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ERGONOMICS INTERVENTION USING COGNITIVE APPROACH IN REDUCING WORK ERROR

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ABSTRACT

Based on the search causes of occupational accidents due to human error using CREAM method in gathering station PT X, it was found the cognitive activities played a role in error contribution. From four cognitive function, based on analysis, the failure or error were dominated by observation and execution. More in-depth study was performed to determine the cause of error as well as recommendation needed using FMEA method. Ergonomics intervention was part of the recommendation of improvement. Implementation of recommendation can decrease RPN number, meaning the recommendation were the appropriate one.

Key word : cognitive function, FMEA, ergonomics intervention

1. INTRODUCTION

PT X, a national company operated in petroleum processing sector, has five work station that are production well, gathering station, water cleaning plant, water injection plant, and injection well. This study focused on the gathering station where many errors (failure) done by the worker. These errors can lead to operational failure and work accident. From the previous study at PT X regarding error while working related to failure of cognitive function (Figure 1), it was found that from four cognitive function, based on analysis, the failure or error in gathering station were dominated by observation and execution.(Rizani, 2010). Cognitive activity can be related with how people to perceive, think and remember.

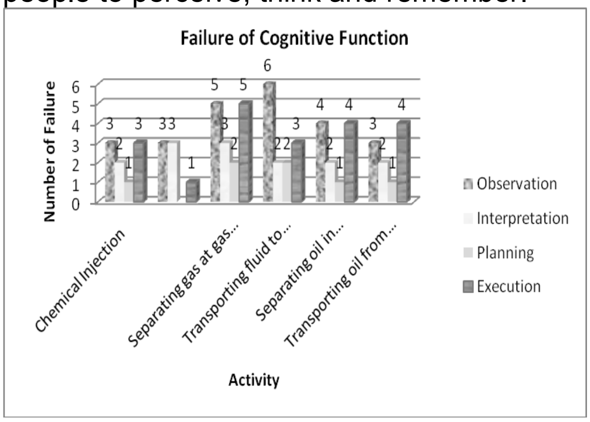

Figure 1 Failure of Cognitive Function

This study aimed to explore futher the cause of errors that occur, propose ergonomics intervention, and implement the proposed of intervention.

2. THEORETICAL BACKGROUND

2.1 CREAM

CREAM or Cognitive Reliability Error Analysis Method, a method developed by Erik Hollnagel, is a tools for human reliability analysis (HRA). CREAM was developed from analysis principle which contain method clasification scheme dan a model. The main aim of CREAM is giving practical approach to performance analysis and prediction. The three main area of CREAM are task analysis, opportunities for error reduction, considering human performance on overall system safety. One of the important step of CREAM is determining the cognitive control mode (COCOM). There are four cognitive function in COCOM which are observation, interpretation, planning and executions.(Hollnagel, 1998)

2.2 FMEA (Failure Modes and Effect Analysis)

FMEA can be divided into two, namely Design FMEA and Process FMEA. Hidden problems that can potentially be

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investigated, the likelihood of defects can also be shown to the right before the product is passed on to the customers, the effect on the overall system can be studied and the control decisions can be taken immediately, so that modifications to the production phase and additional costs to fix the errors can be avoided.
In this study, FMEA is used as a tool to determine the most critical type of failure that requires treatment first. From the results of the FMA, improvement priority will be given on the component that has the highest RPN (Risk Priority Number). The RPN is a product of multiplying value of severity (S), occurrence (O) and detectability (D).
There is another way to determine the priority of risk using occurrence/severity matrix and risk ranking tables (Reliasoft,2003). The Occurrence/Severity matrix provides an additional or alternative way to use the rating scales to prioritize potential problems. This matrix displays the occurrence scale vertically and the Severity scale horizontally. The points represent potential causes of failure and they are marked at the location where the Severity and Occurrence ratings intersect. The analysis team can then establish boundaries on the matrix to identify high, medium and low priorities.

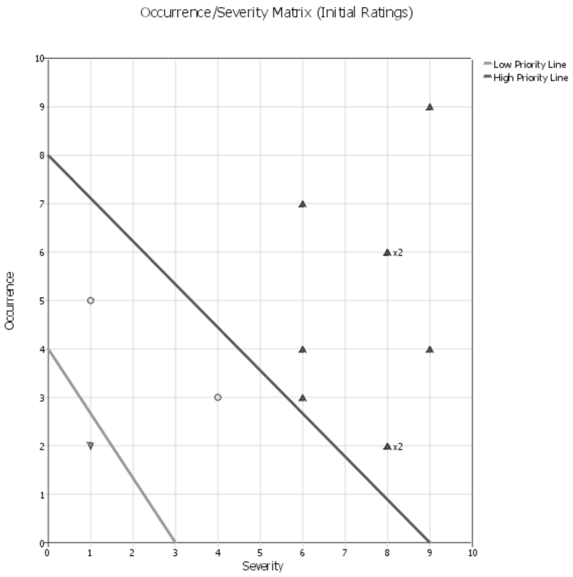

Figure 2 Occurence/Severity Matrix

In addition to, or instead of, the other risk assessment tools described here, the organization may choose to develop risk ranking tables to assist the decision-making process. These tables will typically identify whether corrective action is required based on some combination of Severity, Occurrence, Detection and/or RPN values. As an example, the table in Figure 3 places Severity horizontally and Occurrence vertically [McCollin, in Reliasoft 2003].

O/S	1	2	3	4	5	6	7	8	9	10
1	N	N	N	N	N	N	N	N	C	C
2	N	N	N	N	N	N	10	8	C	C
3	N	N	N	N	10	7	6	5	C	C
4	N	N	N	8	6	5	4	4	C	C
5	N	N	10	6	5	4	3	3	C	C
6	N	N	7	5	4	3	3	2	C	C
7	N	10	6	4	3	3	2	2	C	C
8	N	8	5	4	3	2	2	2	C	C
9	N	7	5	3	3	2	2	1	C	C
10	N	6	4	3	2	2	1	1	C	C

Figure 3 Sample risk ranking table

The letters and numbers inside the table indicate whether a corrective action is required for each case.
N = No corrective action needed.
C = Corrective action needed.
= Corrective action needed if the Detection rating is equal to or greater than the given number.
For example, according to the risk ranking table in Figure 3, if Severity = 6 and Occurrence = 5, then corrective action is required if Detection = 4 or higher. If Severity = 9 or 10, then corrective action is always required. If Occurrence = 1 and Severity = 8 or lower, then corrective action is never required, and so on.(Reliasoft,2003)

3. RESEARCH METHOD

3.1 Constructing FMEA

From cause effect diagram or diagram why-why, potential cause contributing to error were tried to be translated to FMEA form as seen in Table 1.

Table 1. FMEA of Potential Failure in Gas Station

Key Process Step or Input		Potential Failure Mode	Potential Failure Effects	SEV	Potential Causes	OCC	Current Controls	DET	RPN	Action Recommended	Priority
Chemical Injection	Taking the chemical from storage	object failure	inject chemicals that are not appropriate, cause process failure	7	No labelling in chemical storage	5	Nothing	3	105	Labeling and grouping of chemicals	▼
	Filling the chemicals fluid using handpump	Unprocedural action	operator exposed to chemicals	9	how to fill is inappropriate	4	Controlling	2	72	Designing display and using of personal protective equipment (PPE)	▼
Receiving the fluid from the field	Opening valve to GS	the speed not match	Leak of flowline	9	Operator works in a hurry	5	Nothing	4	180	Training for the operator how to open the valve	▼
		Unprocedural action	cause wounds or injuries to the operator	8	Not using personal protective equipment	6	PPE	3	144	The supervisor providing working examples correctly and replicably.	▼
Gas separating at the gas boot	Examining that the valve must be in open state	Unprocedural action	operational failure	8	Incomplete Examination	5	SOP	7	280	creating SOPs for gas separation process and disseminating to the worker.	▼
	Supporting Operation	Negligence Inspection	operational failure	9	Not checking equipment before use	5	Controlling	3	135	Providing information supporting the use of equipment	▼
		Unprocedural action	cause wounds or injuries to the operator	9	Not using personal protective equipment	6	PPE	3	162	Designing display and using of personal protective equipment (PPE)	▼
Draining fluid to the wash tank	Fluid which had been separated flow to the wash tank	Negligence Inspection	Leak of flowline	7	Delay of response	3	Inspection	6	126	Substituion of operator/shift	▼
	Tank cleaning	Unprocedural action	cause wounds or injuries to the operator	9	unawaraness of danger from environment	4	PPE	6	216	Checking the condition before and during tank cleaning	▼
Drain the fluid from the shipping tank to consumen	Flow from the shipping tank to outgoing line	Negligence Inspection	Leak of flowline	9	Delay of identification flow condition	4	Controlling	5	180	Creating SOPs of oil flow process to *outgoing line* and supervise the workers in *control room*.	▼
	Oil sampling	wrong assumption	Inapproriate taking the sample	9	mark on the valve not clear	6	Labelling	2	108	Creating sampling card	▼

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3.2 Calculating The RPN

It was determined how much value of severity, occurrence and detectability of any cases. Then RPN was calculated by product of multiplying the three factors mentioned before. Ranking of RPN was showed the level of priority.

Other than using conventional RPN calculation, determining the priority also can be conducted by using occurrence/severity matrix and risk ranking table. By the combination value of severity and occurrence using occurrence/severity matrix, all activity described were classified for high priority to be solved. If using risk ranking table, for example from activity gas separating at the gas boot with the key input was examining that the valve must be in open state, the value of severity was 8 and the value of occurrence 5. Because the corrective action needed if the value of detectability 3 or more, this activity was absolutely classified as the activity with corrective action needed.

1.3 Proposing Ergonomics Intervention

In the introduction, it was stated that the most disturbed cognitive function were observation and execution. Based on relation of CPC (common performance condition) and control mode, it was can be concluded the appropriate strategy tactical control. This control was needed for many failure caused by lack of follow procedures or rules. This finding was suitable with that one found in FMEA format.

The ergonomics intervention that were proposed were :

1. Labeling and grouping of chemicals

Labeling process was carried out with the help of supplier. The example of label was depicted in figure 4.

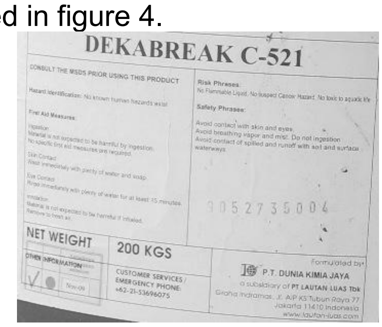

Figure 4 Chemical Label

2. Designing display and using of personal protective equipment (PPE) in injection station.
   Designing process concerns with rules to make ergonomically display like font size, style, color etc.(Bridger, 1995). The proposed display was depicted in figure 5.

Figure 5 Display for PPE in Injection Station

3. Training for the operator how to open the valve
   After training the supervisor must control the operator regularly.
4. Creating SOPs for gas separation process and disseminating to the worker. SOP contained information the purpose of the operation, definition of terms, step by step operation, equipment must be used and related document required.(Kroemer, 2001)
5. Providing information supporting the use of equipment.
6. Designing display and using of personal protective equipment (PPE) in Gas Boot
   The result of design was depicted in figure 6.

Figure 6 Design of HS in Gas Boot

7. Creating SOPs of oil flow process to *outgoing line* and supervise the workers in *control room*.
   SOP contained information the purpose of the operation, definition of terms, step by step operation, equipment must be used and related document required.
8. Creating sampling card

In the sampling process before the oil flows to the outgoing ling, there was the potential failure of false assumption. Because of the samples taken consisted of 24 valves, then the identification of common errors.

Therefore necessary design label/sampling car to avoid misidentification. Figure 7 showed the design of sampling card equipped with the information of the valve serial number, sampling area, temperature, pH, time of collection, name of operator, and additional notes.

BADAN OPERASI BERSAMA
PT. Bumi Siak Pusako - Pertamina Hulu
CPP BLOCK, CENTRAL SUMATERA BASIN

LABEL SAMPEL

No. Urut : ....
Lapangan : ....
Area : ....
Temperatur : ....C°
pH : ....
Tgl & Waktu Sampling : ....
Diambil Oleh : ....
Pengawetan : ....
Catatan : ....

HSE Environmental Protection

Figure 7 Sampling Card

1.4 . Implementation

Implementation was conducted in a couple of weeks. The purpose of this activity was to compare condition before and after implementation. Of course RPN was expected to be impaired.

4. RESULT AND DISCUSSION

From constructing FMEA, it can be formulated several recommendation related to the failure. Other than using conventional RPN calculation, determining the priority also can be conducted by using occurrence/severity matrix and risk ranking table. By the combination value of severity and occurrence using occurrence/severity matrix, all activity described were classified for high priority to be solved.

From Table 2, comparison RPN before and after implementation. It can be seen that most of RPN value decreased.

5. CONCLUSION

1. From FMEA format construction can be detected the cause of errors that occur as well as can be proposed ergonomics intervention as recommendation.
2. Implementation of ergonomics intervention can decrease the RPN number, meaning the proposal were appropriate one.

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AUTHOR BIOGRAPHIES

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Table 2 Comparison of RPN number Before and After Implementation

Process Step or Input		Potential Failure Mode	Before				After			
			S	O	D	RPN	S	O	D	RPN
Chemical Injection	Taking the chemical from storage	object failure	7	5	3	105	2	3	2	12
	Filling the chemicals fluid using handpump	Unprocedural action	9	4	2	72	5	3	2	30
Receiving the fluid from the field	Opening valve to GS	the speed not match	9	5	4	180	4	3	3	36
		Unprocedural action	8	6	3	144	4	4	3	48
Gas separating at the gas boot	Examining that the valve must be in open state	Unprocedural action	8	5	7	280	4	4	4	64
	Supporting Operation	Negligence Inspection	9	5	3	135	6	3	3	54
		Unprocedural action	9	6	3	162	6	4	3	72
Draining fluid to the wash tank	Fluid which had been separated flow to the wash tank	Negligence Inspection	7	3	6	126	7	3	6	126
	Tank cleaning	Unprocedural action	9	4	6	216	9	4	6	216
Drain the fluid from the shipping tank to consumen	Flow from the shipping tank to outgoing line	Negligence Inspection	9	4	5	180	4	3	3	36
	Oil sampling	wrong assumption	9	6	2	108	2	3	2	12