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(Research Article)

Understanding of hazard communication through pictorial symbols designed for building construction projects at Aisyiyah Hospital, Pekalongan

Milenia Rahma Izza *, Heru Prastawa and Manik Mahachandra

Faculty of Engineering, Department of Industrial Engineering and Management, Diponegoro University, Semarang, Central Java, Indonesia.

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Abstract

Occupational Safety and Health (OSH) hazard communication plays an important role in the construction project work environment. So as to reduce hazards in the workplace that cause injury or loss of life and material damage. Conduct a test using a psychometric assessment to find out the understanding and meaning of the respondents regarding the hazard symbols installed in the construction project area. In addition, providing education about pictogram symbols and potential hazards around the project. The effect of having pictogram symbols in the Aisyiyah Hospital construction project area significantly increases knowledge about any potential hazards that might occur. The way to increase awareness of the dangers around is to pair warning messages with compatible symbols. It is concluded that warning messages accompanied by these symbols can contribute to the effectiveness of potential hazard warnings in construction projects.

Keywords: Healty Safety Work; Risk Assessment; Pictorial Symbol; Hazard Perception; Construction Project

1. Introduction

Occupational Safety and Health (OSH) issues are still often neglected, as indicated by the high number of workplace accidents, including construction projects. The importance of implementing Occupational Safety and Health (OSH) in field operations is not yet fully understood by construction service providers, resulting in OSH not being fully implemented properly [1]. The Occupational Safety and Health Administration (OSHA) created a new rule at the end of 2012 to modify the Hazard Communication Standard (HCS; OSHA, 1994) in accordance with the UN's Globally Harmonized System (GHS) on the Classification and Labeling of Chemicals. By modifying the HCS, OSHA will require changes in the content of Material Safety Data Sheets (MSDS) and product labels. Using GHS terminology, MSDS documents are known as Safety Data Sheets (SDS) [2]. The low understanding of OSH is reflected in the numerous work accidents that occur during construction work [3]. The suboptimal implementation of occupational safety and health management systems in building construction, and the frequent delays in work execution compared to the implementation schedule, result in less than optimal project performance [4]. Therefore, there is a need to identify the key factors in OSH implementation so that the execution of construction projects can proceed well [5].

In building construction projects, Occupational Safety and Health (OSH) is very important, aiming to provide protection to hospital employees, patients, visitors, and people in the vicinity, as they are assets that must be maintained and safeguarded. According to H.W. Heinrich's domino theory (1930), the cause of work accidents is unsafe actions by humans, such as refusing to use safety equipment at work, removing safety devices, or working while joking around. These actions can endanger themselves or others and can end in accidents [6]. In addition, there's the factor of unsafe conditions in the environment, which are conditions in the work environment, whether it's equipment, materials, or an environment that is unsafe and hazardous [1]. There are several ways to address unsafe actions by humans and unsafe

* Corresponding author: Milenia Rahma Izza

conditions in the environment, namely through engineering controls, administrative controls, and the use of personal protective equipment (PPE) [7]. Engineering controls are the most effective and are the primary required choice, while personal protective equipment (PPE) is the last line of defense [8]. However, when in the field, risk control methods through engineering are still difficult to implement due to internal and external factors. Therefore, the use of personal protective equipment (PPE) is still mandatory as an effort to reduce residual risk [2].

The use of hazard symbols with command messages will be better absorbed by readers and provide information lessons by effectively conveying the messages within the symbols. Research examining the use of pictorial symbols in warnings was conducted by Young and Wogalter (1990). Their research found that notification, understanding, and memory of instruction manual warnings are facilitated when commands are shown with pictorial icons. It is crucial that readers understand hazard symbols, and these symbols must correspond to the hazards indicated by verbal messages in the surrounding environment [9]. The method used in assessing respondents' understanding of hazard symbols is a matching test, where respondents are asked to choose the most understood meaning of a hazard symbol among other symbols. In construction projects, placing warning messages with compatible hazard symbols can facilitate project needs that can lead to significant improvements in safety and security effectiveness within the project [10]. There are two objectives of the research: to identify potential hazards in each location of Aisyiyah Hospital and to provide education and test respondents' understanding of hazards from hazard symbols. The design of pictorial symbols is explained. Understanding and perception of hazards from symbols are tested through matching tests and psychometric assessments, respectively.

2. Material and methods

2.1. Pictorial symbols

There are 4 hazard symbols designed in this research, where the purpose of these pictorial designs is to provide types of information and hazards to be communicated to readers or people passing through the construction project [11]. The chosen hazard symbols are based on observing the conditions around the hospital and communication between project workers and people crossing the construction project area [12]. The "sharp object hazard" symbol functions as a warning sign about the danger of sharp objects in the hospital building construction project area [13]. It is usually installed in project areas where sharp objects are present. The "caution - tripping hazard" symbol functions as a sign to warn pedestrians to always pay attention to their steps when in the construction project area [14]. Wires, hoses, or cables crossing the project area can cause someone to trip and get injured [15]. The "danger - falling objects" symbol functions as a sign to warn pedestrians to be more careful when passing through the project area. Falling accidents are very dangerous because they can result in injuries ranging from bruises, broken bones, dislocations, brain contusions, to death. The "caution - ongoing project work" symbol is to warn road users to be careful of work being carried out on the part of the road they will pass. The designed hazard symbols each have different shapes. As shown in Figure 1. below:

Figure 1 Hazard Symbols

2.2. Respondents

The respondents in this study totaled 31 people, including: hospital visitors, hospital employees, and road users. The respondents in this study are people who frequently cross the project area, thus being affected by the building construction. Respondent selection was done in 1 day, and they were directly given a questionnaire about understanding hazard symbols. There was no special selection in choosing respondents; the sampling of 31 people aims to allow the collected data to be tested using SPSS software to find the standard deviation for each hazard symbol. Respondent demographics are presented in Table 1.

Table 1 Demographics of Participants

Demographics	**Respondents**	
Gender	Male	39% (n=12)
	Female	61% (n=19)
Age	Average	25-45

2.3. Procedure

Using psychometric assessments. First, respondents were interviewed about whether they were aware of the hazard risks in the construction project area without hazard symbols, whether the current conditions were disruptive for road users and hospital users. Second, hazard symbols were placed in the construction project area aiming to provide guidance to respondents about the potential hazards they may encounter. Hazard communication must be done through proper methods that can enhance understanding and alertness of road users. Third, an assessment of respondents' understanding of the installed hazard symbols was conducted at several locations of the building construction project. The assessment involved 31 respondents, including hospital employees, hospital visitors, and road users in the block. This assessment aimed to determine the extent of respondents' knowledge about hazard symbols and the hazards they may face when present in the construction area. Fourth, education was provided regarding the symbols installed in the construction area and their perceived meanings. This aimed to ensure respondents understood the commonly used symbols for projects and could learn about the hazard risks in the project area. Thus, road users would be more cautious when passing through the construction area, enabling them to protect themselves from potential risks.

3. Results

3.1. Respondent Analysis

Respondents' assessment of potential hazards in the construction project area was conducted using the interview method. Out of the 31 respondents interviewed, they were asked whether people around the project were aware of the hazards if there was no Occupational Safety and Health (OSH) communication. The results showed that only 25% understood the dangers of passing through the construction project area. Then, hazard symbols were installed to provide warnings to road users around the project area, and an assessment was conducted to determine the extent of road users' knowledge about hazard symbols and their perceptions. By conducting this assessment, education could be provided to road users to always be cautious when passing through the project area. The proportion of responses in the matching test and the standard deviation of hazard knowledge for the four symbols are presented in the following Table 2.

Table 2 Pictorial Symbols

Pictorial Symbols	**Awareness**		**Standar Deviation**
	Symbol	Purpose	
	23	19	2
	26	21	2,5

	19	15	2
	29	30	0,5

The understanding of each symbol was assessed using the proportion of responses given in the matching test. It was hypothesized that each hazard symbol was presented to respondents to determine the level of understanding and perception of that symbol. The research results showed that for the "sharp object hazard" symbol, 74% demonstrated understanding and 61% perception. For the "caution - tripping hazard" symbol, 84% understanding and 68% perception. For the "danger - falling objects" symbol, 61% understanding and 48% perception. Lastly, for the "caution - ongoing project work" symbol, 94% understanding and 97% perception. Among the four symbols, the one with the highest value was the "caution - ongoing project work" symbol, as this symbol contains a sentence which would be better understood when read. The text on the symbol is also large, so if installed in the project area, it would attract more attention from pedestrians around the hospital.

The perceived hazard of the symbols was assessed through an Analysis of Variance (ANOVA), which showed a significant effect. The standard deviation values were: "sharp object hazard" symbol 2.00, "caution - tripping hazard" symbol 2.50, "danger - falling objects" symbol 2.00, "caution - ongoing project work" symbol 0.50. Further Tukey tests for pairwise comparisons showed that the mean hazard perception ratings for the pictorial symbols differed significantly, as shown in the following Figure 2.

Frequency Table

Symbol

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	19.00	1	25.0	25.0	25.0
	23.00	1	25.0	25.0	50.0
	26.00	1	25.0	25.0	75.0
	29.00	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Purpose

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	15.00	1	25.0	25.0	25.0
	19.00	1	25.0	25.0	50.0
	21.00	1	25.0	25.0	75.0
	30.00	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Figure 2 Frequency Table

4. Discussion

This research selected symbols according to the hazards occurring in the project area and aimed to test the understanding and perception of hazards from the four symbols. The purpose was to ensure that the hospital construction project proceeded smoothly without endangering pedestrians passing through the project area. The symbols used were: "sharp object hazard" symbol, "caution - tripping hazard" symbol, "danger - falling objects" symbol, and "caution - ongoing project work" symbol. This research is supported by several previous studies regarding hazard symbols. First, a study conducted by [8] related to hazards in Norway concerning work hazards due to sharp objects.

This study supports the importance of implementing hazard symbols in work areas as they can provide warnings to pedestrians, employees, and workers when crossing the project area. The research results showed that work injuries caused by sharp objects could be fatal, accounting for as much as 29% of all other potential work hazards. Therefore, it is necessary for construction project owners to use the "sharp object hazard" symbol in construction areas to create a safe work environment.

Furthermore, a study conducted by [16], related to hazards in Malaysia concerning work hazards caused by the abundance of materials around factories, which often caused factory employees to trip. This study supports the need to install hazard symbols in factory areas to warn road users to be more careful when crossing the project area. The results of this study showed that around 65% of road users were unaware of the potential hazards they might encounter when passing through the project area. The research then recommended providing symbols related to work-related accidents. Thus, with this case, there is a need to provide hazard symbols, one of which is the "caution - tripping hazard" symbol in the construction project area. Then, a study conducted by [17], related to the hazards faced by workers in New Zealand due to being struck by materials falling from upper floors of buildings. This made the safety and security of workers poor and could create a negative impression of construction projects. This study supports the need to provide warning symbols for workers to be more careful. The research also supports the implementation of Occupational Safety and Health (OSH) symbols in work areas. This will greatly assist construction workers. With the presence of these symbols, workers in the project area will be more cautious about surrounding hazards. The research conducted by [18] also discussed the hazards that occur in the work environment. Hazards can result in minor to severe injuries, from cuts to fatalities. To minimize these hazards, it is important for individuals to be aware of protecting themselves. External factors also play a role, such as providing appropriate symbols in work areas.

In the literature review available from previous research, [19] concluded that workplace safety warnings greatly influence safety and health in the work environment. The current survey attempts to assess how the presence of hazards and prevention pictograms affect the speed and accuracy of understanding. Respondents' understanding was evaluated because it is the most important factor in workplace communication [20]. Scores from the psychometric tests showed that the perceived hazards of these symbols corresponded to the hazards in the construction project area. Among the four hazard symbols, the one least known by road users was "danger - falling objects". Because the symbol's shape was less familiar, respondents were less aware of the symbol's name and meaning. The mean psychometric ranking values of the four symbols differed significantly, with the hazard perception ranking of the symbols considered consistent with the hazards communicated in the construction project hazard messages. Therefore, the perceived hazards of the designed pictorial symbols were considered satisfactory and could be used as a form of warning message in work areas. The results of this research certainly have certain limitations. This study evaluated the understanding and perception of hazards through hazard symbols. Previous research has also stated that symbols must be tested in the context of their use. The context of using these symbols is as warning messages in construction project areas. Therefore, the contribution of these four symbols to the understanding and perception of hazards from construction project warning messages should be evaluated through experiments where the hazard symbols must be tested further to identify the internal and external factors that cause accidents in the workplace.

5. Conclusion

In this research, subjective responses and ratings were used to test the understanding and perception of hazards from the symbols. In further research, it is expected that the impact of using these symbols with warning messages in construction project areas should be further investigated through experiments in various construction project conditions. The respondents in this study were people affected by the new building construction project at Aisyiyah Hospital, and the study can be expanded to other road users impacted by the new building construction. Since construction project areas must have standardized security, these pictorial symbols can be expected to produce similar results when tested by road users from different construction projects. Testing hazard symbols in construction project areas is considered to enhance the originality of the research. It is considered that installing hazard symbol warning messages in construction project areas can improve the effectiveness of warnings, resulting in better safety in new building construction.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest to be disclosed.

References

[1] Ali, A., Rana, I. A., Ali, A., & Najam, F. A. (2022). Flood risk perception and communication: The role of hazard proximity. Journal of Environmental Management, 316(May), 115309. https://doi.org/10.1016/j.jenvman.2022.115 309

[2] Boelhouwer, E., Davis, J., Franco-Watkins, A., Dorris, N., & Lungu, C. (2013). Comprehension of hazard communication: Effects of pictograms on safety data sheets and labels. Journal of Safety Research, 46, 145–155. https://doi.org/10.1016/j.jsr.2013.06.001

[3] Mohamed Tahoon, D., Anwar Abdel-Fattah, N., & Sabry Hegazi, Y. (2022). Social vulnerability of historic Districts: A composite measuring scale to statistically predict human-made hazards. Ain Shams Engineering Journal, xxxx, 102002. https://doi.org/10.1016/j.asej.2022.102002

[4] Figueroa, R., Taramasco, C., Flores, C., Ortiz, L., Vásquez-Venegas, C., Salas, P., & Zeng-Treilter, Q. (2022). A Physician's Perspective on the Incorporation of Pictograms as a Supplement to Medical Instructions in Chile: A Pilot Study. Irbm, 1, 100712. https://doi.org/10.1016/j.irbm.2022.04.001

[5] Dalvie, M. A., Rother, H. A., & London, L. (2014). Chemical hazard communication comprehensibility in South Africa: Safety implications for the adoption of the globally harmonised system of classification and labelling of chemicals. Safety Science, 61, 51–58. https://doi.org/10.1016/j.ssci.2013.07.013

[6] Keil, J., Edler, D., Dickmann, F., & Kuchinke, L. (2019). Meaningfulness of landmark pictograms reduces visual salience and recognition performance. Applied Ergonomics, 75(April 2018), 214–220. https://doi.org/10.1016/j.apergo.2018.10.00 8

[7] Lazaro, M. J., Yun, M. H., & Kim, S. (2022). Stress-level and attentional functions of experienced and novice young adult drivers in intersection-related hazard situations. International Journal of Industrial Ergonomics, 90(January 2021), 103315. https://doi.org/10.1016/j.ergon.2022.103315

[8] Kristoffersen, S., Normann, S. A., Morild, I., Lilleng, P. K., & Heltne, J. K. (2016). The hazard of sharp force injuries: Factors influencing outcome. Journal of Forensic and Legal Medicine, 37, 71–77. https://doi.org/10.1016/j.jflm.2015.10.005

[9] Dowse, R. (2021). Designing and reporting pictogram research: Problems, pitfalls and lessons learnt. Research in Social and Administrative Pharmacy, 17(6), 1208– 1215. https://doi.org/10.1016/j.sapharm.2020.08.0 13

[10] Hong, H. P., Sheng, C., Pozos-Estrada, A., & Gomez, R. (2022). Modeling and estimation of hurricane wind hazard affecting Mexican coastal regions. Journal of Wind Engineering and Industrial Aerodynamics, 230(September), 105199. https://doi.org/10.1016/j.jweia.2022.105199

[11] Ng, A. W. Y., Chan, A. H. S., & Ho, V. W. S. (2017). Comprehension by older people of medication information with or without supplementary pharmaceutical pictograms. Applied Ergonomics, 58, 167–175. https://doi.org/10.1016/j.apergo.2016.06.00 5

[12] Gao, X., & Niu, X. (2022). Influence of tidal level on quantifying the probability of nearshore tsunami hazard. Ocean Engineering, 266(P3), 112986. https://doi.org/10.1016/j.oceaneng.2022.112 986

[13] Alhamid, A. K., Akiyama, M., Aoki, K., Koshimura, S., & Frangopol, D. M. (2022). Stochastic renewal process model of time- variant tsunami hazard assessment under nonstationary effects of sea-level rise due to climate change. Structural Safety, 99(August), 102263. https://doi.org/10.1016/j.strusafe.2022.1022 63

[14] Lu, G., Liu, A., Guo, W., & Zhang, X. (2022). Seismic fragility curves development for double-column piers of highway bridges applying Cox hazard models of survival analyses. Structures, 45(September), 2104– 2116. https://doi.org/10.1016/j.istruc.2022.09.056

[15] Kasza, G., Csenki, E., Szakos, D., & Izsó, T. (2022). The evolution of food safety risk communication: Models and trends in the past and the future. Food Control, 138(February). https://doi.org/10.1016/j.foodcont.2022.109 025

[16] Salim, N. A., Jasni, J., & Othman, M. M. (2021). Reliability assessment by sensitivity analysis due to electrical power sequential tripping for energy sustainability. International Journal of Electrical Power and Energy Systems, 126(PA), 106582. https://doi.org/10.1016/j.ijepes.2020.10658 2

[17] Hinze, A., Konig, J. L., & Bowen, J. (2021). Worker-fatigue contributing to workplace incidents in New Zealand Forestry. Journal of Safety Research, 79, 304–320. https://doi.org/10.1016/j.jsr.2021.09.012

[18] Guerriero, L., Ruzza, G., Guadagno, F. M., & Revellino, P. (2020). Flood hazard mapping incorporating multiple probability models. Journal of Hydrology, 587(March), 125020. https://doi.org/10.1016/j.jhydrol.2020.1250 20

[19] Reijnen, E., Laasner Vogt, L., Fiechter, J. P., Kühne, S. J., Meister, N., Venzin, C., & Aebersold, R. (2022). Well-designed medical pictograms accelerate search. Applied Ergonomics, 103(May), 103799. https://doi.org/10.1016/j.apergo.2022.10379 9

[20] Pereira, J. A., Macêdo, D., Zanchettin, C., de Oliveira, A. L. I., & Fidalgo, R. do N. (2022). PictoBERT: Transformers for next pictogram prediction[Formula presented]. Expert Systems with Applications, 202(April), 117231. https://doi.org/10.1016/j.eswa.2022.117231