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A Study on The Basic Error of The Representative Travel Time By Section Environment And Traffic Characteristics of National Highway

*Hyun Suk Park
Korea Institute Of Civil Engineering And Building, 283 Goyangdae-Ro Goyang-Si, Korea.
*Corresponding Author: *Hyun Suk Park*

ABSTRACT:- There is a basic error that the traffic information provided by the road driver cannot be reduced even if the traffic information provider reduces the travel time estimation and the prediction error. Since individual vehicles in the same information providing period receive a single travel time, there is an error between the travel time and the representative travel time value experienced by each individual vehicle unless all the vehicles travel at the same travel time.

In this study, we measured the basic error rate of congestion and non - congestion in 12 types of national highway in order to check how the basic error varies according to the traffic conditions and the road environment. In case of non - congestion in the intermittent flow section, the average error rate decreased about 8% on average as the section length increased by about 1 km. It is analyzed that the error rate change is insignificant at the time of congestion. The variation of the basic error rate was small in the continuous flow section irrespective of the section length condition and congestion. It is necessary to provide the basic error rate together with the average travel time when providing traffic information, or to reduce the error rate by providing the merging of the average travel time information of the consecutive adjacent sections in the case of the short intermittent flow section non - congestion having a high basic error rate.

Keywords:- ITS, Travel time estimation, Travel time error, traffic information, National Highway ITS

I. INTRODUCTION

Drivers often experience that the travel time information provided by private or public services is different from the actual travel time required when traveling. The main reason may be an error which occurs during the estimation and prediction of the provided travel time information. However, there is a basic error that a traffic information provider cannot reduce even if it reduces the travel time estimation and prediction error as much as possible. Individual vehicles may travel in a cluster, but not all vehicles in a traffic information collection period travel with the same travel time, resulting in a deviation from the provided single representative travel time. The extent of deviation will vary depending on the section environment and traffic conditions when the driver is driving.

In this study, we define the inherent error which individual vehicles cannot help experiencing depending on the section environment and traffic conditions of national highway as a basic error, and identify how the inherent basic error varies in accordance with the change of the section environment and traffic conditions. There is a need to quantify the basic error according to the section environment and traffic conditions and provide a representative travel time value each vehicle is being provided together with a possible error range.

II. REVIEW OF PREVIOUS STUDIES

A. Study on the Error of Representative Travel Time Value

Iida (2008) found that, as shown in Fig. 1, the travel times of individual vehicles do not greatly deviate from the mean or the mode in the case of the route A which has a small variance of the section travel time distribution, but that in the case of the route B which has a large variance of the travel time distribution, there may be a large difference from the mean or the mode of travel time because the travel times of individual vehicles fluctuate [5].

This suggests that the mean or mode of travel time may differ from the travel times of individual vehicles depending on the route section, and that the reliability of travel time information may vary depending on it.

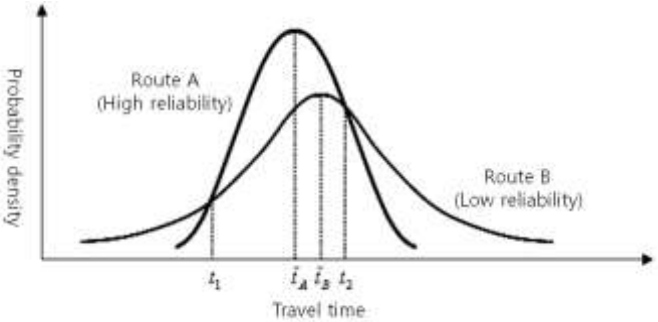


Fig. 1: Travel time distribution of routes A and B

ITS America's Advanced Traveler Information System (ATIS) Committee (2000) defined the important items for ensuring the information quality of the ATIS as the accuracy, reliability and real-time of information, and presented the ATIS data quality guidelines for traffic data. We classified real-time traffic data into four types of data: traffic detector data, accident/event records, images, and road and environment sensor data. The data quality standards for seven attributes of each data are presented in Table 1 [4].

Table 1: Attribution and quality level of traffic detector data

Attribution	Quality level
Object	Highway - Aggregation point data Main arterial road - aggregated section data
Accuracy	Error rate less than 15%
Confidence	Quality measurement of error-prone data included in the data
Delay	Less than 5minutes
Availability	Over 95% available
Breadth of Coverage	Highway – Main arterial road Main arterial road - main arterial axis
Depth of Coverage	Highway – between major ICs Main arterial road - main arterial road, highway

The FHWA (2004) published a white paper on traffic data quality evaluation and developed a data quality evaluation for different applications through case studies on quality evaluation items such as accuracy and completeness, and presented the evaluation standards as shown in Table 2 [1]. Later, as the reliability of data quality has become more important due to the increase of traffic data and the emergence of private real-time services, the FHWA (2008) has presented the data quality standards including travel time, speed and weather information, covering both public and private sectors, as shown in Table 3 [6].

Table 2: Quality evaluation result of traffic data (Austin case study)

Quality evaluation item	Law data	Data base	Traveler Information
Accuracy	1 minute speed: · MAPE 12.0% · RMSE 11mph	Traffic volume per hour: · MAPE 4.4% · RMSE 131 vehicles	Travel time: · MAPE 8.6% · RMSE 1.56 min
Completeness	· Traffic volume 99% · Occupancy rate 99% · Speed 98%	· Traffic volume 99% · Occupancy rate 99% · Speed 99%	· Website 100% · ARS 96%
Effectiveness	· Traffic volume 99.9% · Occupancy rate 99.9% · Speed 99%	· Traffic volume 97% · Occupancy rate 98% · Speed 99%	·Route travel time 97%

Table 3: Data quality evaluation criteria for real-time traffic information (Recommend)

Quality evaluation item	Travel time	Speed	Weather information
Accuracy	Error range 10-17%	Error range 5-20%	Recommended to include information that matches the actual situation
Completeness	95%~100%	95%~100%	100%(24hours/7days)
Effectiveness	90%~100%	90%~100%	90%~100%

Although the ATIS Committee and the FHWA presented the error range of the accuracy of traffic information and made management guidelines therefor, they are based only on the errors occurring during the generation of traffic data and do not reflect the basic error resulting from the deviation between the provided representative value and each individual vehicle’s value. If the basic error is reflected, the range of error will change according to the road section and traffic characteristics.

B. Concept of Basic Error of Representative Travel Time Value

Researches on the reliability of the travel time provided by a traffic control center have been mainly focused on the errors that occur in the process of estimation and prediction of travel time information, and the management thereof. However, there is a basic error that a traffic information provider cannot reduce even if it reduces the error of traffic time estimation and prediction as much as possible. Individual vehicles within the same information providing period receive a single representative travel time value, which causes a slight inevitable deviation from the actual travel time experienced by the individual vehicles within the period. Individual vehicles may travel in a cluster, but not all vehicles within the corresponding traffic information collection period travel with the same travel time, resulting in an error compared to the provided single representative travel time value. In this chapter, we will review in detail the errors that may occur in the process of generating traffic information and the conceptual difference between the errors and the basic errors that occur according to the traffic conditions and the section environment.

As shown in Table 4, the errors that may occur in the process of generating traffic information include: an error occurring in the process of estimation of travel time, such as traffic information collection, outlier removal, correction of missing data, section travel time calculation and representative value calculation, and an error occurring in the process of predicting travel time by correcting time sag. The errors result from the sample collection of traffic data, error in the collection and processing equipment, limitation of traffic algorithm, and lack of parameter optimization, etc. These errors can be reduced by efforts to improve the collection and processing system and traffic algorithms, etc.

Table 4: Errors that may occur when generating travel time information

<table>
<tr><th colspan="2" rowspan="2">Division</th><th colspan="5">Travel time estimation</th><th rowspan="2">Travel time predict ion</th></tr>
<tr><th>Traffic information collection</th><th>Outlier removal</th><th>Correction of missing data</th><th>Section information calculation</th><th>Calculate the representative value</th></tr>
<tr><td rowspan="2">Sectio n detect or</td><td>Sample collection</td><td>Sampling error due to insufficient sample size, Error due to equipment failure</td><td rowspan="3">Outlier value removal and normal value removal error</td><td rowspan="3">Error in correction due to historical data and adjacent equipment data</td><td rowspan="2">-</td><td rowspan="3">Error setting travel time aggregate ion interval etc.</td><td rowspan="3">Error due to time delay reflection error etc.</td></tr>
<tr><td>Parameter collection</td><td rowspan="2">Error due to equipment failure</td></tr>
<tr><td colspan="2">Point detector</td><td>Errors due to errors in calculating delay values at intersections</td></tr>
</table>

The error that occurs when individual vehicles are provided with a single representative travel time value varies depending on the unique driving characteristics of individual vehicles exhibited under a specific section environment and traffic conditions, independently of the error generated in the process of traffic information generation. As shown in Fig. 1, the errors of the travel times experienced by individual vehicles become smaller as the travel time values of the individual vehicles collected in the relevant period converge toward the representative travel time value, and the errors become larger in the opposite case.

This study focuses on the fact that there is an inherent basic error that occurs according to the section environment and traffic conditions, even if there is no error generated in the process of traffic information generation. Below I identify how the error varies and propose a differentiated traffic information providing strategy according to the section environment and traffic characteristics.

III. VARIATION OF TRAVEL TIME DISTRIBUTION ACCORDING TO SECTION AND TRAFFIC CHARACTERISTICS OF NATIONAL HIGHWAY

In this section, we identify the changes in the distribution of travel time according to the section and traffic conditions that may occur in national highway in order to identify the factors that change the reliability of traffic information according to the section and traffic characteristics of national highway, and analyze how the varying travel time distribution characteristics affect the reliability of travel time.

In order to take into consideration the various sections and traffic characteristics existing on national highway, we selected 12 types of road sections as shown in Table 5 from the section from which the ITS center of the Seoul Regional Construction and Management Administration collects traffic information with DSRC. They include section types of all possible combinations of the number of signal intersections and the section length in the national highway of the metropolitan area. Table 6 shows the detailed section status. We analyze the distribution characteristics of 24 travel time data obtained by adding the condition of the presence or absence of traffic congestion to the 12 types of sections.

Table 5: Section by road type

Number of signal intersections / Section length(km)	Continuous flow section	Intermittent flow section		
	0	1	2	3 or more
1 or less	-	CASE1-1	CASE1-2	CASE1-3
Greater than 1～2 or less	CASE2-0	CASE2-1	CASE2-2	CASE2-3
Greater than 2～3 or less	CASE3-0	-	CASE3-2	CASE3-3
Greater than 3	CASE4-0	-	-	CASE4-3

※ Traffic flow type (CASE) ID generation rule: CASE (section length) - (number of signal intersections)

※ It is divided into intermittent flow section and continuous flow section according to presence or absence of signal intersection.

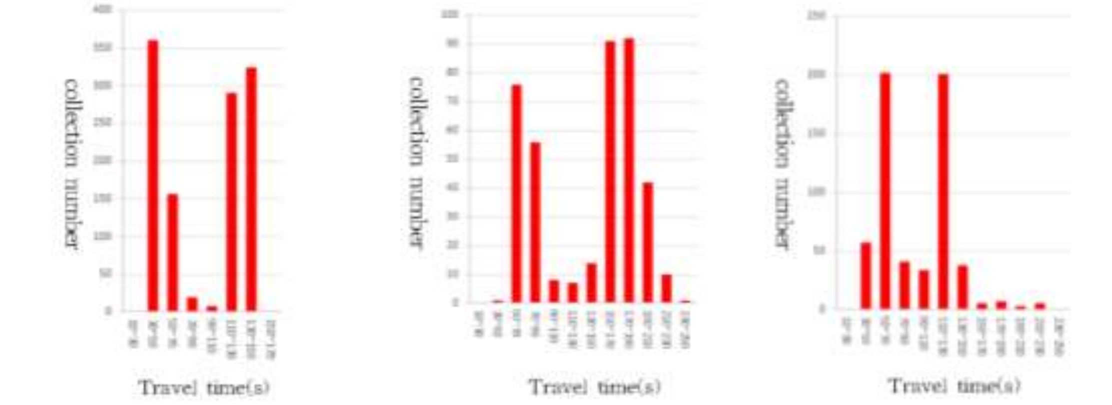
Table 6: Verification section status

ID	Line NO.	Start point name (Equipment ID)	End point name (Equipment ID)	Length (m)	Intersectio ns(n)
CASE 1-1	1	342 Yoochon-dong, Pyeongtaek	340 Yoochon-dong, Pyeongtaek	872	1
CASE 1-2	1	Osan-dong Osan-City	Won-dong Osan-City	754	2
CASE 1-3	3	Sadongri, Icheon City	Amiri, Icheon City	910	4
CASE 2-0	39	Yangnori Hwaseong City	Gupori Hwaseong City	1,944	0
CASE 2-1	3	Shinhari, Icheon City	Jinri-dong, Icheon City	1,085	1
CASE 2-2	1	284 Byeongjeong Pyeongtaek City	337 Byeongjeong Pyeongtaek City	1,248	2
CASE 2-3	3	544 Shinhari, Icheon City	631 Shinhari, Icheon City	1,436	8
CASE 3-0	39	Gujangri Hwaseong City	Changgokri Hwaseong City	2,879	0
CASE 3-1	43	Neungwonri, Yongin City	Donglimri, Yongin City	2,121	1
CASE 3-2	39	Yodangri Hwaseong City	Hyeongokri Pyeongtaek City	2,450	2
CASE 3-3	3	Saniri, Gwangju City	Ssangdongri, Gwangju City	2,232	3
CASE 4-0	39	Changgokri Hwaseong City	Yangnori Hwaseong City	3,280	0
CASE 4-3	1	Jinandong Hwaseong City	Gwongseondong Suwon City	3,696	3

A. Variation of Travel Time Distribution of Intermittent Flow Section

The intermittent flow section having a signal intersection within the section and the section length of less than 1 km exhibits an extremely bimodal asymmetric travel time arrival distribution, as shown in Fig. 2. The green signal at the upstream intersection turns on, the vehicles waiting at the upstream intersection stop line and the vehicles not waiting at the stop line arrive in turn, and when the red signal at the upstream intersection is turned on, the vehicle will not arrive for the certain period time. The bimodal asymmetric travel time arrival distribution is formed due to the repetitive arrival patterns of these vehicle groups, as shown in (a) of Fig. 3. As the section length increases, the bimodal shape changes and when the length exceeds 2 km, it changes to a unimodal shape. This is because the effect of the traffic flow interruption by a stop signal is offset, so that the certain repeated time interval between arrival and missing data found in the section of less than 1 km, as shown in (b) of Fig. 3, disappears.

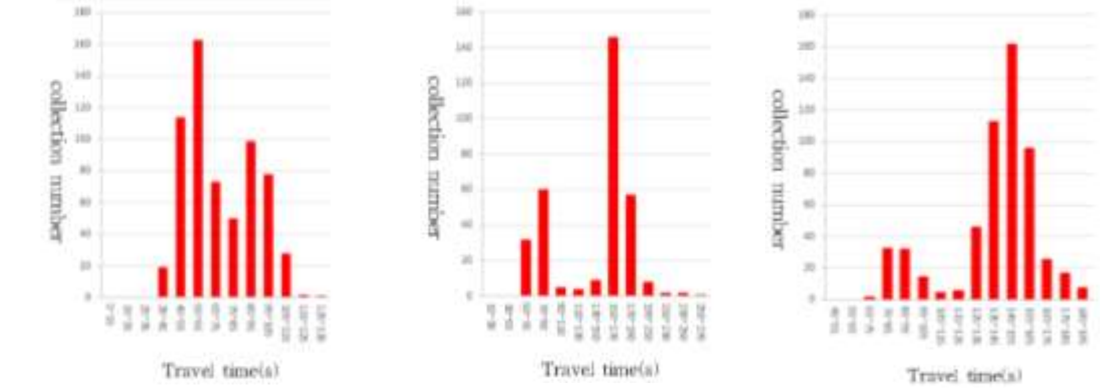
In the case of congestion of the intermittent flow section, the travel time arrival distribution approaches the unimodal shape irrespective of the change of road conditions, as shown in Fig. 4. It is analyzed that this is because the length of the total traffic time increases sharply due to the traffic congestion caused by an increase of the incoming traffic volume, which made the influence of the section length and signal intersection relatively insignificant [3].



(a) CASE 1-1 Non-congestion (February 17, 2015, 15 17:30-19:30)

(b) CASE 1-2 non-congestion (June 15, 2015, 15: 09: 00-11: 00)

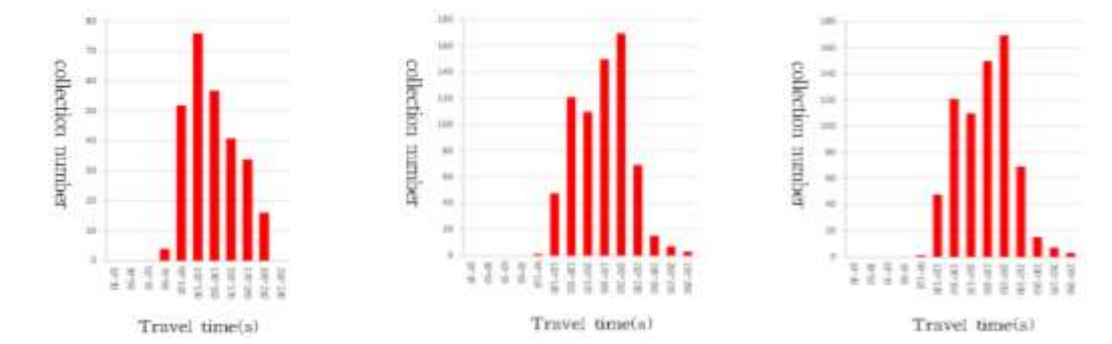
(c) Case 1-3 Non-congestion (June 15, 2015, 14: 30-16: 30)



(d) CASE 2-1 non-congestion (June 15, 2015, 19: 00-21: 00)

(e) Case 2-2 Non-congestion (December 12, 2014, 14:00 - 16:00)

(f) CASE 2-3 non-congestion (June 15, 2015, 09:00 to 11:00)

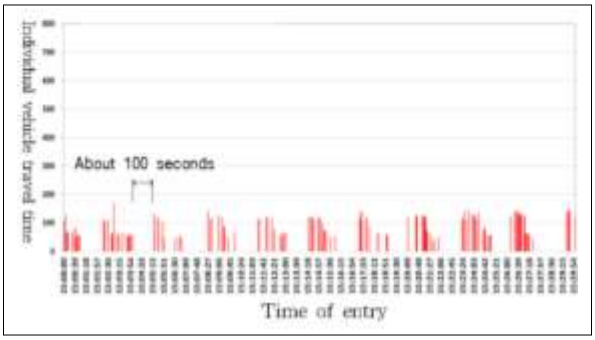


(g) CASE 3-2 Non-Congestion (June 15, 2015, 19: 00-21: 00)

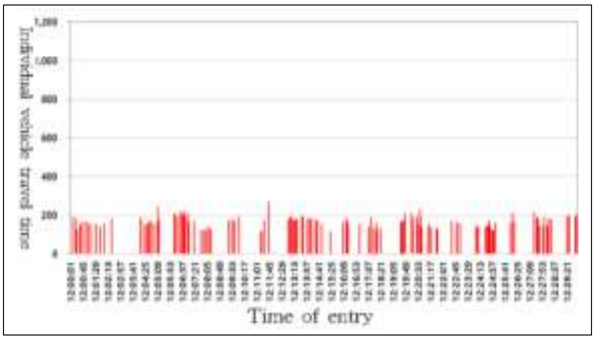
(h) CASE 3-3 Non-congestion (June 15, 2015, 12: 00-14: 00)

(i) CASE 4-3 Non-congestion (June 15, 2015, 12: 00-14: 00)

Fig. 2: Change of travel time distribution by section length (intermittent flow, non-congestion)

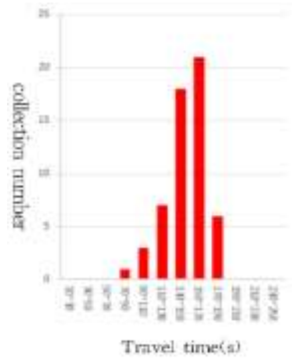


(a) CASE 1-3 Non-congestion (July 24, 2015, 15:00～15:30)

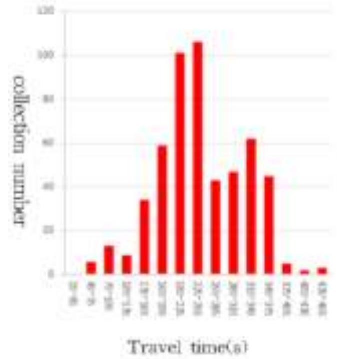


(b) CASE 3-3 Non-congestion (June 12, 2015, 12: 00-12: 30)

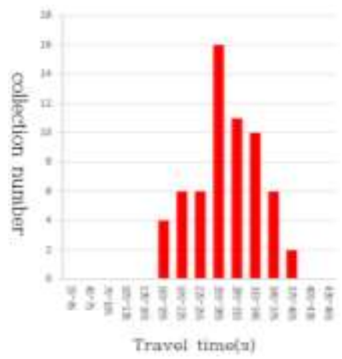
Fig. 3: Changes in the distribution of individual vehicle arrival times by section length (intermittent flow, non-congestion)



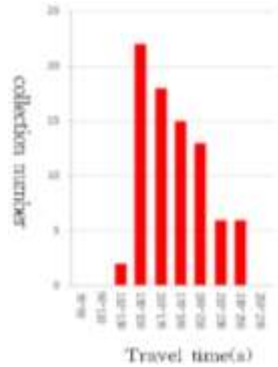
(a) CASE 1-1 Congestion
(February 17, 2015, 16:10～16:15 on)



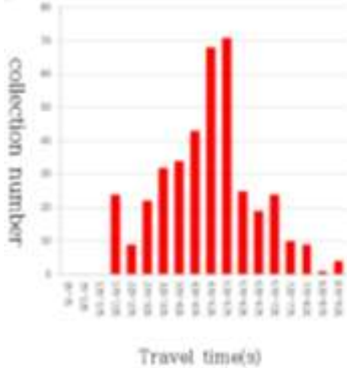
(b) CASE 1-2 Congestion
(June 15, 2015, 06:55～08:45)



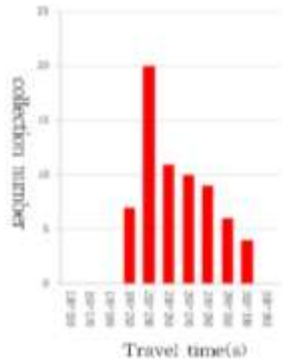
(c) CASE 1-3 Congestion
(June 15, 2015, 18:40～18:50)



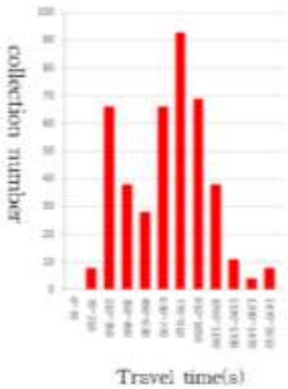
(d) CASE 2-1 Congestion
(June 15, 2015, 18:20～18:30)



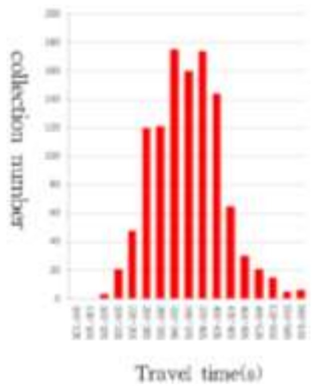
(e) CASE 2-2 Congestion
(December 12, 2014, 17:00～19:00)



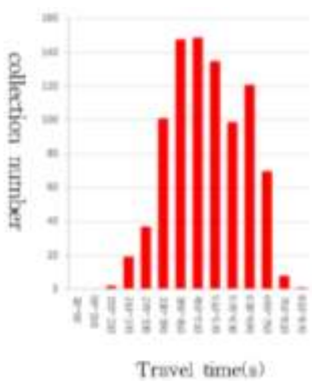
(f) CASE 2-3 Congestion
(June 15, 2015, 08:00～09:00)



(g) CASE 3-2 Congestion
(June 15, 2015, 09:35～12:35)



(h) CASE 3-3 Congestion
(June 15, 2015, 17:30～19:30)

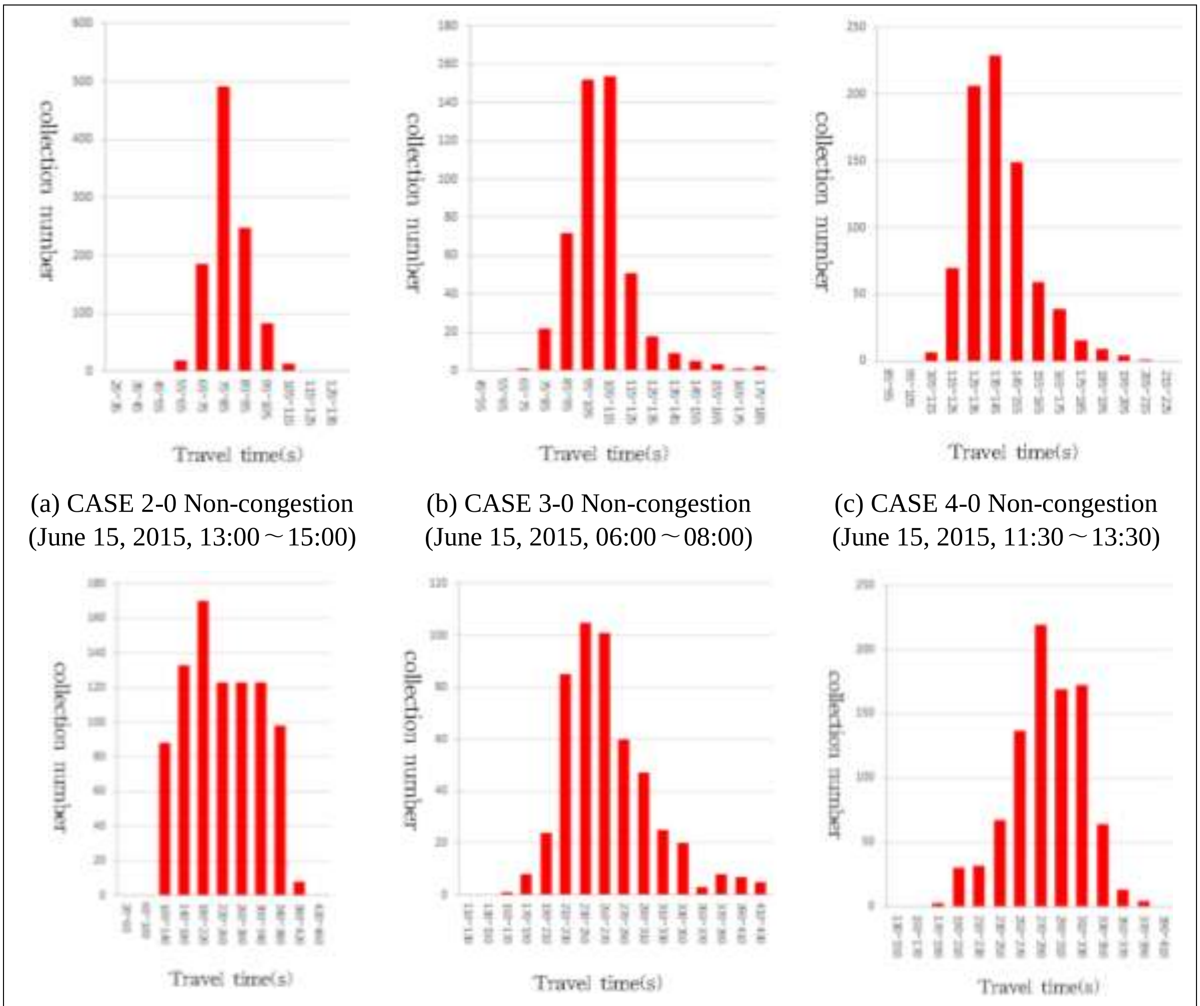


(i) CASE 4-3 Congestion
(June 15, 2015, 17:35～19:35)

Fig. 4: Change of travel time distribution by section length (intermittent flow, congestion)

B. Variation of Travel Time Distribution of Continuous Flow Section

As shown in Fig. 5, the continuous flow section exhibits a unimodal travel time arrival distribution regardless of the variation of the section and traffic conditions. This is because the traffic flow is not interrupted since there is no signal intersection within the section.



(a) CASE 2-0 Non-congestion (June 15, 2015, 13:00～15:00)
(b) CASE 3-0 Non-congestion (June 15, 2015, 06:00～08:00)
(c) CASE 4-0 Non-congestion (June 15, 2015, 11:30～13:30)
(d) CASE 2-0 Congestion (June 15, 2015, 16:20～17:20)
(e) CASE 3-0 Congestion (June 15, 2015, 17:20～18:00)
(f) CASE 4-0 Congestion (June 15, 2015, 16:40～18:40)

Fig. 5: Variation of travel time distribution by section length (continuous flow, congestion and non-congestion)

IV. BASIC ERROR OF REPRESENTATIVE TRAVEL TIME VALUE

A. Criteria for Basic Error Measurement

If the parameter is defined as θ and the estimate of θ is defined as $\hat{\theta}$, when the expectation of the estimate is taken, an estimate identical to the parameter is referred to as an unbiased estimator or an unbiased estimate, which satisfies the relation of Equation (1):

$$E(\hat{\theta}) = \theta \qquad (1)$$

In general, the estimate ($\hat{\theta}$) of field data may be similar to the population mean (θ). However, generally, it is a biased estimator because it does not satisfy Equation (1) due to sampling and non-sampling errors. In this case, the effectiveness is evaluated by using the mean square error (MSE), which is the sum of the variance and the bias2, as in Equation (2) [2]. If sampling and non-sampling errors were not generated when estimating the travel time of the collected data, the bias becomes'0' and only the variance is left, which constitutes a basic error that inevitably occurs under the traffic conditions of the corresponding section.

$$MSE[\hat{\theta}] = E[\hat{\theta} - \theta]^2 = E[\{\hat{\theta} - E(\hat{\theta})\}^2] + \{E(\hat{\theta}) - \theta\}^2 = V[\hat{\theta}] + [B(\hat{\theta})]^2 \qquad (2)$$

However, since the relative basic errors of the data collected from different section environments and traffic characteristics need to be compared, the coefficient of variation (CV), which is generally used to compare the relative dispersion of the data with different measurement units, is more appropriate than the variance. As shown in Equation (3), the coefficient of variation is calculated by resizing the value unit by using the standard deviation, which is the square root of the variance, which is the square of the basic error, and dividing it by the mean travel time to convert the data into a percentage error of the mean travel time.

$$\text{CV(Coefficient of variation)} = \frac{\sigma[\bar{\theta}]}{E[\bar{\theta}]} \quad (3)$$

B. Basic Error according to Section and Traffic Characteristics

In order to calculate the basic error according to section and traffic characteristics, the basic error according to the presence or absence of traffic congestion for the 12 national highway sections in Table 6 is calculated using the coefficient of variation (CV). Table 7 summarizes the data collection date, and the data collection times at non-congestion and congestion, of the 12 sections. To calculate the basic error, the collected data was subjected to preprocessing to remove abnormal data.

Table 7: Travel time data collection time according to road type and traffic condition

Division	Section ID	Evaluation date	Evaluation time	
			Non-congestion	Congestion
Intermittent flow section	CASE 1-1	‘15.2.17	17:30～19:30	16:10～17:15
	CASE 1-2	‘15.6.15	09:00～11:00	06:55～08:45
	CASE 1-3	‘15.6.15	14:30～16:30	18:10～19:10
	CASE 2-1	‘15.6.15	19:30～21:30	18:10～19:05
	CASE 2-2	‘14.12.12	14:00～16:00	17:00～19:00
	CASE 2-3	‘15.6.15	09:00～11:00	08:00～09:00
	CASE 3-2	‘15.6.15	19:00～21:00	09:35～12:35
	CASE 3-3	‘15.6.15	12:00～14:00	17:30～19:30
	CASE 4-3	‘15.6.15	15:00～17:00	17:35～19:35
Continuous flow section	CASE 2-0	‘15.6.15	13:00～15:00	16:20～17:20
	CASE 3-0	‘15.6.15	06:00～08:00	17:20～18:00
	CASE 4-0	‘15.6.15	11:30～13:30	16:40～18:40

※ Traffic flow type (CASE) ID generation rule: CASE (section length) - (number of signal intersections)

1) Intermittent Flow Section

In the case of non-congestion of the intermittent flow section, as shown in Table 8 and Fig. 6, the longer the length of the traffic information collection section is, the smaller the basic error rate of the representative travel time value is. The mean error rate decreased by 8% per 1km increment of section length. When the length increased from the section of CASE 1 to the section of CASE 2, the error rate decreased by 14%, which is the greatest reduction among all cases. However, the increase and decrease of the number of signal intersections within a section did not show a significant correlation with the increase and decrease of the error rate.

In the section of CASE 1, which has the section length of less than 1 km, the travel time arrival distribution in the case of non-congestion exhibits an extremely bimodal asymmetric distribution around the representative value, as shown in Fig. 2. Therefore, the deviation between the representative value and an individual vehicle’s value is relatively large. However, it is analyzed that when the section length increases to exceed 2 km (CASE 3), the difference between the representative value and an individual vehicle’s value, that is, the basic error, decreases because the influence of the traffic flow interruption by a signal stop is offset and thus because the travel time arrival distribution changes into a unimodal shape around the representative value.

In the case of congestion, the error rate decrease with increasing section length was 3% on average, which is insignificant compared with the case of non-congestion. It is analyzed that in the case of congestion, the influence of the section length and the signal intersection is relatively small due to the sharp increase of the travel time resulting from the increase of the incoming traffic volume, and thus that, as shown in Fig. 4, the distribution of travel time of all types of sections changes to a unimodal shape around the representative value. Therefore, the basic errors between the representative value and an individual vehicle's value also become similar.

Table 8: Variation of error rate of representative travel time by section environment and traffic Characteristics (Intermittent flow section)

Section type	Section ID	Error rate per section ID (CV, %)		Error rate per section type (CV, %)		Increase / decrease of error rate when increasing section extension (%)	
		Non-congestion	Congestion	Non-congestion	Congestion	Non-congestion	Congestion
CASE 1	CASE 1-1	44%	17%	39%	17%	-	-
	CASE 1-2	35%	17%				
	CASE 1-3	38%	18%				
CASE 2	CASE 2-1	26%	16%	25%	15%	14%▼	3%▼
	CASE 2-2	31%	14%				
	CASE 2-3	18%	14%				
CASE 3	CASE 3-2	20%	13%	18%	12%	7%▼	3%▼
	CASE 3-3	16%	10%				
CASE 4	CASE 4-3	14%	12%	14%	12%	4%▼	0%

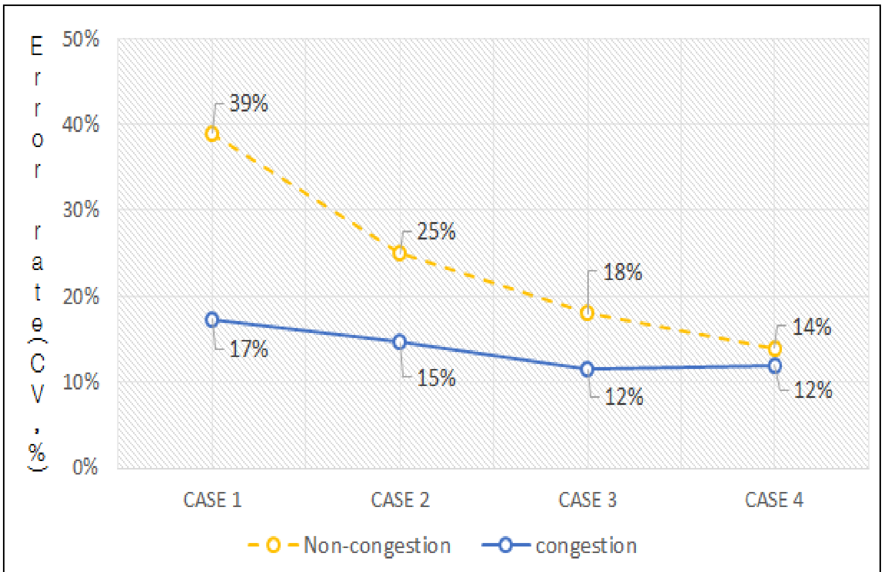


Fig. 6: Variation of error rate of representative travel time by section environment and traffic Characteristics (Intermittent flow section)

2) Continuous Flow Section

For the continuous flow, the error rate decrease with increasing section length was 2% on average at congestion and 0% on average at non-congestion, as shown in Table 9 and Fig. 7. It is analyzed that in the case of the continuous flow, there is no effect of the traffic flow interruption by a signal intersection, and thus that, as shown in Fig. 5, the travel time distribution have unimodal normal distribution characteristics, irrespective of the length of the traffic data collection section and the presence or absence of congestion. Therefore, the basic errors between the representative travel time value and an individual vehicle's value is analyzed to be similar.

Table 9: Variation of error rate of representative Travel Time by section environment and traffic Characteristics (Continuous flow section)

Section type	Section ID	Error rate per section ID (CV, %)		Error rate per section type (CV, %)		Increase / decrease of error rate when increasing section extension (%)	
		Non-congestion	Congestion	Non-congestion	Congestion	Non-congestion	Congestion
CASE 2	CASE 2-0	10%	10%	10%	10%	-	-
CASE 3	CASE 3-0	12%	8%	12%	8%	2%▲	2%▼
CASE 4	CASE 4-0	10%	6%	10%	6%	2%▼	2%▼

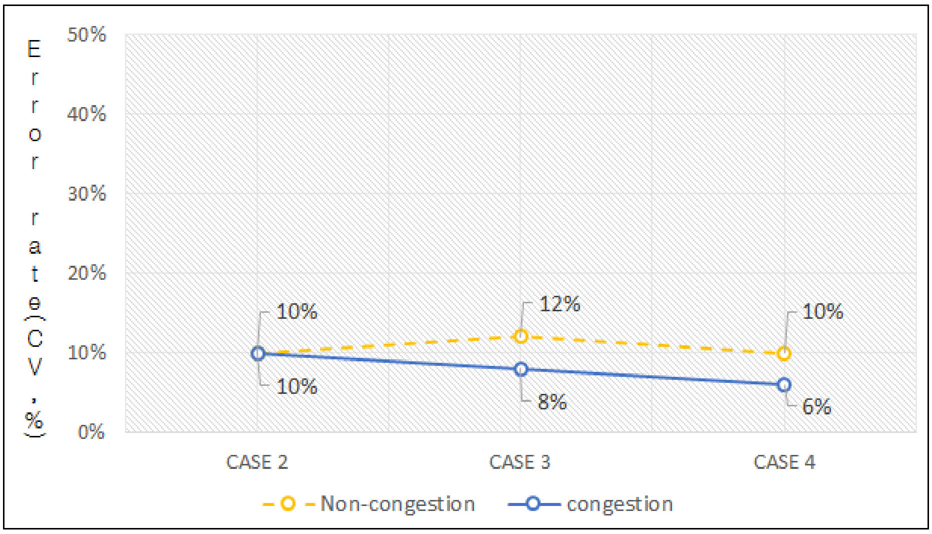


Fig. 7: Variation of error rate of representative Travel Time by section environment and traffic Characteristics (Continuous flow section)

V. CONCLUSION

There is a basic error of the representative travel time that occurs due to the section environment and traffic characteristics, independently of the errors that occur during the generation process, such as the estimation and prediction of travel time. Individual vehicles within the same information providing period are provided with a single representative travel time value, resulting in an inevitable deviation from the actual travel time experienced by the individual vehicles.

We selected 12 types of road sections by combining the length of traffic information collection sections and the number of signal intersections that can exist in national highway and added the condition of the presence or absence of traffic congestion thereto, to measure the basic error of representative travel time value. Although, the variance should be used given that there is no bias in the mean squared error, the coefficient of variation (CV), which is a percentage error of the mean travel time, was used since the errors of sections with different section environments and traffic characteristic should be compared.

We found that in the case of non-congestion of the intermittent flow section with a signal intersection in the section, the basic error rate decreases as the length of the traffic information collection section increases. It is analyzed that this is because, although when the section length is short, the travel time arrival distribution has an extremely bimodal distribution around the representative value, when the section length increases, the influence of the traffic flow interruption by a signal stop is offset, so that the travel time arrival distribution changes into a unimodal shape. In the case of congestion of the intermittent flow, the error rate decrease with increasing section length was insignificant in comparison with the case of non-congestion. It is analyzed that this is because the increase of incoming traffic volume increased the length of travel time, making the influence of the section length and signal intersection insignificant and thus changing the travel time distribution of all types of sections into a unimodal shape. It was found that in the intermittent flow section, the increase and decrease of the number of signal intersections in all traffic conditions is not correlated with the increase or decrease of the basic error.

In the continuous flow section without a signal intersection in the section, the basic errors in all types of sections were relatively small and similar, compared to the intermittent flow section. It is analyzed that this is because the travel time distribution has a unimodal shape regardless of the length of the traffic information collection section and the presence or absence of congestion since the flow of traffic is not interrupted.

Based on the above analysis results, we present the following suggestions for improvement of traffic information providing strategies. First, we suggest providing a basic error rate (CV), which varies as shown in the analysis results according to the length of the information providing section and the presence or absence of congestion, together with the mean travel time information provided to drivers. The basic error rate, which is a percentage of a standard error to a mean travel time value, shows the probability that the travel time will change by ±CV (%) of the mean travel time at 95% confidence level.

Second, for the mean travel time information of the case of non-congestion of intermittent flow sections with a section length of less than 2 km, which have a relatively high basic error rate of 20% or more, we suggest reducing the error rate by merging the mean travel time information of consecutive adjacent sections. Since there are cases where the negative error and the positive error of two sections offset each other, the basic error rate of the merged section will be lower. The second method is considered to be more reasonable in terms of lowering the complexity of system implementation and given the convenience of operation.

Our future research tasks are as follows. In this study, we used the daily data of each section to measure the basic error of the representative travel time value according to traffic characteristics of the 12 types of sections of national highway. In the future, it will be necessary to study the change in basic error measurements using big data of travel time for over 5 years and reflecting external environment factors such as road weather.

REFERENCES

[1]. Battelle Memorial Institute (2004), Traffic Data Quality Measurement, FHWA.
[2]. Hong-Joon Kim, Jin-Soo Kim (2013), Statistics Lecture, Myungjin Book Publishing
[3]. Hyun-Suk Park (2017), "A Study on Determination of the Optimal Collection Interval of Individual Vehicle's Travel Time Collected in the Intermittent Flow Sections of National Highway Using DSRC", Journal of Korean Society of Transportation, 35(1), February 2017, pp. 63-78
[4]. http://ops.fhwa.dot.gov/publications/fhwahop08038/02litreview.htm
[5]. Iida, Y. (2008), New paradigm for traffic planning, Technical Academy
[6]. K. Ahn, H. Rakha, and D. Hill (2008), Data Quality White Paper, FHWA.

*Hyun Suk Park. "A Study on The Basic Error of The Representative Travel Time By Section Environment And Traffic Characteristics of National Highway." International Journal Of Engineering Research And Development, vol. 13, no. 10, 2017, pp. 80–90.