KnE Life Sciences
ICOHS 2017
International Conference of Occupational Health and Safety (ICOHS-2017)
Volume 2018

Conference Paper

Construction Project Safety Climate in Indonesia

Paul Mangiring and Fatma Lestari

Occupational Health and Safety Department, Faculty of Public Health, Universitas Indonesia, Jl. Margonda Raya, Beji, Pondok Cina, Kota Depok, Jawa Barat 16424, Indonesia

Abstract

Construction and engineering sector makes important contributions to the economic, social, and environmental goals of a nation; however, it has a poor reputation of an unsafe industry to work. Safety climate is the perceived value placed on safety in an organization at a particular point in time. These perception and beliefs can be influenced by attitude, values, opinions, and actions of other workers who are involved in an organization's project. The objective of this study is to evaluate the safety climate as an important part of macro ergonomics domains and determine the importance of each safety climate factor in a construction company. The Macroergonomic Organizational Questionnaire Survey (MOQS) method was used in this study to collect data. The questionnaire used was the applied safety climate questionnaire presented by Prof Martin Loosemore and Dr. Riza Yosia Sunindijo of the UNSW, Sydney, Australia, and Professor Fatma Lestari of the University of Indonesia. The questionnaire was distributed to the respondents from a sample with 5 percent accuracy and 95 percent confidence level. Data collected were then analyzed using SPSS V.22 software and Kolmogorov–Smirnov Method. The number of returned valid questionnaires was 21 of 22 or 95.45 response rate. The participants consisted of 66.7 percent man and 33.3 percent women with an average of age 27.57 years old (95% CI: 25.48–29.67). Most of the respondents had an undergraduate degree (76.2%), while the remaining respondents graduated from a diploma program (23.8%). The average length of work in construction among respondents was 3.33 years (95% CI: 2.17–4.50). The results indicated that mean of safety climate score was 216.76 (95% CI: 209.14–224.38). No relationship was found between age and safety climate (*p*-value 0.620), sex and safety climate score (*p*-value 0.550), education and safety climate score (*p*-value 0.869), and length of work in construction and safety climate score (*p*-value 0.751).

Keywords: safety climate, safety of work environment, Macroergonomics Organizational Questionnaire Survey (MOQS), Kolmogorov–Smirnov Method

Corresponding Author:
Fatma Lestari
fatma@ui.ac.id

Received: 15 May 2018
Accepted: 3 June 2018
Published: 19 June 2018

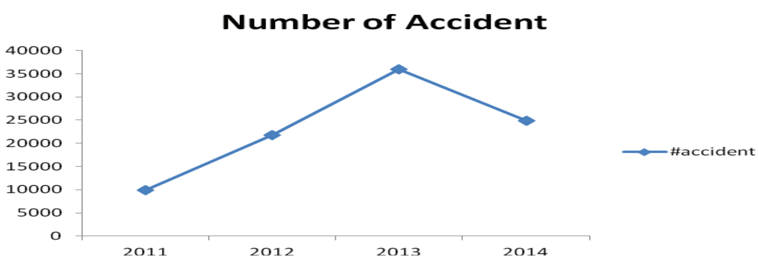
Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICOHS 2017 Conference Committee.

1. Introduction

In the present days, the construction sector in Indonesia has grown rapidly, along with the improved economic situation in Indonesia. Moreover, construction becomes one of Indonesia's economic supports since it absorbs a considerable workforce. Data from the Central Bureau of Statistics (BPS) show that the number of workers in construction sector has increased significantly, from 4,844,689 in 2010 to nearly doubled in 2015 with 8,208,086 workers, which is 7 percent of 114 million existing workers in that year (BPS, 2016) [10]. The expectation is that the rapid development of the construction sector will be followed by improved health, safety and environment systems in this sector since those will directly impact the execution of construction works. However, this sector is considered to be at high risk for occupational accidents. Despite the fact that the BPS data does not specifically include information on occupational accidents in the construction sector, another data source from the Indonesian National Social Security for Workers, or known as BPJS Ketenagakerjaan (Bpjs Ketenagakerjaan, 2016b) has documented that at least 30 percent of occupational accident cases occur in the construction sector. Since the construction sector contains a large number of workforce and carries great risk for accidents, the importance of preventing occupational accidents in this sector becomes an important aspect to note.

One way to prevent occupational accidents is by improving the Occupational Safety and Health (OSH) performance in the company. The OSH performance can be assessed from the atmosphere of a workplace. This atmosphere will be able to show whether or not a company applies good OSH procedures. One of the measure that can be used to assess the workplace atmosphere in terms of OSH is as the safety climate.



Year	Number of Accident
2011	9891
2012	21735
2013	35917
2014	24910

Figure 1: Number of accident, 2014. Source: Directorate of Occupational Health and Sports, Ministry of Health, 2014 [11].

Safety Climate reflects shared employee perceptions of how safety management is being operationalized in the workplace, at a particular moment in time [5]. One advantage of Safety Climate is a robust predictor of subjective and objective safety outcomes across industries and countries, which was the reason why the safety climate is considered the key indicator of safety performance in this study. Most safety climate research has generally focused on the worker level, for example, investigating the behavior, attitude, and perception of workers towards safety [1, 6 – 9]. The safety climate is different because it can be seen as the 'mood' of an organization, based on what the workers experience at a specific time. Because safety climate only reflects a snapshot of safety at one point in time, it can change rapidly on a daily or weekly basis. Safety climate survey is also economical and easy to do and many studies have supported the soundness of the safety climate tool in predicting safety performance [3]. A recent study also found that the safety climate may be a more powerful predictor of safe work practices compared to legislation [4].

For example, safety climate might be heightened after implementing a new safety procedure or after an incident. If the heightened safety climate is maintained over time, it can lead to changes in the underlying culture. As safety climate captures the attitude towards safety at a specific point in time, it is a useful indicator of safety performance. Measuring safety climate is usually done using an employee survey or team discussions.

To understand the safety climate in the construction sector, an initial study was performed in a construction company. This study aimed to understand the safety climate by specifically assessing the OSH perception in a construction project in Indonesia. Should there be any indications of poor OSH, the result of this study can be informed the government in developing a long-term plan and OSH guidelines to continuously improve the OSH condition in the construction industry in Indonesia.

2. Materials and Methods

This study was conducted in functional units of a Construction Company located in East Jakarta in 2017. An applied safety climate questionnaire presented by Prof Martin Loosemore and Dr. Riza Yosia Sunindijo of UNSW Sydney, Australia, and Prof Fatma Lestari of University of Indonesia was used. In addition, the Entropy method was also used to measure the weight of safety climate factors. Furthermore, the relationships between safety climate and employees' demographic characteristics such as age, education, job experience, amount of training received, and marital status were examined using the Kolmogorov–Smirnov statistical analysis method. All data were analyzed using SPSS V.22 software.

To collect the data, the Macroergonomic Organizational Questionnaire Survey (MOQS) Method was used. This method was selected because it can quickly and inexpensively identify the symptoms of work system design problems and locate where these problems may occur within the work system. Sometimes a problem is only identified in some work system units but the MOQS can be developed and used to determine how widespread the problem is throughout the organization.

Questionnaires were distributed to a total of 22 construction company workers with various functions in one shift but only 21 returned valid questionnaires. The routine work schedule of these workers was 8 am to17 pm every week day.

2.1. Occupational safety and health questionnaire

The Occupational Health and Safety Questionnaire consists of 58 questions. on the Health, Safety and Environment conditions and implementation in the company.

2.2. Normality test using Kolmogorov–Smirnov method

Kolmogorov–Smirnov test (**K–S test** or **KS test**) is a nonparametric test of the equality of continuous, one-dimensional probability distributions that can be used to compare a sample with a reference probability distribution (one-sample K–S test) or to compare two samples (two-sample K–S test) [2].

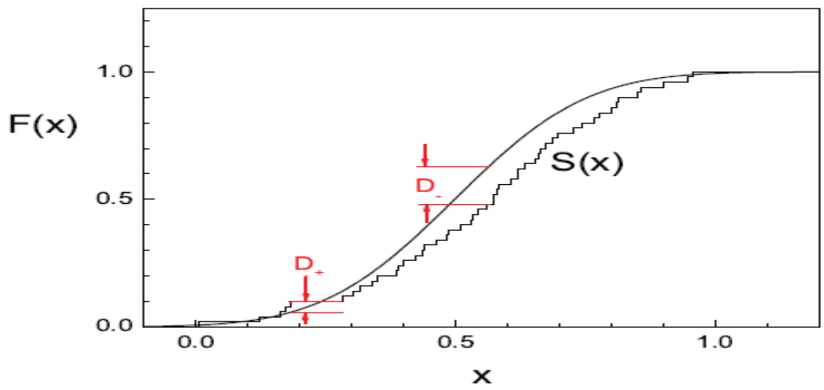


Figure 2: Comparison of the empirical distribution function S(x) with the theoretical distribution function F(x).

The Kolmogorov–Smirnov test compares the distribution function

$$F_0(x) = \int_{-\infty}^{x} f_0(x)dx \quad (1)$$

with the corresponding experimental quantity S,

$$S(x) = \frac{\text{Number of observations with } x_i < x}{\text{Total number}} \quad (2)$$

The statistical testing was performed by looking at the maximum difference D between the two functions:

$$D = \text{sup}|F(x) - S(x)| = \text{sup}(D_+, D_-). \quad (3)$$

The quantities D+, D– denote the maximum positive and negative difference, respectively. S(x) is a step function, an experimental approximation of the distribution function and is called the Empirical Distribution Function (EDF). An example is depicted in Figure 3 for comparison with the distribution function F(x) of Ho. To calculate S(x), all N elements are sorted in the ascending order of their values, xi < xi + 1, and 1/N is added at each location of xi to S(x). Then S(xi) is the fraction of observations with x values that are less or equal to xi,

$$S(x_i) = \frac{i}{N}, \qquad S(x_N) = 1 \quad (4)$$

In the χ2 test, the expected distribution of D can be determined, which will depend on N, and the experimental value of D can be transformed into a *p*-value. To get rid of the N dependence of the theoretical D distribution, D∗ = $\sqrt{}$ND is used. Its distribution under Ho is for not too small N (N > ≈ 100) independent of N and available in the form of tables and graphs. For even numbers larger than 20, the approximation D∗ = D($\sqrt{}$N + 0.12+ 0.11/$\sqrt{}$N) is still a very good approximation5. The *p*(D∗) function is displayed in Fig.3.

The Kolmogorov–Smirnov test emphasizes more on the center of the distribution than the tails because the distribution function in the center is tied to the zero and one values and, thus, is not too sensitive to deviations at the borders.

3. Results

3.1. Respondent characteristics and safety climate scores

The distribution of the respondent characteristics and safety climate scores in this study are described in the following tables.

Based in on the Table 1, the average age of respondents was 27.57 years, with a variation of 4.6 years. The youngest respondent was 22 years old and the oldest was 39 years old. From the analysis it can be concluded that there is 95 percent confidence that the average age of respondents was between 25.48 years to 29.67 years. The

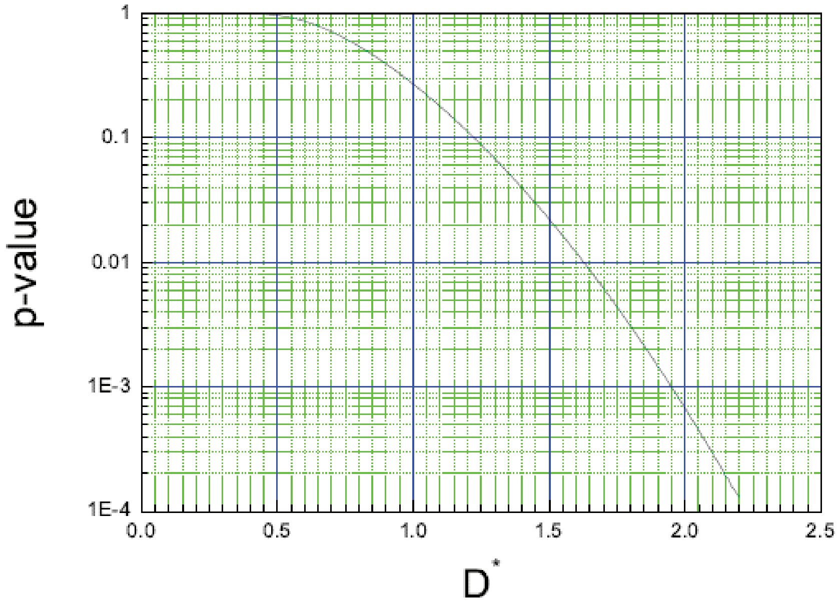


Figure 3: *P*-value as a function of the Kolmogorov statistical test of D.

Table 1: Distribution of respondents.

Variable	Mean	SD	Minimum–Maximum	95% CI	p-value of K-S Test
Age	27.57	4.6	22–39	25.48–29.67	0.084
Length of Work in Construction	3.33	2.556	0–10	2.17–4.50	0.156
Safety Climate Score	216.76	16.745	190–246	209.14–224.38	0.063
Characteristics				**Frequency**	**Percentage**
A. Sex					
Male				14	66.7
Female				7	33.3
Total				21	100.0
B. Education					
Diploma 3				5	23.8
Undergraduate				16	76.2
Total				21	100.0

result of using Kolmogorov–Smirnov normality test presented a *p*-value of 0.084 (*p*-value > 0.05), meaning that the data were normally distributed.

Fourteen men (66.7%) and 7 women (33.3%) participated in this study, giving a total of 21 respondents, Sixteen respondents (76.2%) had an undergraduate degree and 5 had a diploma degree (23.8%).

The average length of work of the respondents was 3.33 years, with a variation of 2.556 years. The shortest length of work was 0 years and the longest was 10 years. It can be concluded with 95 percent of confidence that the average length of work of respondents was between 2.17 years to 4.50 years. The result the Kolmogorov–Smirnov normality test presented a p-value of 0.156 (p-value > 0.05), meaning that the data were normally distributed.

The average safety climate score of respondents was 216.76, with a variation of 16.745. The lowest safety climate score was 190 and the highest safety climate score was 246. It can be concluded with 95 percent confidence that the average safety climate score of respondents was between 209.14 to 224.38. The result of the Kolmogorov–Smirnov normality test revealed a p-value of 0.063 (p-value > 0.05), meaning that the data were normally distributed.

3.2. Bivariate analysis

The results of the bivariate analysis of between Safety Climate Score and various variables are listed in Table 2.

Table 2: The distribution of safety climate score by sex.

Variable	Mean of Ranks	Sum of Ranks	p-value of Mann–Whitney Test
A. Age*			
B. Sex			
1. Male	10.43	146	0.55
2. Female	12.14	85	
C. Education			
1. Diploma	10.6	53	0.869
2. Undergraduate degree	11.13	178	
D. The Length of Work*			

* No significant relationships were found between safety climate score and age (p-value = 0.467) based on the correlation analysis, sex (p-value = 0.550), education (p-value = 0.869), and the length of work (p-value = 0.578).

4. Conclusions

The number of returned valid questionnaires is 21 of 22 and the response rate is 95.45. The respondents consist of 66.7 percent man and 33.3 percent women with an average of age 27.57 years old (95% CI: 25.48–29.67). Most respondents have an undergraduate degree(76.2%) while the remaining have a diploma degree (23.8%). The average length of work in construction of respondents was 3.33 years (95% CI: 2.17–4.50). of the mean safety climate score in this study is 216.76 (95% CI: 209.14–224.38). No significant relationships between safety climate score and age (p-value = 0.620), sex (p-value = 0.550), education (p-value = 0.869), and length of work in construction (p-value = 0.751) are found.

5. Suggestions

To get a more detailed picture of safety climate condition, future studies could explore the following areas [12]:

1. The important skills for project management personnel to manage construction safety.
2. Safety learning and knowledge development should not only be regarded as a transfer of knowledge from one person to another or from a kind of storage medium to someone's mind.
3. Relationships between project management personnel's skills and other key project objectives, such as time, cost, quality, and sustainability may be further researched.
4. Focus on implementing the skill development model

Employees' behavior is predicted to be improved by safety climate promotion [5] and changing culture from a negative to a positive status should be considered a prolonged process and time until the number of accidents and injuries can be decreased.

To get a more detailed picture, future studies should utilize a questionnaire that also include the following parts [12]:

1. Conceptual Skill: The ability to envision the project as a whole
2. Leadership: The ability to unite a group together and motivate it towards goals.
3. Emotional Intelligence

4. Interpersonal Skill: The ability to relate to one another
5. Technical Skill: The job-specific knowledge and techniques that are required to perform specific tasks proficiently
6. Safety Management Tasks
7. The way people behave, think, and feel about safety issues in the organization

Conflict of Interest

The authors declare that they have no competing interests.

Ethical Clearance

This research has been reviewed and approved by the Ethics Committee of UNSW Sydney.

Acknowledgment

This work was supported by UNSW Sydney and Universitas Indonesia. The author is thankful to the organizations and to those who have supported and participated in this study. Without their contribution, the data collection process in this study would not have been possible.

References

[1] Dedobbeleer, N. and Béland, F. (1991). A safety climate measure for construction sites. *Journal of Safety Research,* vol. 22, no. 2, pp. 97–103.

[2] Bohm, G. and Zech, G. (2010). *Introduction to Statistics and Data Analysis for Physicists*.

[3] Davies, F., Spencer, R., and Dooley, K. (2001). *Summary Guide to Safety Climate Tools*. Norwich: HSE Books.

[4] Smith-Jackson, T., Hindman, D., Shields, L., et al. (24–26 August 2011). *Safety Climate and Use of Fall Arrest Systems* (Paper presented at the CIB W099 2011 Conference). Washington.

[5] Cooper, M. D. and Phillips, R. A. (2000). Exploratory analysis of the safety climate and safety behavior relationship. *Journal of Safety Research*, vol. 35, pp. 497– 512.

[6] Langford, D., Rowlinson, S., and Sawacha, E. (2000). Safety behaviour and safety management: Its influence on the attitudes of workers in the UK construction industry. *Engineering, Construction and Architectural Management*, vol. 7, no. 2, pp. 133–140.

[7] Lin, S., Tang, W., Miao, J., et al. (2008). Safety climate measurement at workplace in China: A validity and reliability assessment. *Safety Science*, vol. 46, no. 7, pp. 1037–1046.

[8] Siu, O.-l., Phillips, D. R., and Leung, T.-w. (2004). Safety climate and safety performance among construction workers in Hong Kong: The role of psychological strains as mediators. *Accident Analysis and Prevention,* vol. 36, no. 3, pp. 359–366.

[9] Williamson, A. M., Feyer, A., Cairns, D., et al. (1997). The development of a measure of safety climate: The role of safety perceptions and attitudes. *Safety Science,* vol. 25, no. 1–3, pp. 15–27.

[10] Central Bureau for Statistics, 2016.

[11] Directorate of Occupational Health and Sport, Ministry of Health, 2014.

[12] Sunindijo, R. Y. (2012). *Skills for Developing Safety Climate in Construction Projects*.