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COMPREHENSION OF SAFETY SIGNS FOR CONSTRUCTION WORKERS: COMPARISON OF EXISTING AND NEWLY DESIGNED SIGNS

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The comprehension of safety signs for construction workers was compared among existing and improved designs. Safety signs considered were existing signs, existing signs improved by adding text, existing signs improved by adding/changing pictorials, and existing signs improved by adding/changing pictorials and text. Three hundred and eighty-four construction workers were randomized for assignments into four groups. They were working on nine constructions work sites randomly selected from work sites located in Bangkok, Thailand. The number of workers in each work site was calculated for the proportion of the sample size and then they were randomized so that equal numbers of workers were included in the four groups. The four types of safety signs and an interview form were used to test their comprehension of safety signs. For data analysis, percentages, means, standard deviations, the chi-square test, the one-way ANOVA and LSD tests were applied. The results showed that the mean comprehension scores of the existing signs improved by adding text, the existing signs improved by adding/changing pictorials, and the existing signs improved by adding/changing pictorials and text were significantly higher than those of the existing signs. In addition, the mean comprehension scores of the existing signs improved by adding text and the existing signs improved by adding/changing pictorials and text were significantly higher than those of the existing signs improved by adding/changing pictorials. The highest mean comprehension score of safety signs for the construction workers was found in the existing signs improved by adding/changing pictorials and text. These results indicated that for construction workers, the comprehension of safety signs with pictorials and explanatory text was better than that of the existing signs.

Key Words: safety sign; improvement; construction; worker; comprehension test

INTRODUCTION

The construction work has rapidly increased in the past decade. New technology has been utilized to improve the quality in construction workplaces. It is well recognized that the construction work is classified as the high risk job. There are many cases of work-related injuries and fatalities reported in construction work. The Social Security Office showed that there were 6, 614 work sites all around Thailand. There were 173 cases of death and 24, 870 cases of injuries shown in this report (Social Security Office, 1998).

Chongsuvivatwong et al. (1988) found that the injuries causing absenteeism among construction workers in Thailand were nail in foot, cuts, fall from high, and particle in eyes in the descending order of incidence. They suggested that most of the construction workplaces in Thailand had poor safety measures. The government has launched relevant laws and regulations in order to minimize the occupational health and safety problems in Thailand.

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There are several safety tools mentioned in the labor regulations. “Provision of safety signs” is one of the example measures in improving the safety of construction work. The employers agree to comply with the regulations, but unfortunately the number of accident cases is still high. It is well known that the useful safety signs should be distinctive as well as attractive and should thus provide good communication to workers. When workers perceive warning information, they are to recognize the hazard so that they can make a decision to avoid it.

The understanding or recognition of safety signs of the Thai construction workers is, however, often questionable. Studies of Rumpagaporn (1996) showed that the factors related to the comprehension of safety signs included the educational level, work experience, duration of work and the type of safety signs. Most of the existing safety signs in Thailand have been adopted from foreign countries where there are considerable differences in cultural, socioeconomic and educational conditions. The educational level of Thai construction workers is uniformly low. Most of them are young migrants from poor rural areas of the country.

Therefore the establishment of effective safety signs should be based on local factors of local workers. This paper is aimed at comparing the comprehension of safety signs by Thai construction workers between the existing and the newly designed signs. We focused on new designs of such signs improved by adding text, adding/changing pictorials or adding/changing pictorials and text.

METHODS

Four types of safety signs and an interview form were used to investigate the comprehension of workers. The 4 types included existing signs in use in Thailand (type 1), existing signs improved by adding text in Thai language (type 2), existing signs improved by adding/changing pictorials (type 3) and existing signs improved by adding/changing pictorials and adding text in Thai language (type 4). Each type of the sign was used for one group of the workers.

Subjects: Three hundred and eighty four workers including both sexes were randomly selected from 9 construction work sites in Bangkok, which were also selected randomly. The number of workers by sex in each site was represented proportionately in the sample size. Then the 384 workers were divided randomly into 4 groups as shown in Table 1.

Table 1. Number and % ratio by sex and educational level of the workers in each group.

Qualitative variables	Total (N = 384)		Group 1 (N = 96)		Group 2 (N = 96)		Group 3 (N = 96)		Group 4 (N = 96)	
	N	%	N	%	N	%	N	%	N	%
Sex										
Male	306	79.7	80	83.8	75	78.1	75	78.1	76	79.2
Female	78	20.3	16	16.7	21	21.9	21	21.9	20	20.8
Educational level										
Primary school or lower	285	74.3	64	66.7	75	78.1	73	76	73	76
Junior high school	67	17.4	24	25	16	16.7	13	13.5	14	14.6
Senior high school or higher	32	8.3	8	8.3	5	5.2	10	10.5	9	9.4

Safety signs used

Eleven existing signs were selected for the study by taking into account the types of major severe accidents among construction workers i.e., those referring to cautions about radiation, fragile roofs, and lifting items; caution in general; cautions about the risks of electric shocks, machinery, and explosions; caution about overhead hazards; an emergency stop push-button; the need of foot protection; and wearing a face shield. The 11 safety signs are shown in Figure 1.

Name of Safety sign	Safety sign Type I	Safety sign Type II	Safety sign Type III	Safety sign Type IV
1. Caution radiation				
2. Caution fragile roof				
3. Caution lifting item				
4. Caution				
5. Caution, risk of electric shock				
6. Caution, risk of machinery				
7. Caution, risk of explosion				
8. Caution over head hard				
9. Emergency stop push – button				

Fig. 1. Four types of safety signs shown to the subjects.

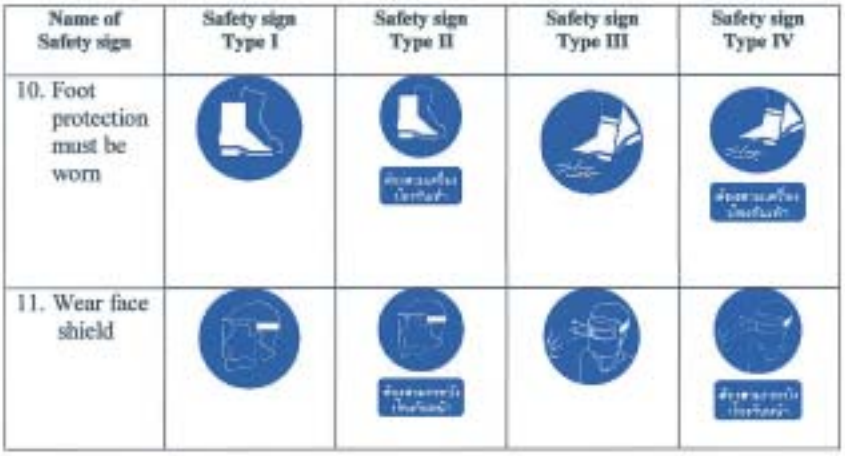

Fig. 1. Continued.

Interview form

The interview form is comprised of 4 parts; 1) general information including the educational level, 2) questions about the comprehension of safety signs, 3) information related to accidents, and 4) information related to personal protective equipment (Appendix). The interviews were held during lunchtime of the workers. The homogeneity of the educational level of workers was determined by the chi-square test. The comprehension score collected using the second part of the questionnaire was evaluated according to preset criteria. The full score was 11 points from 11 signs. The mean comprehension scores of four different types of safety signs were analyzed by the one-way ANOVA tests. The multiple comparisons among mean comprehension scores of safety signs were tested by the Least Significant Difference test (LSD test).

RESULTS

As shown in Table 1, most of the subjects were male workers (79.7%) and 72.1% of them had finished primary school. From the chi-square test ($\chi^2 = 0.234$), it was found that the differences in educational level and gender of workers among the four groups were not statistically significant.

The one-way ANOVA was applied as a tool to compare the mean comprehension score among the 4 different types of safety signs. The mean comprehension scores of safety signs for type Ⅰ, Ⅱ, Ⅲ and Ⅳ and results of ANOVA are shown in Table 2. Difference of the mean comprehension scores of

Table 2. The comprehension score of four different safety signs and results of one-way ANOVA.

Type of safety signs	N	Mean	SD	F	*P*
Type Ⅰ, existing signs	96	4.31	1.60	342.261	<.0001
Type Ⅱ, existing signs improved by adding text	96	10.24	2.08		
Type Ⅲ, existing signs improved by adding/changing pictorials	96	7.53	1.43		
Type Ⅳ, existing signs improved by adding/changing pictorials and text	96	10.76	0.96		

safety signs among the four types was statistically significant ($p<0.0001$). The Least Significant Difference (LSD) test was applied to the multiple comparisons of the mean comprehension scores. It was found that the mean comprehension score of type Ⅳ was significantly higher than that of type Ⅰ, Ⅱ or Ⅲ at $p<0.0001$, $p<0.022$ and $p<0.0001$, respectively. The mean comprehension score for type Ⅱ safety signs was significantly higher than that for type Ⅰ or Ⅲ at $p<0.0001$. Further, it was found that the mean comprehension score for type Ⅲ was significantly higher than that for type Ⅰ at $p<0.0001$.

DISCUSSION

This study demonstrated the comparative levels of comprehension about the four types of safety signs. All of the workers who participated in this study were randomly selected as subjects. It was found that the educational level of workers was typically low, as already shown by Chongsuvivatwong et al. (1998) This factor was classified as the parameter affecting the understanding of safety signs in the study of Rumpagaporn (1996).

A majority of the workers could not understand the important relevant information from existing signs. However, the understanding of the existing signs improved by adding/changing pictorials and text was significantly better than in the case of the existing signs ($p<.0001$). Apparently, the existing signs do not serve as the powerful stimuli in the process of human information processing.

The relevant components of the cognitive model for understanding safety signs include stimuli, perception, memory, decision making and response (Schiffman, 1993). Obviously, people do not make a decision to avoid the hazard if people could not perceive and recognize the signs (Heinrich, 1987). As a result, injuries or damage will inevitably occur. Baber and Wanklink (1992) reported that the presenting symbols and instructions was the most effective method for the comprehension of such signs. Kline and Beitel (1994) concluded that safety signs such as open-close door signs having symbols and text together was far more effective when compared with signs only with symbols or only with text.

The present study suggested that improving safety signs by adding text or adding/changing pictorials can actually facilitate the understanding of the signs by local workers. The effectiveness of safety signs secured through better designs is important for the prevention of occupational fatalities and injuries particularly in construction sites. The use of pictorials and text should therefore be considered in improving conventional safety signs.

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Appendix. The interview form used in the study. Editorial notes are shown in italics.

The interview form: comprehension of construction safety sign

Part 1 General information

Instruction: check / in ( ) as required and fill in the blanks with correct information.

1. Sex ( ) 1. Male ( ) 2. Female
2. How old are you?…… years (over 6 months quoted as 1 year)
3. Education
   ( ) 1. Primary school ( ) 2. Junior high school ( ) 3. Senior high school
   ( ) 4. Diploma ( ) 5. Bachelor or higher
4. What are your jobs in construction work? (over 1 choice can be answered)
   ( ) 1. General work as …. ( ) 2. To bend or to tie iron
   ( ) 3. Perform brick ( ) 4. Lay cement ( ) 5. Carpenter
   ( ) 6. Painter ( ) 7. Welder ( ) 8. Others….please identify….
5. How long have you been working in construction industry?……years
   (over 6 month quoted as 1 year)
6. Have you ever worked before? ( ) No ( ) Yes please identify……..
7. Have you got accident while working in construction site?
   ( ) No ( ) Yes.. please identify……...
8. Have you got knowledge related to safety sign?
   ( ) No ( ) Yes Which method? (over 1 choice can be answered)
   ( ) trained / tough by whom? please identify
   ( ) by reading
   ( ) to be informed by friend or foreman
   ( ) others .. please identify
9. Are there any safety signs in your work site?
   ( ) No ( ) Yes… please identify…….
10. What are safety rules in your working site?……..

Part 2 About safety signs

1. Safety sign No.X*. Have you ever seen it before?

   **For X, the figures 1 to 11 were serially given.*

   ( ) No ( ) Yes … Which method? (over 1 choice can be answered)
   ( ) 1. At work site.
   ( ) 2. Trained by whom?… please identify……
   ( ) 3. By reading ( ) Others.. please identify……..

What does this sign mean?

Comprehension ……

Suggestion from worker

In case this sign means "Y"*, what should it be for the improvement?

**For "Y", "Caution radiation", "Caution fragile roof", "Caution lifting item", "Caution", "Caution, risk of electric shock", "Caution, risk of machinery", "Caution, explosion", "Caution, overhead hazard", "Emergency stop push-button", "Foot protection must be worn", "Wear face shield" were serially given.*

What pictorials should it be?…….

What text should it be?……..

What color should it be?……

Part 3 Information about accident

Instruction: check / in ( ) as required and fill in the blanks with correct information.

1. Have you got accident as follows when working in work site or in the past 1 year?

1.1 Struck by falling objective

( ) No ( ) Nearly ( ) Yes …. times

1.2 Electric shock

( ) No ( ) Yes……times

1.3 Over head hard accident

( ) No ( ) Nearly ( ) Yes …. times

1.4 Struck or crash by machine

( ) No ( ) Nearly ( ) Yes …. times

1.5 Particle / liquid in eye

( ) No ( ) Nearly ( ) Yes …. times

1.6 Nail / material in foot

( ) No ( ) Nearly ( ) Yes …. Times

1.7 Fall from high / scaffolds and ladders

( ) No ( ) Nearly ( ) Yes …. times

1.8 Have you ever worked with radiation?

( ) No

( ) Yes…, if yes…Have you ever got accident from radiation when working with it?

( ) No ( ) Nearly ( ) Yes …. times

1.9 Have you ever worked with fire / explosive substance?

( ) No

( ) Yes…Have you ever got accident when working with it?

( ) No ( ) Nearly ( ) Yes …. times

1.10 Have you ever seen emergency accident or fire in work site?

( ) No

( ) Yes, but it was not severe, It was under control……times

( ) Yes, it was serious

1.11 Struck by object

( ) No ( ) Nearly ( ) Yes …. Times

Part 4 Information about personal protective equipment

Instruction check / in ( ) as required and fill in the blanks with correct information.

Are there any personal protective equipment as follow in your work site?

1.1 Head protection equipment such as helmet

( ) No ( ) Yes

How often do you use it?

( ) No ( ) Seldom ( ) Almost ( ) Every time

1.2 Foot protection equipment such as safety shoes

( ) No ( ) Yes

How often do you use it?

( ) No ( ) Seldom ( ) Almost ( ) Every time

1.3 Safety belt

( ) No ( ) Yes

How often do you use it?

( ) No ( ) Seldom ( ) Almost ( ) Every time

1.4 Eye protection equipment such as safety glasses

( ) No ( ) Yes

How often do you use it?

( ) No ( ) Seldom ( ) Almost ( ) Every time

1.5 Are there any emergency stop push–button in your work site?

( ) No

( ) Yes…. Where does it locate in your work site?… please identify……..

1.6 When will you press emergency stop push–button?……