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NIGHT OPERATION OF GOODS VEHICLES AND ITS EFFECT ON REDUCTION OF TRAFFIC ENTERING CBD*

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This study has been developed to examine the effect of night operation of goods vehicles on the reduction of goods vehicles number entering the CBD. This study is based on an interview with the owners of stores and a field survey in some of the main commercial streets in Osaka CBD.

The analysis of this data showed that 45% of all owners accepted a suggestion for working some additional hours after the official working time for goods delivery and pick-up. A simulation model was developed to calculate the reduction rates in the number of goods vehicles by the use of such a system. Results of the model showed that an 18% total reduction of all goods vehicles entering the study area can be achieved, consequently relieving the pressure created by the number of vehicles entering the CBD.

1. INTRODUCTION

The dominant image of the urban goods vehicles movement problem in the minds of many observers is that of a string of trucks, each loaded to only a fraction of its capacity, winding their way through congested streets competing with other traffic modes for movement space or for dock spaces (1). These factores have created several problems of traffic flow and regulation and control are recognized as urgently necessary. Consequently a suggestion of the night operation of goods vehicles and the subsequent effect on the reduction of the number of goods vehicles is an important subject to study.

Some studies about reduction of traffic entering a CBD can be described as follows: In the U.S.A., the frieght from New Jersy to Long Island is transported in a combination of rail and goods vehicles. Many goods end

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the rail part of their journey in yards in New Jersy and are then trucked through New York city out to Long Island (2).
In Boston, the downtwon is a congested area, two forms of traffic restraints have been examined, increases in parking charges and area licence of travel in the downtwon (3). In the San Fransisco Bay area, implementation experience with several diffrent transportation system management measures have been examined. Neighborhood traffic restrictions, road and congestion pricing, toll increases, and parking management (4). Also some other restraints in the San Fransisco Bay area are being discussed by using bus-carpool lanes (5). In Singapore, the objective of study was to reduce traffic congestion through by 25 to 30 per cent during the morning peak in the CBD area. Six facilities of traffic restraints were studied and the effect of these policies on pedestrians examined (6). In Camden, in inner London, the balance between environmental improvements, public transport and private cars usages was studied. Each of these studies had calculated the degree of restraints on private cars required to achieve environmental and public transport objectives in relation to alternative road networks (7). In Columbus, Ohio, CBD area, the impact of routing urban small shipments through consolidated terminals of goods vehicles loads ranging from 1 to 5000 lbs was examined (8). In New York city, consolidated terminals have been studied and evaluated (9). In Osaka city, loading behaviour of goods vehicles and consolidated terminals study have been examined based on the field survey and the simulation model. Results showed that a 60% reduction rate of all goods vehicles entering the study area can be obtained (10, 11, 12). In Osaka city, the system of night operation of goods vehicles transporting frieght is not existed.
The purpose of this investigation is to study and analyze the effects of working additional hours to deliver and pick-up goods after the official working time on reduction of goods vehicles arriving in the study area in Osaka CBD.

2. DATA COLLECTION PROCEDURES

In this study, the field survey and owners interview were carried out in CBD area of Osaka city in some of the main commercial streets in Senba which is located in Higashi-Ku, this is a well known commercial area and the major activity is wholesaling as shown in Fig. 1. The data which was collected by field survey consists of: carried load, maximum load capacity utilization, type of goods vehicles, activity types, and plate number of goods vehicles.
The interview survey was carried out to ask the owners of stores about their opinions of working some additional hours after the official working time just to deliver and pick-up goods. The interview questions

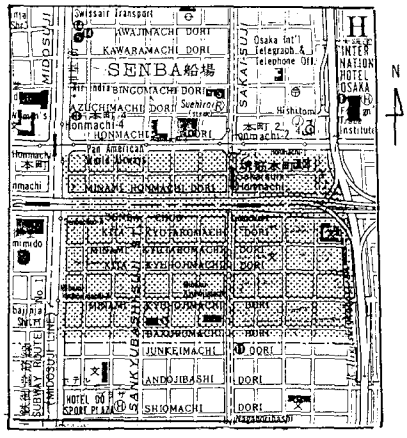
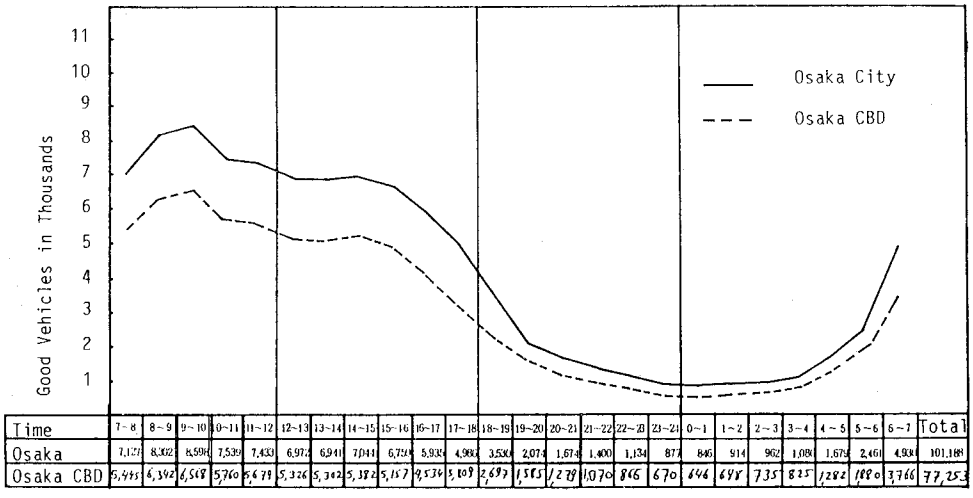


Fig. 1 Map of study area

concerned: the type of store, daily working times and off days during the week, if any problems would result in case of working some additional hours after the official working time, how many additional working hours required, also if these additional hours are needed for goods delivery or pick-up or both, and the expected percentage of loading activities which can be carried out during the additional hours compared with the daily loading activities.



Time	7~8	8~9	9~10	10~11	11~12	12~13	13~14	14~15	15~16	16~17	17~18	18~19	19~20	20~21	21~22	22~23	23~24	0~1	1~2	2~3	3~4	4~5	5~6	6~7	Total
Osaka	7,127	8,302	8,598	7,539	7,433	6,972	6,941	7,041	6,794	5,930	4,986	3,580	2,074	1,674	1,400	1,134	877	846	914	962	1,098	1,679	2,461	4,938	101,188
Osaka CBD	5,495	6,342	6,548	5,760	5,678	5,326	5,342	5,382	5,157	4,536	3,109	2,693	1,585	1,278	1,070	866	670	646	698	735	825	1,282	1,880	3,766	77,253

Fig. 2 Hourly Distribution of Good Vehicles

3. OSAKA HOURLY DISTRIBUTION OF GOODS VEHICLES

According to O-D survey in 1975, the flow of goods entering Osaka city was 6,530,000 tons/year. Fig. 2 shows that the hourly distribution of goods vehicles entering Osaka city and CBD in the day time (13,14).
This figure shows that 72% of total goods vehicles entered Osaka CBD between 7:00 to 17:00, this indicates that the night operation of goods vehicles well worth studying.

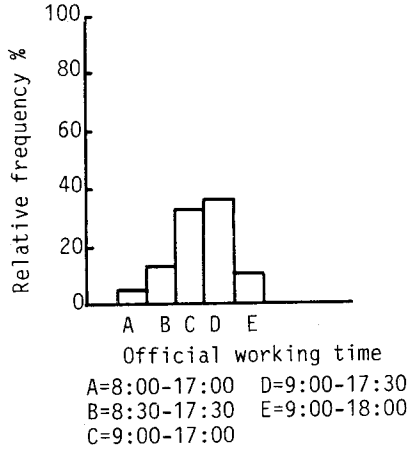


Fig. 3a Weekly working distribution

4. ANALYSIS OF COLLECTED DATA

(1) Stores type distribution

From the interview survey, it was found that 95% of all stores are wholesalestores, while 5% of these stores were wholesale and retail stores.

(2) Weekly working distribution

Fig. 3a shows the weekly working distribution for all stores in the study area based on the interview survey. In this figure, 50.8% of all stores finish their work every day at 17:30 while 11.2% of these

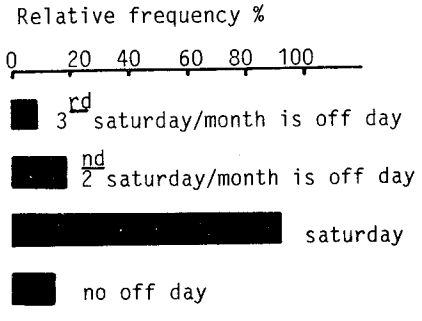


Fig. 3b Weekly off days distribution

stores finish at 18:00.

Fig. 3b shows that 91% of all stores take Sunday every week as an off day while 9% of all stores work all the week without off time. Also 17.3% of all stores take the second Saturday of every month in addition to Sunday as an off day. 6.1% of all stores take the third Saturday as an off day in addition to sunday.

(3) Distribution of night operation availability

Fig. 4 shows the distribution of night operation availability for working some additional hours after the official working time for goods delivery and pick-up. In this figure 34.4% of all owners accepted the suggestion of working some additional hours, 42.2% refused the suggestion, and 23.4% of all owners did not answer the interview questions. After excluding owners did not answer the questions, then the ratio of owners who accepted the suggestion of working some additional hours will rise to 45% while the ratio of owners who refused will be 55%. Fig. 5 shows the acceptance reasons distribution of night operation of goods delivery and pick-up. In this figure, 11% of all owners accepting the suggestion, gave the reason of saving loading space, while 59% of them gave the reason of making delivery and pick-up quicker and 30% of all accepting owners gave other reasons.

Fig. 6 shows the refusing reasons distribution, 68% of all owners who refused the suggestion said that there were no problems with the present situation, while 11% refused because of the high cost needed to implement this proposal and 2% because shortage of employees and 19% refused because all previous reasons together.

(4) Distribution of proposed additional hours of night operation

Fig. 7 shows the distribution of proposed additional hours by the owners. In this figure, 54% of all owners suggested additional working hours less than or equal to one hour, 25% of them suggested one and half hours, 12.5% of them suggested two

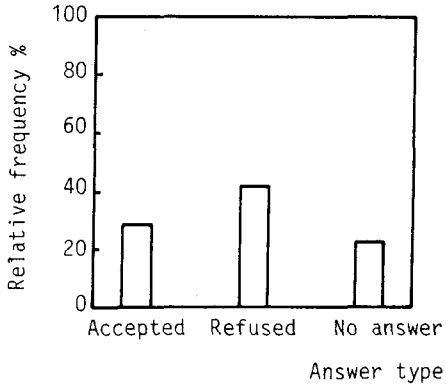
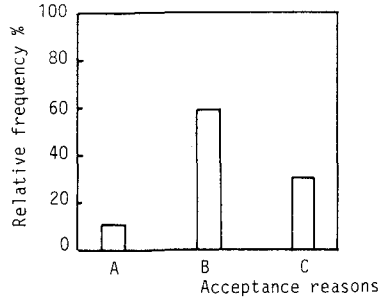
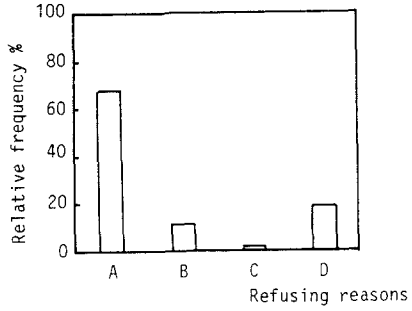


Fig. 4 Distribution of night operation availability



A = Saving spaces
B = Making delivery & pick - up quickly
C = Both and others

Fig. 5 Acceptance reasons distribution



A = No problems
B = High costs
C = Shortage of employees
D = Others

Fig. 6 Refusing reasons distribution

hours, and 8.5% of them suggested two and half hours. Also Estimated additional hours distribution are also shown, which is fitted with the probability density function of exponential distribution.

(5) Expected loading distribution during additional hours

Fig. 8 shows the expected loading distribution during the suggested additional working hours as resulted from interview survey. In this figure, 12% of owners who have the desire to conduct night operation expect to finish 10% of total daily loading during these additional hours, while 36% expect to finish 20%, 40% expect to finish 30%, and 12% of all expect to finish more than or equal to 40% of total daily loadings. Table 1 shows the expected loading distribution related to the suggested additional hours.

Table 1 Expected loading distribution related to suggested additional hours

Expected Loading % / Suggested Hours	10-20%	20-40%	40%
≤1 hour	71.5	35	50
1.5 hours	9.5	45	16.5
2 hours	9.5	15	16.5
2.5 hours	9.5	5	17
Total	100%	100%	100%

Fig. 9 shows the distribution of loading activity. In this figure, 27% of all owners will deliver goods during the suggested additinal hours, 61% will pick-up, and 12% will do both pick-up and delivery.

5. NIGHT OPERATION SIMULATION MODEL

The percentage of goods vehicles entering

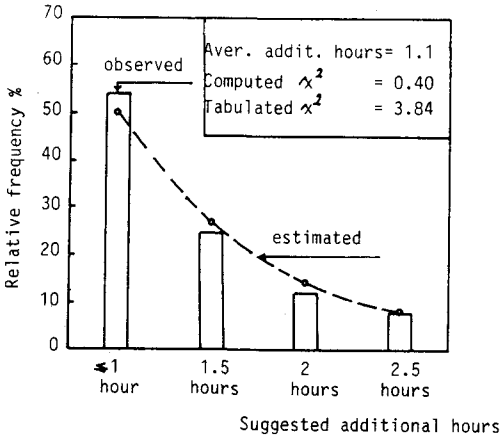


Fig. 7 Distribution of suggested additional hours

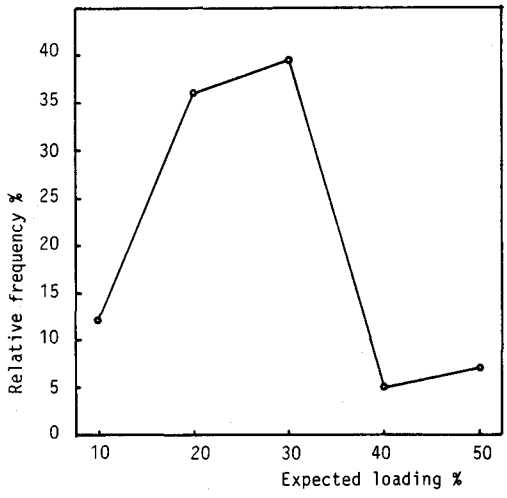


Fig. 8 Expected loading per cent distribution during suggested additional hours

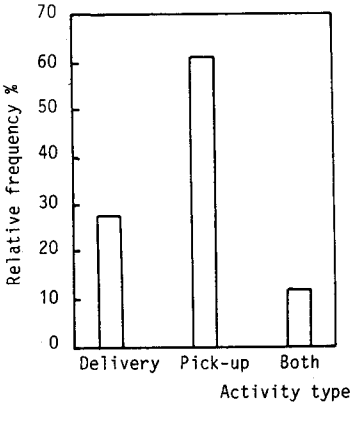


Fig. 9 Activity type distribution

Osaka CBD after 17:00 is small in comparison with total volume. To relieve the congestion of traffic during the day time, a suggestion of night operation for goods vehicles delivery and pick-up is examined here based on field and interview surveys by the use of night operation simulation model which is a mathematical abstraction of the involved factors. This model has been developed to determine the reduction in the number of goods vehicles when using a night operation system.

(1) Features and elements of the model

The most important elements, such as operating functions, input and output variables can be explained as follows:

Operating function

F(AH) = the generated probability density function of the suggested additional hours of night operation which is found to yield to the exponential distribution.

Input variables

N = Number of total goods vehicles.
I = Number of total stores.
M = Number of accepted stores.
AH = Average suggested additional hours.
AC(I)= Expected owners accepted night operation system, I = 1, 2, 3.....M
ADH(J)= Suggested additional working hours, J = 1, 2, 3, 4
ELH(K) = Percentage of loading activities which can be carried out during additional working hours compared with daily loading activities, K = 1, 2, 3

Output variables

EXP = Expected per cent of stores for every case of suggested additional hours and loading activity type.
EXV = Expected goods vehicles number for every case of suggested additional hours and loading activity type.
EXR = Expected reduction ratio for every case of additonal hours and loading activity type. Fig. 10 shows the flow diagram of night operation simulation model.

(2) Model Validation

Since the building of night operation simulation model is to reduce the number of goods vehicles entering the CBD, the model performance must be verified. This was accomplished by comparing the results generated by the simulation model with those estimated from the interview survey. To make this comparison to check the model`s validity, figure 11 shows the relative frequency distribution of the suggested additional hours obtained from the interview survey, together with the results of the simulation run of the same conditions for purposes of comparison. The results from the simulation run are in reasonable overall agreement with the interview results, Then, the model can be applied to similar studies with changing the parameters to the conditions required.

6. MODEL APPLICATION AND RESULTS

The purpose of this part of the study is to examine the effect of night operation for goods delivery and pick-up on the reduction of goods vehicles number entering the study area of Osaka CBD by using a night operation simulation model. The application results of the model indicate a substantial reduction for goods vehicles realized by implementing the suggestion of night operation. The reduction ratio in case of suggestion for working less than or equal to one hour is 12% of total goods vehicles, and the total reduction of all suggestions is 18% of total goods vehicles.

7. CONCLUSIONS

This study showed the characteristics of loading for goods vehicles in some of the

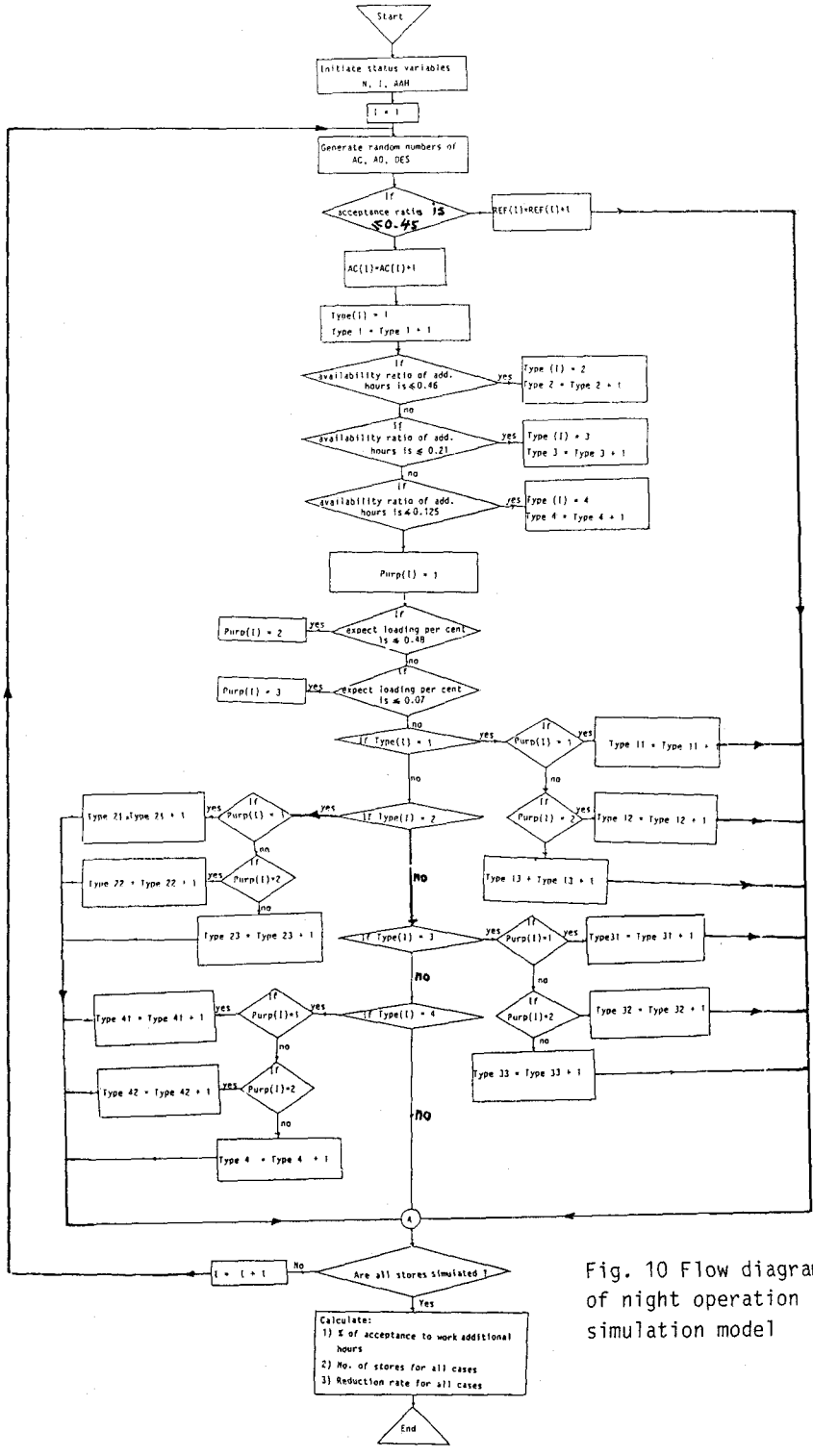


Fig. 10 Flow diagram of night operation simulation model

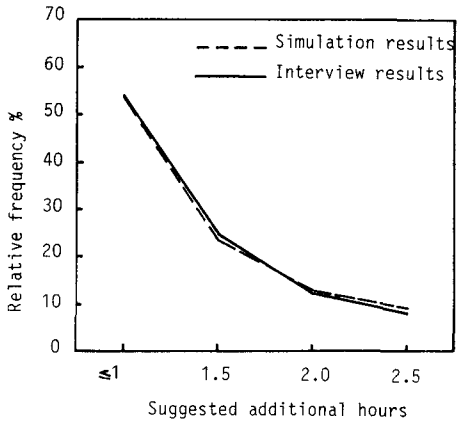


Fig. 11 Relative frequency of additional hours for simulation and interview results

main commercial streets in Osaka CBD. These characteristics are clarified based on field survey and interview with stores owners. Finally the main results are:

1) Percentage of owners who accepted the suggestion of working some additional hours after the official working time are, 54%, 25%, 12.5%, and 8.5% for less than or equal to one hour, one and half hours, two hours, and two and half hours respectively.

2) Distribution of night operation availability for goods delivery and pick-up after the official working time is 45%.

3) Average suggested additional hours of night operation is 1.1 hours after the official working time.

4) Total reduction in goods vehicles volume during the night operation system is 18% from all goods vehicles.

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