

A Study on Perception Assessment and Analysis of Safety Signs Used in the Workplace

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Abstract : Since most construction workers comprehend information on work through sight, the importance of safety signs are increasing by the day. In Korea, due to the sharp economic progress and the higher standard of the workforce, since the end of 1980, each year the number of foreign workers entering the country who working simple technical jobs have increased this condition. This study researched safety signs, which are the final accident prevention measures at the workplace. Based on the study, comprehension of the standard safety signs of the Occupational Safety and Health Act (OSHA) was lacking at a level of 2.5. Also, the perception level of the Industry Public Safety Law (38%) was very low. And, it was found that sex and experience or non-experience in safety training was not an issue in the level of understanding. However, when satisfying the standards of the Occupational Safety and Health Act and changing the safety signs, the level of understanding went up to 3.49 and the perception level was increased significantly to 70%. Thus, it is concluded that, since the foreign workers are mainly from non-English speaking countries and because the workers of Korea are not familiar with English, in order to provide proper safety information, there must first of all be simplistic and concise pictograms. This will provide needed information and must be coupled with simple English words that can give additional information to the worker and be effective in helping him understand and perceive the safety sign. Also, it has been determined that the existing forms of safety signs and their effectiveness in industry accident prevention must be reassessed.

Key words : safety signs, level of understanding, perception level, OSHA

1. Introduction

There are many different kinds of safety signs used in the workplace, each conveying various meaning according to the category of work or danger. The current state of affairs is such that it is difficult for a worker to perceive accurately the information which the signs seek to convey.

Since the latter part of the 1980s, the economic structure of Korea has become progressively advanced and as a result, it is now an importer of overseas labor as it brings in foreign workers. Currently, over 1,160,000 people foreigners reside in Korea. This shows a geometric increase in the ratio of foreigners from 0.10% of the overall resident registered population of the 1980s to

2.35% today. It is estimated that this trend towards an increased number of foreigners will accelerate at an even higher rate [1].

If we look at the actual rate of accident suffered by foreign workers, we find that it has increased by 22% from 0.37 in 2007 to 0.45 in 2008. Reduce the occurrence of accidents in industry, domestic workers and foreign workers, while there has been an increase in the occurrence of accidents [2]. Moreover, since culture and language differ for each country, foreign workers face much difficulty in understanding the safety signs of our country. Because of this, the possibility of accidents increases. Also, while the safety signs have an important function as a means of providing direct/indirect safety guard, much more research on its efficiency is required.

Therefore, building on the importance of safety signs

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Table 1. Description of subjects

Nationality	Number of subjects	Sex		Existence of the working experience	Existence of safety training experience	
		Male	Female		Yes	No
Chinese	30	25	5	Yes	15	15
Japanese	50	42	8	No	16	34

which function as the last device for accident protection in the workplace, this study will review their utility via a survey of the level on comprehension of safety signs and seek an appropriate form of expression of safety signs for domestic/foreign workers.

2. Research Subjects and Method

The subjects of this research include 30 Chinese workers currently engaged in work domestically from the foreign workers of Chinese nationality who occupy more than 80% of the total foreign workers as well as 50 Japanese university students. The male to female ratio for research subjects and the composition ratio of Chinese and Japanese with and without work experience and the existence or non existence of safety training are shown in Table 1. Generally, when assessing a safety sign, the ANSI (American National Standards Institute) Z535 (procedure for development of safety symbol and sign) commonly serves as a foundation, and in terms of content, ISO (International Organization for Standardization) 9186 [3] and ISO 9186-2 [4] are combined and evaluated [5]. This kind of a combined method of evaluation should, at the time of design, focus not only on a simple testing of the level of comprehension but also on assessing (perception evaluation) ‘how’ the respondents would act after looking at a proposed sign.

In this experiment, after developing existing signs to actual size using the Adobe Illustrator CS2, they were projected on a screen. The experimental space had all sides sealed so as to have no outside interference. In respect to the research subjects, small groups of 5 persons were set up, and after placing each safety sign on the screen for 15 seconds, the subjects were given 15 seconds to respond on an answer sheet about the level of comprehension and the action guideline which one

believed was required by the safety sign. In the case of safety signs, since urgent situations exist on numerous occasions, which require information to be perceived and put into practice within a short span of time, the response time used is 15 seconds. The test on the level of comprehension was implemented in the form of responding via the SD method questionnaire (5 point criteria: 5 points; the meaning of the safety sign is understood clearly, 4 points; the meaning of the safety sign is not clear but understandable, 3 points; a sketchy meaning is understood; 2 points; it is not understood, 1 point; it is not understood at all). This study calculated the reliability using the Cronbach's α , which seeks internal consistency.

As a result, this study found that the reliability of each sphere was high at over 0.7. The number of questions on the answer sheet and the reliability are shown in Table 2. In respect to evaluation of the level of perception, the respondents who had more than 3 points in the level of comprehension were asked to write subjectively about the action required and the meaning of the safety signs.

Also, the distance from the research subject to the screen was set at 3 m and 5 m so that it was the same distance as between a worker and safety signs during work. Fig. 1 shows the level of comprehension and the method of evaluating the level of perception.

3. Results and Consideration

3.1 Assessment of the level of comprehension and perception of existing safety signs

3.1.1 Results of analysis of the level of comprehension by type of existing safety signs

The assessment of the level of comprehension of the type of safety signs was examined and analyzed via the

Table 2. The composition of the answer sheet and the reliability

Field	Number of questions	Number	Cronbach' α
The types of existing safety signs according to the Occupational Safety and Health Act	39	1~39	0.938
The types of improved safety sign	39	40~78	0.951

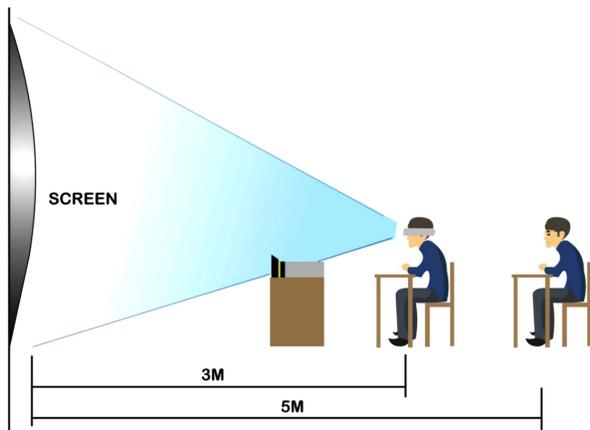


Fig. 1. Illustration for the test of comprehension level and the evaluation method of perception level.

SPSS 14.0 K. The result of evaluation of the level of comprehension about the type of safety sign made according to the domestic law on industrial safety and health is as shown in Table 3, and on the SD method questionnaire, where the level of comprehension is outstanding as it nears 5 points, the outcome was approximately 2.

Thus, this study discovered that generally the level of comprehension was low. In particular, it was found that the level of comprehension of safety signs, such as the industrial safety signs 2 and 14 warning about high temperature or explosives, and are seen only at industrial sites was significantly low. Because of this, there is a concern about accidents, since the worker does not know the details during work or the response measures during an emergency situation. There is also a concern

Table 3. The results of test of the comprehension level about the type of safety sign made according to the domestic occupational Safety and Health Act

No.		Mean	±S.D	No.		Mean	±S.D
New1.		2.95	±1.60	New21.		2.96	±1.53
Caution-High voltage				Do not enter			
New2.		1.62	±1.22	New22.		1.90	±1.48
Caution-High temperature				No riding on vehicles			
New3.		2.85	±1.53	New23.		3.25	±1.64
Caution-Falling object				No open flames			
New4.		3.06	±1.64	New24.		2.90	±1.57
Caution-Acute Toxicity				Emergency stretcher			
New5.		1.76	±1.29	New25.		3.45	±1.51
Caution-Laser beam				Exit-Left			
New6.		1.75	±1.36	New26.		2.85	±1.53
Caution-Overhead object				First exit			
New7.		2.85	±1.53	New27.		2.58	±1.48
Caution-Slippery floor				Eye wash station			
New8.		1.65	±1.18	New28.		3.21	±1.66
Caution-Radioactive				Exit-Right			
New9.		1.94	±1.41	New29.		4.25	±5.79
Caution-Corrosive				First aid			
New10.		2.59	±1.52	New30.		2.70	±1.66
Caution-Oxidizing agent				Safety first			
New11.		3.58	±1.49	New31.		1.61	±1.28
Caution-Risk of danger				Wear ear protection			
New12.		2.61	±1.69	New32.		2.44	±1.62
Caution-Harmful substance				Wear gas mask			
New13.		2.66	±1.43	New33.		1.80	±1.42
Caution-Flammable				Wear dust mask			

Table 3. The results of test of the comprehension level about the type of safety sign made according to the domestic occupational Safety and Health Act(continued)

New14. Caution-Low temperature		1.66	±1.23	New34. Wear eye protection		2.37	±1.50
New15. Caution-Explosive		1.44	±1.04	New35. Wear face shield		2.82	±1.66
New16. No smoking		3.62	±1.77	New36. Wear head protection		3.06	±1.65
New17. Do not move		2.06	±1.53	New37. Wear protective clothes		2.35	±1.44
New18. No passage		3.08	±1.55	New38. Wear protective gloves		2.62	±1.49
New19. Do not use		2.99	±1.60	New39. Wear foot protection		2.90	±1.53
New20. No access for fork-lift		3.34	±1.36	Average		2.50	

Table 4. The results of test of the perception level about the type of safety sign of the Occupational Safety and Health Act

No.	Correct answers/Answers	The level of perception	No.	Correct answers/Answers	The level of perception
No. 1	5/16	31%	No. 21	12/24	50%
No. 2	1/8	13%	No. 22	8/24	33%
No. 3	1/12	8%	No. 23	8/16	50%
No. 4	12/28	43%	No. 26	8/12	67%
No. 5	1/8	13%	No. 25	20/24	83%
No. 6	0/8	0	No. 26	20/28	71%
No. 7	16/20	80%	No. 27	7/24	29%
No. 8	0/4	0	No. 28	20/29	69%
No. 9	0/6	0	No. 29	4/28	14%
No. 10	0/24	0	No. 30	1/24	4%
No. 11	16/36	44%	No. 31	5/10	40%
No. 12	1/16	6%	No. 32	0/4	0
No. 13	4/28	14%	No. 33	4/12	33%
No. 14	2/8	25%	No. 34	8/12	67%
No. 15	4/12	33%	No. 35	7/20	35%
No. 16	36/36	100%	No. 36	19/20	95%
No. 17	2/8	25%	No. 37	11/24	46%
No. 18	16/36	44%	No. 38	19/20	95%
No. 19	3/32	9%	No. 39	18/20	90%
No. 20	1/12	8%	Average		38%

increased severity of accidents due to an inadequate response when the accident occurs.

3.1.2 Result of analyzing assessment of the level of perception of safety signs

The result of assessing the level of perception of safety signs is shown in Table 4. Overall, this study discovered that among the responses with above average comprehen-

sion, only 38% accurately perceived the meaning of the safety signs so as to act immediately. The remaining 62% assimilated wrong information or did not know the meaning of the safety signs. In the case of industrial safety signs 6, 8, 9, and 10, there was an instance where not even 1 respondent perceived the meaning so as to take appropriate action. There was also a case with safety sign 19 where, while the comprehension level was average, many respon-

Table 5. The results of analysis of the type of safety sign

The types of safety sign	Nationality		P-value
	Japanese(n=47) (Mean±S.D)	Chinese(n =24) (Mean±S.D)	
The safety sign of the Occupational Safety and Health Act	2.23±0.64	3.37±1.02	P<0.01

Table 6. The results of analysis of the comprehension level for each sex of the type of safety sign

The type of Safety sign	Sex		P-value
	Male(n =67) (Mean±S.D)	Female(n =13) (Mean±S.D)	
The safety sign of the Occupational Safety and Health Act	2.64±0.95	2.46±1.04	0.607

Table 7. The results of comprehension level for existence/non existence of experience of safety training for types of safety sign

The type of safety sign	Existence of safety training		P-value
	Yes(n =31) (Mean±S.D)	No(n =49) (Mean±S.D)	
The safety sign of the Occupational Safety and Health Act	2.54±0.94	2.68±0.97	0.546

dents had perception errors.

However, in the case of safety signs which are seen often in everyday life such as the no smoking sign of the safety sign 16, this study found that the comprehension level and perception level were both high because the sign has been learned through experience.

3.1.3 Results of analysis of comprehension level by nationality for the type of safety sign

The result of T-test analysis of the comprehension level for type of safety sign by nationality using the APSS 14.0K is shown in Table 5. This study discovered that there is a significant in the average value for the level of comprehension of safety signs between the Chinese and Japanese, and the comprehension level of the Chinese was shown to be higher than that of the Japanese. In the case of the industrial safety signs made according to the law on industrial safety and health, the Japanese had 2.23 points and the Chinese, had 3.37 points. With 3 points, which the average, as standard, a corresponding value was derived with the Japanese leaning in the direction of having difficulty with comprehension and the Chinese in the direction of displaying ready comprehension.

It was generally expected that the comprehension level of the Japanese, who had higher educational background, would be higher, but it was discovered that the comprehension level of the Chinese was slightly higher.

This study finds that this is because the Chinese research subjects, as persons with work experience, had frequent experiences with observing safety signs during work.

3.1.4 Results of analysis of the comprehension level by gender for each type of safety sign

When we look at the responses showing the comprehension level for each gender regarding the type of safety sign, it was shown overall that men had a somewhat higher comprehension level than women. Men had 2.64 points and women acquired 2.46 points for safety signs made according to the Occupational Safety and Health Act.

However, as a result of the T-test, the Occupational Safety and Health Act did not show any significant arising from gender.

3.1.5 Result of analysis of comprehension level regarding the existence/non existence of safety training

Table 7 shows the results of the comprehension level based on the existence/non-existence of safety training.

This study discovered that a person with experience obtained 2.54 points, and a person without experience acquired 2.68 points, so that a person without experience displayed a slightly higher level of comprehension. However, it is not possible to know clearly significant. Also, the result of the T-test shows that there was no significant in the average value based on the existence/non existence of safety training.

3.2 Assessment of the level of comprehension and perception of improved safety signs

3.2.1 Design of basic model for improved safety sign

The basic model of the safety sign was designed according to Clause 1 of Article 9 of the regulation for

Table 8. The results of test of the comprehension level about the types of improved safety signs

No.		Mean	±S.D	No.		Mean	±S.D
New1.		3.92	±1.40	New21.		3.76	±1.47
Caution-High voltage				Do not enter			
New2.		3.17	±1.73	New22.		3.23	±1.72
Caution-High temperature				No riding on vehicles			
New3.		3.54	±1.56	New23.		4.34	±1.05
Caution-Falling object				No open flames			
New4.		4.00	±1.38	New24.		3.84	±1.44
Caution-Acute Toxicity				Emergency stretcher			
New5.		2.68	±1.55	New25.		3.96	±1.41
Caution-Laser beam				Exit-Left			
New6.		2.68	±1.68	New26.		2.85	±1.39
Caution-Overhead object				First exit			
New7.		3.77	±1.35	New27.		4.00	±1.34
Caution-Slippery floor				Eye wash station			
New8.		2.38	±1.68	New28.		3.58	±1.14
Caution-Radioactive				Exit-Right			
New9.		2.03	±1.59	New29.		3.65	±1.62
Caution-Corrosive				First aid			
New10.		2.53	±1.59	New30.		3.23	±1.73
Caution-Oxidizing agent				Safety first			
New11.		4.01	±1.36	New31.		3.93	±1.47
Caution-Risk of danger				Wear ear protection			
New12.		2.62	±1.61	New32.		3.25	±1.64
Caution-Harmful substance				Wear gas mask			
New13.		3.23	±1.53	New33.		2.72	±1.64
Caution-Flammable				Wear dust mask			
New14.		3.44	±1.68	New34.		2.69	±1.65
Caution-Low temperature				Wear eye protection			
New15.		2.75	±1.71	New35.		4.00	±1.38
Caution-Explosive				Wear face shield			
New16.		4.56	±1.02	New36.		4.17	±1.23
No smoking				Wear head protection			
New17.		3.44	±1.72	New37.		3.82	±1.52
Do not move				Wear protective clothes			
New18.		4.23	±1.29	New38.		3.70	±1.49
No passage				Wear protective gloves			
New19.		3.89	±1.51	New39.		4.01	±1.35
Do not use				Wear foot protection			
New20.		3.25	±1.57	Average		3.49	
No access for fork-lift							

enforcement of the Occupational Safety and Health Act. The basic model below the basic model and width were made to be equal. Also, it was designed in a way that in terms of the height, 1/3 of the rectangular model was

added, and simple English words were also added to supplement the pictogram. In this test, added English words were simple idiomatic expressions. Because there is no official English word regulation for the safety

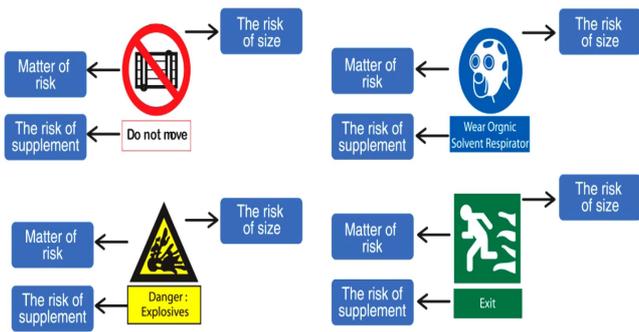


Fig. 2. The final design of improved safety signs.

signs in Korea except English names of signs. The word regulation of pictogram design should be shorter and clearer than the names of signs. Moreover, the design of the color and chromaticity of the improved safety sign is in accordance with Article 8 of the regulation for enforcement of the law on industrial safety and health. Fig. 2 shows examples and classifications of the improved safety sign.

3.2.2 Results of analysis of the level of comprehension of improved safety signs

The result of analysis of the level of comprehension of the improved safety signs is as shown in Table 8.

This study shows that the level of comprehension was outstanding, with a total of 9 signs having over 4 points including 4.34 points for New 23. This study also found that the level of comprehension for 9 signs was less than

3 points, including 2.03 points for New 9.

However, when compared to corresponding existing safety signs, this is an increase of approximately 1 point for comprehension level.

Also, the overall average was 3.49, and this was a significant increase in comprehension level when compared to the existing types of safety sign. It is thus judged that the information which a worker needs during work can be more appropriately provided when compared to the existing types of safety signs.

This study finds that this is because the respondents' comprehension was supplemented with the addition of letters. Because of this, in the case of English words which people come across often in everyday life such as NO FIRE of New 23, the comprehension level for safety signs increased dramatically. In the case of English words which people do not come across often in everyday life such as Corrosives of New 9, it is judged that the comprehension level increased by a small margin because only the respondents who knew the word were helped in terms of comprehension level.

3.2.3 Results of analysis of comprehension level by nationality for improved types of safety sign

Table 9 shows the results of T-test of the comprehension level by nationality of the improved types of safety sign.

This study discovered a meaningful significant for the average value of Japanese and Chinese (P<0.01).

This is the same result as for the existing safety signs, and since the Chinese have work experience, the

Table 9. The results of analysis of the comprehension level for each nationality of the type of improved safety sign

The type of safety sign	Nationality		P-value
	Japanese(n=47) (Mean±S.D)	Chinese(n=24) (Mean±S.D)	
The safety sign of Industrial Safety and Health Act	2.23±0.64	3.37±1.02	P<0.01

Table 10. The results of analysis of the comprehension level for each sex of the type of safety sign

The type of safety sign	Sex		P-value
	Male(n=67) (Mean±S.D)	Female(n=13) (Mean±S.D)	
The safety sign of the Occupational Safety and Health Act	2.64±0.95	2.46±1.04	0.607

Table 11. The results of comprehension level for existence/non existence of experience of safety training for types of safety sign

The type of safety sign	Existence of safety training		P-value
	Yes(n=31) (Mean±S.D)	No(n=49) (Mean±S.D)	
The safety sign of the Occupational Safety and Health Act	2.54±0.94	2.68±0.97	0.546

Table 12. The results of test of the perception level about the types of improved safety signs

No.	Correct answers/Answers	The level of perception	No.	Correct answers/Answers	The level of perception
New1	29/32	91%	New11	36/40	90%
New2	23/24	96%	New12	16/20	80%
New3	16/28	57%	New13	8/36	22%
New4	39/40	98%	New14	32/36	89%
New5	24/28	86%	New15	26/28	93%
New6	0/8	0	New16	44/44	100%
New7	32/40	80%	New17	32/36	89%
New8	0/9	0	New18	32/44	73%
New9	4/12	33%	New19	35/40	88%
New10	4/28	14%	New20	16/28	57%
New21	43/44	98%	New31	8/20	40%
New22	20/32	63%	New32	3/16	19%
New23	44/44	100%	New33	1/8	13%
New24	39/44	89%	New34	36/36	100%
New25	36/36	100%	New35	36/40	90%
New26	40/40	100%	New36	33/40	83%
New27	36/36	100%	New37	13/32	41%
New28	41/44	93%	New38	32/36	89%
New29	4/24	17%	New39	42/44	95%
New30	16/20	80%	Average		70%

effect of learning safety signs based on experience during work has occurred.

3.2.4 Results of analysis of comprehension level by gender for improved types of safety sign

Table 10 shows the result of T-test of the comprehension level by gender for the improved types of safety sign. This study found that there was no meaningful significant for men and women.

This indicates that the comprehension level for safety signs has no relation to the gender of men and women.

3.2.5 Results of analysis of comprehension level for existence/nonexistence of experience of safety training for improved types of safety sign

Table 11 shows the results of T-test of the comprehension level for existence/non existence of safety training for the improved types of safety sign. It was discovered that the experience of having received safety training did not exert any influence upon the level of comprehension of safety signs.

This is because like earlier research, general safety training does not provide any help for understanding the

safety signs.

3.2.6 Result of analysis of perception level for improved types of safety sign

Table 12 is the result of analysis of the level of perception of the improved types of safety sign. Overall, it shows a high level of perception with an accuracy of 70% and as such, much improvement has been made when compared to the level of perception of the existing safety signs. This study finds that this is because the confusion which may occur with the pictogram was minimized by providing auxiliary information based on character string.

This study has assessed that the level of perception of the improved types of safety sign such as New 16, New 25~27, and New 34, which used easy English phrases that can be acquired based on learning in everyday life even if English is not used as a native language, provided comparatively accurate information to the respondents.

Therefore, this study finds that accidents that occur due to faulty perception of safety signs on the part of a worker can be reduced considerably and that a proper

response measure during an emergency can be recommended.

4. Conclusions

Building on the importance of safety signs which function as the last device for prevention of accident at worksites, this study has arrived at the following conclusions by examining their utility based on a survey of comprehension level for safety signs and by reviewing appropriate types of expressions for safety signs for domestic/foreign workers.

1. The result for the level of comprehension and perception of existing safety signs has provided the assessment that the overall comprehension level is low. As such, the concern for safety accidents occurring to a foreign worker is great because he or she does not know the risk components of the workplace, details requiring attention during work, and response measures during an emergency situation. There is also the concern that the scale of accident may increase because of inadequate response to an accident.

2. The result of evaluating the level of comprehension and perception of the improved types of safety sign to which English words have been added shows that the comprehension level was 3.49 points, which is an improvement from the existing types of safety sign. Thus, it is judged that they can more properly provide information required by a worker during work than the existing types of safety signs. Also, because they

exhibit an accuracy of 70% for evaluation of perception level, they can significantly reduce accidents that occur because a worker has incorrectly perceived a safety sign during work and can recommend proper response measures when an emergency situation arises.

3. In respect to supplying proper safety information on worksites to Korean's workers who are not familiar with English, a worker may find it more effective when seeking to understand and perceive safety signs if we provide the necessary information via simple and clear pictogram and auxiliary information by the addition of simple English words. Hence, we must examine again the efficiency of conveying information by the existing safety signs and reevaluate the corresponding effect of preventing industrial accident.

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