Vol. 6, No. 12 December 2015 ISSN 2079-8407
Journal of Emerging Trends in Computing and Information Sciences

http://www.cisjournal.org

A Public Transit HUD Operating Strategy to Reduce Bus Accidents

[1] **Jisoo Kim**, [2] **Bum-Jin Park***, [3] **Weon-eui Kang**
[1] Researcher, Korea Institute of Civil Engineering and Building Technology, Korea
[2] Senior Researcher, Korea Institute of Civil Engineering and Building Technology, Korea. *Corresponding author
[3] Senior Research Fellow, Korea Institute of Civil Engineering and Building Technology, Korea
[1] js.kim0331@kict.re.kr, [2] park_bumjin@kict.re.kr, [3] yikang@kict.re.kr

ABSTRACT

As use of public transit has increased, safety issues have been arouse. The most critical issue about public transit safety, public transit related accident would lead major accident because it transports large number of passengers. Furthermore, most bus accidents occur due to bus driver's careless behavior. To reduce these bus accidents, a Head-Up Display (HUD) prototype for public transit is developed in this research. The public transit HUD is aim to give drivers information with maintaining their eyes forward, so it can reduce their careless behavior and make public transit more safety. Before adopting the HUD to bus, a survey of bus drivers was conducted about its information display design and satisfaction. Based on their choice, public transit HUD information display strategy is developed with two situations, driving and stopping. Most bus drivers are assured that the HUD will help drivers drive safely and bus accidents will reduce.

Keywords: *HUD, head-up display, public transit, information, bus driver.*

1. INTRODUCTION

Use of public transport has increased on the back of the public transport-centered government policy to enhance transport efficiency, but accidents with public transport easily result in fatalities. This is particularly true in bus accidents caused by the driver's careless behavior, such as negligence in keeping the eyes forward, failure to maintain a safe distance and crash stops, which account for 80% of all bus accidents. Figure 1 shows how to difficult to maintain their eyes forward because of divers on-board terminals for information. The bus accident rate in Korea over the past ten years has stayed at a level of 13% of all traffic accidents and thus it is necessary to reduce the accident rate with public transport as represented by the bus.

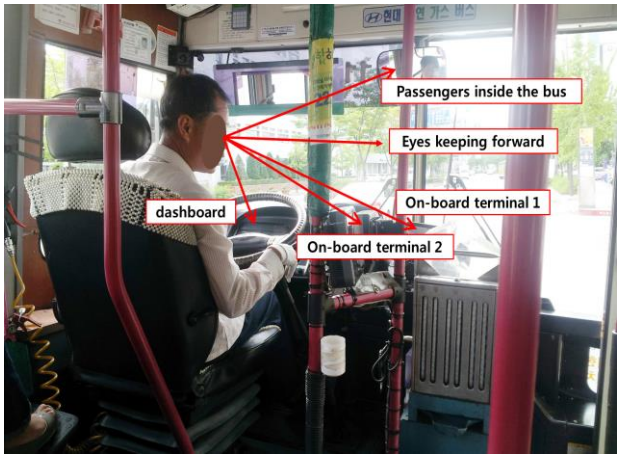


Figure 1: Difficulty to keep eyes forward

HUDs (head-up displays) have been used more frequently recently and studies on HUDs have intensified. According to Son et al. [1], the response by the drivers using HUD is faster by 2.5 times than that of drivers using navigation at the center of the dashboard. For this reason, our research team developed an HUD dedicated to public transport in a bid to enhance the running stability of the bus, where it can be difficult to keep the eyes forward. This study is intended to identify bus drivers' preference with regard to the type and configuration of information displayed on the HUD so as to determine the information to be displayed on the HUD.

Figure 2: Public transit HUD prototype

2. OUTLINE OF THE STUDY

The survey of bus drivers was conducted twice. The first survey was aimed at identifying the operation status of bus drivers and the satisfaction with various terminals supporting the operation and the information which the drivers prefer in fact. The survey was conducted by interviewing 32 bus drivers at Goyan-si(city), Gyeonggi-do.

As a result of the first survey, information which the drivers prefer was checked and the proposal with a prototype HUD was made. Based on such result, the second survey was conducted by showing the various screen configurations developed using test HUD to identify the satisfaction and preference. Direct interview

with 80 bus drivers at Goyang-si (city) and Anyang-si (city) of Gyeonggi-do was conducted.

3. THE OUTCOME OF THE FIRST SURVEY

The categories of the first survey are outlined as follows.

① Experience of accident during operation and analysis of cause

② Current use of terminal and satisfaction

③ Investigation of preferred information depending on operation situation

As a result, most of drivers have experienced the accident and believed another party was mostly responsible for the accident.

Table 1: Cause of accident during operation

	1st	2nd	3rd	4th	5th
Driver's carelessness(surveyee)	14	3	3	3	0
Driver's carelessness(another party)	13	10	2	0	0
Pedestrian's carelessness	2	10	8	1	0
Defective vehicle	0	0	0	1	4
Poor road condition	0	2	4	5	0
Others	1	0	0	0	1

In case of the accident due to driver's carelessness, the cause reportedly includes excessive workload to meet the schedule, increased fatigue due to short of break time and lack of concentration due to heavy workload.

Table 2: Cause of driver carelessness

	1st	2nd	3rd	4th
To meet the operation schedule	15	3	1	1
Short of breaktime	2	10	4	2
Heavy workload	8	4	6	1
Lack of safety device	1	1	3	7
Others	2	0	0	0

Answers to the question on using on-board terminal are as Table 3 ~ 5.

Table 3: Frequency of using on-board terminal

	From time to time	When stops	10 times or less	Rarely
Respondents	24	4	4	0

Most of drivers acquire operation information through the terminal from time to time during operation which is directly related to overload among the causes of driver's carelessness. To monitor the terminal, it's necessary to move driver's attention which leads to negligence to keep eyes forward that might cause the accident.

Table 4: Information acquired through on-board terminal

	1st	2nd	3rd	4th	5th
Headway	28	3	0	0	0
Passengers getting on/off	3	11	2	3	1
CCTV/mirror	0	3	5	2	1
Speed	1	9	3	3	0
RPM	0	0	6	2	0
Others	0	0	0	0	1

Information acquired by the driver during operation is in order of headway, passengers getting on & off, speed and passengers on board. Most of drivers always check the headway and passengers getting on & off.

When it comes to the question on satisfaction with current terminal, drivers were generally satisfied, but stressed the need of improvement.

When it comes to information preference depending on operation situation, information which the drivers prefer was identified. Operation situation was categorized into [normal operation, approach to the stop, stay at stop and departure from the stop] and information provided were 19 kinds in total as Table 5 and the drivers chose the information they prefer, irrespective of the quantity.

Vol. 6, No. 12 December 2015 ISSN 2079-8407
Journal of Emerging Trends in Computing and Information Sciences

http://www.cisjournal.org

Table 5: Information which can be provided

Time Distance to bus ahead	Time Distance to bus behind	Location of bus ahead	Location of bus behind
This stop	Next stop	Route	Traffic Status
Current Speed	Speed Limit	Fare	Bell for off
Front door open	Rear door open	Onboard CCTV	CCTV outside
RPM	Fuel	Engine state	

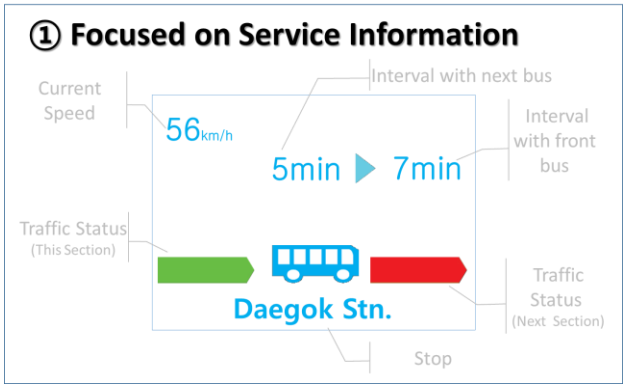
Under normal operation situation, drivers chose 4.5 kinds of information on average and the distance to the buses ahead / behind was considered the most important and when approaching to the stop, they chose 3.4 kinds and the bell for off and information on stop arrived were preferred the most. During stay at the stop, they chose 3.5 kinds and preferred door open. When leaving the stop, 3.9 kinds were adopted and the distance to the car ahead and rear door open were considered the most important information.

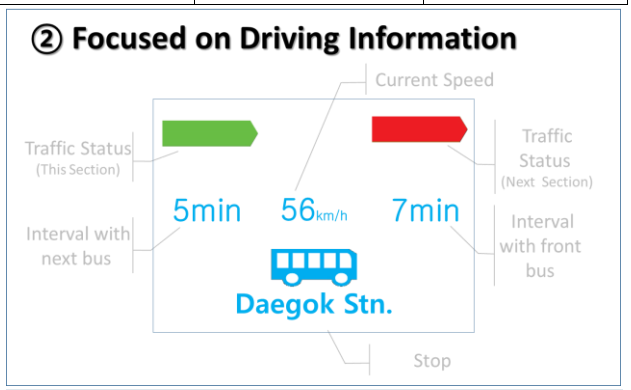
Table 6: Preference depending on operation situation

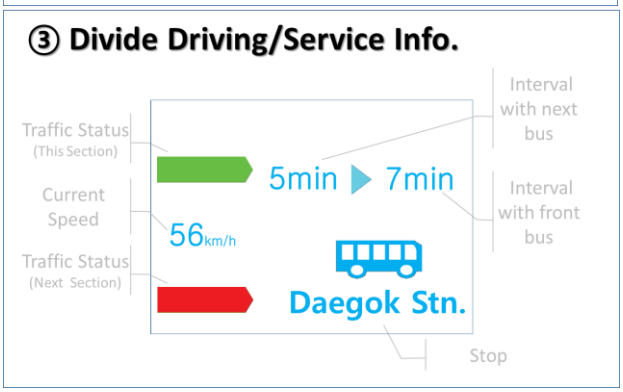
Classification	Normal Operation	Approach	Stop	Departure
Information chosen (avg.)	4.5	3.4	3.5	3.9
1st	Distance to bus ahead	Bell for off	Front door open	Distance to bus ahead
2nd	Distance to bus behind	This stop	Rear door open	Rear door open
3rd	Current Speed	Distance to bus ahead	Fare	Front door open
4th	Traffic Status	Current Speed	CCTV	CCTV outside
5th	This stop	-	-	-

Based on the outcome of the first survey, information by situation for the second survey was proposed. But in consideration that 4 different kinds of operation situation in the first survey may cause confusion, it's classified again into during operation and during stay at stop and the information required when approaching to the stop and leaving the stop was only considered changed during operation and stay at stop.

Information displayed during 2 operation situations are as Figure 2 and Figure 3.







Vol. 6, No. 12 December 2015 ISSN 2079-8407
Journal of Emerging Trends in Computing and Information Sciences

http://www.cisjournal.org

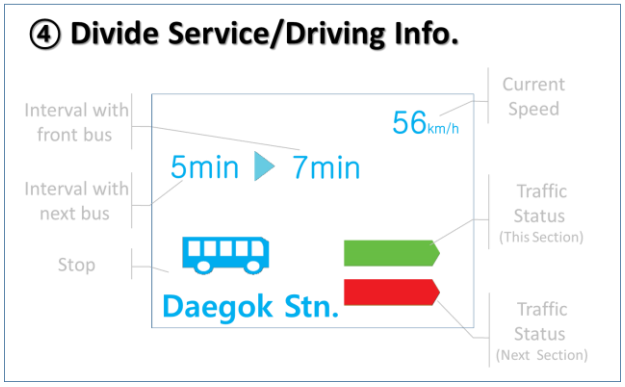


Figure 3: Information assign design for driving situation

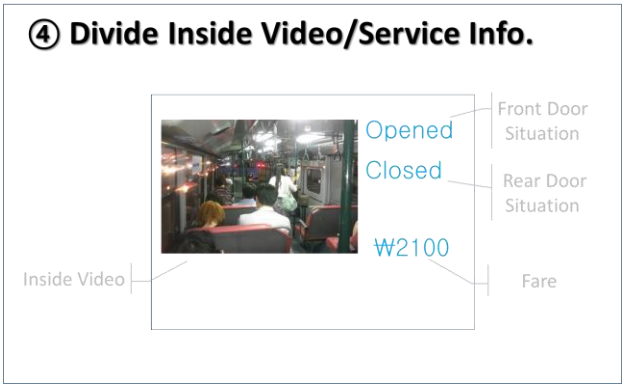
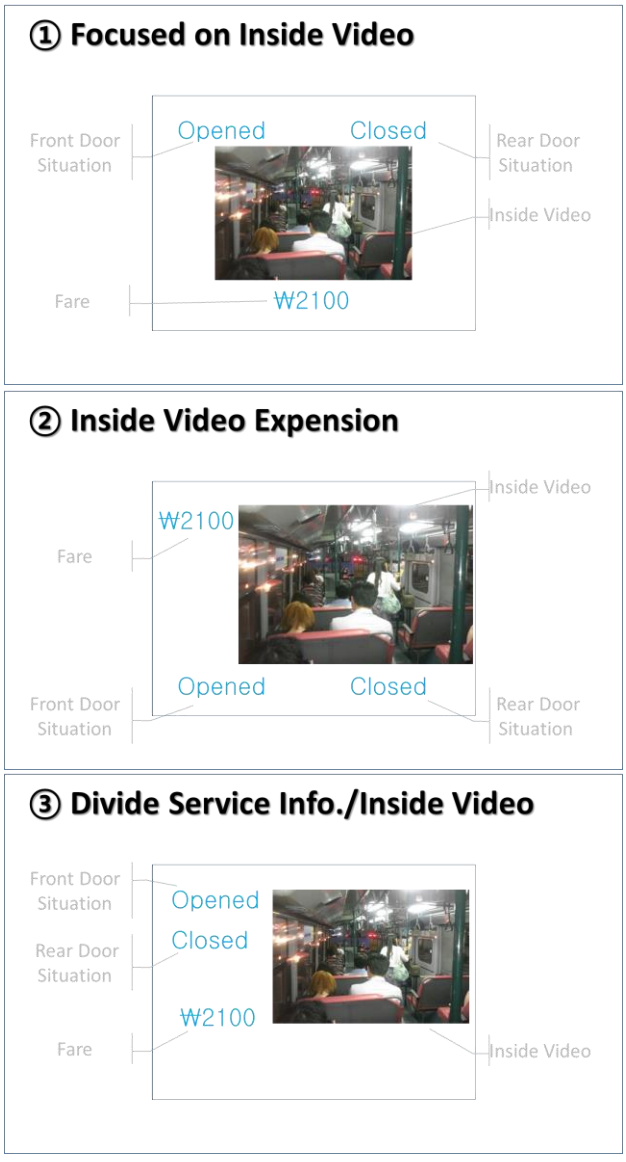


Figure 4: Information assign designs for stopping situation



4. OUTCOME OF THE SECOND SURVEY

The second survey was conducted based on the outcome of the first survey using the information by operation situation, which included preference of display and satisfaction with public transport HUD. When it comes to preference of information display by situation, operation information-centered display was preferred the most while information inside the vehicle was on put on the top during stay at stop. The second survey result during operation was similar to the first survey result preferring operation-related information, but during stay at stop, image inside the vehicle on the 4th was chosen. Because door open information is displayed in color text while information inside vehicle is displayed in image and the information volume is large.

Vol. 6, No. 12 December 2015 ISSN 2079-8407
Journal of Emerging Trends in Computing and Information Sciences

http://www.cisjournal.org

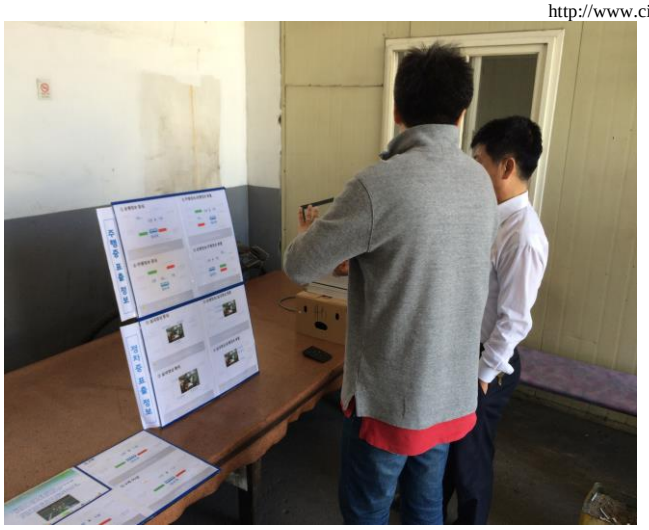
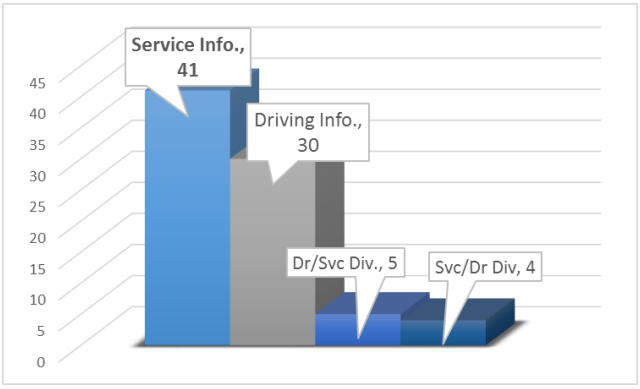
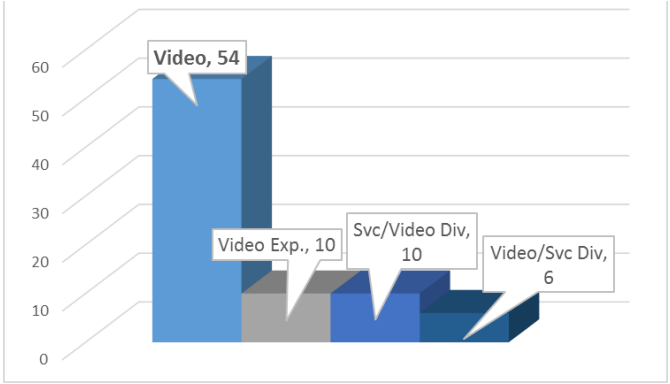


Figure 5: 2nd survey with HUD prototype



Preference of driving situation assign design



Preference of stopping situation assign design

Figure 6: Bus drivers' information assign design preference

The survey of satisfaction with public transport HUD was conducted after simulating the situation using test set so that the driver checks the information individually while driving the vehicle equipped with HUD. As a result, satisfaction with HUD was 4.51 of 5.0 which indicated very high satisfaction level.

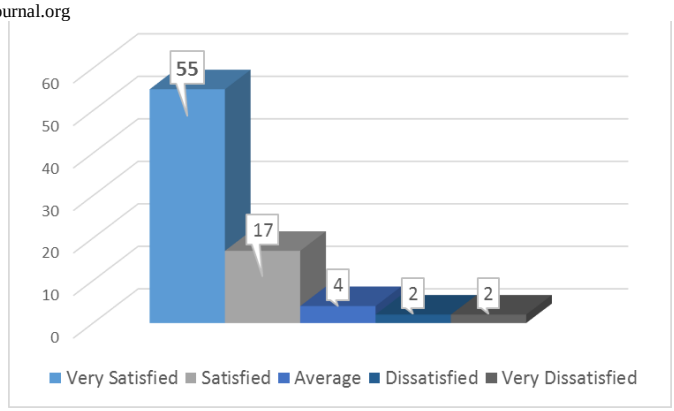


Figure 7: Satisfaction of public transit HUD

And the opinion that keeping eyes forward would be increased thanks to using HUD reached 4.25 of 5.0 and the opinion that accident due to driver's carelessness would be reduced was 4.04 of 5.0, indicating that HUD would possibly reduce the accident caused by driver's carelessness as originally intended. And the use of information comparing to current terminal was 3.94 of 5.0, indicating the potential increase in whole.

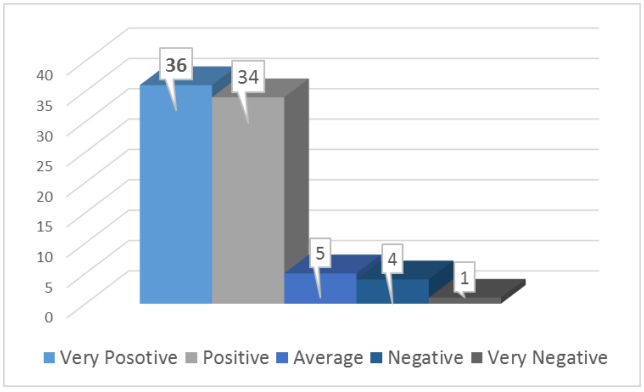


Figure 8: Expectation on keeping eyes forward

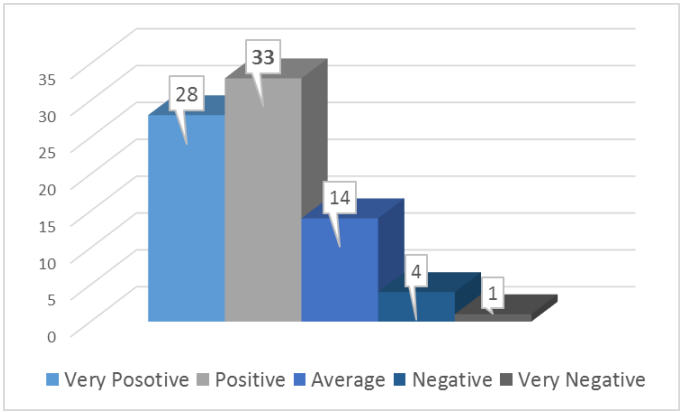


Figure 9: Expectation on reducing accidents due to driver's carelessness

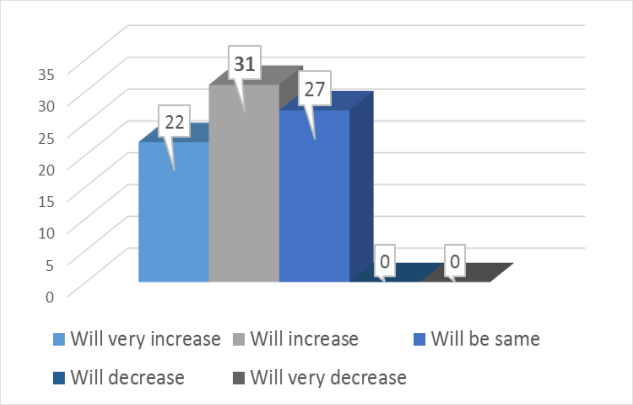


Figure 10: Expectation on frequency of using HUD compared to current terminal

5. CONCLUSION

Accident with public transport would inevitably severe because of mass transport characteristics and thus, the efforts to improve the safety have been made in various ways. As part of such efforts, HUD technology that acquires the operation information while driver keeps eyes forward to reduce the accident by driver's carelessness was developed.

Based on technology developed, the survey of the driver's preference of display information and design was conducted and moreover, survey to identify the satisfaction with HUD was also carried out.

Consequently, most of drivers were very satisfied with public transport HUD and thus based on such preference, information display strategy during operation and stay at the stop was established.

ACKNOWLEDGEMENT

This research was supported by a grant from a Strategic Research Project (Development of Head-Up Display in Public Transit) funded by the Korea Institute of Civil Engineering and Building Technology.

REFERENCES

[1] Son, H. B., Ban, H. J., Yang, K., and Lee, Y. C., "Implement of Intelligent Head-Up Display for Vehicle", Proceedings of the Korean Institute of Intelligent Systems, Vol. 20, No. 3, pp. 400-405, 2010.

[2] Kang, W. E., Moon, B. S., Park, B. J., Roh, C. G., and Kim, J., Annual Report of Development of Head-Up Display in Public Transit, Korea Institute of Civil Engineering and Building Technology, South Korea, Dec. 2014.

[3] Kim, J., Park, B. J., Kang, W. E., and Lee, J. Y. , "Analysis of Public Transit HUD Information Preference for Enhancing Transit Running Safety", The 2014 Korea Institute of ITS International Conference, The Korea Institute of Intelligent Transport Systems, South Korea, Oct. 2014, p. 182

AUTHOR PROFILES

Jisoo Kim received the master's degree in urban engineering from the Yonsei University in South Korea in 2007. Currently, he is a researcher at Korea Institute of Civil Engineering and Building Technology.

Bumjin Park received the doctoral degree in transportation engineering from the Yonsei University in South Korea in 2010. Currently, he is a senior researcher at Korea Institute of Civil Engineering and Building Technology.

Weon-eui Kang received the doctoral degree in transportation engineering from the Kyushu University in Japan in 1993. Currently, he is a senior research fellow at Korea Institute of Civil Engineering and Building Technology.