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Case Study of Bus Tourist's Sightseeing Time in a New Sightseeing Spot

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Abstract**—**As a result of traffic congestion caused by sightseeing and shuttle buses using park-and-ride parking lot near sightseeing spot, the waiting time for tourist increases. In this paper, when bus parking lot near sightseeing spot are overcrowded and full, a model for tourists getting off a bus on a congested road and transfer to the sightseeing spot by foot is proposed and verified. A model of getting off a bus on a congested road when the sightseeing parking lot is overcrowded was considered by the case analysis. As a result, effectiveness of the model of getting off a bus on a congested road could be quantitatively verified for times when parking capacity is exceeded and the bus parking lot next to the sightseeing spot is overcrowded.

Keywords**—**Transportation demand management, Park-and-ride, Traffic congestion, Tourist satisfaction.

I. Intorduction

IT takes longer for tourists to reach a tourist site when there is traffic congestion than when there is not. However, the bus departure time cannot be delayed to compensate for their late arrival. This means that traffic congestion shortens tourists' sightseeing time, and significantly decreases their satisfaction. Widening roads and increasing parking capacity at tourist sites are considered effective means of easing traffic congestion, thus improving tourist satisfaction. However, geographical limitations and economic issues may make this solution infeasible.

When traffic congestion occurs, a bus can be utilized more effectively by changing how the tourists move from the bus to the tourist site. In particular, a tourist can getting off the bus before arriving at the parking lot, and then walk to the tourist site, instead of waiting to getting off at the parking lot. When this method is realized, the tourist does not need to wait in the bus until it has parked, and can enjoy the scenery on the way to the tourist site. Furthermore, since stores along the road where the many tourists would walk would make a profit, this method could also contribute to local economical development.

As explained above, the method benefits both the tourist and the storekeepers in the area around the tourist site. In addition, it can shorten the time it takes the tourists to reach the site, and thus they will have more time to see it. However, whether the time it takes to arrive at the tourist site is decreased and by how much the sightseeing time is actually increased when the tourists getting off on a congested road instead of in a parking lot have not yet been analyzed quantitatively.

In this paper, a model that describes tourists getting off a bus on a congested road and moving to a tourist site on foot, in a scenario where the bus parking lots near the site are overcrowded, is proposed and verified. It will be referred to as the model of bus getting off on a congested road.

The road network design is raised as one of the effective methods of easing traffic congestion. Asakura [1], [2] reviewed an optimal road network design model with traffic congestion and application. However, construction of a new road network may be difficult by restrictions of investigate and environment. In that case, efficient practical use of the existing road network is called for.

Inoue [3], Matsui [4], Felix [5] and Peter [6] reviewed route guidance in the existing road network. The route guidance is a traffic control which aims at achieving an optimum distribution of traffic over alternative routes in the network by recommending the best route from a certain origin to a desired destination. However, it is studied about the case where it arrives periodically like a shuttle bus. It cannot treat about the case of a sightseeing bus which arrives at random.

There are also many examples which are carrying out park-and-ride for easing traffic congestion caused by private cars. Endo [7], Nakamura [8] and Sakamoto [9] reviewed the evaluation of a social experiment of the park-and-ride system for a central city area. Morikawa et al. [10], Yamazaki et al. [11], Watanabe et al. [12], Yuzawa et al. [13], [14] and David et al. [15] reviewed the park-and-ride system for a tourist site. However, these are also studies for shuttle buses and are not sightseeing buses.

As previous works, Sakuma et al. [16]-[18] reviewed the operation method of a sightseeing bus. However, in order to make it getting off in a parking lot, the waiting time in a bus becomes long. When the trips have set arrival times, sightseeing times are shortened and tourist satisfaction is significantly decreased.

This paper distinguishes itself from this previous study by focusing specifically on behavior of tourist instead of bus. And the model that describes tourists getting off a bus on a congested road and moving to a tourist site on foot.

II. Parking Lot for Near Sightseeing Spot

A. Outline of Sightseeing Spot Parking Lot

In many sightseeing spot parking lot, sufficient traffic and parking capacity cannot be maintained on the surrounding roads. Since traffic congestion occurs only during holidays and

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peak seasons, and are not constant, it is difficult to confirm the effects of positive investments.

In such sightseeing spot, the use of privately-owned cars in the surrounding areas is restricted. People who come by their own cars are transferred from a large-capacity remote parking lot to the bus parking lot near the sightseeing spot by shuttle bus.

In addition, shuttle buses which are used to transfer tourists from large public transportation systems such as railways, as well as sightseeing buses, enter the parking lot near the sightseeing spot.

As shown in Fig. 1, travel by these buses significantly affects the assessment of transportation and distribution. Assessment of transportation and distribution in sightseeing spot is influenced by various factors, such as time for sightseeing, transportation method, road structure, the relationship with local residents, environmental issues, etc.

Traffic congestion at times significantly decreases the satisfaction of the bus tourists and may lead to a change in itinerary.

Furthermore, exhaust gas emissions caused by idling buses are a major complaint by local residents.

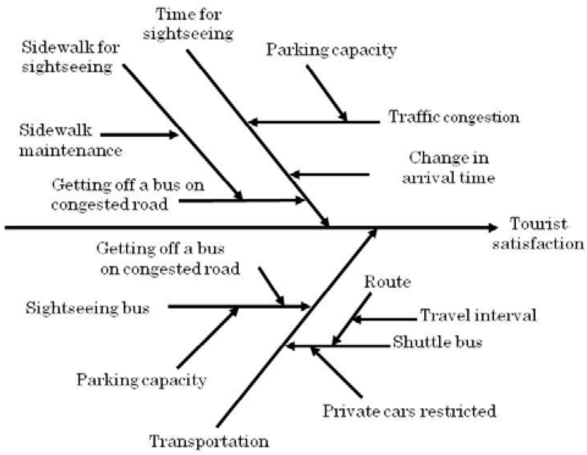

Fig. 1 Diagram of characteristics of transportation and distribution at a sightseeing spot

B. Outline of a Model of Getting off a Bus

1) A Definition and Components of a Model of Getting off a Bus

The model suggested in this paper, modeled a flow of bus and tourist from the arriving to the area to the leaving from the area.

The components of the model of getting off a bus are classified to road, parking lot, sightseeing spot, moving object. These are shown in Fig. 2. The road is classified to street, sidewalk and pedestrian crossing. The parking lot is classified to standby space of bus and bus stop. The moving object is classified to bus and tourist.

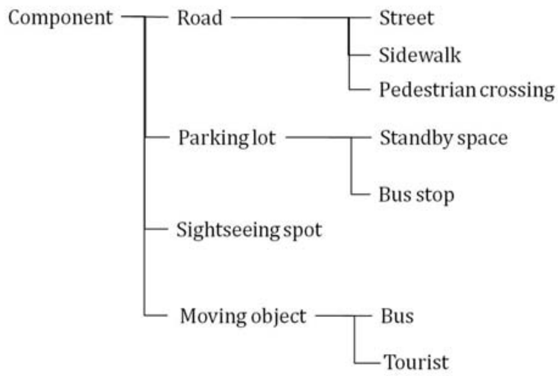

Fig. 2 Components of model of getting off a bus

2) Type of the Model of Getting off a Bus

The model of getting off a bus has two types, a model of getting off a bus in parking lot and a model of getting off a bus on congested road. The model of getting off a bus in parking lot is a model in case of a tourist getting off a bus in a parking lot. The model of getting off a bus on congested road is a model in case of a tourist getting off a bus on road at the time of traffic congestion, and the tourists goes to the sightseeing spot by walk.

Difference in tourist flow of two types of models is shown in Fig. 3. Assume that the departure time from a sightseeing spot does not change. In case of getting off a bus at a parking lot, a tourist getting off a bus at a sightseeing spot after queuing for parking. Therefore, sightseeing time depends on the parking queue length.

On the other hand, in case of getting off a bus on road, a tourist walks to a sightseeing spot without queuing for parking.

Therefore, sightseeing time does not depend on the parking queue length. From this, when a queue for parking occurs, if the distance to a sightseeing spot is short, getting off a bus on a road makes sightseeing time longer.

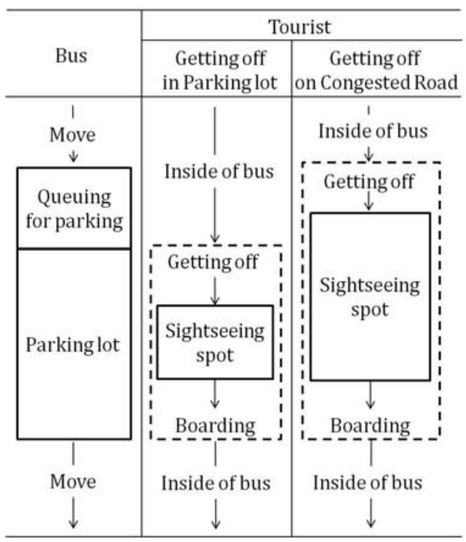

Fig. 3 Flow of bus and tourist

III. Model of Getting off on Congested Road

In this paper, focus is placed on tourist satisfaction regarding sightseeing buses, and a model where tourists getting off the bus on a congested road and head to the sightseeing spot by foot, as shown in Fig. 4, are examined. Furthermore a model where tourists continue to ride the bus during traffic congestion and getting off in the parking lot next to the sightseeing spot is called a model of getting off a bus in parking lot.

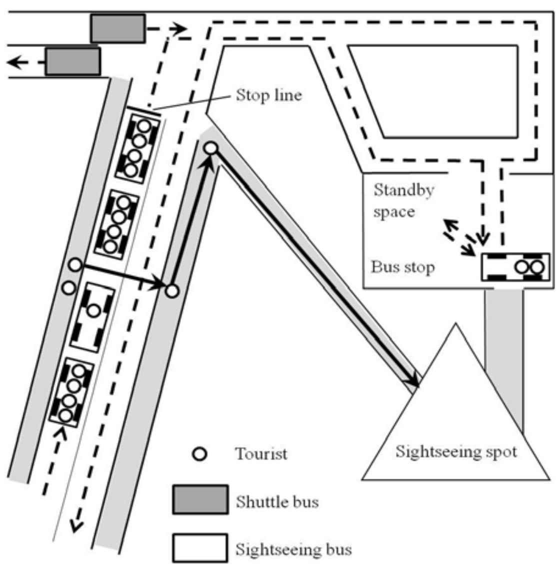

Fig. 4 Model of getting off a bus on a congested road

In the model of getting off a bus at the parking lot, time W_{qp} is from when the sightseeing bus arrives at the end of the traffic congestion line after tourists board and heads to the sightseeing spot, until it enters the parking lot next to the sightseeing spot, and reaching the sightseeing spot, and is described by the following formula.

$$W_{qp} = W_{qj} + T_{ep} + T_{es} \tag{1}$$

W_{qj} : Waiting time

T_{ep} : Traveling time

T_{es} : Walking time

W_{qj} is the waiting time for the sightseeing bus. T_{ep} is the bus traveling time for distance l_{ep} from the beginning of the waiting line until the parking lot. T_{es} is the time required to walk distance l_{es} from the parking lot to the sightseeing spot. W_{qj} is different for each sightseeing bus. This is described by the following formula, using number L_q of sightseeing buses already waiting ahead of the bus arriving at the end of the waiting line, and the average service rate (μ) of the parking lot.

$$W_{qj} = \frac{L_q}{\mu} \tag{2}$$

$$\mu = \frac{L_S}{T_p} \tag{3}$$

$$W_{qj} = \frac{L_q T_p}{L_S} \tag{4}$$

$$T_{ep} = \frac{l_{ep}}{V_{ep}} \tag{5}$$

$$T_{es} = \frac{l_{es}}{V_{wo}} \tag{6}$$

$$W_{qp} = \frac{L_q T_p}{L_S} + \frac{l_{ep}}{V_{ep}} + \frac{l_{es}}{V_{wo}} \tag{7}$$

On the other hand, in the model of getting off a bus on a congested road, W_{qo} is the time from when the sightseeing bus arrives at the end of the waiting line after tourists board and heads to the sightseeing spot, and the tourists getting off and head to the sightseeing spot by foot. This is described by the following formula, using T_{ws} and T_{wo} to represent the time required for l_{ws} and l_{wo} described in Fig. 4.

$$W_{qo} = T_{ws} + T_{wo} \tag{8}$$

$$T_{wo} = \frac{l_{wo}}{V_{wo}} \tag{9}$$

$$l_{wo} = l_{ba} \times L_q \tag{10}$$

$$T_{wo} = \frac{l_{ba} \times L_q}{V_{wo}} \tag{11}$$

$$T_{ws} = \frac{l_{ws}}{V_{wo}} \tag{12}$$

$$W_{qo} = \frac{l_{ba} \times L_q + l_{ws}}{V_{wo}} \tag{13}$$

Therefore, when W_{qp} is larger than W_{qo}, the model of getting off a bus on a congested road is considered better than the model of getting off a bus in a parking lot. Especially for tours where the visiting time, including waiting time due to the traffic congestion, is set, tourist waiting time due to traffic congestion may be reduced and visiting time increased using the model of getting off a bus on a congested road.

IV. Case Analysis

A. Purpose and Method of Case Analysis

In this paper, analyze to inspect validity of the formula for computation of the time to the sightseeing spot.

The analysis target is HanamiyamaPark in Fukushima city, fukushima, japan, and compared the actual value data with the time to the sightseeing spot. The calculation result of the formula changed the number of the queue, and substituted it for each of (7) and (13), and calculated time to the sightseeing spot. Set the range of changing the number of the queue to 0-80, because the maximum of the number of the actual queue was 80. The input value other than the number of the queue it based on observation, distance or speed, and existing documents and so on.

To obtain actual value data, we carried out a field survey in HanamiyamaPark.

B. Analysis Target

HanamiyamaPark in Fukushima city, which receives 2.3 million visitors a year and approximately 40,000 visitors a day during peak season, was targeted. HanamiyamaPark is an up and coming sightseeing spot. The park is privately-owned, surrounding roads are narrow, and parking lot expansion is difficult. Every year during cherry-blossom season, to reduce traffic congestion caused by private cars and etc., travel by private car is restricted in the vicinity. Tourists visiting by private cars are taken by shuttle bus from a large-capacity remote parking lot to a parking lot for buses next to the park. Furthermore, there are shuttle buses coming from Fukushima station and sightseeing buses from other parts of the prefecture, as well as buses form other prefectures. More than 300 sightseeing buses come each day during the peak season. As shown in Fig. 5, there are exclusive roads for sightseeing buses and shuttle buses so that the shuttle buses can smoothly run. However, in spite of a park-and-ride system for private cars, traffic congestion still occur due to the sightseeing buses. At times, tourists must wait in the bus for more than 40 minutes, resulting in unavoidable changes in itinerary and significant dissatisfaction. In addition, exhaust gas emitted by the idling bus leads to complaints from the local residents.

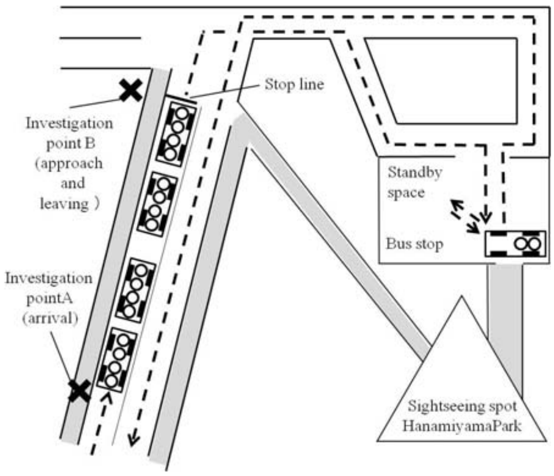

Fig. 5 Investigation points in case study

C. Outline of Field Survey

The field survey was carried out in four days of the time of cherry blossom viewing in 2009 in two roads around the HanamiyamaPark, investigation point A and B of Fig. 5, as it was shown in Table I. The investigation method was considered as the observation investigation by an investigator, and the Investigation item for bus is license plate number, arrival time at the end of bus queue, approach time to the parking lot, departure time from the parking lot.

TABLE I
OUTLINE OF FIELD SURVEY

Item	Content
Sightseeing spot	HanamiyamaPark in Fukushima city, Fukushima,Japan
Investigation point	2 points of bus queue -point A,B of Fig. 5-
Investigation date	April 11Sat., 12Sun., 18Sat., 19Sun. -2009-
Investigation time	From 8:30 to 17:00
Investigation method	Observation
Num. of investigators	4 persons aday
Investigation item for bus	Licence plate number Arrival time at the end of bus queue Approach time to the parking lot Departure time from the parking lot
Num. of investigated buses	638 buses during 4 days

There were 638 investigated during four days. The details, 83 buses of April 11, 153 buses of April 12, 181 buses of April 18 and 221 buses of April 19. A cherry tree is time in full blossom and were holidays, there was the most arrival number of 19^{th}.

D.Input Data for the Model of Getting off a Bus and Formula

1) Model of Getting off in Parking Lot

As the HanamiyamaPark was shown in Fig. 6 and Table II, the model of getting off a bus in parking lot was modeled and the input data of the formula was set up using the model.

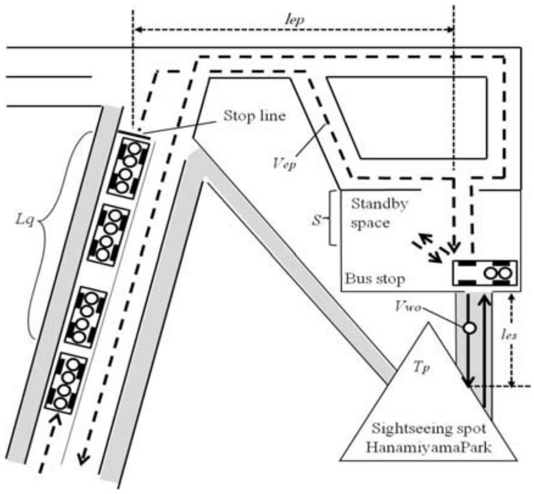

Fig. 6 Model of getting off in parking lot

The parking capacity Ls of the sightseeing spot parking lot was inputted as 50 sets.

TABLE II
INPUT DATA (IN PARKING LOT)

Item	Symbol	Value
Parking capacity	*Ls*	50(buses)
Stay time in sightseeing spot	*Tp*	90(min)
Running speed of bus	*Vep*	300(m/min)
Walking speed of tourist	*Vwo*	60(m/min)
Distance from stop line to bus stop	*lep*	600(m)
Distance from bus stop to sightseeing spot	*les*	300(m)

The time of stay in the sightseeing spot, as T_p, was set to 90 [min] in consideration of the time when the elderly people who occupy most tourists can fully travel the HanamiyamaPark round tour course.

Bus speed, as V_{ep}, was set to 300 [m/min], because of the run part is a narrow path and considered that it is a low speed from a pedestrian's safety.

A walk speed of tourist, as V_{wo}, since most tourists who visit that elderly people's walk speed is considered to be 60 [m/min] and the HanamiyamaPark were elderly people, it was referred to as 60 [m/min].

The distance from a stop line to the bus stop in a sightseeing spot parking lot l_{ep} and the distance from bus stop to a sightseeing spot l_{es} measured actual length there,and set it to 600 [m] and 300 [m] as a near value, respectively.

2) Model of Getting off on Congested Road

As the HanamiyamaPark was shown in Fig. 7 and Table III, the Model of getting off a bus on congested road was modeled, and the input data of the formula was set up using the model.

A walk speed of tourist, as V_{wo}, was set to 60 [m/min] as well as the model of getting off in parking lot.

The distance from a stop line to sightseeing spot, as l_{ws}, was measured there, and was set to 1,200 [m] as a near value. Since the large-sized bus was about 9 [m], and most arriving buses were large-sized buses, average distance between two buses and average length of bus were set to 10 [m] as a near value.

TABLE III
INPUT DATA (ON CONGESTED ROAD)

Item	Symbol	Value
Walking speed of tourist	*Vwo*	60(m/min)
Distance from getting off point to sightseeing spot	*lws*	1.2×10^3(m)
Average distance between two buses +average length of bus	*lba*	10(m)

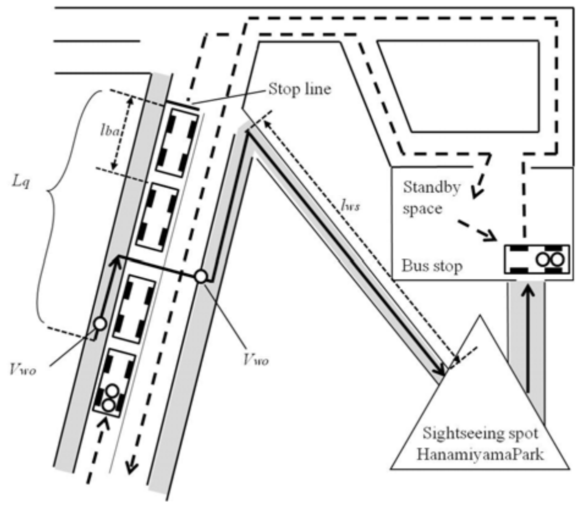

Fig. 7 Model of getting off on congested road

E. Calculation Method of the Comparative Date

1) Outline of the Comparative Data

Since it was thought that there is most number of arrivals among site survey results, and traffic congestion has occurred, the data for comparing the time to the sightseeing spot was calculated the formula using the data on April 19, Sunday.

As comparative data, calculated that the number of the queue and the time to sightseeing spot.

2) The Calculation Method of the Number of Queuing

The number of queuing, as L_q, was computed about each bus which arrived using the arrival time of a bus and the arrival time and approach time of other buses.

The arrival time of the bus i is set to t_i. Approach time is set to u_i. The total of a bus is set to N. When the bus i arrives, the variable which judges whether bus j is in queuing is set to x_{ij}. The x_{ij} fills the following formulas.

$$x_{ij} = \begin{cases} 1 : t_j < t_i < u_j \\ 0 : \text{others} \end{cases} \tag{14}$$

As shown in the following formula, the number of queuing of the arrival time of each bus was calculated in totaling x_{ij} for every bus.

$$L_q = \sum_{j=1}^{N} x_{ij} \tag{15}$$

F. Analysis Results

The actual measurement data from April 19, the day with the most tourists in 2009, was used for analysis. Fig. 8 shows the correlation between time required for the sightseeing bus at the end of the line in the traffic congestion after tourists have boarded until entering the sightseeing spot, and the number of buses already waiting in line when the bus joins the line.

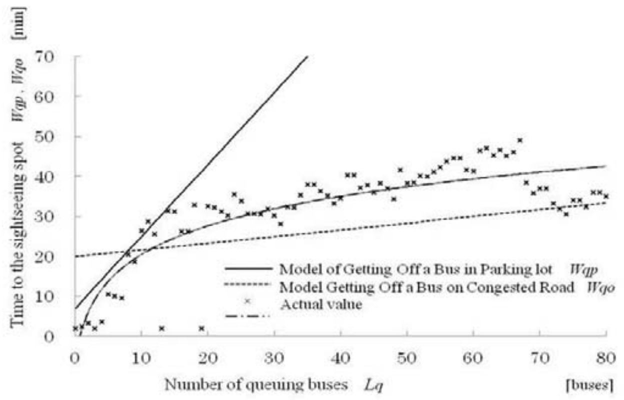

Fig. 8 Relationship between time to the sightseeing spot and number of queuing buses

As shown in theoretical value in Fig. 8, traffic congestion began at 9:20 and peaked at 11:06 when the waiting line was the longest. The average service rate μ is described by the following formula, where T_p is the field survey time and L_q is the number of sightseeing buses leaving the parking lot during that time.

In the field survey conducted by this study, L_q was 69 (buses) at T_p was 106 (minute), and μ was 0.65. In the model of getting off a bus at the parking lot, W_{qp} was calculated using (7). T_{ep} was 1 (minute) and T_{es} was 5 (minutes).

$$W_{qp} = 1.80 L_q + 7.00 \qquad (16)$$

On the other hand, in the model of getting off a bus on a congested road, W_{qo} was calculated using (13). Here, T_{wo} is calculated using l_{wo}, the distance from point of getting off shown in Fig. 7 until the entrance of the sidewalk, and V_{wo} walking speed. From the field survey, T_{ws} was calculated as 10 minutes, and V_{wo} was 60 meter per minute.

$$W_{qo} = 0.17 L_q + 20.00 \qquad (17)$$

It became Fig. 8 when it showed (16) (17) and comparative data by a diagram. In addition, the comparative data demanded approximation curve.

As showed in Fig. 8, the model of getting off a bus in parking lot is larger a slope than model of getting off a bus on congested road, and the bus number at an intersecting point is 7.98 than (13). In other words, when waiting number is less than 7, the model of bus getting off a bus in parking lot has a shorter waiting time. When be more than 8, the model of getting off a bus on congested road shortens.

In addition, the approximation curve of the actual value became the logarithmic function as showed in Fig. 8.

When waiting number is less than 7, take the value that Model of getting off a bus in parking lot and an actual value are close in.

When waiting number is more than 8, as for the actual value, it becomes a middle value of Model of bus getting off a bus in parking lot and the model of getting off a bus on congested road.

The following things can be assumed from these two things.

When be less than 7, all tourists getting off a bus in parking lot, the Model of getting off a bus in parking lot almost agreement with an actual value.

When be more than 8, it is thought that there was a value at the middle of model of getting off a bus on congested road and the Model of getting off a bus in parking lot. Because in case where getting off a bus in the parking lot is mixed with getting off a bus on congested road.

As shown in Fig. 8, the model of getting off a bus on a congested road was more effective than the model of getting off a bus at the parking lot, with a shorter comparative travel time to the sightseeing spot as number of waiting sightseeing buses increased. At the peak period, when the maximum number of waiting sightseeing occurred in field survey, the last bus was 69^{th}. Analysis value of the model of getting off a bus at the parking lot, as calculated by (7) was 112 minutes, and but the actual measured value determined by the field survey was 47 minutes. Analysis value of the model of getting off a bus on a congested road calculated by (13) was 22 minutes. It is assumed that one reason why the actual measurement value between the two models was an intermediate value is that some buses arbitrarily implemented the model of getting off a bus on a congested road. This getting off tourists indicates that a congested road can function as a parking lot, and the model can be implemented by analyzing parking capacity.

V. Conclusion

In this paper, a model of getting off a bus on a congested road when the sightseeing parking lot is overcrowded was considered.

As a result, effectiveness of the model of getting off a bus on a congested road could be quantitatively verified for times when parking capacity is exceeded and the bus parking lot next to the sightseeing spot is overcrowded. It is possible to predict the time required for tourists to arrive at the sightseeing spot, when a sightseeing bus joins the end of the waiting line. Furthermore, in cases where there is a long waiting time for sightseeing buses to enter the parking lot, sufficient time for sightseeing can be provided by implementing the model of getting off a bus on a congested road.

In the future, consideration of the timing for application of the model of getting off a bus on a congested road during traffic congestion is planned.

Acknowledgment

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