Mobile Traffic Warning Signs, Can It Be Applied?

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Abstract. The mobile warning signs is the concept of placement of traffic signs board. The application of mobile warning signs is tested using two standards that consist of legibility distance and glance legibility. The procedure is begun by attaching a camera at the car observer to record the tested car installed with the mobile traffic warning sign. The result of observation will produce a documentation in a video file format. The video then comes into an editing process to trim the parts that point to the legibility distance and glance legibility. The trims of video are given to the respondents. This research uses a mobile phone equipped with Google Maps, iOnRoad Professional, Lollipop Screen Recording and VSDC Video Editor. The result confirms that the respondents’ standard of legibility is fulfilled by the requirement of mobile traffic warning signs which is designed (46x69) cm in board size, 5 cm in letter size and clearview font. This distance affirms the maximum legibility distance of 50 meters within 7 second and minimum legibility distance of 20 meters within any range of time interval. The glance legibility eventually will not affect significantly when the following car moves as the warning sign attached-car does.

1. Introduction

The effectiveness of traffic warning signs depends on its feature to communicate the message to the drivers [1]. In order to afford the aim of communication, the warning sign legibility is the first basic requirement that must be fulfilled. The legibility of traffic warning signs is affected the most by both legibility distance and glance legibility [2], as well as the drivers’ capability to detect the warning and how long the time required to respond it [3].

The peripheral perceiving panel of the drivers consists of three sides, including left-front, straight-front and right-front [4]. The analysis of percentage of eye focus that using eye tracking confirms the result that the drivers mostly take their time to focus at the straight-front side while driving. This statement is in accordance that the drivers have more effortless job to catch the perceiving panel at the straight-front side compared to the right and left sides. Generally, the more information gathered will affect to the slower visual searching. In other side, the drivers will have the maximum accuracy in reminding the pictured-traffic warning signs and minimum accuracy to process the information [5].

The variations of displays can affect the different system of searching. The evaluation of works can indicate the drivers’ capability to see and process the information of the warning signs within a short time in less visual requirement [6]. There are two things attracted the drivers’ attention in the peripheral perceiving panel, including the other cars at the front, right or left sides [7].
The drivers’ viewer reaction time toward the traffic sign means as the interval of time that is required to detect, read and respond the message of the traffic signs captured by the vision cone. After the viewer reaction distance toward the traffic sign is adjusted, the distance between the traffic sign and following car can be defined. The defining of viewer reaction distance is needed to find out the legibility. The distance between the driver and traffic sign at the first time of legibility will decline due to the speed of moving car [8].

A particular picture or symbol of a traffic warning sign should be legible within a short time interval. In case of a high traffic or unfamiliar tracks, a driver only has a short time to extract the information of a traffic sign. Moreover, it will become a big challenge for a driver in a big city with a crowded traffic, to comprehend the message conveyed by a traffic sign in a short time, since the sign might be blocked by bigger vehicles, trees or other things [2].

The placement of traffic warning sign is consider by the ergonomic review of following car driver. H-point at the Figure 1 is called as the haunches position, which is the pivot point between leg and limb that is measured to the surface of the road. The H-spot of some vehicles such as trucks, buses and caravans is higher than sedans and sport cars [8].

![Figure 1. The driver’s perceiving angle to the following car [9]](image)

The warning signs are normally installed either at the edge or above the road. However, there are a couple of factors affecting the drivers’ capability to comprehend those signs, including area and perceiving panel, cone vision, legibility distance and glance legibility. Nowadays, most of the existing traffic warning signs prioritize contents that warn the happening of traffic accidents and the road track conditions, such as road constriction, slick road, winding road and steep slope that potentially will cause harm.

The basic principle of moving traffic warning signs works through the installment of the signs at the rear car. When the car moves on the road, the signs will be legible by the drivers behind. The position of the installment should be at the exact angle of perceiving panel to make the drivers convenient in seeing and catching the meaning of those signs clearly. The variants of the car speed will always be in minimum value, since both sign-installed car and the following ones move in line. The more often the sign-installed car moves, the more other cars behind can see the signs.

The mobile traffic signs contain the warning to remind the drivers of driving safety, such as prohibition of using mobile phone while driving; prohibition of driving while having some particular
distractions such as getting drunk, drowsy and indignant; keeping the safe distance and avoiding the aggressive behaviour such as overtaking the other cars. The mobile traffic signs are designed based on the standard which is in a rectangle or square shape, with yellow background made from retroreflective materials.

2. Materials and Methods
This experiment aims to explore the application of mobile traffic warning signs by determining the safe distance between two moving cars.

2.1. Materials
The car observer is the type of passenger car as Figure 2 shows. The mobile traffic warning sign applied in this research functions to remind the drivers of the safety distance. It is designed in a rectangular shape which is (46x69) cm in size printed with 2 inch or 5 cm clearview fontsize. The tested car then moves and followed by the surveyor that drives on the other car equipped with an active camera. The documentation resulting a video file format then comes into an editing process to be trimmed based on the data of both legibility distance and glance legibility.

![Figure 2. Mobile warning sign design and installation.](image)

The testing of mobile warning signs uses the correlation of both glance legibility and legibility distance toward the sign installed at the back car. The mobile traffic warning sign installed-car or the tested car is recorded using the active camera installed in the car observer. The video file documentation then comes into an editing process of trimming based on the glance legibility and legibility distance. The results of editing are then given to the respondents. The main property used in this procedure includes a mobile phone installed with Google Maps, iOnRoad Pro, Lollipop Screen Recording and VSDC Video Editor.

2.2. Methods
There are 100 respondents with legal driving license who involve in this research. Every respondent is requested to share their opinion by choosing the number of scale provided on a questionnaire relating to their capability to read and understand the warning sign in the part of video file that is presented on the LCD screen. There could be 1, 3 or 5 respondents involved in each section that is conducted in a special room where the researcher and operator guide them directly. The examples trims of video recorded are shown by Figure 3.
This research uses Guttman scale to find out the opinion of respondents relating to their capability to understand the meaning of the mobile traffic warning sign presented from the trim of video documentation. There are provided two options, including YES and NO. Respondents can choose the option YES if they can see and understand the message of the mobile traffic warning sign from the display of video documentation clearly. Otherwise, they can choose NO. Every choice of YES is given 1 point, while NO is given 0. The last procedure to find out the legibility distance and glance legibility is done by dividing the total of scales with the total of respondents.

3. Results and Analysis

Each trim of the video displayed to the respondents comes from the combination of legibility distance and glance legibility, such as 20 m – 1 second, 20 m – 3 second, 20 m – 5 second and so on. The first to display is the most difficult one which is 60 m – 1 second, by the aim to diminish the emotional impact from 1 video to others, thus the respondents will only share their objective point of view. The result of legibility distance and glance legibility is shown at the Table 1.

Table 1. Legibility distance and glance legibility of mobile traffic warning signs

| Legibility Distance | Distance (m) | Mean of Legibility (%) |
|---------------------|--------------|------------------------|
|                     | 20           | 91.75                  |
|                     | 30           | 57.00                  |
|                     | 40           | 5.75                   |
|                     | 50           | 0.25                   |
|                     | 60           | 0.00                   |

| Glance Legibility  | Time (second) | Mean of Legibility (%) |
|--------------------|---------------|------------------------|
|                    | 1             | 19.75                  |
|                    | 3             | 37.25                  |
|                    | 5             | 46.50                  |
|                    | 7             | 51.25                  |

Figure 4(a) shows the comparisons of the legibility distance of mobile traffic warning sign by the respondents which confirms that the stretch of 20 m in distance results 91.75% average of legibility with
the value of standard deviation equals to 15.19; 30 m in distance results 57.00% average of legibility with the value of standard deviation equals to 36.83; 40 m in distance results 5.75% average of legibility with the value of standard deviation equals to 5.25; 50 m in distance results 0.25% average of legibility with the value of standard deviation equals to 0.5; and 60 m in distance results 0.00% average of legibility.

Figure 4(b) shows the comparisons of the glance legibility of mobile traffic warning signs by the respondents which confirms that the stretch of 7 seconds in time interval results 51.25% average of legibility with the value of standard deviation equals to 51.46; 5 seconds in time interval results 46.50% average of legibility with the value of standard deviation equals to 50.95; 3 seconds of time interval results 37.25% with the value of standard deviation equals to 46.07; and 1 second in time interval results 19.75% average of legibility with the value of standard deviation equals to 33.08.

![Figure 4(a)](image1.png)

![Figure 4(b)](image2.png)

**Figure 4.** The percentage of comparison based on legibility distance and glance distance

4. Discussion

In every 10 m of legibility distance for all range of time interval shows more significant value than the variant of 2 second time interval. The result of experiment confirms that 1 second of time interval at the 20 m of distance still results 69% legibility; 3 second of time interval at 20 m of distance results 98% legibility. The two-tailed Anova analysis confirms that there is a significance of legibility distance between 20 m and 30 m; and 40 m and 50 m. While, there is no significance of legibility glance at the interval time of 1, 2, 5 and 7 second.

The value of legibility derives from the scales given by respondents based on their capability in extracting the message of mobile traffic warning signs displayed via LCD screen. Immediately, the quality of video file and camera, especially the censor and lens resolution, impacts to the message legibility. Actually, the mobile traffic warning sign installed at the back car can be seen directly by the driver in the car observer in the distance of 40 m and 50 m. However, the video documentation can only display the maximum resolution in the distance of 20 m and 30 m. While human’s vision can turn from one angle to another to focus and produce the 3D shaped-objects, a digital and mobile phone camera can only produce 2D shaped-objects due to the feature that can only capture all pixels at once.

The comparison between mobile phone camera and human’s vision shows the significant value. The mobile phone camera with the best resolution is currently owned by Nokia 808 PureView with 41 MP resolution, while, according to Clarkvision, human’s vision can afford 576 MP resolution. The mobile phone camera used in this research has 13 MP resolution or equals to 2.26% of human’s vision resolution. While human’s vision can turn from one angle to another to focus and produce the 3D shaped-objects, a digital and mobile phone camera can only produce 2D shaped-objects due to the feature that can only capture all pixels at once.
5. Conclusion
The legibility test of the mobile traffic warning signs which plate is designed (46x69) cm in size and 2 inch or 5 cm clearview fontsize is legible at the maximum distance of 50 m within 7 second and 20 m within all time interval. The time interval of extracting the information basically does not affect too much to the legibility of mobile traffic warning signs, since both sign and car are moving in line. It means that at the distance of 50 m and 60 m, the following car moves faster than the traffic sign-installed car, that needs more than 7 second in time interval. This feature excludes from the static traffic warning signs installed at the roadsides, since the probability to see and comprehend the meaning of those kind of signs will be longer than the mobile ones, depending on the speed of car that traverses. So, the glance legibility eventually will not affect significantly when the following car moves as the warning sign attached-car does and the mobile traffic warning car can be applied.

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