COMPARATIVE STUDY ON DRIVERS' PARKING PLACE CHOICE BEHAVIOR IN PUSAN AND OSAKA

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abstract : Today, most urbanized areas have been confronted with parking problems. It can be said that these are some of the most severe problems that must be eliminated to improve urban transportation systems. The purpose of this study is to analyze drivers' parking behavior based on two surveys in Pusan, Korea, and Osaka, Japan. Since the questionnaire scenario for the two areas are complete the same, we can easily compare the parking place choice characteristics of Pusan and Osaka.

1. INTRODUCTION

Parking is the common problem which needs to be solved in urbanized areas. Since parking problem is influenced by the structure of the city, the infrastructure of transportation system, and the behavior of the citizens, it is believed that the characteristics of parking problem is various. Therefore, it is an interesting issue that must be dealt in comparative study on behavior of parking in different cities.

If we compare car ownership ratio of Korea and Japan, Japan exceeds about three times more than that of Korea (Japan: 1 auto / 2.0 person , Korea: 1 auto / 5.9 person). It is expected that the car ownership in Korea will increase rapidly. Since social structure of Korea is similar to that of Japan, it must be meaningful to compare parking issues on urbanized areas in these two countries. Therefore, first this study focuses on identifying the fundamental parking issues in Pusan in Korea and Osaka in Japan. Secondly based on questionnaire surveys, comparative study of parking place choice behavior in the two cities are carried out.

In order for parking policy decisions to be well founded, appropriate analysis of drivers' parking behavior is indispensable. As identifying the characteristics of parking behavior is the essential factor to construct the Parking Management System, parking studies are going on in many aspects. Regarding the parking place choice behavior, since the presentation of a state-of-the-art review of parking models as an integral component of urban transport systems by Young et al.(1991), many parking location choice models have been developed. Further, Cullinane and Polak (1992) have pointed out that parking enforcement is increasingly perceived as a key feature of urban transport policy. Nevertheless, there is little research dealing with parking location choice models in which parking enforcement and usage of on-street parking places (usually illegal) are discussed except for Axhausen et al.(1991) and Tsukaguchi et al. (1993). As recently parking information system has been installed in lots of cities, Thompson et al.(1992, 1993), Muromachi et al.(1993), and Tsukaguchi et al.(1994) discussed the system. In Korea, there are few researches on parking place choice behavior, except for Jung(1990), Suh and Jung (1991) in which the reasons for choosing parking places including on-street

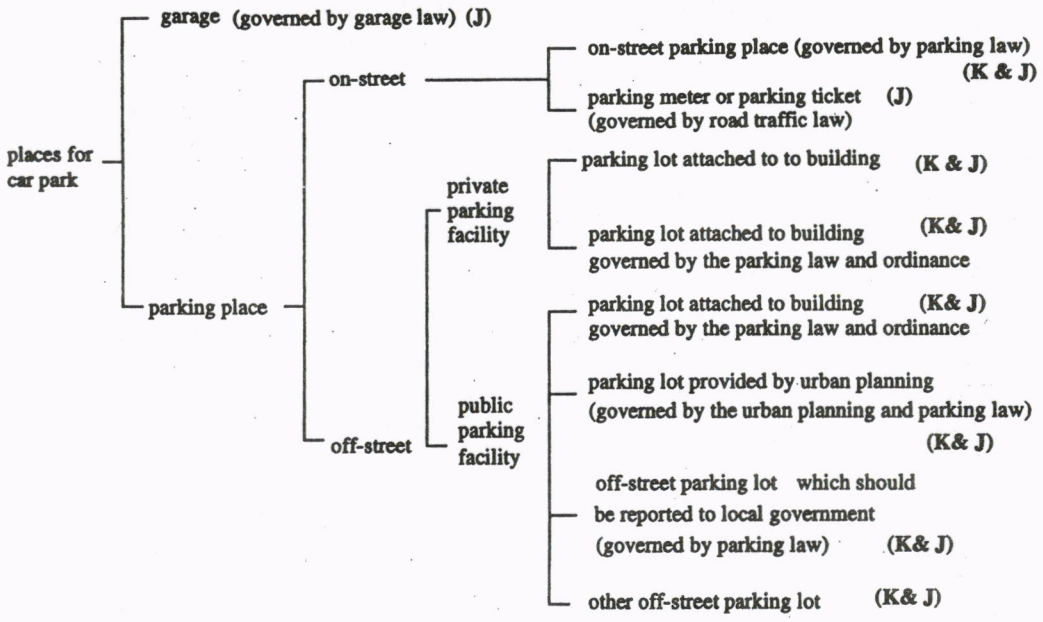

Fig. 1 Type of Parking Places in Korea and Japan

parking were investigated.

However, all these studies are restricted to a city or a region. The comparative study on parking place choice behaviors between two cities where social structure are similar were conducted in England and Germany by Axhausen and Polak (1991), which was mainly based on a stated preference survey.

2. PARKING LAW IN KOREA AND JAPAN AND PARKING CONDITION IN PUSAN

2.1 Comparison of Parking Law in Korea and Japan

The main law in parking facility construction and management in Korea and Japan is Parking Facility Law which was constituted in Japan in 1957 and in Korea in 1979. Also some of larger cities of the countries have their own parking ordinances.

Fig. 1 illustrates the type of parking lots which are classified according to the law in Korea and Japan. As sown in Fig. 1, the parking law system in the countries have many similar points, but considering the current conditions on parking facilities in Korea and those of Japan, following differences can be identified.

a) Off-street parking place which have to be reported to local government is called as " todokede parking place" in Japan. These parking places have to be satisfied the standard, and they are distinguished from other off-street parking places. In Korea, if anyone who wants to manage parking facility, he or she should report to the local

Table 1 Parking Facilities in Pusan city

on-street parking	off-street parking	parking place attached to buildings	sum
40228	31841	144702	216771
(18.5%)	(17.7%)	(66.8%)	(100%)

1994.12 (unit : parking stall)

government, but there are not distinguished clearly from other off-street parking places.

b) Parking place provided based on urban planning law is not available on the CBD in Korea.

c) Minimum standard for off-street parking attached to building is more severe in Korea, and also the usage of building is classified in detail.

d) Recently, there are very few on-street parking places in Japan, whereas most of the public parking facilities in the CBD in Korea are on-street parking places. These on-street parking places are located along most of wider streets except for arterial streets.

e) In Korea, there is no law on parking garage, and the classification of parking space and storage is not apparent. However, residential house has its own standard for parking facility.

f) There are many parking meters and parking tickets in the CBD of Japanese cities, but on-street parking is usually prohibited in the urban areas of Japan, except for places where parking meters or parking tickets have been installed.

g) In Korea parking meters and Parking tickets were introduced in the past, but these were not successful.

2.2 Parking Place Construction and Management in Pusan

(1) Parking place Supply in Pusan

The current condition of parking places in Pusan is shown in Table 1. As parking place attached to building contains garages, it is difficult to indicate the number of parking places. However, it is easy to understand that the ratio of on-street parking places is far greater than off-street parking places. This situation is quite different from that in Japan.

Among these parking facilities in Pusan, 83% out of 14,000 parking spaces are on-street parking spaces, which have been constructed by Pusan City Government and managed by the Parking Facility Management Authority. Therefore, it can be said that most of the public parking spaces managed in the CBD in Pusan are on-street parking places.

The parking fees of the on-street and off-street parking places managed by the Authority are the same, however, in order to restrain the long-term on-street parking, for parking longer than two hours 50% additional fee is collected. In Japan there does not exist such system for the parking meter and parking ticket. Currently, parking facility based on urban planning is not operated in the CBD in Pusan, but it is planed that the parking fee has a different fare structure. For example, the land use in Pusan is classified into 1st to 3rd class, and parking fee in 1st class such as the CBD is the highest and the cheapest in the

Table 2 Use of Parking Places in Pusan

	avarage parking duration	parking turnover	peak occupancy	average
on-street	97.0min	5.82	1.20	0.936
off-street	210min	2.90	1.01	0.846

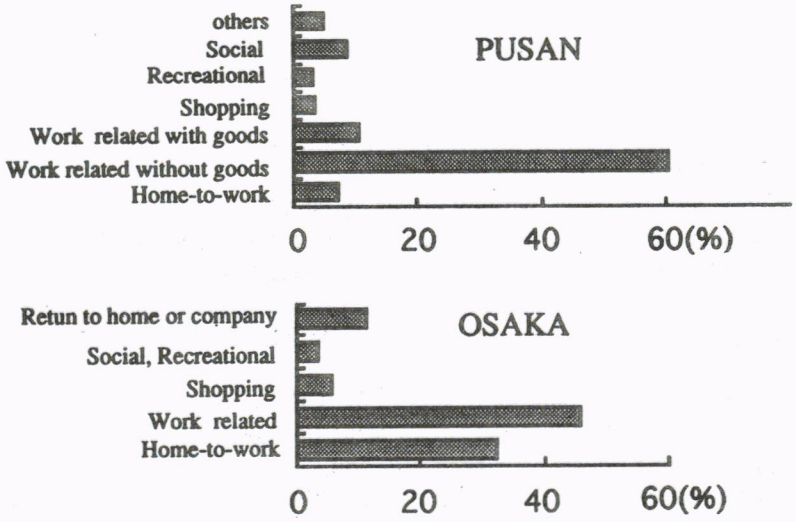

Fig. 2 Percentage of On-street Parking by Tip Purpose

3rd class located in the suburban area.

(2) Use of Parking Place

Table 2 illustrates the condition of parking place use in Pusan. According to Table 2, it can be said that parking places are utilized efficiently in Pusan, because in spite of its low turnover ratio, the average occupancy ratio is very high comparing with the ratio of the Osaka CBD (about 0.7 (average in peak hour)).

Fig. 2 illustrates the parking purpose of on-street parking in Pusan and Osaka. The data in Osaka are obtained by the road traffic census carried out in 1991, and the data in Pusan were obtained by the observation survey carried out in 1990. So, we should careful that the characteristics of the data are a little different. But it can be seen that when we compare the data in two cities, it is obvious that the percentage of home-to-work trip of on-street parking in Pusan is small, and about 60% of on-street parking is work related trip, whereas the percentage of home-to-work trip in Osaka is comparatively large.

Also, a significant difference between the on-street parking in Osaka and Pusan is that the illegal on-street parking rate in arterial streets in Pusan is lower than that of Osaka. That is because there are a lot of on-street parking places which have been constructed according to the parking demand, in addition to the frequent enforcement of illegally parked vehicles in the arterial streets. Indeed there few illegal parked vehicles in arterial

streets, but a lot of illegally parked vehicles in other streets in the Pusan CBD.

Meanwhile, the law of parking garage is not constituted in Korea yet, there are a lot of on-street parked vehicles especially in residential streets. According to the survey conducted by the author, high density on-street parking of 15 vehicles per 100m were observed along local streets in a residential area.

3. EXPERIMENT ON PARKING PLACE CHOICE BEHAVIOR

Korea and Japan have similar systems on planning and managing parking facilities as described above, however, the usage of on-street spaces are different. Considering the similarity and difference between the two metropolitan areas, experiments were carried out to clarify the characteristics on parking place choice behavior in Pusan and Osaka.

3.1 Scenario of the Experiment

Parking behavior is influenced by a level of parking facility construction, parking management system and so on. That is, main factors that influence parking place choice behavior are the parking fee, distance from a parking place to a destination, waiting time to enter a parking place, expected parking time, frequency of illegal parking enforcement.

Generally speaking, it is difficult to know characteristics of parking place choice behavior including on-street spaces, based only on investigations of actual conditions. One reason is because it is difficult to create suitable survey conditions in which factor levels are combined appropriately. Another reason is that drivers do not know the conditions of every parking place. Therefore, behavioral experiment was conducted in Pusan and Osaka, and stated preference data were obtained.

In this experiment, drivers are given all information concerning the parking places and the frequency of illegal parking enforcement. Strictly speaking, this kind of information is not currently provided to drivers, but this may change the introduction of parking guidance systems in the near future. The factors used in this experiment have been chosen based on previous research (Tsukaguchi and Jung(1989)), and factor levels reflect the present situation of the Osaka and Pusan CBD. The scenario of the experiments in Osaka and Pusan are completely the same, except for parking fee.

This experiment has been carried out to understand the kind of parking location, including on-street spaces, drivers choose under several various situations. That is, in this experiment, one of three places near the destination is chosen from an off-street parking place 1, an off-street parking place 2, and an on-street place (illegal place). The main purpose of parking is assumed to be shopping. For parking place 1, the parking fee per hour, distance to the destination, and waiting time are given as 500 yen/hr., 100 m, 5 min. respectively for the Osaka Survey. In the case of Pusan, for parking place 1, the parking fee per hour, distance to the destination, and waiting time are given as 3000 won/hr., 100 m, 5 min. respectively. For parking place 2, there are two parking fee rates, and distance to the destination and waiting time are as shown in Table 3. Parking fees are adopted based on the average fees in Pusan and Osaka CBD. Also, there are two additional factors, expected parking duration and frequency of illegal parking enforcement given at

Table 3 Conditions of Parking Places for Experiment in Pusan and Osaka.

factor	Parking place 1	Parking place 2
parking fee (Pusan)	3000 won/hr	2000 won/hr, 4000 won/hr
(Osaka)	500 yen/hr	400 yen/hr, 600 yen/hr
distance	100 m	50m, 150m
waiting time	5 min	0 min, 10 min
epected parking time	30 min, 90 min	
enforcement	1~2 times/week,	4~5 times/week

two levels. Since the on-street parking place is next to the destination, the distance from this place to the destination is given as 0 m. Though a very convenient parking place, drivers must risk paying a penalty since it is an illegal parking place.

3.2 Data Collection

Regarding the data collection, the Osaka data were obtained when drivers came to a police station for their drivers' license renewal with the assistance of the Osaka Prefectural Police. In addition, constructing companies and a think tank participated in data collection. Also, the university students participated in the experiment. This experiments were done in 1990 and 1991, and the total number of subjects are 243 business people and 179 university students.

On the other hand, the data were collected through the students in Pusan National University and their family members. This experiment was done in 1995, and total number of people who participated in the survey are 179(business people:96%, university students : 4%).

Combining the factor levels in Table 3, five variables with the 2 levels are associated, thirty two cases are prepared to the experiment. However, in order to release the load of subjects, sixteen cases shown in Table 4 have been adopted to conform with the design of experiment.

4. EXPERIMENT RESULTS

As described above, sixteen case are prepared to the experiment, but, among them there are some cases in which a better parking space is quite apparent, because persons who participated in the survey can respond easily .

Excluding these cases, ten cases are chosen for the analysis. Fig. 3 is illustrated to use for the comparison on the parking place choice behavior in the two cities. In this figure these cases are arranged from A through F. Using A, B, C, and D, we can consider the relation between parking fee and a distance to a destination, on the other hand, using E and F, the relation between a distance to a destination and waiting time can be discussed.

Table 4 Cases Adopted for Experiment

Case	Parking fee (won/h(yen/h))	Distance (m)	Waiting time (min)	Expected parking time (min)	Enforcement (times/week)
1	2000 (400)	50	0	30	1~2
2	4000 (600)	50	10	30	1~2
3	2000 (400)	50	10	30	4~5
4	4000 (600)	50	0	30	4~5
5	2000 (400)	50	10	90	1~2
6	4000 (600)	50	0	90	1~2
7	2000 (400)	50	0	90	4~5
8	4000 (600)	50	10	90	4~5
9	2000 (400)	150	10	30	1~2
10	4000 (600)	150	0	30	1~2
11	2000 (400)	150	0	30	4~5
12	4000 (600)	150	10	30	4~5
13	2000 (400)	150	0	90	1~2
14	4000 (600)	150	10	90	1~2
15	2000 (400)	150	10	90	4~5
16	4000 (600)	150	0	90	4~5

Generally, it can be seen in Fig.3 that the choice rate of on-street parking places is very low in Pusan, comparing with Osaka. But in practice there are a lot of illegally parked vehicles in Pusan CBD.

As described before, the places where many illegally parked vehicles exist are the secondary roads rather than the arterial. And a lot of on-street parking facilities are prepared, if space is available, in which parking clerk is on duty and drivers have to pay parking fee. In the places other than these parking facilities being installed, frequency of illegal parking enforcement is very high and is performed in very strict manner.

First, let us consider A. Among all the cases, case 9 is the most similar case between Pusan and Osaka. In case 9, the choice rate for parking place 1 and 2 are almost the same, which means that difference of 100m has almost some utility as the difference of 200 yen/hr. in Osaka and 1000 won/hr. in Pusan respectively, if parking places are comparatively crowded, such as waiting time of 5 to 10 minutes.

When the condition in parking place 2 is changed, and parking place 2 becomes to be a parking place which is located close to the destination, but its parking fee is expensive (case 2), the choice rates of the place in Pusan and Osaka are quite different. In Osaka, people still choose the on-street parking facility, but in Pusan, many drivers try to find out cheaper parking facility. This behavioral change seems to reflect the above mentioned difference of the parking management system in Pusan and Osaka.

In A composed of case 9 and 2, a frequency of illegal parking enforcement is 1 or 2 times per week. When the frequency of enforcement is changed to 4 or 5 times/week (in

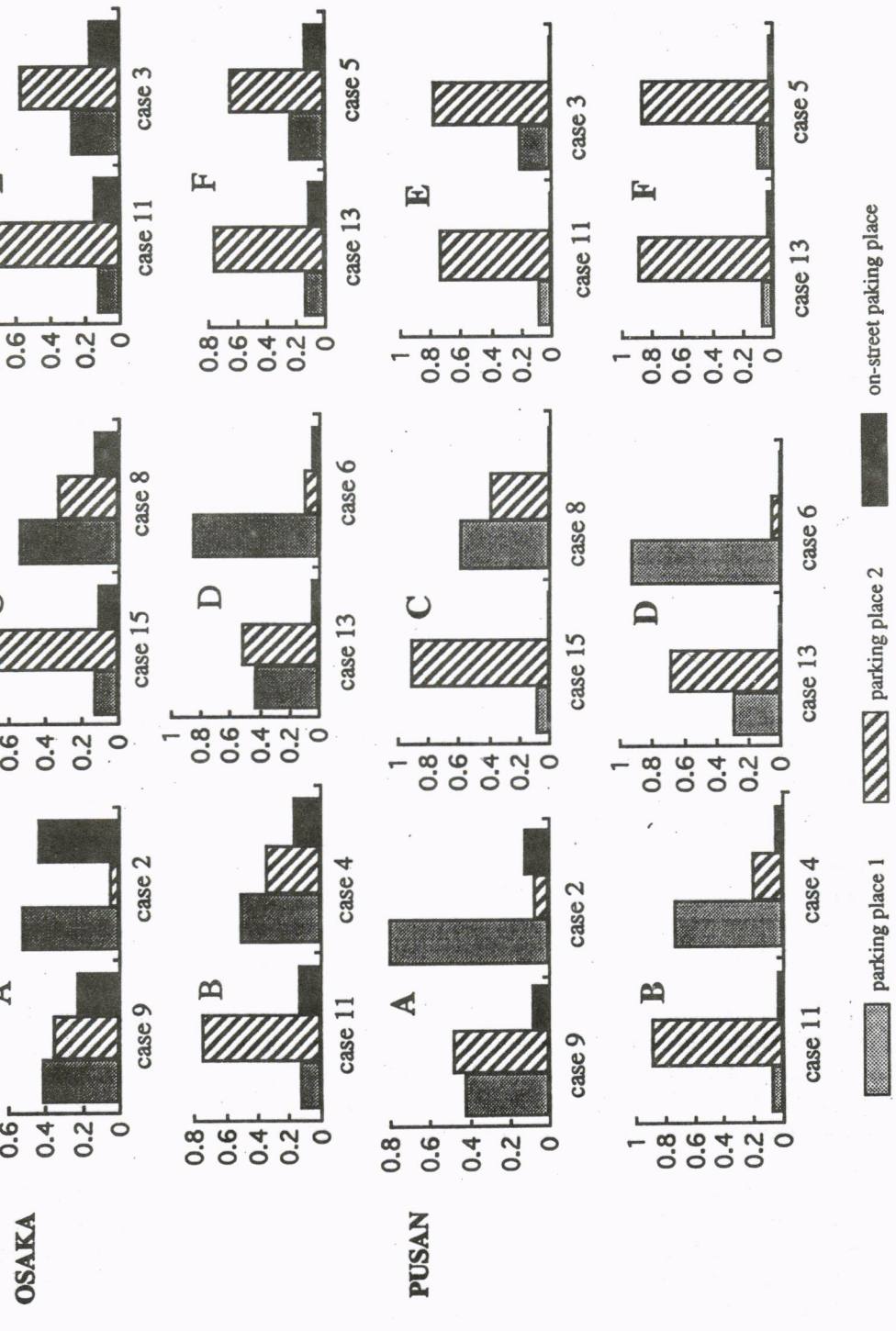

Fig.3 Comparison of Experimental Results

Table 5 Correlation Ratio

	1st axis	2nd axis
Pusan	0.5233	0.0343
Osaka	0.3696	0.2241

the cases of **B**), many drivers move to cheaper parking place in spite of increase of walking distance. Also, if we compare case 9 and case 11, it can be said that the influence of waiting time on the parking place choice behavior is significant. That is, in case 9, the usage of parking place 1 and 2 are balanced, but when the waiting time in parking place 2 decreases, the choice rate of parking place 2 increases, which is located in further distance but with cheaper fee. Expected parking time does not have a large effect on the behavior , except for the change between case 2 and case 8 in Osaka.

In **E** and **F**, when the waiting time becomes short in parking place 2, the choice rates of the place are almost the same in case 11 and 3, and case 13 and 5 in Pusan. Almost the same result was obtained in Osaka. Therefore, five minutes of waiting time may be equivalent to the distance of about 50 meter.

According to the Osaka data in this study, only illegal parking enforcement seems to be effective to reduce the number of on-street parked vehicles.

5. COMPARISON OF PARKING PLACE CHOICE BEHAVIOR BASED ON DISCRIMINANT ANALYSIS

Using the five factors including the parking fee, distance from a parking place to a destination, waiting time to enter a parking place, expected parking time, frequency of illegal parking enforcement, and the characteristics of subjects such as age, sex, and occupation, as explanatory variables, a discriminant analysis was carried out. Because these characteristics are expresses as categories, all variables in this analysis are dummy variables. The results of parameter estimates are indicated in Fig.4, also the correlation ratios of the analysis are shown in Table 5.

In this analysis, the first axis presents the factors related to the choice between off-street parking places 1 and 2, and the second axis presents the factors involving the choice made between an on-street and off-street parking space. Former factors include parking fee, walking distance to the destination and waiting time to enter the parking lot, while the latter factors include expected parking duration and frequency of parking enforcement.

In the case of Osaka, the correlation ratios are large enough to consider the characteristics of the first and second axes. But in the case of Pusan, the correlation ratio for the second axis is too small to consider the meaning of the axis. Therefore the characteristics of the parking place choice behavior can be explained based on the first axis in Pusan

When we compare the first axis of Fig.4, there are not large difference in the two metropolitan areas. The main factors related to the choice made between off-street parking places are parking fee, walking distance to the destination and waiting time to enter the

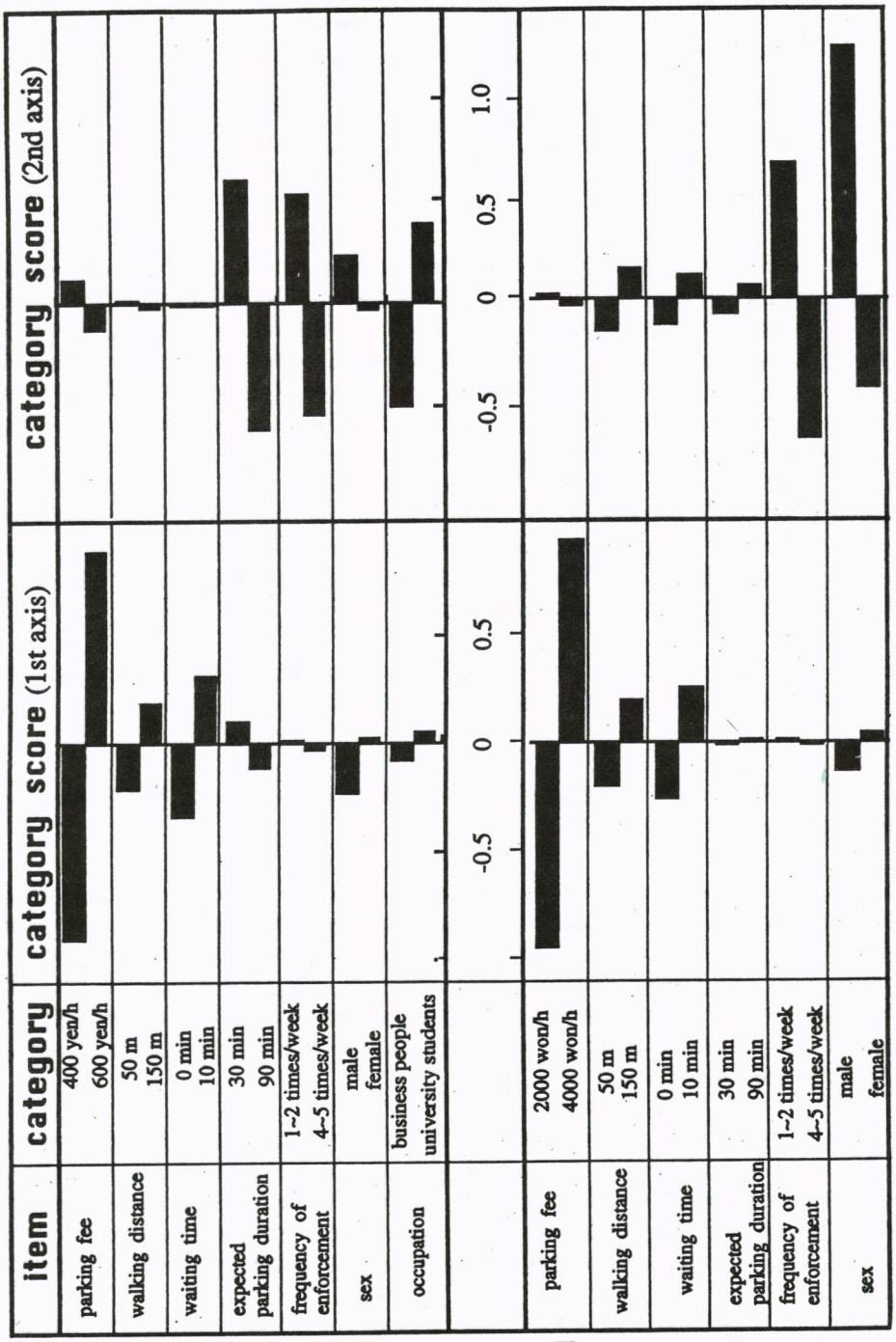

Fig. 4 Results of Discriminant Analysis

parking lot. And expected parking duration has some effects on the parking place behavior in Osaka. Also, in Osaka, the effect of the frequency of enforcement is very large.

6. GENERAL CONCLUSION

The general conclusions in this study are as follows:

(1) This study identified parking construction and management system in Korea and Japan, and then the present parking conditions in Pusan and Osaka were compared.

(2) Based on the questionnaire surveys carried out in Pusan and Osaka Metropolitan Areas, in which the experimental scenario is completely the same, the characteristics on parking place choice behavior of the two urbanized areas are investigated. The main factors related to the choice of parking facilities in Pusan and Osaka are almost the same, but in drivers' awareness on on-street parking there is a little difference between the two metropolitan areas. It must be reflection of the difference in parking management systems in the areas.

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