

## A Resilience Approach to Improving Safety Performance in Construction

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### ABSTRACT

The construction industry is recognized as having inherent risks with high levels of change and uncertainty. The complexity of this project poses a challenge to traditional safety management approaches. As an alternative, a resilience approach to traditional safety management is used, which is designed to deal with uncertainty in a high-risk work environment in the form of a resilience safety culture. This research will look at the relationship between resilience safety culture variables, and safety performance in a state-owned construction company in Indonesia using the partial least squares structural equation modeling approach. Resilience safety culture variables in this study include management commitment, reporting, learning, anticipation, flexibility, awareness, co-worker's safety perception, supervisor's safety perception, safety attitudes, understanding of risk, safety resources, and safety procedures. The results of the PLS-SEM test show that there are 9 relationships between variables that have a significant positive influence. As a significant variable that has a direct effect on safety performance, awareness is the main determining factor for improving the company's safety performance. With the significant influence of safety awareness on safety performance, there is a need to increase safety awareness to ensure consistent improvement in safety performance. It is recommended for companies to be able to increase safety awareness, one of which is through safety awareness workshops as a way to improve safety performance. The provision of this workshop is an initiative to increase the ability to anticipate and manage risk proactively which can result in an increased level of awareness of hazards and provide a deeper understanding of safety at work sites so that appropriate preventive measures can be taken to reduce the possibility of accidents or unwanted incidents. These results are expected to be used as a guideline for companies in increasing their safety performance.

## 1. INTRODUCTION

The Indonesian construction industry contributed an average of 9.94 percent to the national gross domestic product from 2015 to the third quarter of 2021. This amount is recognized as the fourth-largest share of the entire national GDP. By 2023, the construction industry is expected to employ up to 8.7 million people. However, by only contributing 9.94 percent of GDP, this industry accounts for 32 percent of the total work accident cases in Indonesia. Occupational accidents in the construction industry have an impact on the micro, meso, and macro levels. At the micro level, work accidents can cause delays in the implementation of construction projects, excess costs, and opportunity losses, resulting in fatal injuries to workers. Meanwhile, at the micro level, work accidents have an impact on the performance of construction service providers and legal liability, and at the macro level, work accidents can affect national productivity, a competitive index, so that the cost of losses is equivalent to 4 percent of GDP. In fact, today's construction companies have traditionally adopted a safety management strategy that emphasizes prevention and protection to reduce worker exposure to hazards in the work environment [1].

However, this traditional safety culture has proven to still create loopholes for work accidents in the construction industry. The existing safety culture has weaknesses by only

focusing on one dimension of it, ignoring the dynamic interactions between culture, technology, and organizational structure, trying to link the concept of safety culture with various negative events such as accidents, not recognizing the basic principles of system theory, and not considering aspects of resilience [2]. As an alternative, a resilience approach is used as a form of traditional safety management designed to deal with uncertainty in a high-risk work environment in the form of a resilience safety culture. This approach is understood as a system's ability to adjust its function before, during, or after changes and disturbances so that it can continue to carry out the necessary operations both under expected and unexpected conditions [3]. Due to the dynamic and complicated nature of construction projects, the resilience approach may be advantageous to the construction sector. Hazards can be challenging to forecast and avoid during construction projects since there are numerous stakeholders, shifting environmental factors, and unforeseen incidents. Through the encouragement of a culture of continuous learning, development, and cooperation, a resilience strategy may assist construction organizations in anticipating and addressing these difficulties [2].

The company that is the object of the study is a state-owned construction company. Currently, the company has its own safety maturity level assessment system called risk maturity level, which is used to evaluate the implementation of risk

management and is periodically measured every year. The implementation of risk management in this company is measured for its maturity level through the risk maturity level self-assessment mechanism, with the results showing a level of safety maturity of 3.89 (2021) [4]. This study will examine the relationship between resilience safety culture variables which include management commitment, reporting, learning, anticipation, flexibility, awareness, co-worker's safety perception, supervisor's safety perception, safety attitudes, understanding of risk, safety resources, and safety procedures on safety performance. The proposed strategy is formed based on this relationship, where the strategy recommendations provided are useful for improving safety in the company as the object of this study. This research will provide a strategy for companies to achieve consistently high safety performance through a resilience safety culture to reach a higher level of maturity.

## 2. THEORETICAL STUDY

Resilience, at its core involves making adjustments to performance in response to disruptive events, whether they occur before, during, or after the event. When adopting a resilience approach, the primary focus is on establishing a system that can effectively handle and recover from these disruptions. This approach involves a systematic examination and practical implementation of the concept of resilience. As a result, it encompasses various indicators and activities aimed at managing and enhancing system resilience. Rather than treating performance and safety as separate and conflicting aspects, the resilience approach seeks to align and balance them. Consequently, a higher level of resilience leads to improved safety performance and a reduction in safety incidents [3].

### 2.1 Resilience safety culture

Resilience safety culture is defined as an organizational culture that encourages safe practices to improve safety in organizations that desire cost-effective safety management by emphasizing resilience, learning, and continuous improvement that aim to achieve consistently high safety performance [2]. Adapting resilience in a safety culture refers to the awareness of the gap between work as imagined and work as done, where a bridge is made between what is done in the field and what is planned. Furthermore, because there is a gap between work as done and work as imagined, there is a need for management to learn from normal work and from daily work in the field [5].

Also, consider workers as a solution in cases where deviation occurs; think of it as an adaptation process, and give more authority to workers in making decisions. These things will change the concept of work and workers where actual work is really important for safety and job variability is an unavoidable thing where work is declared unsafe only if variability adaptation is carried out in an unsafe manner. Furthermore, workers are work experts who must be involved where their behavior reflects an attempt to adapt and equalize the hierarchy so as not to hinder worker-management communication. Adopting resilience in a safety culture will have the impact of reconciling safety and efficiency, increasing safety performance, and increasing efficiency [5].

In this study, the variables of management commitment,

reporting, flexibility, learning, awareness, anticipation and perception of safety from colleagues and supervisors will be adopted because they are said to be generally used as variables in research related to resilience in the construction industry [3]. In addition, this research also makes the variables of safety attitudes, risk understanding, safety resources, safety procedures as research variables because these factors are important elements that contribute to reduce the possibility of accidents and injuries and improved the safety performance [6].

#### 2.1.1 Management commitment

According to Chen, management commitment refers to the priority management gives to safety, especially when it conflicts with production. Safety management is an integral part of other organizational management, such as production management. In this case management commitment is influential in considering the trade-off between safety and production. In his research, Chen et al. [7] found that management commitment has the strongest impact on unsafe events, which confirms its central role in influencing the safety performance. Management plays an important role in facilitating the implementation of safety at construction sites as well as acting as a role model for safety performance [8]. Chen et al. [7] also states that supervisor safety perceptions were very important, considering the impact of management commitment on other indicators was mainly achieved through supervisor safety perceptions. Management's commitment to safety affects worker safety performance by encouraging a shared view of company safety requirements where supervisors serve as a conduit for communicating company safety goals to front-line employees and providing critical feedback on the appropriateness of their behavior. Other studies by Mullen [9] found that workers were reluctant to discuss safety issues with their superiors because when they asked for safety equipment to be provided, they were asked to provide it themselves. This results from poor management attitudes and a lack of commitment to safety, which suggests that only the simplest practice of providing the minimum safety equipment can prevent workers from performing work in an unsafe manner. This shows the important role of management commitment in ensuring the availability of safety resources [9]. Another study also found that apart from having an effect on safety performance and supervisor safety perception, management commitment also has a positive influence on safety procedures [10]. Management support in redesigning organizational procedures to improve usability and address safety priorities demonstrates the importance of management acting as a key player in reliability improvement initiatives [11].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H1: Management commitment has a positive and significant effect on safety performance.

H2: Management commitment has a positive and significant effect on supervisor's safety perception.

H3: Management commitment has a positive and significant effect on safety resources.

H4: Management commitment has a positive and significant effect on safety procedure.

#### 2.1.2 Supervisor safety perception

Supervisor safety perception refers to the extent to which a supervisor is perceived to exhibit behavior related to safety in

the workplace [7]. According to Chen's research, a supervisor's safety perception has a positive influence on learning, reporting and co-workers' safety perceptions. Management's impact on learning and reporting is achieved through the supervisor's safety perception, highlighting the important role of supervisors in promoting a good learning and reporting culture [7]. In strengthening company policies related to learning and reporting culture, this can be achieved through the role of supervisors, who practice "leading by example" by following all the safety measures expected and safety reporting actions to be practiced by frontline workers [11]. According to Sean, although workers may be reluctant to speak up about safety concerns because it challenges managerial authority, supervisor's actions may help employees more accurately assess the risk of voicing concerns about safety. By displaying their commitment to safety and taking action when issues are brought to their attention, supervisors may promote the reporting of safety events. Employee's intentions to report safety occurrences were correlated with their belief that management would pay attention and take appropriate action. As a result, supervisors who are open to safety suggestions and responsive to safety issues can assist staff in determining the risk of raising concerns about safety [12]. In her research, Intan suggested that the relationship between safety commitment at the top of the organization and the incidence of injury in the work group is fully mediated by the competency of the supervisor in safety, which emphasizes the importance of the supervisor's influence on work groups related to safety [6]. When supervisors convey concern for employee safety by valuing suggestions for improving safety, workers develop beliefs that their organization has a positive orientation toward safety, which in turn increases the probability that workers will participate in safety. It suggests that downward-directed inspirational appeals and consultations can generate strong commitment within the workers to work-related tasks [12].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H5: Supervisor's safety perception has a positive and significant effect on learning.

H6: Supervisor's safety perception has a positive and significant effect on co-worker's safety perception.

H7: Supervisor's safety perception has a positive and significant effect on reporting.

### 2.1.3 Learning

Learning culture is employees' perception of whether they are informed of past lessons and whether they can learn from past events of both successes and failures [7]. Research in the construction industry in Ontario found that a good learning culture has a significant positive effect on anticipatory abilities and co-worker's perception of safety [7]. By proactively anticipating problems, the organization can use accidents that occur in other locations as an opportunity to check whether similar problems may exist within the organization. Organizations are said to be able to make extensive use of the so-called early warning instructions that are received when there is an incident at another location [11]. Learning from injuries that occur in the workplace makes workers aware of the importance of safety in the workplace [9].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H8: Learning has a positive and significant effect on anticipation.

H9: Learning has a positive and significant effect on co-worker's safety perception.

### 2.1.4 Anticipation

Anticipation refers to whether workers on site assess the potential safety impact caused by their decision. Anticipation is focused on the process of identifying current and potential hazards and the roles of stakeholders [7]. Chen et al. [7] in his research states that awareness is a very important channel node, as it is the master node for anticipation, perception of co-worker safety, and reporting. Employees in organizations that invest in a number of initiatives at both the individual and organizational levels to increase their ability to proactively anticipate problems perceive these initiatives as good things and result in an increased level of awareness [11].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H10: Anticipation has a positive and significant effect on awareness.

### 2.1.5 Reporting

According to Chen's research on a case study in Canada, awareness is a very important channel node, as it is the master node for anticipation, perception of co-worker safety, and reporting. He found that reporting culture has a positive influence on the safety perceptions of coworkers, and a good reporting culture will increase coworker safety perceptions [7]. A good reporting culture is critical to effective risk management and an organization's ability to build resilience. This is because only through error reporting and analysis can an organization get an accurate picture of the current state of its operations and identify areas that may need attention [11]. Reports of safety concerns from workers that are properly addressed, increase the probability of worker participation in safety because workers believe that the organization has a positive orientation towards safety [12].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H11: Reporting has a positive and significant effect on co-worker's safety perception.

H12: Reporting has a positive and significant effect on awareness.

### 2.1.6 Co-worker safety perception

According to Chen, co-worker safety perception refers to a person's perception of whether co-workers follow safety rules and behave safely. In his research, Chen et al. [7] found that coworkers' safety perceptions significantly influence awareness, indicating their important role in promoting safety awareness, suggesting that communication within or between teams can enhance safety awareness at the individual, intra-team, and inter-team levels. Although managers and supervisors have more formal power in hierarchical organizations and are charged with legal and moral responsibility for safety, experienced work colleagues may be perceived as sources of referent and expert power. Coworkers are important conduits of safety information and new safety rules, and they have an important influence on worker attitudes [12]. Individuals are said to be more likely to have positive safety attitudes and work safely if they experience positive socialization influences from co-workers [9]. Intan's research reveals that social interaction with the environment is proven to help shape shared perceptions and adaptive characteristics that control behavior [6].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H13: Co-worker's safety perception has a positive and significant effect on safety attitude.

H14: Co-worker's safety perception has a positive and significant effect on awareness.

#### 2.1.7 Safety attitudes

According to Chan, safety attitudes have the most effective influence on the possibility of a high number of accidents. The probability of a high number of accidents decreased from 31.8 percent to 27.8 percent when the safety attitude value changed from average or bad to good [13]. The safety attitude of construction workers can affect the fatality rate associated with the use of cranes, heavy equipment, and other equipment [14]. Mullen's [9] research states that safety attitudes can predict a person's perception of risk at work. These findings show that a better safety attitude, better risk understanding [9]. The ability to respond to and deal with disturbances and changes was significantly related to good relationships with co-worker's perceptions of risk and information related to safety issues [15].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H15: Safety attitude has a positive and significant effect on safety performance.

H16: Safety attitude has a positive and significant effect on understanding of risk.

#### 2.1.8 Understanding of risk

According to research by Chan found that an understanding of risk is considered an effective factor for reducing the probability of a high number of accidents, with the probability of a "high" number of accidents decreasing by 2.9 percent [13]. The complexity of technology, job tasks, and organizational structures of construction projects have brought about changes and uncertainties in the nature of safety risks. This has undermined the effectiveness of traditional safety management approaches, which are largely dependent on the extent to which safety risks are known or can be made known. Therefore, understanding and anticipating the changing shape of risks before adverse events occur has the potential to significantly improve the safety performance of construction organizations [1].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H17: Understanding of risk has a positive and significant effect on safety performance.

#### 2.1.9 Safety resources

One of the most important elements of management support is investing the resources needed to implement initiatives for redesigning organizational procedures to improve usability and address safety priorities. These findings emphasize the importance of investing in resources as a key player in reliability improvement initiatives [11]. In his research, Chan found that safety resources have an influence on the possibility of a high number of accidents. The probability of a high number of accidents decreased from 31.8 percent to 29.6 percent when the safety attitude value changed from average or bad to good [13]. According to Abas, it is important to provide workers with safety equipment at construction sites to ensure safe working conditions. Applying this safety factor can reduce the number of accidents on construction projects,

increase productivity, complete projects on time, reduce compensation costs, and increase employee morale [16].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H18: Safety resources has a positive and significant effect on safety performance.

H19: Safety resources has a positive and significant effect on safety procedure.

#### 2.1.10 Safety procedure

Referring to Chan, safety procedures are considered the second most effective factor for reducing the possibility of a high number of accidents, where the probability of a "high" number of accidents decreased by 3.9 percent [13]. Intan's study also shows that safety procedures are said to need to be prepared because they play a significant role in influencing safety performance. Safety procedures are important in ensuring that potential risks are identified and addressed, and that corrective actions are taken to prevent accidents or incidents from occurring. By implementing effective safety procedures, organizations can improve their safety performance and reduce the likelihood of accidents or incidents [6].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H20: Safety procedure has a positive and significant effect on safety performance.

#### 2.1.11 Flexibility

Although it seems contradictory, stability and flexibility are said to be both necessary to achieve and maintain resilience. Organizations should be aware of when and how procedures should be strengthened and what practices should be permitted to increase local autonomy in response to operating variability. Furthermore, according to Shirali's research, it was stated that in measuring flexibility, indicators were used related to decision-making by workers without having to wait for the boss's approval when faced with a critical situation. From these indicators, it can be drawn a common thread that flexibility affects safety procedures, especially when dealing with critical situations, and whether safety procedures provide room for workers to act in the event of a dangerous situation [17].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H21: Flexibility has a positive and significant effect on safety procedure.

#### 2.1.12 Awareness

Awareness is about whether people on site are aware of potential safety hazards [7]. According to Chen's research, management commitment and awareness are two variables that have a direct impact on unsafe events, and awareness has the second strongest impact on unsafe events after management commitment [7]. In line with Chen, Mu'Awiya's research also states that there is a need to create awareness about safety issues to ensure consistent improvement in safety performance. Creating awareness on safety concerns is important because it helps to ensure that workers are informed about potential hazards and risks associated with their work environment. This knowledge can help workers to identify potential hazards and take appropriate measures to prevent accidents and injuries. When workers are aware of safety concerns, they are more likely to take safety seriously and

follow safety procedures and guidelines. This can lead to a safer work environment and reduce the likelihood of accidents and injuries [1].

The following hypotheses can be advanced based on previous research's theoretical foundation:

H22: Awareness has a positive and significant effect on safety performance.

### 3. METODOLOGY

This research was conducted using an explanatory research approach to see the relationship and influence between the independent variables and the ties that exist in the hypothesis. This research based on quantitative approach, conducted by distributing an online survey based on a Likert scale of 1–5. The sampling method used in the survey process is probability sampling with a random sampling technique. This method ensures that every member of the population has an equal chance of being selected, which helps to reduce bias and increase the accuracy of the results. This research requires at least 70 respondents to fulfill the minimum number of samples. This is because research with PLS analysis requires a minimum of 10 times the number of indicators in an independent variable with the most indicators, where in this study the independent variables with the most indicators are learning variables and safety procedures with 7 indicators. So with 89 respondents obtained from this survey, the number of respondents is said to be sufficient and has statistical power. Respondents have the requirement to be directly involved in a project at this company and have attended training or safety induction.

Before measuring and testing the structural model, preliminary data analysis will be carried out. A data homogeneity test will be carried out based on the education and work experience groups through the Kruskal Wallis test with IBM SPSS Statistics software. Based on the data obtained, it was observed that 1% of the respondents had a masters degree, 53% bachelors degree, 7% Bachelor of Applied Science degree, 10% associate degree and 29% high school degree. From the test result, that there was no difference in the views of respondents in the education group. Based on the data obtained, it was observed that respondents who had experience under 5 years were 27%, experience 6-10 years were 56%, and experience over 10 years were 17%. From the test result, that there was no difference in the views of the respondents in the work experience group.

Using SEM-PLS, inner and outer model tests will be carried out. The inner model refers to the relationship between the final variables, while the outer model refers to the relationship between the indicators and the final variables. Testing the measurement model, or outer model, focuses on testing the reliability or consistency as well as the validity or accuracy of a construct. Testing for reliability will use Cronbach alpha and composite reliability, where a construct variable is said to be reliable if it gives a Cronbach alpha value above 0.7 for confirmatory research. Whereas by using composite reliability, if it gives a value above 0.7, it can be said that the construct has acceptable reliability. In testing validity, the outer loadings and average variance extracted, or AVE value, can be used. An indicator can be declared to meet convergent validity and have a high level of validation if the outer loading value is greater than 0.7 for confirmatory research while the average variance extracted value is above 0.5 [18].

Testing the structural model, or inner model, focuses on

assessing the relationship between variables. In evaluating the relationship between variables, there are several stages, namely the path coefficient, which describes the closeness of the relationship between variables. To assess the path coefficient, you can refer to the t-test obtained from the bootstrapping results. In this study, we used two tails with a significance of 5%. With a significance of 5%, the hypothesis can be said to be proven if the t-value is above 1.96. With a value of more than 1.96 indicates a significant influence on the variable. Furthermore, the structural model test will use  $R^2$  to measure the level of variation in the independent variable as it changes to the dependent variable, and the higher the  $R^2$  value, the better the prediction model of the proposed research model. A reference value of 0.67, 0.33, and 0.19, respectively, indicates that the model is strong, moderate, or weak [19]. From the results of calculating the inner model, it will be possible to determine whether the research hypothesis can be proven or not.

### 4. ANALYSIS AND FINDINGS

#### 4.1 Analysis

Based on the results of the outer model test in Table 1, it was found that the loading value of each indicator was above 0.7, which indicated that the construct contributed more than 50% of the indicator variance, resulting in adequate item reliability. The results also show that the Cronbach alpha and composite reliability values of each construct are above the value of 0.7, which indicates that the measurement indicators are in accordance with their respective constructs.

Based on the AVE value, Table 1 shows the value of the AVE construct in this study, with the value of each variable being more significant than 0.5. Therefore, the construct on each variable is declared valid. Next is testing the structural model by looking at the value of  $R^2$ , where the  $R^2$  value of safety performance is 68%, meaning that the independent variables in this study are management commitment, anticipation, safety behavior, understanding of risk, safety resources, and safety procedures, which contribute to the safety performance variable by 68%, of which the remaining 32% are the contributions of other variables not discussed in this study.

**Table 1.** Reliability and validity test

Variable	Cronbach's Alpha	Composite Reliability	AVE
Management commitment	0.964	0.972	0.873
Reporting	0.972	0.978	0.899
Learning	0.986	0.988	0.921
Anticipation	0.961	0.97	0.864
Flexibility	0.965	0.973	0.878
Awareness	0.945	0.965	0.901
Co-worker's safety perception	0.945	0.961	0.86
Supervisor's safety perception	0.978	0.982	0.902
Safety attitude	0.927	0.948	0.819
Understanding risk	0.96	0.971	0.898
Safety resources	0.932	0.957	0.881
Safety Procedure	0.985	0.987	0.917
Safety Performance	0.974	0.976	0.716

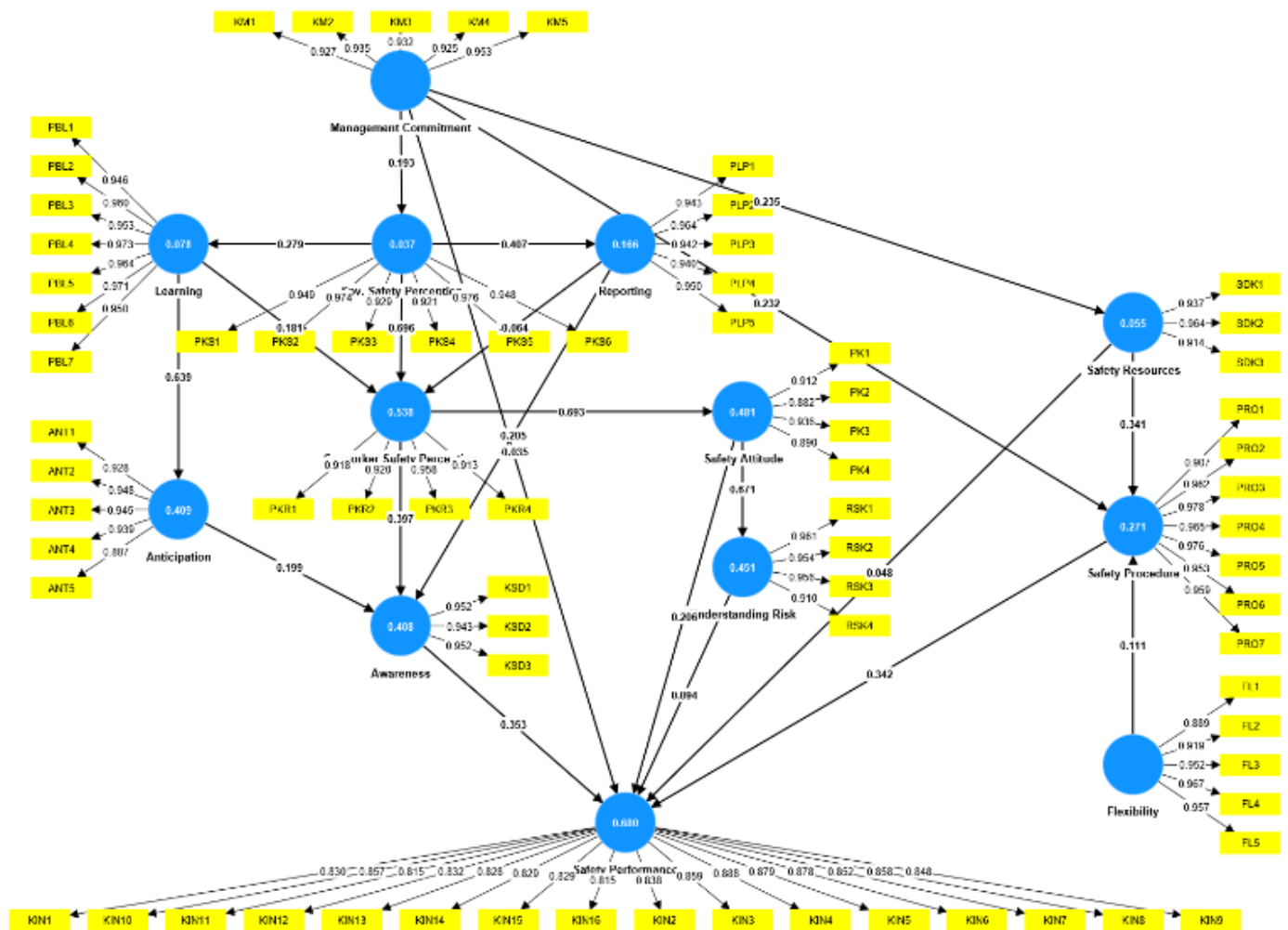


Figure 1. Loading indicator for each variable

Table 2. Hypothesis testing results

Hypothesis	Coefficient	T Statistic	Result
H1	-0.035	0.397	Not supported
H2	0.193	1.365	Not supported
H3	0.235	1.7	Not supported
H4	0.232	1.559	Not supported
H5	0.279	1.993	Supported
H6	0.696	8.293	Supported
H7	0.407	3.249	Supported
H8	0.639	6.178	Supported
H9	0.181	1.249	Not supported
H10	0.199	1.019	Not supported
H11	-0.064	0.407	Not supported
H12	0.205	0.914	Not supported
H13	0.693	7.169	Supported
H14	0.397	2.265	Supported
H15	0.206	1.828	Not supported
H16	0.671	5.662	Supported
H17	0.094	0.716	Not supported
H18	0.048	0.604	Not supported
H19	0.341	2.188	Supported
H20	0.342	1.726	Not supported
H21	0.111	0.794	Not supported
H22	0.353	2.394	Supported

The final stage is hypothesis testing, which refers to the path coefficient value. The bootstrap is used for hypothesis testing in PLS-SEM, and the results can be seen in Figure 1, which are then tabulated into Table 2. Of the 22 hypotheses, there are nine that have proven to have a significant effect with a

statistical t value above 1.96. The hypotheses that have been proven are: supervisor's safety perceptions on coworker's safety perceptions with t value 8.293, coworker's safety perceptions on safety attitude with t value 7.169, learning from anticipation with t value 6.178, safety behavior on risk understanding with t value 5.662, supervisor's safety perceptions on reporting with t value 3.249, awareness of safety performance with t value 2.394, coworker's perception of safety on awareness with t value 2.265, safety resources on safety procedures with t value 2.188, and supervisors' perceptions of safety on learning with t value 1.993.

#### 4.2 Findings

As shown in Table 2, H1 states that there is a significant positive relationship between management commitment and safety performance with a t value of 0.397. So, based on the constraints, it is proven that H1 is not supported. It can be concluded that management commitment has a negative effect on safety performance, meaning that when management commitment increases, it will weaken safety performance. H2 states that there is a significant positive relationship between management commitment and the supervisor's safety perception, with a t-value of 1.365. So, based on the constraints, it is proven that H2 is not supported. It can be concluded that management commitment has no significant positive effect on the supervisor's safety perception, meaning that higher management commitment does not affect the supervisor's safety perception much. H3 states that there is a

significant positive relationship between management commitment and safety resources, with a t-value of 1.7. It is proven that H3 does not support the relationship. It can be concluded that management commitment has no significant positive effect on safety resources, meaning that higher management commitment does not affect safety resources too much. H4 states that there is a significant positive relationship between management commitment and safety procedures, with a t value of 1.559. It is proven that H4 does not support the relationship between management commitment and safety procedures. It can be concluded that management commitment has no significant positive effect on safety procedures, meaning that higher management commitment does not affect safety procedures too much.

The differences between the findings of this study and earlier studies on H1, H2, H3, and H4 could be explained by Hossam Aboelsaad's statement regarding the current safety culture, in which management tends to make a commitment to safety without involving those in the field. The current safety culture also gives rise to a safety bureaucracy, where the process is used as the goal instead of reducing risk as the goal, which results in an accumulation of safety practices that do not contribute to risk reduction (cluttering). This cluttering has an impact on losing focus on real risks where organizations only focus on accident numbers and show compliance with the government. Then, with lots of safety practices, it creates a false sense of security in workers and wastes resources [5]. Therefore, on H1, the existing safety commitments actually make safety performance decrease because the commitments are still not right to prevent and anticipate any disturbance that occurs. So on H2, the effect of management's commitment to supervisors is low due to a lack of management in involving supervisors in the site in determining effective policies. Besides that, the low relationship between management's commitment to procedures and safety resources on H3 and H4 results from a lack of management in seeing conditions in the field, so that safety procedures and resource allocation are considered inappropriate. In addition, the different results are possible due to differences in the approach to safety performance where in previous research the reference for developing hypotheses used lagging indicators on safety performance while this study used leading indicators. Therefore, in making commitments, management needs to learn from daily work in the field so that the commitments and policies adopted are effective in improving safety performance, not just to show compliance with government regulations [5]. Management must also move from simply providing health and safety policies and codes of conduct to placing emphasis on the need for supervisors to effectively enforce health and safety measures on-site [20].

H5 stated that there is a significant positive relationship between the supervisor's safety perception and learning, with a t-value of 1.993. So, based on the restriction of limitation, it is proven that H5 is supported and the relationship between the supervisor's safety perception and learning is stronger. The conclusion is that the supervisor's safety perception positively affects the learning, meaning that the higher the supervisor's safety perception, the more useful learning they will get. H6 stated that there is a significant positive relationship between the supervisor's safety perception and the co-worker's safety perception, with a t-value of 8.293. So, based on the restriction of limitation, it is proven that H6 is supported and the relationship between the supervisor's safety perception and the co-worker's safety perception is stronger. The conclusion is

that the supervisor's safety perception positively affects learning, meaning that the higher the supervisor's safety perception, the higher the co-worker's safety perception. H7 stated that there is a significant positive relationship between the supervisor's safety perception and reporting, with a t-value of 3.249. So, based on the restriction of limitation, it is proven that H7 is supported and the relationship between the supervisor's safety perception and reporting is stronger. The conclusion is that the supervisor's safety perception positively affects reporting, meaning that the higher the supervisor's safety perception, the better reporting culture.

The three hypotheses H5, H6, and H7 are in line with Chen's findings in his research, which state that supervisors play an important role in promoting a culture of good reporting and learning as well as influencing co-workers' perceptions of safety. If workers perceive that their supervisors prioritize safety and take the time to show them the safest way to do things, it is likely that they will also prioritize safety and behave safely. By providing workers with the knowledge and skills they need to identify and report safety issues, supervisors can help to create a culture of continuous improvement. This can lead to improved safety outcomes over time, as workers become more aware of potential safety hazards and take steps to address them [7]. Therefore, it is advisable for companies to require supervisors in the field to carry out routine safety discussions with workers, both routinely and incidentally [21]. In addition, companies can also provide a reporting system that is easy to use universally and can involve workers in accident investigations [11]. Companies are also expected to be able to ask for feedback from employees regarding training programs as a form of program evaluation [22].

H8 stated that there is a significant positive relationship between learning and anticipation, with a t-value of 6.178. So, based on the restriction of limitation, it is proven that H8 is supported and the relationship between learning and anticipation is stronger. The conclusion is that learning positively affects anticipation, meaning that the higher the learning ability, the better the anticipation. The hypotheses are in line with Chen's findings in his research that a good learning culture has a significant positive influence on anticipation abilities. Individuals who have received training and education on safety-related topics are more likely to anticipate potential hazards and take appropriate measures to prevent accidents and injuries [7]. Therefore, it is advisable for companies to be able to learn from work accidents that occur both within the company and outside the company [11]. Furthermore, companies are also advised to involve workers as job executors in discussing and determining appropriate learning programs [23].

H9 states that there is a significant positive relationship between learning and co-workers' safety perceptions, with a t-value of 1.249. It is proven that H9 is not supported. It can be concluded that learning has no significant positive effect on co-workers' safety perception, meaning that higher learning does not affect co-workers' safety perception too much. The differences between the findings of this study and earlier studies on H9 could be explained by Hossam Aboelsaad's statement that the current safety culture results in an accumulation of safety practices that do not contribute to risk reduction. With so many safety practices, this creates a false sense of safety in workers. So that the existing learning does not succeed in increasing the safety perception of workers [5]. Kean Eng Koo found that due to a lack of scientific research, most of the safety training procedures carried out were based



on proven unscientific theories and norms in practice derived from unknown sources [24]. Therefore, in order for the learning to be more effective and to increase the co-worker's safety perception, it is advisable to involve workers in determining the right training program [23].

H10 states that there is a significant positive relationship between anticipation and awareness, with a t value of 1.019. It is proven that H10 is not supported. It can be concluded that anticipation has no significant positive effect on awareness, meaning that better anticipation does not affect safety awareness too much. The differences between the findings of this study and earlier studies on H10 could be explained by Hossam Aboelsaad's statement that the current safety culture creates a gap between work as imagined and work as done where management is fully responsible for providing procedures that, according to workers, are not effective because management does not know what is really happening on the site [5]. This has resulted in initiatives to increase anticipation capability that have not been able to increase levels of hazard awareness, because these initiatives are not based on what actually happens in the field. Therefore, it is recommended for supervisors who act as a bridge between management and workers to carry out toolbox meetings with workers regarding work items and risks before work, which are not command control in nature but in the form of a two-way discussion to increase safety awareness [5].

H11 states that there is a significant positive relationship between reporting and co-workers' safety perceptions, with a t value of 0.407. It is proven that H11 is not supported. It can be concluded that reporting has a negative effect on co-workers' perceptions of safety, meaning that when reporting increases, it will weaken the perceptions of safety among co-workers. H12 states that there is a significant positive relationship between reporting and awareness, with a t value of 0.407. It is proven that H12 is not supported. It can be concluded that reporting has no significant positive effect on awareness, meaning that better reporting does not affect awareness too much.

The differences between the findings of this study and earlier studies on H11 and H12 could be explained by Lekka's research related to blame culture, where it is said that in practice it is difficult to strike a balance between disciplining and blaming on the one hand. Additionally, there are cultural constraints, such as the tendency of employees to solve problems rather than report them, creating additional barriers to promoting an open reporting culture [11]. According to Sean, that employee's intentions not to report safety incidents were related to their perception that management would take no notice, and he found that employees were more likely to invest time and effort into raising a safety issue when they thought supervisors were open to suggestions [12]. This barrier would impact awareness because only through reporting and analysis can an organization get an accurate picture of the current state of its operations and identify areas that may need attention. So if the blame culture in the reporting culture can be eliminated, workers can feel more comfortable and open about reporting problems related to safety. Therefore, it is suggested that company management be able to make a commitment to eliminating blame culture [11]. Supervisors in these companies are also expected to be able to respond immediately to safety reports from workers and be open to input from workers [12].

H13 stated that there is a significant positive relationship between co-workers' safety perception and safety attitude with

a t-value of 7.169. So, based on the restriction of limitation, it is proven that H13 is supported. The conclusion is that a coworker's safety perception positively affects their safety attitude, meaning that the higher a coworker's safety perception, the better their safety attitude. H14 stated that there is a significant positive relationship between co-workers' safety perception and awareness, with a t-value of 2.265. So, based on the restriction of limitation, it is proven that H14 is supported. The conclusion is that a coworker's safety perception positively affects awareness, meaning that the higher a coworker's safety perception, the better their safety awareness.

Both hypotheses H13 and H14 are in line with previous studies by Mullen [9] and Intan showing that positive social interactions with co-workers are proven to help shape shared perceptions and adaptive characteristics that control attitude so that individuals have positive safety attitudes and do work safely [9]. Social relations with co-workers who pay attention to safety are able to shape their self-competence and readiness to face all hazards, problems, or safety risks [6]. Therefore, Chen et al. [7] suggests communication within or between teams in an effort to increase safety awareness at the individual, intra-team, and inter-team levels.

H15 states that there is a significant positive relationship between safety attitude and safety performance, with a t-value of 1.828. It is proven that H15 is not supported. It can be concluded that safety attitude has no significant positive effect on safety performance, meaning that a higher safety attitude does not affect safety performance too much. The differences between the findings of this study and earlier studies on H15 indicate that there is still room for improvement in the current safety attitude in order to significantly improve safety performance. In addition, the different results are possible due to differences in the approach to safety performance where in previous research the reference for developing hypotheses used lagging indicators on safety performance while this study used leading indicators. H16 stated that there is a significant positive relationship between safety attitude and understanding risk, with a t-value of 5.662. So, based on the restriction of limitation, it is proven that H16 is supported and the relationship between safety attitude and understanding risk is stronger. The conclusion is that safety attitude positively affects the understanding of risk, meaning that a better safety attitude leads to a better understanding of risk. The hypotheses are in line with Teresa's findings in her research that a safety attitude in responding to and overcoming disturbances and changes is significantly associated with a good relationship and an understanding of risk [15]. Therefore, it is recommended for companies to be able to increase the safety attitude by creating an excellent institutional environment, which mainly includes institutional control, safety training, and safety atmosphere, paying attention to the important role of personal safety attitude in safety management, and actively using the institutional environment and other organizational resources to jointly promote the improvement of personal safety attitude and create a positive safety culture [25].

H17 states that there is a significant positive relationship between understanding of risk and safety performance, with a t-value of 0.716. It is proven that H17 is not supported. It can be concluded that understanding risk has no significant positive effect on safety performance, meaning that a higher understanding of risk does not affect safety performance too much. The differences between the findings of this study and earlier studies on H17 indicate that the understanding of risk



within the company is still lacking and needs to be improved. In addition, the different results are possible due to differences in the approach to safety performance where in previous research the reference for developing hypotheses used lagging indicators on safety performance while this study used leading indicators. Therefore, it is recommended for companies to be able to increase their understanding of risks with training that focuses on developing a sense of risk with the intention of creating a balanced culture of risk that prevents an underestimation or overstatement of risk [26].

H18 states that there is a significant positive relationship between safety resources and safety performance, with a t-value of 0.604. It is proven that H18 is not supported. It can be concluded that safety resources have no significant positive effect on safety performance, meaning that better safety resources do not affect safety performance too much. The differences between the findings of this study and earlier studies on H18 indicate that the safety resource allocation within the company is still lacking and needs to be improved. According to Hossam Aboelsaad's statement regarding the current safety culture, in which management tends to make a commitment to safety without involving those on site, the safety resources invested by the company are not effective in improving safety performance [5]. In addition, the different results are possible due to differences in the approach to safety performance where in previous research the reference for developing hypotheses used lagging indicators on safety performance while this study used leading indicators. Therefore, it is advisable for management to see and discuss directly with workers on the site what resources are actually needed to support operations. The resource component also contains the facilities needed to carry out projects toward the effective and efficient achievement of goals and objectives through the development of zero accidents [27].

H19 stated that there is a significant positive relationship between safety resources and safety procedures, with a t-value of 2.188. So, based on the restriction of limitation, it is proven that H19 is supported and the relationship between safety resources and safety procedures is stronger. The conclusion is that safety resources positively affect safety procedures, meaning that the better the safety resources allocated, the better the safety procedures generated. This hypothesis is in accordance with Lekka's research, the allocation of necessary resources is particularly important in profit organizations, as production and safety goals can pull in opposite directions. If there is no enough resources, in case of any disturbance company may prioritize production over safety, which can lead to compromising safety procedures [11]. Bearing in mind that in responding to a disturbance, optimal resources are needed. Therefore, it is advisable to provide sufficient available resources so that safety procedures in responding to disturbances will be more effective [28].

H20 states that there is a significant positive relationship between safety procedures and safety performance, with a t value of 1.828. It is proven that H20 is not supported. It can be concluded that safety procedures have no significant positive effect on safety performance, meaning that better safety procedures do not affect safety performance too much. H21 states that there is a significant positive relationship between flexibility and safety procedures, with a t value of 0.794. It is proven that H21 is not supported. It can be concluded that flexibility has no significant positive effect on safety procedures, meaning that greater flexibility does not affect them too much.

Both hypotheses H20 and H21 can be explained through the findings of Hossam Aboelsaad, who states that the current implementation of safety culture places workers as the cause of poor safety performance where companies try and influence worker behavior with regulations and instruct workers what to do because workers are said to be unable to be trusted to carry out safety independently. This view does not provide a flexible space for workers to respond to disturbances in their safety procedures when faced with critical situations. This is contrary to the concept of resilience and safety culture, which considers workers as a solution [5]. The actions of workers in giving opinions regarding safety issues need to be given legal protection, as workers in many countries in North America and Europe have a legal right to refuse work that poses an imminent danger to life [12]. In addition, the different results are possible due to differences in the approach to safety performance where in previous research the reference for developing hypotheses used lagging indicators on safety performance while this study used leading indicators. Therefore, it is suggested that the company can apply a resilience safety culture to give employees the authority to stop work if they are faced with a critical condition and also the authority to refuse to work if the equipment provided is inappropriate [29]. Companies are also advised to be able to authorize workers and staff in the field to use spare resources immediately to respond to disturbances [28].

H22 stated that there is a significant positive relationship between awareness and safety performance, with a t-value of 2.394. So, based on the restriction of limitation, it is proven that H22 is supported and the relationship between awareness and safety performance is stronger. The conclusion is that awareness positively affects safety performance, meaning that better awareness leads to better safety performance. The hypotheses are in line with Chen's findings in his research that awareness is a variable that has a significant direct positive impact on unsafe events [7]. Mu'Awiyah's research also states there is a need to create awareness about safety issues to ensure consistent improvement in safety performance. Therefore, it is recommended for companies to be able to increase safety awareness, one of which is through safety awareness workshops, as a way to improve safety performance. The provision of a safety awareness workshop program that employees are encouraged to attend contributes to the depth and breadth of understanding about safety [11]. Where in increasing safety awareness at the individual, intra-team, and inter-team levels it is necessary to have communication within or between teams [7]. This workshop also needs to be supported by providing comprehensive information regarding the items and work risks as well as the equipment to be used, because information is important in maintaining awareness of safety issues and supporting the ability to anticipate these problems.

## 5. CONCLUSIONS

This study found that safety awareness is a variable that influences safety performance in this company. Therefore there is a need to create awareness on safety issues to ensure consistent improvement in safety performance. Companies need to make efforts to increase awareness of safety, so that the company's safety performance can improve consistently.

Based on the analysis that has been done, this study has several important conclusions. First, the results of data

analysis with PLS-SEM showed that all variables were declared valid and reliable. Not all proposed hypotheses were accepted; there were nine proposed hypotheses that were accepted. Hypotheses that were supported includes the supervisor's safety perception that significantly affects the coworker's safety perception, learning and reporting. Learning that significantly affects anticipation capability. Safety attitudes that significantly affect risk understanding. Awareness that significantly affects safety performance. Safety resources that significantly affect the safety procedure.

Second, 13 other proposed hypotheses were not accepted includes management commitment that has been proven to not significantly affect safety performance, supervisor's safety perception, safety resources and safety procedure. Learning that does not significantly affect the co-worker's perception of safety. Anticipation that does not significantly and positively affect awareness. Reporting that has been proven to not significantly affect co-workers' safety perceptions and safety awareness. Safety attitude that does not significantly affect safety performance. Understanding risk that does not significantly affect safety performance. Safety resources that do not significantly affect safety performance. Safety procedure that does not significantly affect safety performance. Flexibility that not significantly affect the safety procedure.

Third, the main determining factor for improving the safety performance of this company is awareness. Awareness has a significant direct positive influence on the safety performance of this company. This study provides research recommendations to the companies based on the main determinants that improve safety performance through added safety awareness. The company needs to develop a program to improve safety awareness. It is recommended for companies to be able to increase safety awareness, one of which is through safety awareness workshops as a way to improve safety performance, which workers are encouraged to attend and contribute to the depth and breadth of their understanding of safety risk. It is recommended to facilitate all workers, both experienced and not, to carry out safety discussions within or between teams in safety awareness workshops by providing comprehensive information regarding items and the risks of their work and equipment to be used in work as the topic of discussion. The provision of this workshop was part of an initiative in increasing the ability to anticipate and manage risk in a proactive way that resulted in an increased level of hazard awareness and a greater understanding of safety on the job site.

As a limitation of the research, the object of this research is a state-owned construction company, therefore it is suggested for further research to explore this resilience approach for private construction companies operating in Indonesia.

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