

Reading Speed to Be Used For Highway Signs and Traffic Marking In Indonesia

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ABSTRACT

The standard highway sign and traffic marking in Indonesia are adopted from mainly those of the U.S. Department of Transportation, the Manual of Uniform Traffic Control Devices, from England's Road Research Laboratory and from India's Indian Road Congress, which are all based on English language. For Indonesia, further studies are still needed to obtain the more appropriate letter dimension for highway sign and traffic marking, considering that similar words for highway sign in Indonesian language are generally much longer than those of the English version. This means highway user in Indonesia need longer time to read the sign along the roads so that the dimension of lettering and words should not be the same with in English version. From the previous studies, the reading speed was found to be 2 syllables per second and the letter dimension as function of clear-reading distance were given for letter with height-to width ratio $H/B=4/3$ and letter thickness $t = 1/6 H$. This study is the repeated effort to re-investigate the reading speed of letter in Indonesian language. The types of letter are the upper case (Capital letter) and lower case. A total of 40 variations of letter dimension are applied to hundreds of respondents. The results suggested that the average speed of reading letters in Indonesian language is 2 syllables per second and the results will be proposed to enhance traffic signs in Indonesia.

Keywords: Highway sign, traffic marking, letter dimension, clear-reading distance, reading speed

INTRODUCTION

Indonesian standard for traffic control still refer to foreign traffic control such as America (Manual of Uniform Traffic Control Devices), England (Transportation and Road Research Laboratory) and India (Indian Road Congress). This standard must be evaluated because word used in signs in english commonly in one or two syllable. On the other hand, Indonesian language use three untill five syllable and there are no guidance stating the reading sign speed for Indonesian. This evoke question about reading speed in Indonesia. The purpose of this research is to find the reading speed of signs in the road. the average read speed in Indonesia for upper case letter is 2.09 Syllable per second and for lower case letters type is 2.21 Syllable per second. It can be concluded that the average reading speed in Indonesia is 2 Syllable per second. So the result of this research will be proposed to enhance traffic signs according to reading speed in Indonesia.

THEORIES

Driver need some time to respond anything in the road. Total amount of time to respond the stimulus are Perception, Intellection, Emotion and Volition (PIEV). This PIEV acts as psychology process to Perception, Intellection, Emotion and Volition aspects. Another definition for PIEV is an summarize time from watch, feel, hear the traffic situation and

making respond. Perception time is 1.5 second and PIEV time is determined as 2.5 second for secure stopping distance (AASHTO, 1973).

Reading sign time is time needed to read traffic sign. Time needed by eyes to stare at the object is 0.1 – 0.17 second. Also stated that reading time affected by number of words inside sign and the speed driving (Matson, 1995).

For placing traffic sign and designing the road facilities, lateral dimension shall be designed effectively. For focusing the sight, driver will focus on objects distanter than ordinary objects. The focus will be more far as speed driving increase as seen in Figure 1 (Hamilton and Thurstone, 1937).

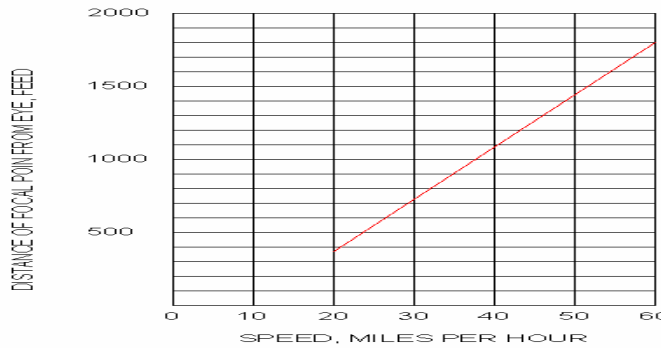


Figure 1. Effect of driving speed to focus distance (Hamilton & Thurstone, 1937)

If “a” is required time to read sign then driver has to see sign in less than “a” second. So it takes at least “a” second to see sign clearly until pass the sign. In slow speed for “a” second driver will make a short distance then small sign letter can be read by driver. On the other hand for high speed driving, for “a” second driver will make long distance then bigger letter dimension will be required.

Placing The Sign

Distance made by driver when reading message in sign is (Matson, 1995; Albayuni & Mochtar, 1993):

$$L = (0,278 V) m/det \times T det.$$

$$L = 0,278 V.T \text{ meter} \dots\dots\dots (1)$$

Where : L is distance, V is design of speed (km/hour), T is time required for reading sign (second), include time to eye movement 0.5 – 1.26 second.

For illustration for designing free view of a sign marking in highway see Figure 2.

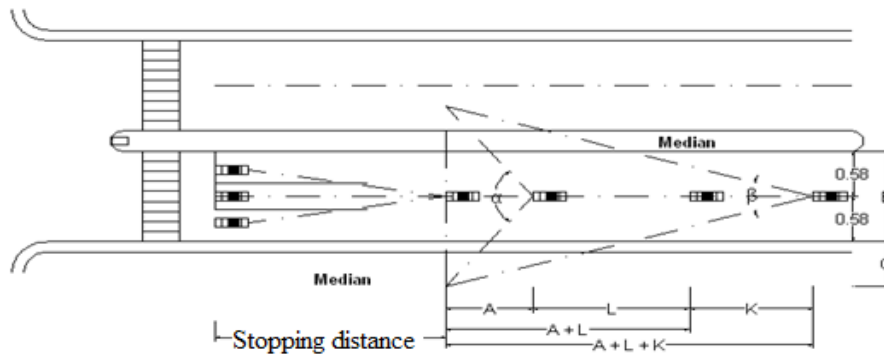


Figure 2. Design of free view of sign marking in highway (Albayuni & Mochtar, 1993)

While B is defined as road width (in meter) and C (in meter) is distance from outer road section to the sign marking, then with assumption driver is on the middle of the road:

$$\tan \frac{1}{2} \alpha = (\frac{1}{2} B + C)/A,$$

Or

$$A = \frac{\frac{1}{2} B + C}{\tan (\alpha/2)} \dots\dots\dots (2)$$

Shoulder width in Indonesia is about 1,0 – 2,5 meter and clear distance from sign marking to outer section of shoulder is 0.6 (MUTCD, 2000). If the width of marking sign assumed equal to 3.0 meter, C is assumed to be maximum to 6,0 meter and B is defined equal to 3.60 meter (= 12 feet). Then A (see position of A in Figure 2), can be estimated as shown in Table 1.

Table 1. Estimated of value A (Albayuni & Mochtar, 1993)

<i>Speed (km/hour)</i>	<i>Pheripheral Vision Effektif, α (°)</i>	<i>Distance A (m)</i>
30	100°	6.5
40	91.4°	7.6
50	82.9°	8.8
60	74.3°	10.3
70	65.7°	12.1
80	57.1°	14.3
90	48.8°	17.3
100	40°	21.4

Distance of free view to a sign marking can describe as: L + A is longest distance where letter / word can be read clearly, and L + A + K is minimum free view, then distance K can be defined as :

$$K = (0,278 V) \times \text{PIEV time} \dots\dots\dots (3)$$

With PIEV time as 2.5 second (AASTHO, 1973), so K = 0,556, where V in km/hour and K in meter. For β = 12° (see Figure 1), so minimum distance A + L + K is equal to (Pignataro 1973) :

$$\text{Minimum } A + L + K = \frac{7.8 m}{\tan 6^\circ} = 74 \text{ meter} \dots\dots\dots (4)$$

Letter

Relation of letter’s height and reading distance has already been described by standard of Transportation and Road Research Laboratory, England TRRL and Indian Road Congress. The mentioned commisions describe the Relation of letter’s height and reading distance as a function of speed and number of word (Kadiyali, 1978) as :

$$X = S/10 + V/100 (N + 6) \text{ inches, and}$$

$$H = 4/3 [S/10 + V/100 (N + 6)] \text{ inches} \dots\dots\dots (5)$$

Where:

X: Letter's height of *lower case letter* (in inches).

H: Letter's height of *capital letter* (in inches).

S: Distance from sign marking to driving path (in feet).

V: speed (in miles per hour).

N: number of word.

There are two kind of letter to be used in traffic marking (Hobbs, 1995):

1. Capital letter, which to be used in all sign or as initial word of lower case (see Figure 3).
2. Lower case with letter position to ascending ("k" as example) or to descending position ("q" for example) in which has the same height as capital letter (see Figure 3).

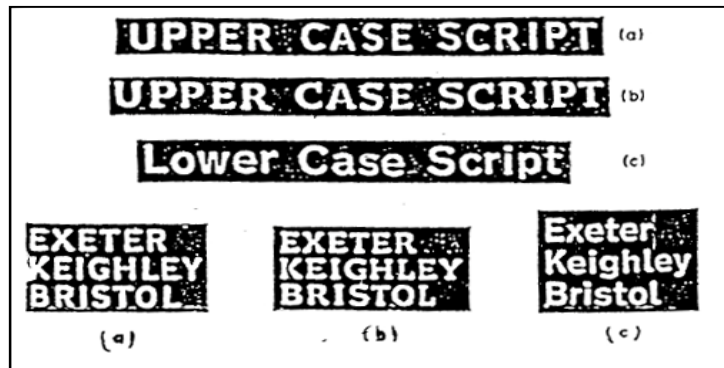


Figure 3. Sign examples (Laboratory Road Research, 1960)
 (a). Capital letters; (b). Seriffed dan; (c) Scripts

Studi about reading distance has already deployed and resulting 162 meter (Albayumi dan Mochtar, 1993) and more conservative than Forbes, Moskowitz dan Morgan (1950) which resulted 700 feet (210 meter). Percentile value determined by Mochtar is 80 percentile, and smaller than used by Forbes (85 percentile). This variable results a little bias than linear regression line (see Figure 4).

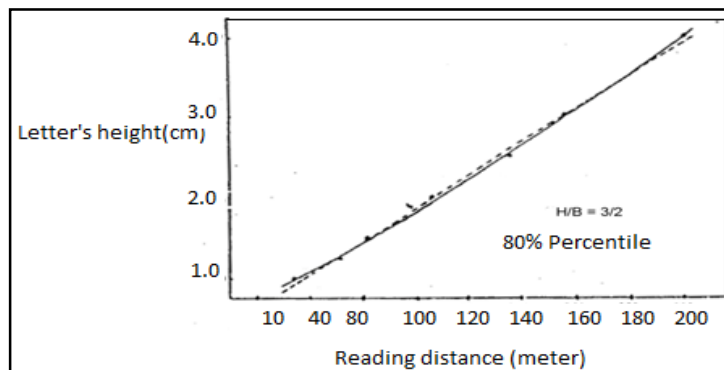


Figure 4. Comparison of linear regression line and polynomial best-fit curve to reading distance for 80 percentile samples (Albayumi & Mochtar, 1993)

Height/width font ratio proposed by Albayuni & Mochtar for height of font 10-40 cm as :

- a. For $H/B = 3/2$

$$H = -1,83 + 0,20 D \dots\dots\dots(6)$$

- b. For $H/B = 3/4$

$$H = -0,76 + 0,19 D \dots\dots\dots(7)$$

Where D is Distance between driver and sign (meter), H is font's height (centimeter).

Both equations have a little different line and result a relatively small different letter's height. For example D = 300 results :

- H= 58,2 cm, according to equation 2-11.
- H= 56,3 cm, according to equation 2-12.

The H has deviation 1,9 cm or 3,3% dari H1, so Mochtar argue for H/B = 3/2 and 4/3 and also letter's thickness (t) =1/6H :

$$H = -1,3 + 0,195 D \dots\dots\dots(8)$$

Effective methods of planning in Indonesia letters proposed by Mochtar as:

- a. Number of syllable inside sign marking, N (syllable).
- b. Reading time, $T = N/2$ second, with assumption reading speed is defined equals to 2 syllable per second.
- c. Vehicle mileage, $L = 0,278 VT$ meter, where V is speed (km/hour).
- d. Required reading clear distance, $D = A + L$, Where A is a function of.

For letter's height design:

$$H = -1,3 + 0,195 (A + 0,139 V \cdot N) \dots\dots\dots(9)$$

Where : H = letter's height design (in cm) , A= Addition factor in Table 2.1, V= allowable speed (in km/hour), N = number of syllable.

METHOD

In Outline, research for solving the problems is shown in Figure 5.

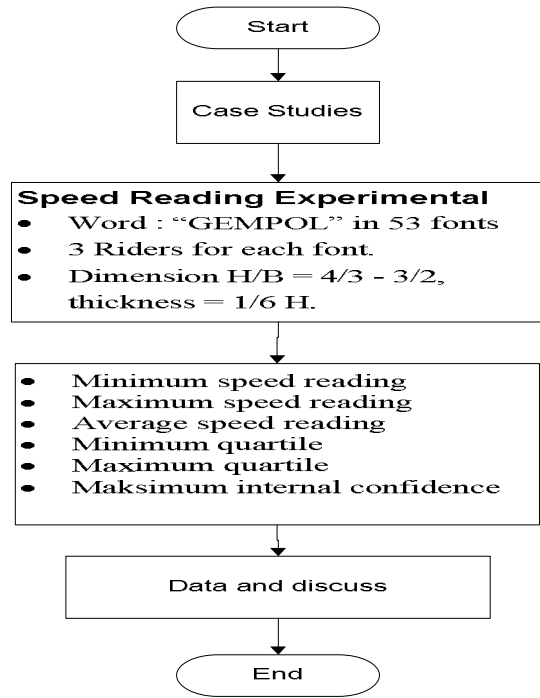


Figure 5. Method's flow chart.

The research is start with case studies. Then followed by speed reading experimental surveys. After accomplished the experimental survey, the data are then analyzed, discussed and the result are then deployed.

RESULT AND DISCUSSION

The study to find reading speed is tested against the 227 respondents to type letters upper case (capital letters) and lower case (small letters). Study is then analyzed statistically by taking the 95% CI (interval confidence). This analysis is required to get a presentative reading speed. The resume of the study is then sorted from the fastest reading speed to the slowest reading speed and shown in Table 2.

From the experimental survey, it can be found that the shortest reading time to read the sentences is 0'22.32" for upper case letter and 0'22.02" for lower case letter. Reading speed is 4.211 syllable per-second for upper case letter and 4.153 syllable per-second for lower case letter. The longest reading time is 3'21.01" for upper case letter and 4'01.51" for lower case letter. The speed reading is 0.185 syllable per-second for upper case letter and 0.318 syllable per-second for lower case letter (see Table 2).

Table 2. Results of reading speed in Indonesia

	<i>Upper Case (syllable/second)</i>	<i>LowerCase (syllable/second)</i>
Minimum Reading Speed	0.1850	0.3180
Maximum Reading Speed	4.2110	4.1530
Average Reading Speed	2.0930	2.0950
Minium quartile	1.2980	1.357
Maximum quartile	2.6630	2.6000
Confidence interval for MU	1.99797 – 2.15519	1.99797 - 2.15519

The descriptive statistic of reading speed are then shown in Figure 6 and Figure 7.

Descriptive Statistics

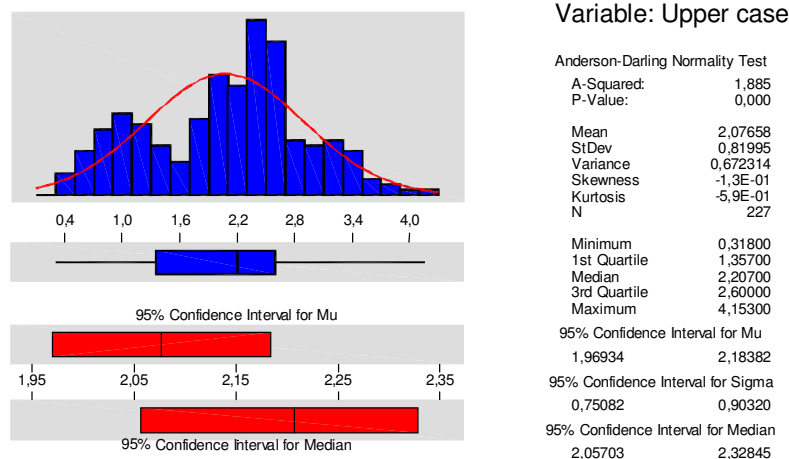


Figure 6. Statistics of reading speed for upper case letter

Descriptive Statistics

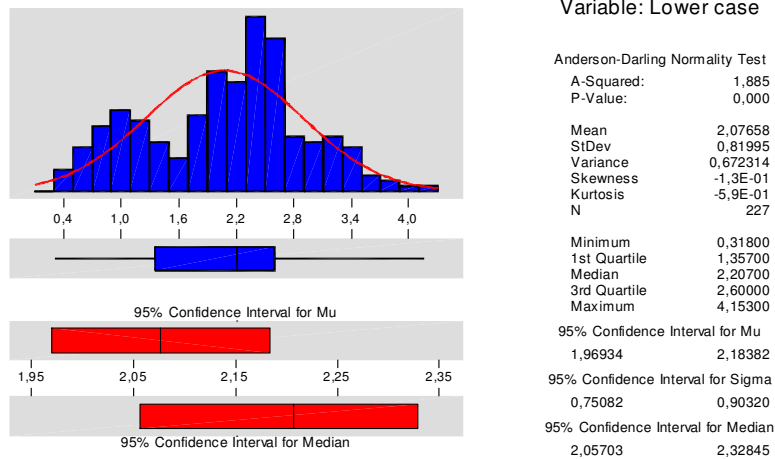


Figure 7. Descriptive statistics of reading speed for lower case letter

It can be seen from descriptive statistics of reading speed that reading speed for upper case font is 2.0766 and for lower case font is 2.0293 (See Figure 6 and Figure 7). So it is found that the average of Indonesian reading speed is 2 syllable/second. This result similar to recent research (see Mochtar, 1993).

CONCLUSION

From the results of research and the discussion, it can be found that the average read speed in Indonesia for upper case letter is 2.09 Syllable per second and for lower case letters type is 2.21 Syllable per second. It can be concluded that the average reading speed in Indonesia is 2 Syllable per second. This reading speed will be very meaningful so it can be implemented against reading signs / information boards in the form of words in Indonesia.

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