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Analysis of Safety Climate in Construction of Coal Fired Steam Power Plant (CFSP) X with Capacity 2x1000 MW

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ABSTRACT

Introduction: Power plant construction process is complex with a lot of labor, machines and flammable materials, and the work carried out has high risk such as lifting, working at height, hot work such as welding, grinding, cutting and other activities that have a high risk.

Objective: The objective of the research is to find out the overall picture of Work Safety Climate at CFSP X and picture of Safety Climate at the Work and Personal level.

Method: The design of this research is quantitative method, 58 questions by Zou & Sunindijo's Safety Climate framework in research of Fatma Lestari, et, al. 2020.

Result: The description of the working Safety Climate of CFSP X from 6 Dimension of Safety Climate are, Management Commitment mean is 3.92, Communication mean is 3,91, Training mean is 3,89, Personal Accountability mean is 3,87, Rule and Safety Procedure mean is 3,92, Supportive Environment mean is 3,90. The description of the Safety Climate at work and personal levels is good, with scores for all dimensions more than >3.30. There were 3 statements that received disagree answer from several respondents, which are: I report people who ignore safety procedures, 23 respondents, my responsibility is to work safely, including reporting colleagues who are not working safely, 5 respondents. There are punishments for unsafe behavior, 14 respondents. The Safety Climate dimension with the highest score is Management Commitment and Roles & Safety Procedure.

Conclusion: The description of the Work Safety Climate, both at work and personal level, is good with score of more than >3.30. Disagree answer from several respondents was related to not wanting to report people who ignore safety procedures because there is punishment for unsafe behavior. The Safety Climate dimension with the highest score is Management Commitment, and for work attributes, both work and personal, Management Commitment and Rule & Safety Procedure dominate the highest average score.

Keywords: Safety Climate; Analysis; Construction Coal Fired Steam Power Plant 2X1000 MW

INTRODUCTION

The Government of the Republic Indonesia create a program to build a 35,000 MW Power Plant in 2015. CFSPP X as a company engaged in power generation contributed to the construction and management of the 35,000 MW electricity supply project distributed on the Java-Bali transmission line (1). The provision of electric power is not only useful, but also dangerous so that its supply and utilization must pay attention to electricity safety provisions (2). 61% of Indonesia's electricity sources come from coal fired steam power plants (3).

Project activities are temporary activities that take place for a limited period of time, with a certain allocation of resources and are intended (4). The construction power plant process are complex with a lot of labor, machinery and flammable materials, and the work carried out has high risks such as lifting, working at height, hot work such as welding, drilling, cutting, and other activities that have high risks. Various heavy equipment is used such as Cranes, Excavators, Borepile machines, Dump Trucks and various other equipment, where to operate it requires special expertise and licenses from the government. To avoid all forms of risks that will occur both naturally and in employment, risk management is needed in managing uncertainty related to the threat of a construction activity (5).

In process of construction, work accidents can occur from minor injuries to the fatality, as recorded in the construction of the CFSPP 2x1000 MW Batang in 2019 project workers died while carrying out construction work, welding subsea pipes by project workers. (<https://jateng.antaranews.com/berita/248765/pekerja-di-PLTU-batang-tewas-saat-mengelas-pipa-di-dasar-laut>)

Another accident was recorded, which is a work accident that fell from a height, from the 19th floor and suddenly died, while carrying out construction work on the CFSPP 1 Muara Enim, South Sumatra, Wednesday, May 7, 2023 (<https://www.detik.com/sumut/berita/d-6707889/ngeri-pegawai-PLTU-sumsel-tewas-jatuh-19-lantai-saat-bekerja>). The potential for fire can be sourced from technical problems such as the large number of flammable materials (6). Fires at power plants, especially CFSPP (Coal Fired Steam Power Plant) have occurred several times, such as, Java-Bali Power Plant Company has a fire case in 2016, as a result of the fire incident several areas were harmed by the loss of production time between 2 days to 5 days (7).

The construction of the CFSPP X with a capacity of 2x1000 MW has implemented a health and safety management system that complies with national and international standards such as IFC (International Finance Corporation), Performance Standard and also ISO 45001. The company is aware that risks in its power generation units can occur, so it requires action to mitigate these risks. The construction of a CFSPP X 2x1000 MW that will supply electricity needs in Java-Bali is included in the national strategic project that is of concern to the central and regional governments. The company is committed to making the environmentally friendly power plant, several technologies are used such as Ultra Supercritical, SCR (Selective Catalyst Reduction), ESP (Electrostatic Precipitator) and FGD (Flue Gas Desulphurization). In general, the CFSPP process starts from the transfer of coal that will be burned to heat the boiler, then the boiler steam will rotate the turbine shaft or stator connected to the Generator, the mechanical energy will be converted into electrical energy and will be flowed through the Transformer to the Substation owned by PLN (Perusahaan Listrik Negara or State Electricity Company). The power plant is operated by the Operation & Maintenance (O&M) department, spread across all parts of the plant process, both operators and maintenance teams.

The implementation of the safety and health management system has been carried out as best as possible and is periodically audited by third parties, but work accidents, especially first aid, still occur. Recorded data on work accidents, especially minor accidents, such as First Aid & Property Damage.

The research questions are, 1) What is the picture of Safety Climate in the construction project of CFSPP X with a capacity of 2x1000 MW?, 2) What is the picture of the Safety Climate at the level of Job based on work attributes Position and Department? , 3) What is the picture of Safety Climate at the level Personal based on work attributes Age, Gender, Education or Training and Experience?

This research aims to get a picture the Occupational Safety Climate in the construction project of CFSPP X with a capacity of 2x1000 MW. Knowing the Safety Climate at level of Job based on work attributes (Position, Department) and level of Personal based on work attributes (Age, Gender, Education and Experience). The Safety and Health Management System is part of the company's overall management system in the context of controlling risks related to work activities (8). The Safety and Health Management System based on Government Regulation No. 50 of 2012 is an obligation set by the state as a form of protection for the workforce. Safety Climate is defined as a summary of the basic perception that employees have about their work environment (9). Workers' perceptions of the work environment and how safety management is implemented on the job site (Hahn & Murphy, 2008). While the latest WorkCover Queensland, 2019 defines the safety climate as the perceived value on safety in an organization at a certain point in time. The concepts of Safety Climate and Safety Performance are related to each other. The better the Safety Climate will encourage a person to obey safety procedures so that it becomes an effort to prevent himself from having an accident. The "Unsafe" activities or behaviors can be used as indicators in the occurrence of work accidents (10). Several studies to find out the relationship between Safety Climate and Safety Performance, Safety

Climate can be a variable that can predict Safety Performance, in addition to being able to predict Safety Behavior and Injury Rate (11).

Organizational Safety Climate is a specific type of individual perception and safety value in the work environment (12). A study of firefighters conducted by Smith and team in 2019 showed significant differences to the Organization's Safety Climate. The results of Safety Climate measurements are described by individuals down to the organizational level to describe the measurement of safety culture (13). Safety Climate measurements show the relationship between Safety Climate and individual age, based on cross sectional research, it was found that younger workers tend to have more work accidents (14). In a study conducted on the construction sector in Indonesia in 2020, Lestari, et.al, used the Mixed Method Research Methodology where the diversity of Safety Climate dimensions used a framework developed by Zou and Sunindijo. There are six dimensions of safety in this study, 1) Management Commitment, 2) Communication, 3) Rules and Procedures, 4) Supportive Environment, 5) Personal Accountability, 6) Safety Training. The researcher uses 6 dimensions as stated in Fatma Lestari's research. The model of personal relationship attributes and values of Safety Climate such as, Age, Type of Age, Experience, and Education (15). The individual-centered research measured by Safety Climate (16).

METHOD

Research methods can be interpreted as a scientific way to obtain valid data with the aim of obtaining, discovering, and developing knowledge (Sukardi, 2018). The design of this study is a quantitative method (Anshori, 2019). The study will use a questionnaire to determine the safety climate of work at the construction stage of the construction of the CFSPP X with a capacity of 2x1000 MW. The research was carried out in the construction project of CFSPP X, with a capacity of 2x1000 MW located in Suralaya, Cilegon and the research period was carried out from mid-April to May 2024. The population (2,389 people) is all workers involved in the construction of CFSPP X with a capacity of 2x1000 MW, Suralaya, Cilegon Banten. In this study, the sample used to observe the Safety Climate of work is personnel of the construction project of CFSPP X from the Civil, Mechanical and Electrical departments. In this study, the researcher used simple random sampling, which is taking sample members from the population randomly without paying attention to the strata in the population (Sugiyono, 2017). The calculation of the number of samples using the Slovin method with a confidence level of 95%, and an error rate of 5% (17) is:

Slovin formula:

$$n = \frac{N}{1 + N(e)^2}$$

n = sample size
 N = population size
 e = maximum error limit tolerated in the sample
 $= 2,389 / (1+(2,389 \times (0,05 \times 0,05)))$
 $= 2,389 / (1+(2,389 \times 0,0025))$
 $= 2,389 / (1+5,9725)$
 $= 2,389 / 6,9725$
 $= 342 \text{ sampel rounded up to } 350 \text{ samples}$

RESULT

The research uses data obtained from a questionnaire of 58 questions in the Safety Climate of Zou & Sunindijo framework in the research of Fatma Lestari, et.al. 2020. The questionnaire in this research is divided into two parts, the first part is about respondent's personal data, Respondent Name, Gender, Age, Education, Experience, Position, Department, the second part is 58 questions from 6 dimensions of Safety Climate.

The description of 354 respondents on the construction of CFSPP X with a capacity of 2x1000 MW is as follows:

- Position

Civil	95 respondents
Worker	267 respondents
Mechanical	139 respondents
Supervisor	66 respondents
Electrical	120 respondents
Manager	21 respondents
- Department

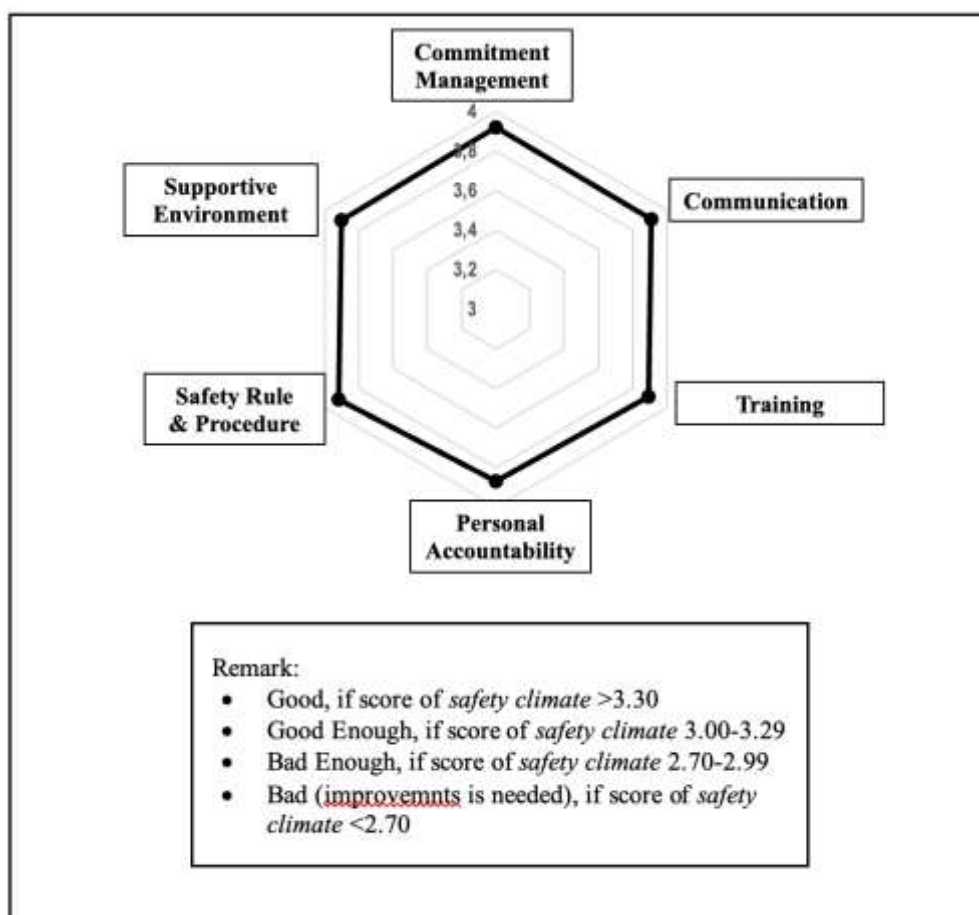
Age	18-24 years old	79 respondents
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25-34 years old	150 respondents	JHS	23 respondents
35-44 years old	87 respondents	SHS	238 respondents
45-54 years old	31 respondents	College	89 respondents
• Gender		• Experience	
Man	337 respondents	0-4 years	103 respondents
Woman	17 respondents	5-9 years	124 respondents
• Education		10-14 years	85 respondents
Elementary School	6 respondents	15-19 years old	42 respondents

Results of CFSP X Safety Climate Overview

Table 1. Results of Safety Climate Overview in Construction of CFSP X

Variable	N	Mean	Standard Deviation
Management Commitment	354	3,92	0,178
Communication	354	3,91	0,189
Training	354	3,89	0,234
Personal Accountability	354	3,87	0,201
Safety Rules and Procedures	354	3,92	0,180
Supportive Work Environment	354	3,90	0,186



Web-Chart 1 Overview of Safety Climate in CFSP X

Results of the Work Level of Safety Climate Overview

Safety Climate at the work level is divided into 2 parts of work attributes, which are: Position and department

Position

Work attributes, the respondent's position is one of the components that can describe the Safety Climate at the job level at CFSPX. The positions studied in the construction of CFSPX are divided into three groups, which are: 1) Workers, 2) Supervisors, 3) Manager

Table 2. Overview of Safety Climate Level Jobs based on Work Attributes Position

Variable	N	Average	Standard Deviation
Management Commitment			
Worker	267	3,93	0,163
Supervisor	66	3,86	0,226
Manager	21	3,92	0,144
Communication			
Worker	267	3,92	0,179
Supervisor	66	3,88	0,227
Manager	21	3,88	0,182
Training			
Worker	267	3,9	0,214
Supervisor	66	3,86	0,287
Manager	21	3,84	0,282
Personal Accountability			
Worker	267	3,88	0,187
Supervisor	66	3,84	0,243
Manager	21	3,82	0,211
Safety Rules and Procedures			
Worker	267	3,93	0,165
Supervisor	66	3,81	0,238
Manager	21	3,94	0,109
Supportive Work Environment			
Worker	267	3,92	0,165
Supervisor	66	3,85	0,247
Manager	21	3,85	0,182

Department

Departments of the respondents were divided into three, which are, 1) Civil, 2) Mechanical, 3) Electrical. The Safety Climate Overview, which describes the 6 Dimensions of Safety Climate, displays the mean value of each dimension as follows:

Table 3. Overview of Safety Climate Level Occupation based on Departmental Work Attributes

Variable	N	Average	Standard Deviation
Management Commitment			
Civil	95	3,92	0,181
Mechanical	139	3,96	0,124
Electrical	120	3,87	0,214
Communication			
Civil	95	3,91	0,169
Mechanical	139	3,96	0,146
Electrical	120	3,86	0,232
Training			
Civil	95	3,81	0,240
Mechanical	139	3,95	0,160
Electrical	120	3,84	0,281
Personal Accountability			

Variable	N	Average	Standard Deviation
Civil	95	3,79	0,224
Mechanical	139	3,92	0,143
Electrical	120	3,84	0,224
Safety Rules and Procedures			
Civil	95	3,99	0,148
Mechanical	139	3,97	0,143
Electrical	120	3,87	0,224
Supportive Work Environment			
Civil	95	3,89	0,198
Mechanical	139	3,96	0,109
Electrical	120	3,85	0,226

Age

Table 4. Overview of Personal Level Safety Climate Based on Age at CFSP X

Variable	N	Average	Standard Deviation
Management Commitment			
18-24 Years	79	3,89	0,218
25-34 Years	150	3,93	0,162
35-44 Years	87	3,91	0,181
45-54 Years	31	3,96	0,106
>55 years and above	7	3,92	0,210
Communication			
18-24 Years	79	3,88	0,219
25-34 Years	150	3,92	0,189
35-44 Years	87	3,90	0,183
45-54 Years	31	3,94	0,128
>55 years and above	7	3,98	0,042
Training			
18-24 Years	79	3,84	0,257
25-34 Years	150	3,92	0,217
35-44 Years	87	3,87	0,236
45-54 Years	31	3,91	0,235
>55 years and above	7	3,88	0,226
Personal Accountability			
18-24 Years	79	3,83	0,211
25-34 Years	150	3,90	0,178
35-44 Years	87	3,84	0,224
45-54 Years	31	3,90	0,193
>55 years and above	7	3,92	0,159
Safety Rules and Procedures			
18-24 Years	79	3,89	0,212
25-34 Years	150	3,95	0,149
35-44 Years	87	3,91	0,209
45-54 Years	31	3,94	0,131
>55 years and above	7	3,90	0,188
Supportive Work Environment			
18-24 Years	79	3,88	0,174
25-34 Years	150	3,92	0,175
35-44 Years	87	3,88	0,215
45-54 Years	31	3,92	0,187
>55 years and above	7	3,96	0,075

Gender**Table 5.** Overview of Personal Level Safety Climate Based on Gender at CFSP X

Variable	N	Average	Standard Deviation
Management Commitment			
Man	337	3,92	0,167
Woman	17	3,81	0,311
Communication			
Man	337	3,92	0,180
Woman	17	3,82	0,312
Training			
Man	337	3,89	0,224
Woman	17	3,83	0,382
Personal Accountability			
Man	337	3,87	0,192
Woman	17	3,79	0,330
Safety Rules and Procedures			
Man	337	3,93	0,172
Woman	17	3,85	0,305
Supportive Work Environment			
Man	337	3,91	0,168
Woman	17	3,80	0,398

Education**Table 6.** Overview of Personal Level Safety Climate Based on Education at CFSP X

Variable	N	Average	Standard Deviation
Management Commitment			
Elementary School	6	3,93	0,135
Junior High School	23	3,92	0,123
Senior High School	236	3,93	0,174
College/University	89	3,89	0,199
Communication			
Elementary School	6	4,00	0,000
Junior High School	23	3,94	0,129
Senior High School	236	3,92	0,175
College/University	89	3,87	0,233
Training			
Elementary School	6	3,96	0,081
Junior High School	23	3,92	0,116
Senior High School	236	3,90	0,205
College/University	89	3,84	0,315
Personal Accountability			
Elementary School	6	3,89	0,074
Junior High School	23	3,85	0,167
Senior High School	236	3,88	0,186
College/University	89	3,84	0,245
Safety Rules and Procedures			
Elementary School	6	4,00	0,000
Junior High School	23	4,00	0,000
Senior High School	236	3,93	0,160
College/University	89	3,88	0,240
Supportive Work Environment			

Variable	N	Average	Standard Deviation
Elementary School	6	3,95	0,054
Junior High School	23	3,95	0,095
Senior High School	236	3,92	0,150
College/University	89	3,84	0,266

Experience

Table 7. Overview of Personal Level Safety Climate Based on Work Experience at CFSP X

Variable	N	Average	Standard Deviation
Management Commitment			
0-4 Years	103	3,90	0,217
5-9 Years	124	3,93	0,154
10-14 Years	85	3,91	0,182
15-19 Years	42	3,96	0,115
Communication			
0-4 Years	103	3,89	0,232
5-9 Years	124	3,93	0,156
10-14 Years	85	3,89	0,202
15-19 Years	42	3,95	0,113
Training			
0-4 Years	103	3,84	0,289
5-9 Years	124	3,92	0,182
10-14 Years	85	3,88	0,243
15-19 Years	42	3,90	0,177
Personal Accountability			
0-4 Years	103	3,85	0,213
5-9 Years	124	3,91	0,143
10-14 Years	85	3,82	0,257
15-19 Years	42	3,90	0,153
Safety Rules and Procedures			
0-4 Years	103	3,91	0,199
5-9 Years	124	3,94	0,141
10-14 Years	85	3,89	0,227
15-19 Years	42	3,95	0,110
Supportive Work Environment			
0-4 Years	103	3,90	0,201
5-9 Years	124	3,93	0,132
10-14 Years	85	3,85	0,247
15-19 Years	42	3,90	0,107

DISCUSSION

The results of the Safety Climate research of 58 questions from 6 dimensions using a likert scale of 1-4. The overall score for the Safety Climate assessments are:

- ✓ Good, if the Value > 3.30
- ✓ Good enough, if the score is 3.00 – 3.29
- ✓ Bad enough, if the value is 2.70 – 2.99
- ✓ Bad (urgently needed improvement), if the value < 2.70

Overview of Safety Climate at Work Level at CFSP X

The results of the Safety Climate overview at the organizational level in the construction of CFSP X with a capacity of 2x1000 MW, were obtained based on the average results obtained from 354 respondents as a whole. The average value of the organization's level Safety Climate is 3.90 which means "Good".

The highest variable was in the dimension of Management Commitment and Safety Regulations & Procedures with an average score of 3.92. This needs to be maintained because it shows that all respondents agree with the importance of Management Commitments and Safety Procedures to be implemented.

However, there were still 36 respondents who answered disagree (DA) and 2 respondents answered strongly disagree (SDA) with several statements contained in the Safety Climate questionnaire.

Table 8. Respondents Who Answered Disagree

NO	DIMENSION	DA	SDA
1	Management Commitment	1	-
2	Communication	-	-
3	Training	6	-
4	Personal Accountability	40	1
5	Safety Rules and Procedures	-	-
6	Supportive Work Environment	25	1

The statements from the Safety Climate questionnaire that were disagreed by the most respondents are:

Table 9. The Most Statements that Respondents Disagree

No.	Statement	Disagree
Personal Accountability Dimension		
31	I report people who ignore safety procedures.	23 Respondents
35	My responsibility is to work safely, including reporting coworkers who are not working safely.	5 Respondents
Supportive Environment Dimension		
47	There is a penalty for behaving insafely	14 Respondents

It can be seen that there are still workers who are reluctant to report their people or colleagues when ignoring work procedures, this is because there is a punishment for behaving unsafe work.

Overview of Safety Climate level Work at CFSP X

An overview of the Safety Climate at the work level at CFSP X is obtained based on the average results of the Safety Climate which is divided into 2, which are, 1). Position/Position, 2). Department.

Overview of Safety Climate level Job based on work attributes Position

Overview of Safety Climate based on Position in the construction of CFSP X with a capacity of 2x1000 MW is divided into 3 (three), which are, 1). Workers, 2). Supervisor, 3). Manager.

- The variable Management Commitment got the highest score of 3.90
- For those who answered disagreed were 31 respondents from workers and 5 supervisors, but the manager level all answered yes.

This shows that Management Commitment has an important role in the implementation of Occupational Safety and Health in the company and affects the position under it.

Overview of Safety Climate level Jobs based on Departmental work attributes

Overview of Safety Climate by Department in the construction of CFSP X with a capacity of 2x1000 MW is divided into 3 groups, which are, 1). Civil, 2). Mechanical, 3). Electrical.

- In Procedure and Regulation Variables, the highest average score was 3.94

- On average, the Safety Climate score of the Mechanical department is the highest of 3.95 from the Civil and Electrical departments, but for the answer to disagree, it is dominated by the Civil team with a total of 18 respondents, mechanical 10 respondents, and Electrical 8 respondents.
- Safety Procedures and Regulations aim to create safe working conditions and can form a safety culture so that the safety climate will be good.

Overview of Personal level Safety Climate at CFSPP X

Overview of Safety Climate at the personal level in the construction of CFSPP X with a capacity of 2x1000 MW obtained the average yield value which has been divided into 4 (four) groups, which are, 1) Age, 2) Gender, 3) Education, 4) Experience.

Overview of personal level Safety Climate based on work attributes Age at CFSPP X

Overview of Safety Climate by Age in the construction of CFSPP X with a capacity of 2x1000 MW is divided into 5 groups, which are, 1). 18-24 years, 2). 25-34 years old, 3). 35-44 years old, 4). 45-54 years, 5). >54 years.

- In the Management and Communication Committee variable, the highest average score was 3.92 out of 5 other dimensional variables.
- On average, the Safety Climate score of the 45-54 age group was the highest (3.93) of other groups.
- However, the disagreement answer was dominated by the age group of 35-44 years with a total of 14 respondents, 25-34 years old with a total of 11 respondents and 18-24 years old with 10 respondents.
- This shows that age maturity has an effect on the perception of safety and in the older group tends to have a good perception of safety.

Overview of Safety Climate at personal level based on work attributes Gender

Overview of Safety Climate by Gender in the construction of CFSPP X with a capacity of 2x1000 MW is divided into 2 groups, which are, 1). Male 2). Woman.

- The Safety Regulations and Procedures variable had the highest average score of 3.89
- On average, the safety climate score of the male gender was the highest (3.9), but the answer to disagree was dominated by men with a total of 34 people answering disagree (DA).

Overview of Safety Climate at the personal level based on work attributes Education

Overview of Safety Climate by Gender in the construction of CFSPP X with a capacity of 2x1000 MW is divided into 4 groups, which are, 1) Elementary School, 2) Junior High School, 3) Senior High School, 4) College/University.

- The Safety Regulations and Procedures variable got the highest average score of 3.95.
- On average, the Safety Climate score of Elementary School was the highest (3.95), but the answer to disagree was dominated by the senior high school group with a total of 20 respondents, junior high school 8 respondents, college/university a total of 6 respondents and elementary school 2 respondents.
- In the work attribute of Education, Safety Regulation and Procedure gets the highest average score, Safety Procedures and Regulations aim to create safe working conditions, and can form a safety culture so that the safety climate will be good.

Overview of personal level Safety Climate based on work attributes Experience

Overview of Safety Climate based on Experience in the construction of CFSPP X with a capacity of 2x1000 MW is divided into 4 groups, which are, 1) 0-4 years 2) 5-9 years, 3) 10-14 years, 4) 15-19 years old.

- In the Management Committee variable, the highest average score was 3.93.
- On average, the 5-9 years of experience Safety Climate score was the highest (3.92), but for the disagreement answers, it was dominated by the 10-14 years group with a total of 14 respondents, 0-4 years old 11 respondents, 5-9 years old 9 respondents, and 15-19 2 respondents.

CONCLUSION

The overview of the occupational safety climate, both at the Work and Personal levels, is good with a score of more than >3.30. There were 3 statements that received Disagree answers from several respondents, which are: 1) I will report people who ignored safety procedures, 23 respondents. 2) My responsibility is to work safely, including reporting colleagues who do not work safely, 5 respondents. 3) There is a penalty for behaving unsafely, 14 respondents.

The Safety Climate dimension with the highest score is Management Commitment and in the work attributes both work and personal Management Commitment and Safety Regulations & Procedures dominate the highest average score.

SUGGESTION

Continue to maintain the Safety and Health System that is already running and socialize again about the importance of reporting unsafe acts that are not in accordance with procedures to prevent accidents. Providing an understanding of Reward and Punishment, that the purpose of this program is to change worker behavior to create a safe, healthy workplace and not pollute the environment.

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