shopping in the Ohmiya station area.

Table-1 List of survey

	content of survey	purpose	method	note
OHTS 1)	video survey of traffic stream	Traffic volume and conditions	VTR recording at all intersection or node	at 11-intersections
	questionnaire to the parking user	an attribute, route, etc.	interview	at 4 parkings
	bus survey	time both of running and stopping	getting on bus	on 4 routes
	parking queue survey	Average speed, etc.	measurement vehicles	8 cars
	large-scale parking survey	user's route, user's attribute, etc.	counting	at 4 parkings
QS 2)	questionnaire survey in catchment area	user's attribute, shopping traffic action and a normal drive action, etc.	questionnaire	Getting 752 respondents

1): Ohmiya station Holiday Traffic Study 2):Questionnaire Survey in catchment area of the department store

3.2.Traffic Volume

Surrounding arteries such as "Route 17" and "Ohmiya Iwatsuki line" function as a trunk road and their hourly traffic volume is during 600-900(vehicles per hour). At the "N3 intersection", 2600 or more cars was passed in hour (17:00-18:00).
As for the streets within the area, "Bus Street" has the most traffic, of which peak flow is 700 vehicles per hour in 14:00. On the other hand, the peak volume of "Main Street" is less than 400 vehicles per hour because of the chronic traffic jam.

3.3.State of Large-Scale Parking

The state of four large-scale parking shown in figure-1 (pointed by circle) was investigated. Table-2 shows the basic data of each parking. The average duration time of each parking was also shown in the table-2, showing that average time is slightly less than two hours, by which users can get the "parking free service". The Eralang distribution of phase 3 or 4 is suited as a distribution of parking time. The average parking time of "The Ohmiya station rooftop parking" is more than two hours because some P&R users exist.

Table-2 Large-scale parking facility in the surveyed area

parking facility	Dept. Store A	Ohmiya Sta.	Dept. Store B-1	Dept. Store B-2
capacity	185	519	296	153
type of parking	underground 2 Floor attendant	roof top 1 Floor self	underground 2 Floor self	space structure self
average parking time	1'59"	2'05"	1'48"	1'49"

3.4.Parking User's Characteristics

3.4.1.Place of Residence

The place of residence of customers distributes mainly in and around Ohmiya station, that is, 33% of respondents of questionnaire survey lives in Ohmiya city and 60% lives in surrounding cities such as Urawa, Ageo Yono, and Iwatsuki (see Figure-2). It is interesting that there is a relationship between the place of residence and selected parking place probably because customers tend to select the parking that can easily enter, i.e. the parking at left side of the street.

3.4.2.Frequency

Parking type and the experience of users also influence the selection of parking. For example, underground parkings are not so selected by "beginners" probably because they are not easy to find their entrance, whereas parking building, that is a landmark of this area, is often used by beginners.

4.CHARACTERISTICS OF HOLIDAY SHOPPING TRIP

4.1.General Characteristics

The car owner ship rate was 81%. It was answered that more than 60% of the respondents has been to Ohmiya area to go shopping five times or more on holidays. There are about 80% drivers who used to decide target parking before leaving house when going to shop with private vehicle. But there are 50% drivers who have flexible idea that final selecting of parking was done near the station area.

4.2.Mode of Transportation

In spite of public transportation service such as train are operated already, as much as 70% of respondents used to use private vehicles who go to shopping to Ohmiya station area. On the other hand, 80% of car owners has experience to use train and/or bus. Car owner's modal split is shown in Figure-3. In this case, the investigation region was divvied into six sectors to consider a regional characteristic (Figure-2). Normally, the ratio of train use is high in the sector where railway line to Ohmiya exists. On the contrary, the ratio of bus use is high in the sector where railway line does not exist. However, the ratio of car use is about 40% in all sectors. From the viewpoint of distance, rate of bicycle and motorcycle is high within 3km area. Bus users reduce suddenly from 5km area. For shopping, the bus mode is competent for short distance. Also, ratio of train use increases as long distance. On the other hand, the ratio of car use is not influenced by distance (average 45%). It is should be noted that about 40% person use always private vehicle regardless of distance and level of public transportation.

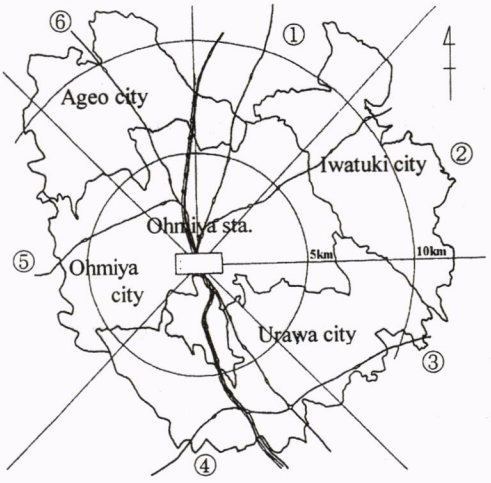

Figure-2 Surveyed Area and Sectors

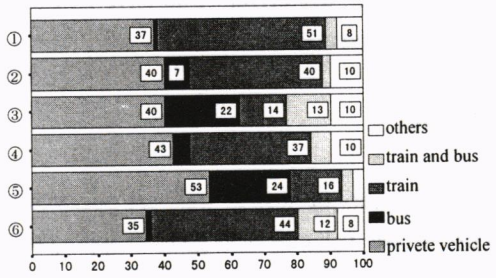

Figure-3 Shopping Modal Split (Car owners) by Sector (%)

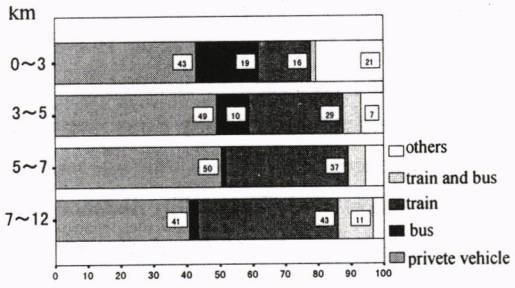

Figure-4 Shopping Modal Split by Distance (Car owners)

4.3.The Trip Time of Each Mode

Figure-5 shows average trip time of car and train according to the distance. The trip time of

train contains the access time, while the trip time of car contains the waiting time to parking (queuing time). The trip time of train takes less than 30 minutes, but the trip time of car takes 45 minutes on the average. Especially in 5-7km distance, there is a big difference as much as 30 minutes. The relationship of running time and queuing time of car trip is shown in figure-6. There is a tendency that the rate of queuing time reduces as distance increases. It is understood that the rate of queuing time is about 56% in 0-3km distance, which weans that spend more than half of trip time in queue. We analyzed that car user's modal selection was not influenced by the trip time of another mode such as train. About 76% person who judged trip time of car wastes more than that of public transportation selected private vehicle to go shopping.

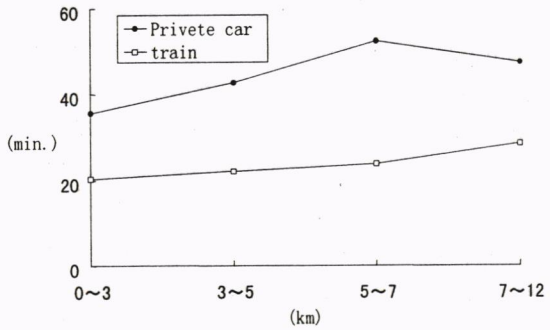

Figure-5 Trip Time by Modal Split and Distance

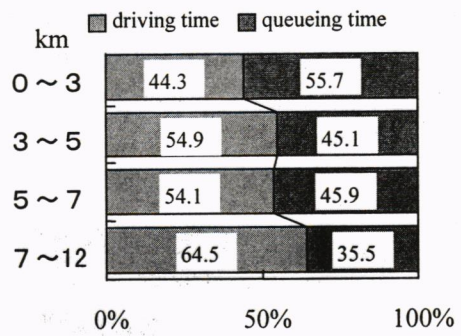

Figure-6 Contents of Trip Time of Private Vehicles by Distance

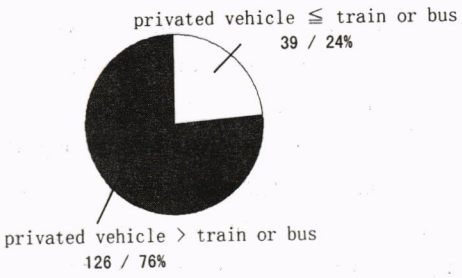

Figure-7 Comparison of Predicted Trip Time (Car owners)

4.4.Factor of Mode Choice

Car users have characteristic that the time factors such as trip time are not important for shopping. Compared with public transportation users such as trains and buses, car users who think, "the accuracy of time is important" is minority (about 30%). Additionally, there are 28% of car users who think, "Time accuracy is not important". But there are less than 10% of bus and train users who think so, and 63% of bus users and 86% of train users think " the accuracy of time is important ". Many car users thought that "Situation when going to shopping" such as weather was more important than "Accuracy of time". There is a tendency that car users value comfort, benefit and convenience, for example door-to-door access. In other words, it can be said that public transportation does not have these advantages such as comfort. The ratio of public transportation user who assumes these factors to be "important" is 58% of bus users and 47% of train users. Car user's mode selection is influenced by their daily driving behavior (see figure-10). Private vehicle was selected by 61% of "almost every day" car users, while only by 25% of "4 and 5 times per month" car users. As a result, it can be said that daily driving frequency has big influence for mode selection of holiday's shopping.

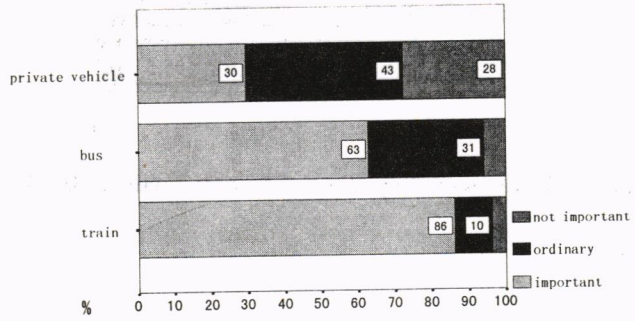

Figure-8 Result of "the accuracy at time"

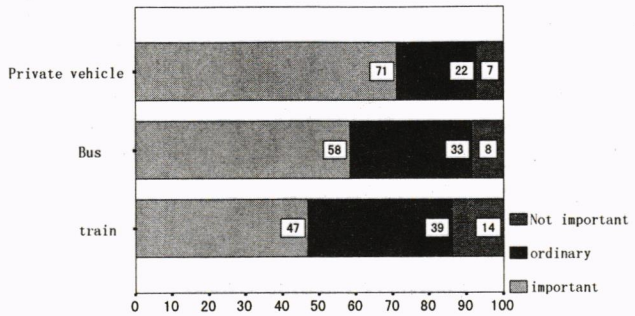

Figure-9 Result of "Situation when going to shopping"

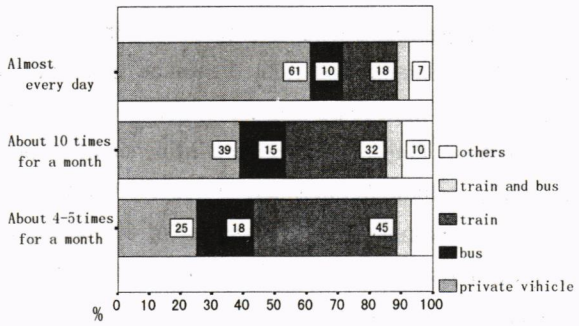

Figure-10 Shopping Modal Split (Car Owners) by Driving Frequency

5.SEVERAL ASPECTS OF TRAFFIC PROBLEM ON HOLIDAYS

5.1.Formation of Queue of Large-Scale Parking

After all the lots are occupied, the queues are generated on the road in every surveyed large-scale. Even before the opening time (10:00AM), queue is beginning to generate in department-A. But it dose not became big trouble because traffic is not so much at this time. The queue on the road is disappeared temporary with department-A opening (at 10:00), and afterwards the volume of queue increases from 11:00 to 12:00. The end of the queue reaches at the intersection-N1 at about 11:30. Later, the queue on the road always existed until 16:30, and end of the queue extended to the rotary around the station. Also the queue approaching to parking of department-B occupied the "Main Street" during all day. Violent congestion was observed in the vicinity area because of complicated condition.

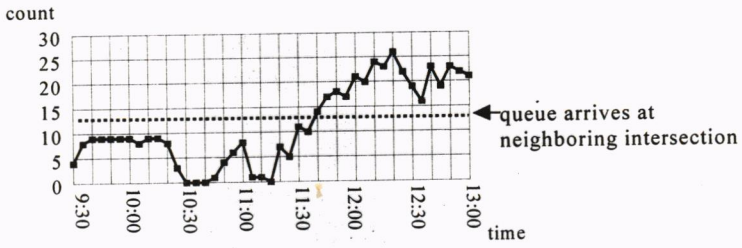

Figure-11 Parking Queue

5.2.Influence of Queue on Neighboring Intersection

Chaotic congestion with the parking queue is generated at the intersection-N1. The right turn vehicle staying within the intersection existed even at red signal phase, because there were exorbitant vehicles which want to go into the queue from the west of the "bus street" after changing the signal phase. Figure-12 shows the influence of queue of intersection-N2. From the north route, traffic volume in afternoon (14:00-15:00) decreased as much as 60% compared with that of in the morning. It is not because of decreasing of car flow from the north, but because it became very difficult to come into the area from north because the end of the queue even reached the intersection-N2.

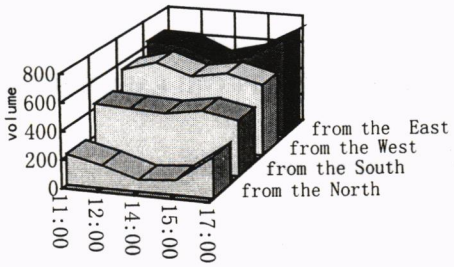

Figure-12 Traffic Volume of Intersection-N2

5.3.Influence on Access Traffic Toward Station

In the queue experience survey, eight vehicles approached to this area to measure time by running specified route (about 2km). And travel time of each main intersection was recorded. The average speed of each route was calculated as less than 25 km/h (to the point of a dotted line shown in figure-13). Average speed of the measurement vehicle of the 3rd route was less than 10 km/h. The average speed decreased step by step while approaching the area. However, such a characteristic is not appeared in 5th and 7th route that pass the back streets. The 11th route's average speed is about double compare with the 1st route.

Simply the 11th route was not very crowded. There is a simple question that "Why doesn't the driver from the western area select the 11th route?" The first reason is that the car driver selects the 1st route naturally according to the guide sign. The second reason is that the car driver can not recognize easily the 11th route that has no guide sign.

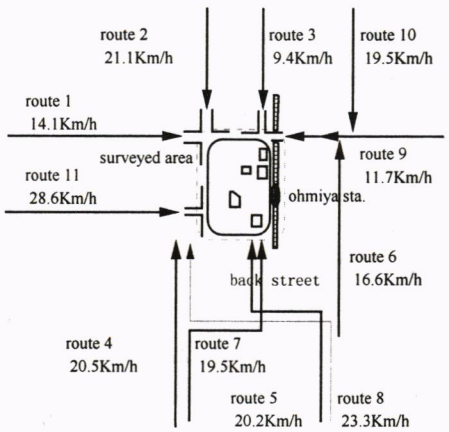

Figure- 13 Averaged Speed Towered to The Area

5.4.Influence on Users

5.4.1.Average Speed in Subject Area

Considerable congestion, of which average speed of all survey links was 7 km/h, was observed. At the worst link, average speed was some hundreds meters per hour. In the "Main Street", most links' average speed was less than 10 km/h in the both directions. There are chronic congestion situation during all day. The average speed is shown in table-3.

Table-3 Average Speed in the Objective Area

time zone	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00
Average speed (km/h)	10.4	8.3	3.1	10.3

5.4.2.Route Choice

There were 148 routes toward four parking as the result of questionnaire investigation (the sample size is 1026). The most popular route is that from the east and turns to the left in the Intersection-N2, and enters "underground parking" of a large shop-B (the ratio is 35%). When driver was able to select more than two routes in the object area, we obtained an interesting result. When the car goes to "underground parking" of large shop-A from

"Intersection-N4", the driver can select various routes in the area in spite of narrow. For example, some cars go straight without turning to the right in "Intersection-N1", and pass the rotary around the station, and queue up in the end of the queue. There also are car driver who use the back street in the south area. And some wandering cars to find parking were observed because of not only shortage of parking but also incompleteness of the guide to the parking and/or the queue. It is observed that drivers who frequently come to this area tend to use rotary and/or buck street.

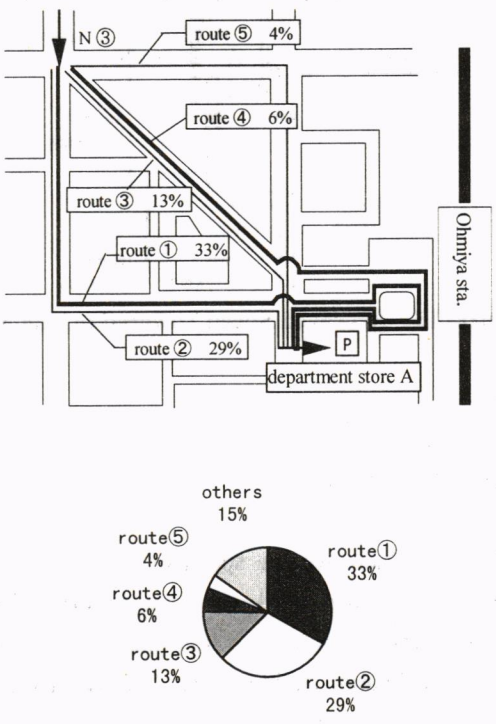

Figure-14 Route Choice Toward Department Store-A parking (data from the intersection N③)

5.4.3.Influence on Rotary in Front of the Station

A rotary I front of the station about 10 vehicles were always observed to park, stop, meet or send someone. Public transportation such as buses or taxies are disturbed, because the vehicle that cannot stop at the specified stopping position stopped as the double lane stopping or ran slowly to searching parking position. More than 70% of stopping time at the rotary was less than two minutes, on the other hand and the time of parking vehicle was

more than 20 minutes. It should be noted that as much as 8% of traffic using the rotary is the vehicles approaching to the queue of the parking of department store-A (see Figure-14 and Figure-16). It means that access traffic to the station including buses and taxies are influenced by unexpected traffic.

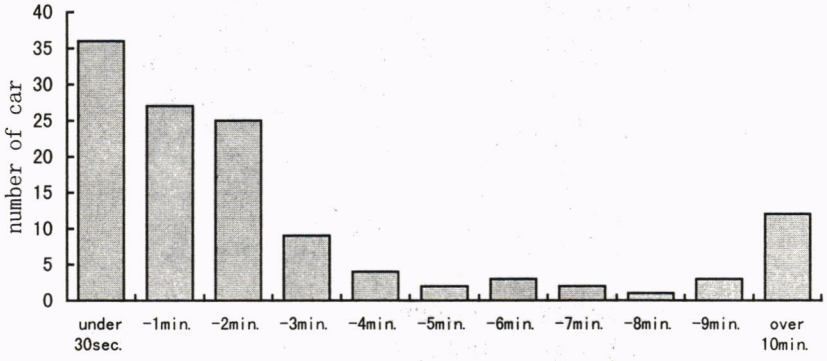

Figure-15 Parking or Stopping Time at Rotary in Front of the Station

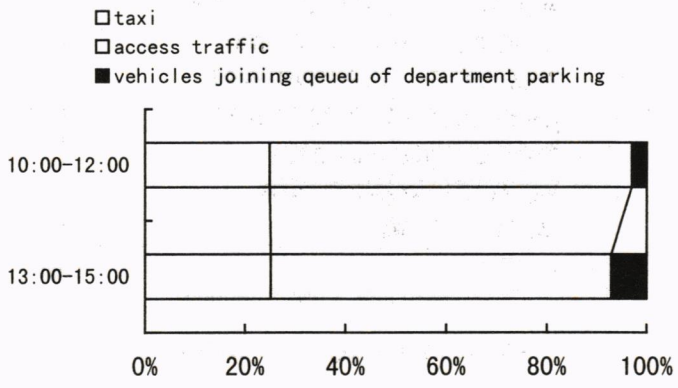

Figure-16 Detail of Traffic Coming Into the Rotary

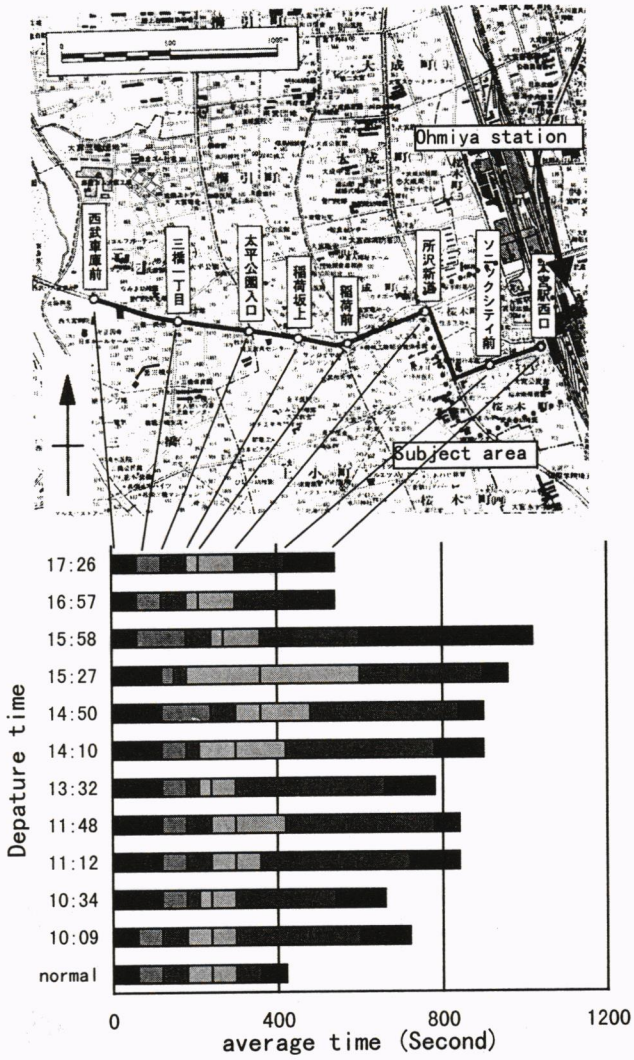

Figure-17 Average Time of Bus

5.5.Influence of Public Transportation

A average of buses speed in the area is remarkably low. In the peak periods, it takes more than five minutes between one section of bus stop (about 200m) which means average speed was about 3 km/h. Average speed between all the districts was about 10 km/h. It should be noted that public transportation to access station is heavy influenced by shopping traffic. The average time between the sections of the bus stops toward the station is shown in Figure-17.

6.SUMMARY

The large-scale department stores adjoining major railway stations had developed peculiarity in Japan to expect customers who use the railway. However, now a variety of traffic problems are occurred according to the progress of motorization. Chaotic congestion by the shopping traffic and the queue on the road around the interaction were generated because of a lack of traffic infrastructure such as parking and traffic information. These conditions cause bad effects on the public traffic and the degenerate function of the rotary in front of the station as traffic node. Moreover, generally speaking in Japan, there often exist trunk roads near major station. The congestion of the station and surrounding area is increased also by the trunk road traffic (mainly through traffic) mixing with the traffic of station facilities and the large-scale shop user. The safety problem is also generated. Car drivers intentionally select route seven in the neighborhood area to avoid recognized congestion. Moreover, the wandering vehicle around the station is generated because lack of wide area traffic signboard and low level of information system. The new traffic information, for example ITS, is necessary to improve this conditions.

REFERENCES

Takaaki Monji, Hisashi Kubota, Kunihiro Sakamoto, Takaomi Sugiura (1995) Analysis of Information Needs for Community-Level Travelers. **2nd World Congress of Intelligent Transportation Systems**, Yokohama Japan, 9-11, November 1995

Kunihiro Sakamoto, Takaaki Monji, keisuke Nakajima, Hisashi Kubota (1995) Some aspects of traffic problem on holiday adjoining major station. **Research and lecture of planning of the civil engineering**, Moji, Japan, December 1995