



Design of risk-based follow up action monitoring tool for health safety and environment (HSE) plan

Sri Suhardono^a, Andes Ismayana^b, Agus Buono^c

^a Professional Engineer Program, Graduate School, Bogor Agricultural University, Dramaga Campus, Bogor 16680, Indonesia

^b Department of Agricultural Industrial Technology, Faculty of Agricultural Technology, Bogor Agricultural University, IPB Dramaga Campus, Bogor 16680, Indonesia

^c Department of Computer Science, Faculty of Mathematics Natural Sciences, Bogor Agricultural University, IPB Dramaga Campus, Bogor 16680, Indonesia

Article Info:

Received: 12 - 01 - 2023

Accepted: 12 - 04 - 2023

Keywords:

Effective, efficient management system, follow-up, HSE, SMHSE

Corresponding Author:

Sri Suhardono
Professional Engineer Program,
Graduate School, IPB
University;
Phone: +628212336 4458
Email:
sri.suhardono@gmail.com

Abstract. *The Health Safety and Environment Management System (HSEMS) has performance targets or matrices that must achieve. It was monitored and reported periodically to various interested parties. The research aims to design monitoring tools or applications based on risk acceptance principles for follow-up action, which will have an impact on maintaining SMHSE performance. The design stage is divided into input data preparation, modeling, and visualization. In compiling the work plan input data on the follow-up sheet according to the hazard identification procedure, 8 (eight) performance matrices are divided into 30 (thirty) operational activities and a total of 155 (one hundred and fifty-five) jobs. Input data is stored using cloud storage for accessing and updating data easier. Data modeling produces 8 (eight) query formulas (M code) for 1 (one) fact table and 7 (six) dimensional tables connected via a star schema. The Data Analysis Expression (DAX) formula for displaying data in visualization contains 6 (six) equations. The follow-up closing performance of the data processed for 2022 was effectively covered by 86% with a total of 515 tasks, where only 1% (6 tasks) had not been completed at the allotted time. Continuous improvement with risk control methods, focusing on reducing the level of risk, residual risk after control is 12% with ALARP (As Low As Responsible and Practicable) status. Spread across improving environmental performance, HSE Communication, emergency response readiness, HSEMS, and Contractor Safety Management System. Residual risk with ALARP status is used as initial information for continuous improvement of the HSE Management System.*

How to cite (CSE Style 8th Edition):

Suhardono S, Ismayana A, Buono A. 2023. Design of risk-based follow up action monitoring tool for health safety and environment (HSE) plan. *JPSL* 13(3): 518–527. <http://dx.doi.org/10.29244/jpsl.13.3.518–527>.

INTRODUCTION

The Health Safety Environment Management System (HSEMS) is mandatory if companies want to compete in the business world. HSE standard requirements for obtaining contracts with various forms of work program assessment, many companies or prospective contractors experience difficulties in trying to meet the management system value requirements set by the owner of the work contract (PTK 2018). The company makes HSEMS with a consultant's help, which will cost a lot of money. When the certification period expires, the company will have difficulty collecting the data and evidence needed to maintain the previously obtained

value. The difficulties experienced are because the HSE program run by a company only increases competitive advantage and does not directly impact financial performance (Purwanto et al. 2014). Many companies prefer to concentrate on activities or work programs that directly impact financial benefits rather than HSE. However, companies that want to move forward sustainably have placed HSE as the main factor in their business activities.

The HSEMS performance assessment is assessed by implementing the work program set at the beginning of the year according to expectations. The HSEMS implementation target is a day without work accidents and environmental pollution (Hughes and Ferrett 2009). Work programs are structured by reviewing preventive measures to address failures or hazards before they turn into incidents. Good programs use leading indicators to drive change and evaluate effectiveness (OSHA 2019). Making a work program starts by selecting performance matrices, setting targets, communicating them to all internal and external stakeholders, periodically discussing results and their achievements, and determining corrective steps. The work program that has been set must be followed up, and its achievements monitored. Follow-up monitoring in an organization is an activity or activities commonly carried out to keep targets achieved per predetermined expectations. The follow-ups can come from various steps of the organizational process, starting from determining the scope or context, planning, implementing, checking, and continuous improvement (ISO 45001 2018). In almost all stages of organizational management, the wide range of follow-up resources is not surprising that a lot of software is marketed to assist organizations or companies in their management.

KSO BOSL (*Kerja Sama Operasi Bass Oil Sukananti Ltd*), Pertamina's partner, is required to maintain HSE performance in activities in the upstream oil and gas sector. Efforts to maintain HSE performance KSO BOSL has a work program set at the beginning of the year, which consists of 8 performance matrices. The eight performance metrics are (1) Improved environmental performance, (2) Approval for the use of equipment and installations, (3) Communication HSE, (4) HSE competence, (5) Emergency response preparedness, (6) HSE management system, (7) Contractor Safety Management System (CSMS), (8) COVID19 Control. KSO BOSL needs the follow-up system due to the passage of time and the increase in monitoring matrices; monitoring data continues to grow, resulting in companies experiencing difficulties summarizing SMHSE improvements. In discussing follow-up, the company uses risk acceptance criteria to state that follow-up has been carried out repairs or closures and the risk of closure is acceptable. According to the KSO BOSL hazard identification procedure, the risk acceptance criteria are divided into three parts; medium-high and low. High risk cannot be tolerated, and medium risk can be tolerated. Low risk can be carried out according to the available resources. This level of risk is generally controlled through established procedures.

ALARP (As Low As Responsible and Practicable) is a risk assessment condition after all resources have been applied to reduce the level of risk to low. The final value is still in the moderate range, but this condition must be carried out based on operational demands and can be closed and meet company expectations (Ostrom and Wilhelmsel 2012). The purpose of making this tool is to monitor performance in real-time, easily accessible so that an effective, efficient evaluation of program performance is achieved and the use of the company's risk acceptance method for continuous improvement can be carried out (Goetsch 2011).

METHOD

Location and Time of Research

The study is carried out in the mining area owned by Pertamina and managed by KSO BOSL in the form of joint operations. The mining site is located on land in South Sumatra, approximately 80 km southwest of Palembang and 20 km southeast of Prabumulih, with an area of 18.25 km². The 2022 HSE Work Plan that has been approved and signed by the KSO BOSL management is used in the research. The HSE plan keeps operations in the BOSL KSO area according to the desired target.

Method of Collecting Data

The research procedure was carried out in three stages. The first was the preparation of input data and the achievement targets. The second was making data modeling by determining fact tables and dimension tables, then making visualizations to assist decision-making in closing tasks or following up. The 2022 HSE program is shown in Table 1.

Table 1 HSE Plan KSO BOSL 2022

HSE plan	HSE task
1. Improved environmental performance	83
2. Approval for use of equipment and installation	12
3. HSE communication	286
4. HSE competencies	19
5. Emergency response preparedness	32
6. SMHSE	28
7. CSMS	42
8. Monitoring of COVID-19	13
Total	515

^aEight metric performance HSE with 515 tasks in 2022

Work program input data consists of 26 columns stored in Google Drive to make it easier to input data and share the necessary information. The input data stored on Google drive conforms to the BOSL-HSEQC-PRO-002 procedure. The collection is not further than recorded in binary code using power query so that any changes or interference to the input data can be recorded properly to the data to be managed at the data modeling stage.

The ETL (Extract Transfer Load) process uses the power query tool with the M Code programming language to clean the input data into a data structure according to the desired algorithm (Puls and Miguel 2016). Power Query consists of steps of formula expressions that create a mashup query. Formula expressions can be evaluated (computed), returning a value. The let expression runs a set of values to be calculated, named, and then used in the next expression, followed by the in statement. For example, a let expression can contain a source variable equal to the Excel value. Current workbook and returns the text value in the proper case. The concept of writing is as follows:

```

let
    Source = Excel.CurrentWorkbook(){[Name="RiskOps"]}[Content],
    #"Changed Type" = Table.TransformColumnTypes(
        Source,{
            {"Risk Category (Operation)", type text},
            {"RiskOpsID", Int64.Type}})
in
    #"Changed Type"

```

Excel's Power Pivot or tabular tool is used to link between tables. Tables in the database are divided into two functions, namely dimensions and fact tables. The dimension contains an explanation of the definition of the data in the fact table. The fact table contains dynamic data from the observed system.

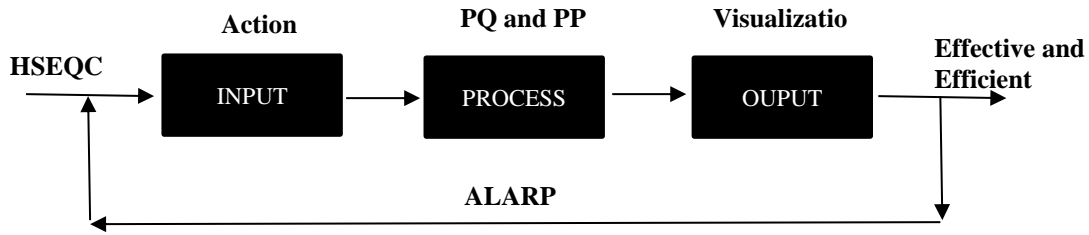


Figure 1 Steps for making a monitoring tool for the HSE plan (Bakhshi 2021)

RESULTS AND DISCUSSION

Compilation of Input Data

The input data structure consists of 3 (three) date columns, 21 (twenty-one) text columns, and 2 (two) number columns. Data is created in one file and multi-sheet to include activities to be monitored. Files are stored using Google Drive facility and Gsheet for data recording. The total number of Gsheet files for monitoring HSE performance is 30 (thirty), and the total sheets for each file are 150 (one hundred and fifty). The Gsheet file is recorded as a table named "tDataInput2". The total algorithm formula generated using power query is 8 equations, as shown in Table 2 (Raviv 2019).

Table 2 List table name and type

No	Query name	Table type	Remark
1	tDataInput2	Dimension	Record HSE performance plan input data.
2	HSEQC objective	Dimension	Data to define activities in each performance matrix.
3	Scope of hazard	Dimension	HSE hazard classification.
4	Operational risk	Dimension	List of risks caused by HSE hazards for operational activities.
5	Corporate risk	Dimension	List of risks caused by HSE hazards that impact corporate interests.
6	Departement	Dimension	Department of HSE, exploitation, operations, and BSM.
7	dCalendar	Dimension	The table is used to define performance concerning time.
8	Follow up Action	Fact	Table to record all follow-ups of the HSE plan.

^bThere are eight algorithms; seven dimension tables and one fact table

Data Management and Modeling

The process algorithm uses M Code, then loaded in a tabular form of facts and dimensions tables on the Excel tabular tool. The total of Data Analysis Expression (DAX) formula generated to make it effective in making visualizations is 18. The eight M Code programming results are divided into three parts, namely dimension tables, fact tables, and reference tables. The dimension table consists of tDataInput2, HSEQC Objective, Hazard Scope, Operational Risk, Corporate Risk, Departments, dCalender. The fact table for recording all follow-ups consists of one "Follow Up" table. The reference table for streamlining the programming step is one table, namely FullGSheet Follow-up. Data modeling uses the principle of "Star Schema" (Adamson 2010), so that all connections in data modeling are connected in "one to many" mode (one unique data to many data) as in Figure 2.

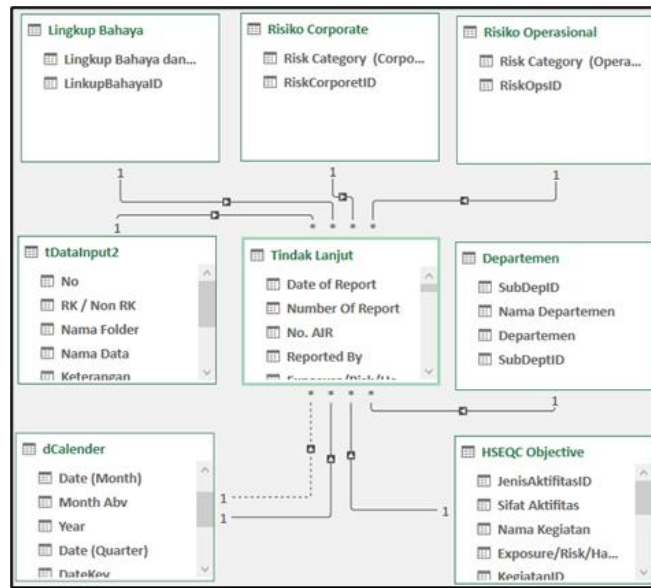


Figure 2 Data modeling follow-up to the HSE work plan

Compilation of Follow-up Monitoring Dashboards

Visualization number 1 monitors the daily findings of targets and closing performance. This visualization is technical and used by the on-site HSE supervisors. Supervisors or heads of departments and above use visualization number 2 to monitor operational closing performance targets. Visualization number 3 monitors closing performance targets to make continuous improvements, complemented by risk-based studies (Knaflic 2015). The DAX formula assists visualization in control tables and graphs. Slicer is used to filter follow-up data with the desired classification. The list of DAX equations used for visualization is as follows (Russo and Ferrari 2020). All DAX measure are mention in table 3.

Table 3 Equations for data visualization purposes

No	Name	Equation	Remark
1	Task	CALCULATE([Total Tugas]; 'HSEQC Objective'[No HSEQC Obj] <= 8)	Number of HSE work plan follow-ups
2	Close	CALCULATE([Total Tugas RK Dashboard];Tindak Lanjut'[Close-out Status] = "Close")	The number of follow-ups already completed closed.
3	Open	CALCULATE([Total Tugas RK Dashboard];Tindak Lanjut'[Close-out Status]="Open")	The number of follow-ups is still open, the status is still in the closing process.
4	Open overdue	CALCULATE([Total Tugas RK Dashboard];Tindak Lanjut'[Close-out Status 1]="Open-Overdue")	The calculation of open follow-up actions exceeds the predetermined target time.
5	Performance	DIVIDE([Total Tugas RK Tertutup];[Total Tugas RK Dashboard])	Follow-up closing performance
5	ALARP	CALCULATE([Total Tugas RK Dashboard];Tindak Lanjut'[Risk Ranking Residual]="M"; Tindak Lanjut'[Close-out Status]="Close")	Counts findings in ALARP status.

°There are six DAX (Data Analysis Expression) measures for data visualization

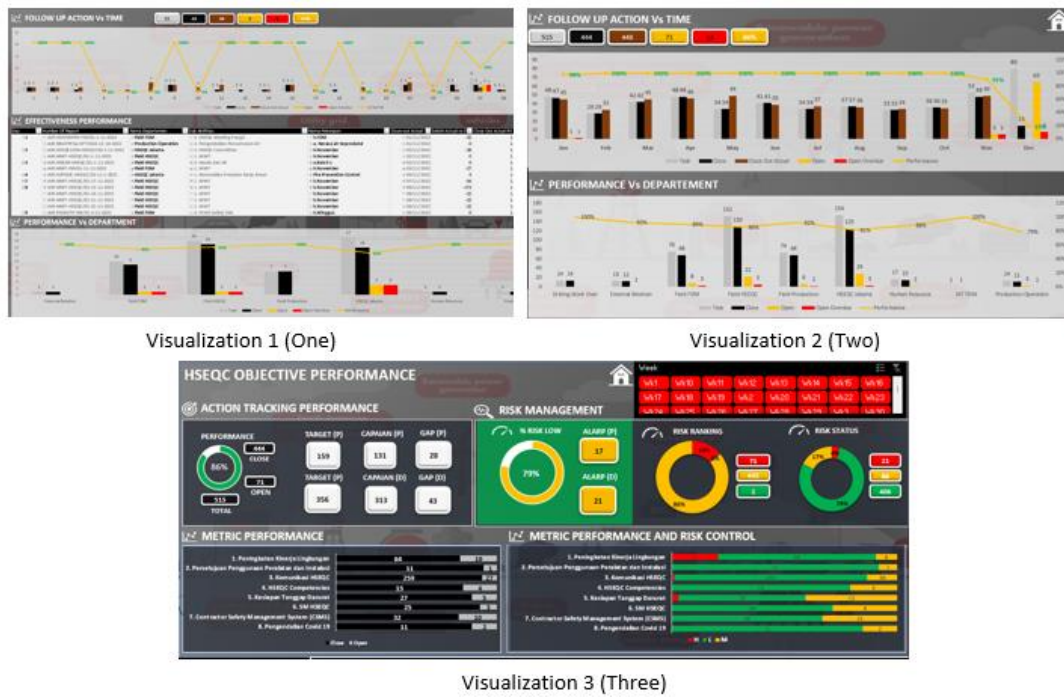


Figure 3 Visualization of follow-up monitoring data

The effective and efficient performance of this tool can monitor 515 fulfillment tasks, show in Figure 3. It can monitor findings that must be closed in November with a percentage of 99%, out of 435 tasks with 6 tasks that must be followed up. Performance up to November 2022 can be seen in Table 4. For performance up to the end of the year, 86% had been closed, with 515 tasks and follow-ups still open 71. Performance until the end of 2022 can be seen in Table 5. While for improvement performance by utilizing the ALARP method in risk control based on the HSE hazard classification of the total follow-up, there are 38 tasks in closed status and a medium risk value. ALARP distribution can be seen in Table 6.

Table 4 Follow-up closing performance until November 2022

HSE plan	Task	Close	Performance (%)
1. Improved environmental performance			
1. Environmental licensing	13	13	100
2. Water pollution control	41	41	100
3. Air pollution control	5	5	100
4. Processing of hazardous and toxic waste	5	5	100
2. Approval for use of equipment and installation			
1. Legality of installation equipment	11	11	100
3. HSE communication			
1. MWT	26	24	92
2. HSE committee	11	11	100
3. HSE meeting function	44	43	98
4. PJSJ safety talk	164	164	100
5. Safety stand down	16	16	100
4. HSEQC competencies			
2. Implementation of BST	11	11	100
3. Hazob dan 5R	3	3	100

HSE plan	Task	Close	Performance (%)
5. Emergency response preparedness			
1. Review ERP scenarios	5	5	100
3. Implementation of ERP training	3	3	100
4. Incident investigation	8	8	100
5. Mini clinic	2	2	100
6. SM HSE			
1. Availability of safe work procedures	15	15	100
2. Implementation of HIRADC	10	7	70
7. CSMS			
1. Occupational risk assessment	4	4	100
2. Contractor prequalification	4	4	100
3. HSE plan selection	5	5	100
4. Pre-work assessment	4	4	100
5. Work in progress assessment	3	3	100
7. Implementation report	11	11	100
8. Monitoring COVID-19			
1. Monitoring COVID-19	11	11	100
Total	435	429	99

^dMonitoring follow up action HSE using tool, 99% close effectively

Table 5 HSE performance until the end of 2022

HSE plan	Task	Close	Performance (%)
1. Improved environmental performance			
1. Environmental licensing	15	13	87
2. Water pollution control	54	41	76
3. Air pollution control	8	5	63
4. Processing of hazardous and toxic waste	6	5	83
2. Approval for use of equipment and installation			
1. Legality of installation equipment	12	11	92
3. HSE Communication			
1. MWT	31	25	81
2. HSE committee	12	11	92
3. HSE meeting function	48	43	90
4. PJSM safety talk	179	164	92
5. Safety stand down	16	16	100
4. HSE Competencies			
1. Availability of BST trainers	1	1	100
2. Implementation of BST	12	11	92
3. Hazob dan 5R	5	3	60
4. MCU	1		
5. Emergency Response Preparedness			
1. Review ERP scenarios	5	5	100
2. Emergency response team training	8	5	63
3. Implementation of ERP training	7	7	100
4. Incident investigation	8	8	100
5. Mini clinic	4	2	50

HSE plan	Task	Close	Performance (%)
6. SM HSE			
1. Availability of safe work procedures	17	17	100
2. HIRADC implementation	11	8	73
7. CSMS			
1. Occupational risk assessment	5	5	100
2. Contractor prequalification	5	4	80
3. HSE plan selection	6	5	83
4. Pre-work assessment	4	4	100
5. Work in progress assessment	5	3	60
6. Final assessment	4		
7. Implementation report	13	11	85
8. Monitoring COVID-19			
1. Monitoring COVID-19	13	11	85
Total	515	444	86

^ePerformance effectiveness monitoring HSE Plan 86%

Table 6 Performance metrics and ALARP risk assessment status

HSE plan	Task	ALARP	Percentage (%)
1. Improved environmental performance	83	6	1
2. Approval for use of equipment and installation	12		
3. HSE communication	286	14	3
4. HSE competencies	19		
5. Emergency response preparedness	32	9	2
6. SM HSE	28	5	1
7. CSMS	42	4	1
8. Monitoring COVID-19	13		
Total	515	38	7

^fThere are 38 ALARP follow up action in 6 metric HSE Plan

The distribution of the HSE plan performance sub-metrics is shown in Table 7. Follow-up or tasks that have been closed but conditions after risk control are still in a condition that can be accounted for and practiced are discussed in HSE committee meetings for improvement so that the need for resources, both people and costs, can be minimized. The completion time can be done more effectively and efficiently. The following year's HSE plan includes performance improvements based on ALARP risk control.

Table 7 HSE sub-metric performance and ALARP assessment status

HSE plan	Task	ALARP	Percentage (%)
1. Improved environmental performance			
1. Environmental licensing	15		
2. Water pollution control	54	3	4
3. Air pollution control	8		
4. Processing of hazardous and toxic waste	6	3	4
Total	83	6	7
2. Approval for use of equipment and installation			
1. Legality of installation equipment	12		
Total	12		

HSE plan	Task	ALARP	Percentage (%)
3. HSE communication			
1. MWT	31	6	2
2. HSE committee	12	8	3
3. HSE meeting function	48		
4. PJSM safety talk	179		
5. Safety stand down	16		
Total	286	14	5
4. HSE competencies			
1. Availability of BST trainers	1		
2. Implementation of BST	12		
3. Hazob dan 5R	5		
4. MCU	1		
Total	19		
5. Emergency response preparedness			
1. Review ERP scenarios	5	1	3
2. Emergency response team training	8	4	13
3. Implementation of ERP training	7	2	6
4. Incident investigation	8		
5. Mini klinik	4	2	6
Total	32	9	28
6. SM HSE			
1. Availability of safe work procedures	17	2	7
2. HIRADC implementation	11	3	11
Total	28	5	18
7. CSMS			
1. Occupational risk assessment	5		
2. Contractor prequalification	5		
3. HSE plan selection	6		
4. Pre-work assessment	4	1	2
5. Work in progress assessment	5	3	7
6. Final assessment	4		
7. Implementation report	13		
Total	42	4	10
8. Monitoring COVID-19			
1. Monitoring COVID-19	13		
Total	13		
Total	515	38	7

§ Distribution 38 (thirty-eight) ALARP in technical activity HSE Plan

CONCLUSION

The application of this follow-up action monitoring system can help organizations to monitor the follow-up of the HSE plan from an effective, efficient side with high accuracy and help the organization to monitor the follow-up of the HSE work plan, the performance of the system from January to November reaches 86% of the total 515 follow-ups, 71 are still open until the end of 2022 and a total of 5 with open status from the time it was agreed to close. By focusing on follow-ups that have been closed with a moderate risk value and tolerable status, risk control has been able to assist the company in continuing improvement efforts.

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