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Needs Assessment of Safety Sign Re-Engineering for Construction Laboratory

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***Abstract*—Needs assessment is an important stage of laboratory development. Thus safety sign's needs assessment provides essential data and decisions for laboratory to develop awareness and sense of safety for protecting users and their properties. This paper is aimed at utilizing of need assessment of safety signs re-engineering and its aspects for Construction Laboratory of Mechanical Engineering Department, Semarang State University. Needs assessment based instrument was administered to the laboratory users as the key participants. Survey method was applied in this study to figure out the existing data from key participants; students, lecturers and technicians. Descriptive analysis with Numerical program (Statistical Product and Service Solutions) SPSS was employed to this study to analyze the collected data. The study found the Construction Laboratory is lack of safety sign. The two hundreds participants stated two major answers—between 'absolutely important' to 'important'. It concluded that the existing safety sign in the Laboratory is absolutely important to be re-engineered. The new safety sign must have the following aspects (1) disallowance aspect; (2) warning aspect; (3) prerequisite aspect; (4) order aspect; (5) emergency phone number; (6) help or support aspect and (7) that safety sign must be combined in text and picture.**

Keywords—needs assessment of safety sign, safety sign re-engineering

I. INTRODUCTION

The expression hazard and the term risk may be qualified in order to identify the origin for example, mechanical, electrical or the nature of the possible risk for example, electric shock, cut, intoxication, fire. The hazard considered in this definition permanently present during the intended use of the machine (for example, movement of hazardous moving components, electric arc during a welding phase, awkward posture, noise emission, high temperature); or might appear unexpectedly (for example, explosion, crushing hazard resulting from unintended or unexpected start-up, projection resulting from breakage, sudden acceleration or deceleration. Machine-related mechanical hazards cannot be eliminated through inherently safe design, they must then be reduced to an acceptable level, or the hazards that cause them must be isolated from the workers by guards that allow the minimum safety distances to be respected. Most of the risks related to mechanical hazards can be reduced to acceptable forces or energy levels by applying a risk reduction strategy [1]. Hazard is defined as a source, situation, or act with a potential for harm in terms of human injury or ill health or a combination of these. Risk is defined as a combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or ill health that can be caused by the event or exposure. For the management of change, the organization shall identify the OH&S hazards and OH&S risks associated with changes in the organization, the OH&S management system, or its activities, prior to the introduction of such changes. The organization shall ensure that the results of these assessments are considered when determining controls. When determining controls, or considering changes to existing controls, consideration shall be given to reducing the risks according to the following hierarchy: (a)elimination; (b) substitution; (c) engineering controls; (d) signage/warnings and/or administrative controls; and (e) personal protective equipment. The organization shall document and keep the results of identification of hazards, risk assessments and determined controls up to date. The organization shall ensure that the OH&S risks and determined controls are taken into account when establishing, implementing and maintaining its OH&S management system [2]. Sensible risk management is about: (a) ensuring that workers and the public are properly protected; (b) providing overall benefit to society by balancing benefits and risks, with a focus on reducing real risks – both those which arise more often and those with serious consequences; (c) enabling innovation and learning, not stifling them; (d) ensuring that those who create risks manage them responsibly and understand that failure to manage real risks responsibly is likely to lead to robust action; and (e) enabling individuals to understand that as well as the right to protection, they also have to exercise responsibility. Health and Safety (Safety Signs and Signals) Regulations 1996: The Regulations require employers to use and maintain a safety sign where there is a significant risk to health and safety that has not been avoided or controlled by other means, like engineering controls or safe systems of work, and where the use of a sign can help reduce the risk. They apply to all workplaces and to all activities where people are employed, but exclude signs used in connection with transport or the supply and marketing of dangerous substances, products and equipment. The Regulations require, where necessary, the use of road traffic signs in workplaces to regulate road traffic [3]. There are many possible safety precaution measures that can be taken to attempt to reduce accidents and injuries in workplaces. Provision of safety signs is one of the significant measures in risk reduction. Safety signs are intended to identify and warn against specific hazards without the use of words [4]. Safety signs should provide good communication to users as a failure to convey

warning information effectively can lead to injury or death. 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. And the establishment of effective safety signs should be based on local factors of local workers. [5]. Caldwell indicated that 'if safety signs are not readily identifiable then their communicative value and hence usability are suspect' [6]. 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 [7]. The factors related to the comprehension of safety signs included the educational level, work experience, duration of work and the type of safety signs [8]. This paper is aimed at utilizing of need assessment of safety signs re-engineering and its aspects at Construction Laboratory of Mechanical Engineering Department, Semarang State University. We focused on acquiring the key participants' feedback and their recommendation. The entire participants' data will not entirely be published in this paper due to the size and its number as well as the paper page limitation.

II. METHOD

A. Participants

One hundred and ninety five Indonesian students from multiple provinces (180 males and 15 females), aged between 20 and 25 years old, participated in the study. 27% of the participants were from Education of Automotive Engineering, the bachelor programme, 70% of the participants were from Education of Mechanical Engineering, the bachelor programme and the remaining of 3% were from the lecturers and technicians. All these participants knew about safety sign and as well as the user of the concerned laboratory.

B. Instrument

Self-administered of need assessment Indonesian questionnaire was designed to gather information about participants' safety sign knowledge, usability, position, size, color, to find whether it is important or not that the existing safety sign should be re-engineered. Fifty questions were developed and asked to all the participants in the likert scale. There were five labels on the questionnaire to judge the participants' feedback. They are: (1) Absolutely important; (2) Very important; (3) Important; (4) Somewhat important and (5) Not at all important. The gathered information from participants was in the qualitative data and therefore they should be converted into quantitative data by providing score on each answer. The scoring method followed the following score formula as shown in Table 1.

TABLE I. SCORE FORMULA

No	Label	Score
1	Absolutely important	5
2	Very important	4
3	Important	3
4	Somewhat important	2
5	Not at all important	1

C. Validity Assessment

The purpose of this validity assessment step is to assess how well a questionnaire measures what it is intended to measure; the validity of a questionnaire is usually assessed by individuals with expertise in some aspect of the subject under study [9]. Validity assessment is needed for the designed instrument of the survey [10]. the notation of measure and category are based on that of count ability [11]. This means the data should be able to be computed in a certain theorem. Before distribution of the questionnaire to the participants, its face and content validity were assessed by eight academics and professionals who were knowledgeable with usability measurement and to comment and suggest changes for the questionnaire.

D. Survey Administration

The participants were asked their availability in order to participate in this study. Participants were briefed on the objectives of the survey and given verbal instructions at the beginning of the test. The participants were asked to complete the safety sign re-engineering need assessment comprehension. The survey was undertaken during normal office hour to ensure participation rate and to allow participants to have enough attention to complete the questionnaire. The participants were explained to provide their own opinion and perception toward the provided questions without other intervention and pressure. Two hundred questionnaires were distributed and 200 questionnaires were completed and returned.

III. RESULT AND DISCUSSION

A. Description of Phisycal Investigation

The laboratory has 3 units of acetylene welding kit, 20 units of SMAW welding machine, 20 units of Tungsten Inert Gas (TIG) and Metal Inert Gas (MIG) welding machine, 1 unit of chainsaw, 10 sets of grinding machine, 1 unit of drilling stand and the wall have been equipped with 8 active blowers to maintain good air circulation in the laboratory while welding process. The laboratory has one safety sign that is located at one of wall side area while other sides wall are empty. The general view of the laboratory is shown in the Figure 1.

Figure 1. The laboratory situation

B. Comprehensive Value

Statistical Product and Service Solutions (SPPS) software was employed to descriptively analyze the data. Descriptive statistics—provided by SPSS—is the systematic arrangement of the statistical data that involves the orderly and systematic presentation of numerical data in a form designed to explain the problem under consideration. It also prepares the ground for analysis and interpretation. Meanwhile, the histogram helps in drawing the inference from the statistical figures.

The selected 30 out of 50 questions were to find out how the participants thought about the importance of safety sign in the laboratory and how safety sign should be re-engineered. Table 2 below describes the need of safety sign in the laboratory. There were 11 items that highlighted how important safety sign in the laboratory (question number 1,2,3,4,5,6,7,9,10,17, and 22). Maximum value if the respondent answered with the highest value (absolutely important = 5) was 55 and the minimum value if the respondent answered with the lowest value (not important at all = 1) was 11.

TABLE II. THE IMPORTANCE OF SAFETY SIGN

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Value	200	37	52	46.89	2.758
Valid N (listwise)	200				

The result shows that all the 200 participants stated two major answers—between 'absolutely important' to 'important'. From the table, it can be seen that the average value for this issue is 46.89 and it is quite close to the maximum value. The standard deviation is 2.758 which is considered low, since there is no significant gap from the minimum to maximum value. Diagram below shows the frequent values given by the participants.

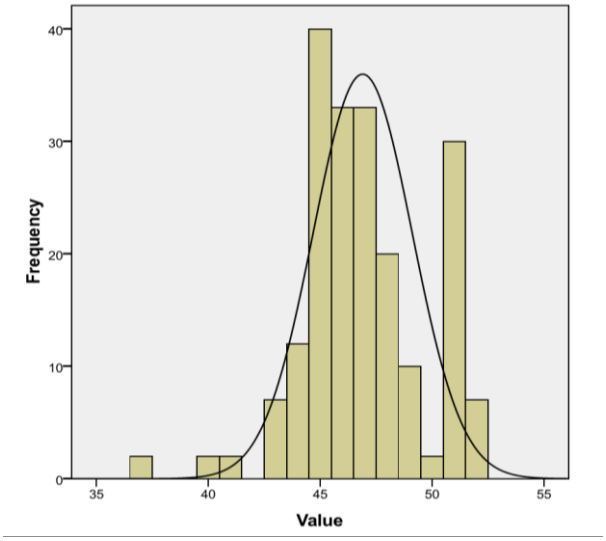

Figure 2. Diagram of frequency vs value

Most participants have 44 to 47 values. There are 40 (20%) participants with 45 value, 33 (16.5%) with 46 and 47 value, and 12 (6%) with 44 value.

Regarding to the design of safety sign, there were five aspects that were asked to the participants. Those aspects talked about (1) how the picture should be placed or design, (2) what about the ideal size, (3) what about the attractive color, (4) how the text should be structured and well delivered the important warnings, and (5) how the content of the text reached the target audience. There were 4 questions dealing with picture issue (number 14,15,16,and 50), 4 questions talked about size (number 19,20,31, and 32), 2 questions about color (number 29,30), 2 questions about text (number 41 and 43) and 7 items described the content of safety sign (number 13,44,45,46,47,48, and 49). Table 3 below shows the description of the participants' answers.

TABLE III. THE IMPORTANCE OF SAFETY SIGN

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
picture	200	15	20	16.62	1.406
size	200	11	19	15.56	1.761
color	200	7	10	8.57	.654
text	200	4	10	7.92	1.136
content	200	23	33	28.56	2.490
Valid N (listwise)	200				

The description above is based on the condition that (1) the maximum value for picture matter (4 items) is 20 and minimum is 4, (2) the maximum value for size (4 items) is 20 and minimum is 4, (3) the maximum value for color (2 items) is 10 and minimum is 2, (4) the maximum value for text (2 items) is 10 and minimum is 2, (5) the maximum value for content (items) (13, 44, 45, 46, 47, 48, and 49) is 35 and minimum is 7. It is shown that all aspects (picture, size, color, text and content) asked in the questioners are urgent according to most of the participants. Their answers are also close to each maximum score from each category. There were few of the participants gave 'somewhat important' to 'not important at all' answers. The low range of standard deviation value (it is between 0.654 to 2.490) also

convinces that almost all participants gave more or less the same answers or opinion.

Content concerns with what is stated in the safety sign warning. It also concerns about the way the statement is constructed whether it is in the form of warning, condition, order or information. Table 4 below highlights the most frequent answers given by the participants, and in fact, the value differs 8 points lower from the maximum value (35).

TABLE IV. THE FREQUENCY OF PARTICIPANTS' ANSWER CONCERNING CONTENT ISSUE

content

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	23	4	2.0	2.0	2.0
	24	11	5.5	5.5	7.5
	25	1	.5	.5	8.0
	26	17	8.5	8.5	16.5
	27	43	21.5	21.5	38.0
	28	32	16.0	16.0	54.0
	29	25	12.5	12.5	66.5
	30	19	9.5	9.5	76.0
	31	15	7.5	7.5	83.5
	32	18	9.0	9.0	92.5
	33	15	7.5	7.5	100.0
	Total	200	100.0	100.0	

The claimed 7 out of 30 questions were to find out how the participants thought about the issue of safety sign content in the laboratory. Table 4 above describes the frequency of participants' answer concerning the content issue of the safety sign in the laboratory. The histogram below signifies the data about the frequency in Table 4 above.

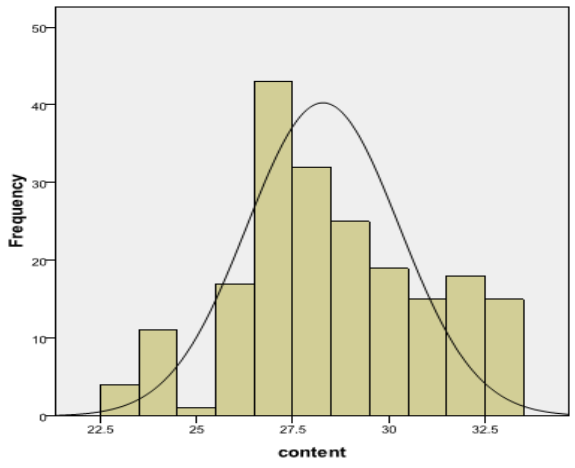

Figure 3. Diagram of frequency vs content

There were 7 items that highlighted participants' answer concerning the content issue of the safety sign in the laboratory (question number 13, 44, 45, 46, 47 and 49). Most participants have 26 to 32.5 values. The standard deviation is 2.758 which is considered low and there is no significant gap from the minimum to maximum value. Concerning the content of safety sign, there were seven aspects that were asked to the participants. Those aspects talked about (1) that safety sign must have disallowance aspect; (2) that safety sign must have warning aspect; (3) that safety sign must have prerequisite; (4) that safety sign must have order aspect; (5) that safety sign must have phone emergency; (6) that safety sign must have support aspect and (7) that safety sign must be combined in text and picture. The Table IV shows the valid value range between 23 to 33, in which 27 is the most frequent valid value 21.5% and 38.0 cumulative percent value.

IV. CONCLUSION

This study successfully investigated need assessment of safety signs re-engineering and its aspects in the Construction Laboratory of Mechanical Engineering Department, Semarang State University. Physical investigation in the laboratory found that the Construction Laboratory of Mechanical Engineering Department, Semarang State University has various machine facilities to do engineering construction works in which each machine has its own potential risk while operating. However the investigation fact shows the Construction laboratory is lack of safety sign and only one basic safety sign utilized in one of the Laboratory wall sides.

The two hundreds participants stated two major answers—between 'absolutely important' to 'important'. In which it can be seen that the average value for this issue is 46.89 and it is quite close to the maximum value. The standard deviation is 2.758 which is considered low and there is no significant gap from the minimum to maximum value. Based on the analyzed data it can be concluded that the existing safety sign in the Construction Laboratory of Mechanical Engineering Department, Semarang State University is absolutely important to be re-engineered. The new safety sign must have the following aspects (1) disallowance aspect; (2) warning aspect; (3) prerequisite aspect; (4) order aspect; (5) emergency phone number; (6) help or support aspect and (7) that safety sign must be combined in text and picture.

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REFERENCES

[1] Giraud, L. (2009). Machine Safety-Prevention of mechanical hazards: Fixed guards and safety distances. IRSST, guide RG-597, Montréal, Canada.

[2] OHSAS, B. (2007). 18001 (2007) Occupational Health and Safety Management Systems. Requirements. British Standards.

[3] Hughes, P., & Hughes, L. (2015). Easy guide to health and safety. Routledge.

[4] R. Ebens, "Designing effective machine safety signs," Occupational Hazards, pp. 29-30, July 2007.

[5] S. Arphorn, N. Augsornpeug, S. Srisorrachatr, and V. Pruktharathikul, "Comprehension of safety signs for construction workers: comparison of existing and newly designed sign," Journal of Human Ergology, vol. 32, pp. 87-94, 2003.

[6] J. Caldwell, "Safety icons and usability: a Peircean reanalysis," in Proceedings of the IEEE International Professional Communication Conference, 2009, pp. 1-8.

[7] Chongsuvivatwong, V., Pas-Ong, S., Ritsmithchai, S., Lebel, L., Kamolrattanakul, P., Dhanamun, B., & Thanomsauy, S. (1998). A Multi-Centre Cross-Sectional Survey on Safety at Construction Sites in Thailand, 1994-1995. Journal of Occupational Health, 40(4), 319-324.

[8] Rumpagaporn, A. (1996). Factors affecting the understanding of safety sign in the workplace [Thesis]. Thai: Industrial Hygiene and Safety, Faculty of graduate studies, Mahidol University.

[9] Litwin, M. S. (1995). How to measure survey reliability and validity (Vol. 7). Sage Publications.

[10] Litwin, M. S. (2003). How to assess and interpret survey psychometrics (Vol. 8). Sage.

[11] Oxtoby, J. C. (2013). Measure and category: A survey of the analogies between topological and measure spaces (Vol. 2). Springer Science & Business Media.

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