THE EFFECT OF FREQUENCY AND PATTERN OF SAFETY COMMUNICATION ON SAFETY BEHAVIOR ON CONSTRUCTION PROJECTS IN SURABAYA

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ABSTRACT: Construction project in Indonesia is one of the most significant contributors to the number of work accidents. Safety communication is generally a top priority in the field, considering that the construction industry is most prone to accidents and injuries. In this study, data were collected by distributing questionnaires to 39 working groups in the Surabaya construction industry, which aims to determine the effect of the frequency and pattern of safety communication on safety behavior, consisting of safety compliance and safety participation of workers in construction projects. The results showed that safety communication occurs once a week in a workgroup. The supervisor performs safety communication with 63.80% of all members in a workgroup. Meanwhile, the average value of safety compliance in all construction projects is considered relatively high. This shows that construction workers are pretty obedient to the existing rules in construction projects. On the other hand, the average value of safety participation in the whole project is relatively low. This shows that workers still do not know the importance of safety participation in construction projects. Safety communication and supervisory out-centrality positively and significantly impact safety compliance. In addition, supervisory out-centrality also completely and greatly influences safety participation.

Keywords: Work accidents, safety communication, frequency of communication, communication pattern, supervisory out-centrality, safety compliance, safety participation

1. INTRODUCTION

Indonesia is one of the developing country. Many high-rise building and warehouse projects develop in Indonesia, especially Surabaya. Construction project development in Indonesia is one of the most significant contributors to work accidents. One of the reasons why the activities of construction projects are delayed or stopped is because the work accident happens while the construction project is going on. This points out that work safety should always become the main concern for each organization. Also, keep in mind that the human welfare and cost that need to be spent related to unsafe behavior, work accidents, and injury are not small (Newnam & Goode, 2019). Furthermore, good safety communication is needed to reduce the risk of work accidents to make the worker behave well.

Good communication can be seen from the interaction social environment, the behavior of workers, and the quality of socialization among the members of the team (Newnam & Goode, 2019). In general, safety communication is becoming the main priority in the working field, recalling that the construction industry is one of the industries with the most considerable risk for accidents and injury (Kines et al., 2010). Safety communication frequency and pattern have an essential role in the construction aspect.

The supervisor has a vital role in the construction industry (Lingard et al., 2019). The interaction between workers and supervisors significantly impacts work safety rather than a senior manager because of the higher frequency of interaction and communication (Therkelsen & Fiebich, 2004)(Zohar, 2003). A communication pattern between workers and supervisors can be analysed using Social Network Analysis (SNA). This program can be used to observe and learn the pattern of safety communication among the actors in a small group (Ordonez & Serrat, 2017). Besides that, the spread of information about work safety should be supported by an excellent communication system to build good safety behavior for the workers. Lack of knowledge about safety behavior could be one of the factors that can cause an unsafe act to happen. A study stated that the decrease in the number of workers' unsafe acts in the work field could improve the work safety in the construction project (Xu et al., 2018). Also, based on the previous studies, the research about the relationship between the frequency and the pattern of safety communication with the safety behavior is still rarely conducted. Hence, this research aims to know the importance of frequency and pattern of safety communication on worker safety behavior in the construction project and the relationship between safety communication and worker safety behavior.

2. LITERATURE REVIEW

2.1. OCCUPATIONAL HEALTH AND SAFETY

Occupational health and safety (OHS) are one of the protection measures that should be proposed for all potency that can cause hazards. This measure is also becoming a means to prevent accidents, defects, and deaths as the consequences of work accidents. Information like unsafe conditions, new regulations, and safety procedures are essential to supporting the work safety program (Andi, 2008). A suitable work safety procedure is a good start for labor safety. In addition to being a direct obstacle, accidents can cause indirect harm, such as damage to work machines and equipment, cessation of the production process for a while, damage to the work environment, and others (Suma'mur, 1981). If every potential hazards have been controlled and qualify the standards, it will contribute to a safe and healthy working environment, which in turn will reduce the risk of loss and have a good impact on increasing productivity. According to the International Association of Safety Professionals, safety is a culture, not a program. The commitment and participation from the whole line in the organization are needed to conduct and maintain an effective safety culture.

2.2. SAFETY COMMUNICATION

Communication is a process of exchanging information between individuals through a system of symbols, signs, or behavior (Marhaeni, 2009). Good communication significantly impacts the quality of the relationship in the work field (Newnam & Goode, 2019). Communication in an organization can be divided into two parts, external communication, and internal communication. An external communication, which generally happens between the organization and the public, is risk communication. On the other hand, internal communication is more likely known as safety communication (Chess et al., 1992)(Parker et al., 2001).

Safety communication is an activity where the safety information is generated and sent to the team (Lin et al., 2010). Safety communication is also a process done by the individual that knows the safety and sends it to the other. Effective safety communication among the supervisors and the workers is a two-way process that includes exchanging information (Liao et al., 2014).

Communication from supervisors to workers involves disseminating safety policies and statements, disseminating safety and risk-related information, such as analysis and prevention of hazardous actions, and providing feedback to workers on their safety performance (HSE, 2005) (Kines et al., 2010) (Olive et al., 2006). In contrast, communication from workers to supervisors is mainly related to safety interactions and reporting, where reporting safety problems and paying attention to supervisors for every action and progress (HSE, 2005) (Kines et al., 2010). In the basic, two-way safety communication has a vital role in maintaining work safety in the work field (Zhang et al., 2020). Hence, without effective communication, there is no clear and meaningful activity that can be done until it is successful (Dainty et al., 2007).

2.3. SAFETY BEHAVIOUR

According to the APA dictionary of psychology (VandenBos, 2007), safety behavior is a behavior that has been done in the relationship of individuals to minimize or prevent a disaster that is carried out. Safety behavior is significantly related to the unsafe act because every worker has a different perception of safety behavior or action. Also, each worker has different habits. According to (Borman & Motowidlo, 1993) safety behavior is divided into two types of action: compliance and participation. Safety compliance refers to the core activities that every individual needs to do to keep safety in the work field.

In contrast, safety participation describes an action that does not contribute directly to every individual safety but that do help to develop an environment to support safety. These behaviors include activities such as participating in voluntary safety activities, attending safety meeting, etc. Every individual motivated to be involved in doing the safety behavior at certain times will be more likely to perform these safety behaviors (Neal & Griffin, 2006).

2.4. SOCIAL NETWORK ANALYSIS (SNA)

Social network analysis (SNA) is a large and growing institute of research on the measurement and analysis of relational structure (Butts, 2008). Jacob Moreno first developed SNA to study social interaction in groups (Alsamadani et al., 2013). SNA can be used to study the safety communication pattern among the actors in a small group in the construction projects. Besides that, SNA also is used to improve the leader's concern about the importance of the network, know the deeper of the relation and connection, and improve the capacity of a network (Hoppe & Reinelt, 2010).

Network density is a measurement that finds the ratio of the actual relationship or existing relationship between network actors to the number of possible connections (Borgatti & Everett, 2006). The higher the density value in a network, the better the relationship between actors (Alsamadani et al., 2013). The network density can be calculated by using the Equation 1:

$$X_1 = \frac{L}{g \ x \ (g-1) \ x \ c} \tag{1}$$

Where,

X_1 = network density

L = the number of relationships that occur

g = the total number of network members (in this case, the working group)

c = highest measurement scale

Centrality can be calculated by every actor as an individual or as a whole network (Alsamadani et al., 2013). Centrality counts the total number of direct communication links between network members and other members of a network (Freeman, 1977). For the purposes of the analysis, supervisory centrality is the total number of communication links that the supervisor has with the workers in a workgroup (Lingard et al., 2019). Centrality can be counted as in-coming or out-coming. First, it represents the number of direct communication links supervisors have received from other group members. Second, it means the number of direct communication relationships supervisors have provided with other group members (Lingard et al., 2019). The Centrality can be counted by using Equations 2 and 3.

$$X_2 \ (Member \ x) = \frac{X_2 \ (Member \ x)}{(g-1)} \tag{2}$$

$$X_3 \ (Member \ x) = \frac{X_3 \ (Member \ x)}{(g-1)} \tag{3}$$

Where,

$X_2 \ (Member \ x) =$ the total number of communication links in-coming owned by supervisor (supervisor in-centrality)

$X_3 \ (Member \ x) =$ the total number of communication links out-coming owned by supervisor (supervisor out-centrality)

$(g-1)$ = total number of maximum communication links owned by the supervisor, where g is the total of network members.

3. RESEARCH METHODOLOGY

3.1. METHODOLOGY FRAMEWORK

The questionnaire method is being used in this research. This method is being used to get the information from every worker in the construction projects. The Framework of this research can be seen in Figure 1.

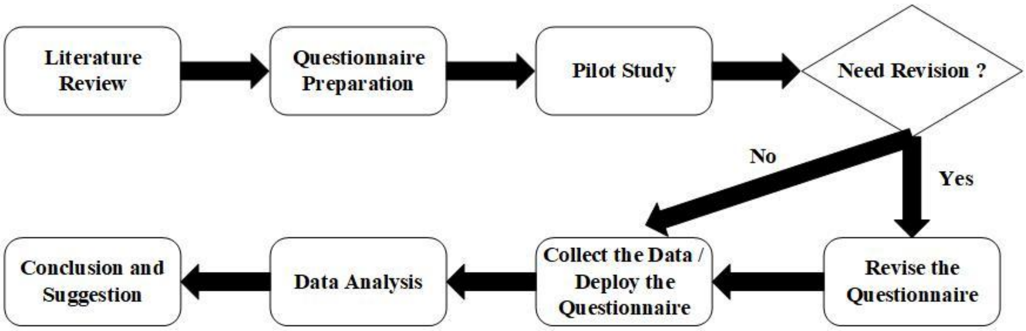

Figure 1. Methodology Framework

In the literature review, a process of researching the information and the reference about the things that are relatable to this research was conducted. The questionnaire was compiled based on the data and information obtained at the literature study stage. There are three parts: general, safety communication, and safety behavior sections.

3.2. QUESTIONNAIRE PREPARATION

The general section includes general questions about worker safety communication in construction projects. For example, the worker's name, gender, age, job, work experience, and how long they worked on the construction project.

The safety communication sections include the questions about safety communication in the construction projects. Worker safety communication questions are the frequency of safety communication between the individual, including the worker with the worker, the worker with the supervisor, or the supervisor with the worker in the work field. A safety communication pattern can also be conducted based on the communication frequency. The frequency measurement was rated on a five-point scale: " 1 = once a month", "2 = biweekly", "3 = weekly", "4 = once a day", and "5 = more than once a day.

In safety behavior section, it divided into two sections. There are safety compliance and safety participation. There were five questions to be answered for safety compliance sections (Li et al., 2018)(Korkmaz & Park, 2021). On the other hand, safety participation consists of seven questions (Li et al., 2018)(Korkmaz & Park, 2021). The scale in the safety behavior section also uses a scale of 1-5 which means strongly disagree to strongly agree. After the questionnaire preparation is finished, the pilot study is conducted to know the lack or weakness in the questionnaire. The pilot study result indicates whether the company needs to revise the questionnaire or not.

3.3. DATA COLLECTION / DISTRIBUTING QUESTIONNAIRES

Data were collected at eight construction projects in Surabaya. The sites were warehouse projects and high-rise building projects with the regulation and procedures regarding work safety in the project. Data were collected from 39 workgroups (samples) engaged across 8 sites, which contain of 342 workers and 14 supervisors. This grouping is based on the rules of the Social Network Analysis (SNA) which examines about working groups. The division of workgroups is carried out by limiting the maximum number of groups, namely 11 people per group, including supervisors. The spreading of questionnaires is done by using face-to-face distribution and purposive sampling, a sampling technique in which the researcher selects the sample by determining unique characteristics in accordance with the research objectives so that it is expected to answer research problems.

3.4. DATA ANALYSIS

In this research, there are three stages for the data analysis, data analysis from the frequency and patterns of safety communication, data analysis from safety behavior, and effect from the frequency and patterns of safety communication on safety compliance and safety participation.

3.4.1. ANALYSIS OF VALIDITY AND RELIABILITY

After the questionnaire data have been collected, an analysis of validity and reliability is conducted to know whether the data is valid or reliable to be used in this research. For analysis of validity, the equation is shown in Equation 4.

$$r_i = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum {\sigma_b}^2}{{\sigma_t}^2}\right) \tag{4}$$

Where,

r_i = Instrument reliability

k = Total of questions

$\sum {\sigma_b}^2$ = Number of data variant

From the results of the validity analysis, the researcher also conducted a reliability analysis to determine the extent of the consistency of the measurements made repeatedly on the subject and under the same conditions. For analysis of reliability, the equation is shown in Equation 5.

$$r_{xy} = \frac{n\sum_{i=1}^{n} x_i y_i - \sum_i^n x_i \sum_i^n y_i}{\sqrt{(n\sum_{i=1}^{n} x_i^2 - (\sum_{i=1}^{n} x_i)^2)(n\sum_{i=1}^{n} y_i^2 - (\sum_{i=1}^{n} y_i)^2)}} \tag{5}$$

Where,

r_{xy} = coefficient of correlation between variable X and variable Y

x_i = the *i*-th data value for the variable group X

y_i = the *i*-th data value for the variable group Y

n = the total number of data

3.4.2. ANALYSIS OF SAFETY COMMUNICATION DATA

For the analysis of safety communication data, network density, and supervisory centrality are conducted in this research. The network density is used to know the actual relation ratio between network actors and the number of possible connections. This value of network density indicates a strong or weak relationship that occurs in a group. The equation is shown in Equation 1. From this analysis, the frequency of safety communication of each workgroup will be obtained.

After getting the network density value, the researcher calculated the supervisory centrality value to determine the number of direct communication relationships between network members and other members of a network. Besides that, supervisory centrality value also can be used to know the safety communication pattern. This value of supervisory centrality indicates the role of supervisor in distributing safety communication. The equation is shown in Equations 2 and 3. From this analysis, the supervisory centrality value of each workgroup will be obtained.

3.4.3. ANALYSIS OF SAFETY BEHAVIOR DATA

After the researchers get the results of data analysis that were valid and reliable to use, the mean from data will be analysed. The safety compliance section consists of five questions. The researcher will take the mean value from each question in one working group. So, there will be five mean values from the five questions of safety compliance. Then, the researcher will take the mean value from the five questions, so the mean value from safety compliance will be obtained.

The same step also will be applied to the safety participation section. The safety participation consists of seven questions. All of the data is acquired in scale form. The researcher also will take the mean value from each question in one working group. So, there will be seven mean values from the seven questions of safety participation. Then, the researcher will also take the mean value from the seven questions, so the mean value from safety participation will be obtained.

3.5. THE EFFECT OF FREQUENCY AND PATTERN OF SAFETY COMMUNICATION ON SAFETY BEHAVIOR

After knowing the frequency and pattern of safety communication and the mean value of safety compliance and participation, the researcher will conduct a regression analysis to determine the effect of safety communication on safety compliance and participation. Regression analysis was carried out in two stages.

First, regression analysis to determine the effect of network density, supervisory in-centrality, and supervisory out-centrality on the safety compliance of each worker in the field. Second, regression analysis to determine the impact of network density, supervisory in-centrality, and supervisory out-centrality on the safety participation of each worker in the field.

4. RESULTS

4.1. PROJECT OVERVIEW

Data were collected from warehouse projects and high-rise building projects with the regulation and procedures regarding work safety in the project. The questionnaires are distributed to eight different projects, where there are seven high-rise building projects (projects A, B, C, D, E, F, and G) and one warehouse project (project H). The building process in projects A, C, G, and H is still under the structural construction process. On the other hand, projects B, D, E, and F are already in the finishing process. Therefore, the control of safety officers in the structural construction process is stricter than in the finishing process.

All of the respondents are male, and the most dominating age of respondents from the questionnaire respondent data is the age of 31-35 years (26%) and the age of 36-40 years (26%). The high school level mostly dominates the education level of the respondents studied by this researcher by 33%.

4.2. VALIDITY AND RELIABILITY ANALYSIS

The validity test was carried out using the Bivariate Pearson method through the IBM SPSS application. Using a two-way test and a significance level of 5%, the items in the questionnaire conclude to be valid if $r_{count} > r_{table\ 5\%}$. The validity test was carried out on 342 collected data. Therefore, the value of df in this test is df = N-2 or df = 340. Thus, the value of the r_{table} (340;0.05) is 0.107. All of the question from safety compliance and participation section have passed the r_{table}, hence we can conclude the data is valid and can be used. Furthermore, safety communication questionnaire items cannot be tested in terms of their validity and realibility because they were not likert scale.

The reliability of the questionnaires can be approved if the Cronbach's alpha coefficient is more than 0,6. The Cronbach's alpha coefficient for safety compliance and participation is more than the minimum value with value of 0,787 and 0,898 respectively. Hence the variables are reliable to be used in this research.

4.3. SAFETY COMMUNICATION FREQUENCY ANALYSIS (NETWORK DENSITY)

The way to get the network density value in each group is to calculate the number of relationships that occur in the group divided by the total number of network members. The network density values for each working group on the project can be seen in Table 1 and the example of safety communication frequency is shown in Figure 2.

Table 1. Value of Variables from each Workgroups

Project (1)	Workgroup (2)	Total of Workers (g) (3)	Network Density (4)		Supervisory In-Centrality (5)		Supervisory Out-Centrality (6)		Safety Compliance (7)		Safety Participation (8)	
			Value	Average	Value	Average	Value	Average	Value	Average	Value	Average
A	{1, 2, 3}	{9, 11, 11}	{0.742, 0.635, 0.636}	0.671	{0,125, 0, 0}	0,042	{1, 1, 1}	**1**	{4.325, 4.260, 4.300}	4.295	{3.438, 3.367, 3.2550}	3.351
B	{4, 5, 6, 7}	{11, 11, 11, 9}	{0.702, 0.705, 0.704, 0,706}	0.704	{0.1, 0.1, 0.1, 0,125}	**0.106**	{1, 1, 1, 1}	**1**	{3.960, 4.040, 4.000, 4.100}	4.025	{3.333, 3.400, 3.267, 3.458}	3.365
C	{8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19}	{11, 11, 11, 11, 11, 11, 11, 11, 11, 11,11, 11}	{0.735, 0.725, 0.711, 0.718, 0.625, 0.620, 0.693, 0.640, 0.744, 0.631, 0.631, 0.658}	0.678	{0.1, 0, 0, 0, 0, 0, 0, 0, 0.1, 0, 0, 0}	0.017	{1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1}	**1**	{4.160, 4.360, 4.180, 4.200, 4.300, 4.500, 4.260, 4.380, 4.180, 3.280, 4.260, 4.220}	4.190	{3.300, 2.700, 3.383, 3.450, 3.417, 3.383, 2.800, 3.350, 3.433, 3.400, 3.283, 3.400}	3.275
D	{20, 21, 22}	{11, 11, 11}	{0.529, 0.504, 0.555}	0.529	{0, 0, 0}	0.000	{0.1, 0.1, 0.1}	0.1	{3.200, 3.140, 3.340}	3.227	{2.400, 2.333, 2.567}	2.433
E	{23}	{6}	{0.600}	0.600	{0}	0.000	{1}	**1**	{3.520}	3.520	{3.500}	3.500
F	{24, 25, 26, 27, 28}	{5, 8, 5, 8, 6}	{0.460, 0.496, 0.450, 0.393, 0.373}	0.435	{0, 0, 0, 0, 0}	0.000	{0, 0, 0, 0, 0}	0.000	{2.400, 2.714, 2.650, 2.629, 2.400}	2.559	{1.667, 1.571, 1.458, 1.452, 1.467}	1.523
G	{29, 30, 31}	{11, 11, 11}	{0.700, 0.718, 0.729}	**0.716**	{0.1, 0.1, 0.1}	0.100	{1, 1, 1}	**1**	{4.340, 4.360, 4.340}	**4.347**	{3.700, 3.450, 3.400}	**3.517**
H	{32, 33, 34, 35, 36, 37, 38, 39}	{9, 9, 9, 9, 9, 9, 9, 9}	{0.447, 0.392, 0.356, 0.381, 0.433, 0.478, 0.411, 0.364}	0.408	{0, 0, 0, 0, 0, 0, 0, 0}	0.000	{0, 0, 0, 0, 0, 0, 0, 0}	0.000	{2.525, 2.600, 2.425, 2.500, 2.575, 2.425, 2.500, 2.425}	2.497	{1.583, 1.458, 1.542, 2.000, 1.417, 1.500, 1.542, 1.417}	1.557

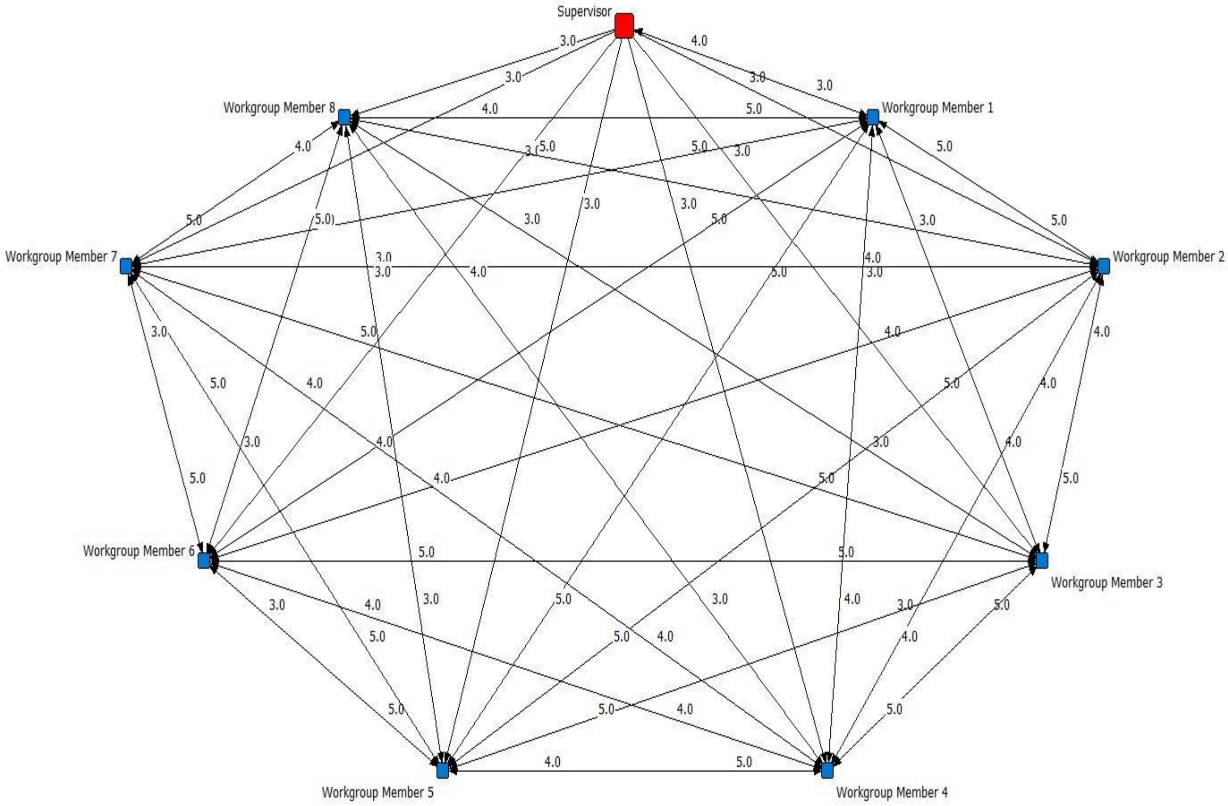

Figure 2. Example of Safety Communication Frequency in Workgroup 1

The value of network density is calculated with using Equation 1. Table 1 in column 4 explained that the project G has the highest average value of network density with 0.716. This value indicates that safety communication/safety information exchange occurred in project G more often (once a day) than other projects. Meanwhile, projects F and H have the lowest value with 0.435 and 0.408 respectively. The low average network density value was conduct once a week due to the lack of safety communication in each group, both safety communication between workers and between workers and supervisors.

If the average network density of the entire project is carried out, the average network density value is 0.592. This value indicates that safety communication occurs once a week in each group. Therefore, the relationship of safety communication that occurs in all projects in this study is quite strong.

4.4. SAFETY COMMUNICATION PATTERN ANALYSIS (SUPERVISORY IN-CENTRALITY)

Supervisor in-centrality is a safety communication calculation that happens from worker to supervisor in a workgroup. A supervisory in-centrality analysis is not concerned with the total frequency of communication but concerning on the frequency of safety communication from worker to supervisor. Based on Figure 2, can be seen that safety communication, which occurs between workers to supervisors, only one workgroup member namely workgroup member 1.

The value of supervisory in-centrality of each workgroups can be obtained by using Equation 2. The way to get the supervisory in-centrality value in each group is to calculate the total number of incoming communication links owned by the supervisor (supervisory in-centrality) divided by the maximum number of possible communication relationships that the supervisor can have.

Table 1 in column 5 explained the value of supervisory in-centrality of each workgroup. As we can see, there are 29 workgroups that do not have the value of supervisory in-centrality, which indicates that there are 29 workgroups that did not do the safety communication from worker to supervisor. Also, we can conclude that the average value of supervisory in-centrality from all projects is very low. This is because workers are passive and do not feel the need to communicate safety with supervisors.

4.5. SAFETY COMMUNICATION PATTERN ANALYSIS (SUPERVISORY OUT-CENTRALITY)

Supervisor out-centrality is a safety communication calculation that happens from supervisor to worker in a workgroup. Based on Figure 2, can be seen that safety communication, which occurs between supervisors to workers, appears in all members of workgroup 1. The value of supervisory out-centrality of each workgroups can be obtained by using Equation 3. This equation is to calculate the total number of outgoing communication links owned by the supervisor divided by the maximum number of possible communication links that the supervisor can have. The result of supervisory out-centrality is shown in Table 1 in column 6.

Based on the result from Table 1, there are 23 workgroups that have the maximum value of supervisory out-centrality. While there are 13 workgroups that have the zero value for the supervisory out-centrality. Also, the average value of all projects is 0.638, it indicates that there is an average of 63.8% where the supervisors did the safety communication to the workers. This value shows a good performance of safety communication by the supervisors. The higher the supervisory out-centrality value, the supervisor can be said to be the center of safety communication that occurs in a work group. This is also supported by research conducted by (Zhang et al., 2020) that effective safety communication involves two-way communication between supervisors and workers.

4.6. SAFETY COMPLIANCE ANALYSIS

Safety compliance analysis aims to determine the compliance of workers with safety regulations in the workplace. The result of safety compliance analysis is shown in Table 1 in column 7. The highest average value of safety compliance is the project G with value of 4.347. The high average value indicates that the workers comply with the application of safety regulations. Projects A, B, C, and G have the better value because the contractors always prioritize workers' safety to achieve zero accidents on the project.

Meanwhile, the average value of low safety compliance is in project F and project H, which is 2.559 and 2.497. This shows that project F and H workers do not comply with safety regulations. One of the reasons why project F has a low average safety compliance score is because the contractor feels that the project has entered the finishing stage, so safety is not given much attention. Meanwhile, the contractors in project H did not apply any safety at all, including personal protective equipment (PPE) to every worker.

The average value of safety compliance for all projects is 3.582, which can be considered quite good. This shows that construction workers are quite obedient to the rules in construction projects. Therefore, it can be concluded that the contractors on construction projects already apply safety regulations quite well.

4.7. SAFETY PARTICIPATION ANALYSIS

Safety participation analysis aims to determine workers' participation in safety activities. Safety participation describes the involvement of individuals in safety activities voluntarily or in attending safety meetings (Griffin & Neal, 2000). The result of the safety participation analysis is shown in Table 1 in column 8.

Through Table 1 in column 8, it is known that the highest average value of safety participation is in project G, which is 3.517. The average value indicates that the workers in project G have a high level of safety participation. The value of safety participation is related to safety communication. This is because the value of worker safety participation is assessed based on worker participation in a safety communication.

Meanwhile, the low average value of safety participation is in projects F and H, which are 1.523 and 1.557. This shows that project F and H workers have a low safety participation rate. The average value of safety participation from all projects is 2.815. The average value is still relatively low, so it can be concluded that the workers still do not have an awareness of the importance of safety participation in construction projects.

4.8. EFFECT OF SAFETY COMMUNICATION ON SAFETY COMPLIANCE AND SAFETY PARTICIPATION

4.8.1. REGRESSION ANALYSIS

Regression analysis is used to determine the effect of safety communication, which consists of network density (X_1), supervisory in-centrality (X_2), and supervisory out-centrality (X_3), on the safety compliance (Y_1) and safety participation (Y_2) of each worker in the field. The regression equation can be seen in Equations 6 and 7.

$$Y_1 = 1.311 + 3.011X_1 - 1.572X_2 + 0.874X_3 \quad (6)$$

$$Y_2 = 1.094 + 1.328X_1 + 0.390X_2 + 1.330X_3 \quad (7)$$

Simultaneous regression test (F-Test) and partial regression test (T-Test) also been conducted in this research. The simultaneous regression test (F-test) determines whether an influence is shared between the independent variables toward the dependent variables. The significant value from the F-test for Y_1 and Y_2 is 0.00, which indicates that at least one of X_1, X_2 and X_3 has a significant influence on Y_1 and Y_2.

The T-Test is to test whether each variable network density (X_1), supervisory in-centrality (X_2), and supervisory out-centrality (X_3) has a significant effect on safety compliance (Y_1) and safety participation (Y_2). The result for Y_1 is X_1, X_3, and Y_1 have a significant value under 0.05, which means the variable has a significant effect on Y_1. Meanwhile, X_2 has a significant value above 0.05 which means it is not significant. Hence, the regression equation changed to Equation 8.

The result for Y_2 from the T-test shows that the variable of X_3 has a significant value of <0.05, which indicates that $X_3$is significant on Y_2. On the other hand, the variables of X_1, and X_2 have a significant value above 0.05 which means they are not significant. Thus, the regression equation changed to Equation 9. Also, all of the variables have passed on the residual test.

$$Y_1 = 1.311 + 3.011X_1 + 0.874X_3 + e \tag{8}$$

$$Y_2 = 1.094 + 1.330X_3 + e \tag{9}$$

The coefficient of determination (R^2) was also carried out in this research. The result can be seen in Table 2.

Based on Table 2, the R-value indicates a positive relationship between Network Density (X_1), Supervisory–Out Centrality (X_3), and Safety Compliance (Y_1). The value of R^2 or the coefficient of determination shows the percentage influence of the variables X_1, and X_3 on Y_1. Therefore, the percentage contribution of the influence of variables X_1, and X_3 to Y_1 is 92.1% while other variables influence the remaining 7.9%. On the other hand, the effect of the X_3 variable on Y_2 is 91.7%, while 8.3% is affected by other variables.

Table 2. Regression Analysis

Model	Predictor	R2	F	Significance	Coefficients			
					B	SE	Beta	Significance
Model 1: Safety Communication regressed on Safety Compliance	Constant	0.921	136.45	0.000	1.311	0.39	-	0.002
	X_1	-	-	-	3.011	0.9	0.494	0.002
	X2	-	-	-	-1.57	1.07	-0.09	0.15
	X3	-	-	-	0.874	0.22	0.531	0
Model 2: Safety Communication regressed on Safety Participation	Constant	0.917	129.59	0.000	1.094	0.43	-	0.016
	X_1	-	-	-	1.328	0.98	0.203	0.185
	X2	-	-	-	0.39	1.17	0.021	0.741
	X3	-	-	-	1.33	0.24	0.755	0

4.8.2. DISCUSSION OF THE EFFECT OF SAFETY COMMUNICATION ON SAFETY

COMPLIANCE

The result of this research shows that the frequency of safety communication and supervisory out-centrality positively and significantly impact worker safety compliance. The coefficient of determination (R^2) also showed a positive relationship with 92.1%. The higher the percentage of the (R^2) of the frequency of safety communication and supervisory out-centrality, the greater the influence given to safety compliance. The importance of safety communication frequency and supervisory out-centrality is supported by (Michael et al., 2006). The frequency of safety communication and feedback from supervisors can make workers understand more about safety issues, such as work safety procedures and the correct use of safety equipment.

4.8.3. DISCUSSION OF THE EFFECT OF SAFETY COMMUNICATION ON SAFETY PARTICIPATION

On safety participation, the calculation results show that supervisory out-centrality has a positive and significant influence on worker safety participation. The coefficient of determination of supervisory out-centrality on safety participation shows a large influence of 91.7%. The results of this study are also supported by (Cigularov et al., 2010), who said that safety communication carried out from supervisors to workers (supervisory out-centrality) can provide a good educational function so that workers can understand every safety regulation and increase workers' awareness of the dangers and consequences that can occur in construction projects.

5. CONCLUSION

The frequency (network density) of safety communications for all construction projects has an average value of 0.592. This value indicates that safety communication occurs once a week for each workgroup member. Therefore, the relationship of safety communication that occurs throughout the project is quite strong.

The pattern of safety communication consists of safety communication that occurs from workers to supervisors (supervisory in-centrality) and safety communications that occur from supervisors to workers (supervisory out-centrality). Of all projects, the average supervisory in-centrality score is low because 29 groups do not have supervisory in-centrality values. Meanwhile, the highest supervisory in-centrality value was only 0.125. The low value of supervisory in-centrality indicates no safety communication from workers to supervisors. The reason is that workers are passive and do not feel the need to communicate safety with supervisors. Meanwhile, the average supervisory out-centrality in all projects is quite high, namely 0.638, which means that supervisors communicate safety to 63.80% of all members in a workgroup. The higher the supervisory out-centrality value, the more it shows that the supervisor can be the centre of safety communication in the workgroup.

Safety behavior in construction projects is divided into two parts: safety compliance and participation. The research results on 39 groups show that the average value of safety compliance in all construction projects is considered quite high, which is 3.582. This shows that construction workers are quite obedient to the existing rules in construction projects, and contractors can apply safety regulations well in construction projects.

Meanwhile, the average value of safety participation in the whole project is quite low, which is 2.815. This shows that workers still do not know the importance of safety participation in construction projects. The average value of safety participation for the entire project (2.815) is lower than the average value of safety compliance for the entire project (3.582). Therefore, it can be concluded that worker safety compliance in the project is better than worker safety participation in construction projects.

Safety communication has a significant influence on safety compliance. Communication frequency (network density) and safety communication from supervisors to workers (supervisory out-centrality) positively and significantly impact safety compliance. The results of this study's calculations indicate a strong relationship between network density and supervisory out-centrality on safety compliance, which is 92.1%. This relationship is modelled by the equation $Y_1 = 1.311 + 3.011X_1 + 0.874X_3 + e$.

In addition, safety communication also has a significant influence on safety participation. Safety communication from supervisors to workers (supervisory out-centrality) positively and significantly influences safety participation. The calculations in this study indicate the effect of supervisory out-centrality on safety participation, which is 91.7%. The relationship between supervisory out-centrality and safety participation is modelled by the equation $Y_2 = 1.094 + 1.330X_3 + e$.

With the regression method, safety communication has a significant influence on safety compliance and safety participation. It can be concluded that safety communication plays an important role in increasing safety compliance and safety participation. From the research that has been done, the researcher hopes to provide a new perspective on safety communication to form a work environment that has good safety compliance and safety participation.

In this study, there were several limitations. First, restricted by access to construction sites and busy work schedules on the sites, so the researcher quantitative data was not large enough. It is recommended that future researchers collect data from a larger number of workgroups. Second, research was conducted in warehouse project and high-rise building projects in Surabaya, the results is likely to be limited. It is suggested for future researchers conduct similar research in other type of project or in other regions, so we can conclude the frequency and pattern of safety communication in every type of projects. Finally, the research did not consider the issue of stability or turnover in group membership. Future research could focus on the stability of membership in each workgroup.

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