

Analysis of ISO 45001 Implementation and an IT-Based SMK₃ Measurement System (Information Technology)

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Implementation of ISO 45001 and an IT-based SMK₃ measurement system is important in maintaining occupational safety and health as well as the continuity of safe work processes. This study analyzes the most influential variables in achieving this goal. Variable analysis was carried out using the MICMAC analysis method to identify trigger variables that have a high influence, variables that can affect the system if it gets intervention, and variables that are affected by other variables. Training effectiveness and occupational safety and health (K3) performance have been shown to be the two main variables that have a significant influence on implementation. The advice given includes increasing the effectiveness of OHS training through relevant and interactive programs, implementing OHS-related policies and regulations, increasing employee involvement in OHS activities, evaluating internal audits regularly, and involving related parties such as contractors, suppliers, customers, and the surrounding community. By following these suggestions, organizations can improve the implementation of ISO 45001 and IT-based SMK₃ measurement systems, create a safer and healthier work environment, and prevent work accidents and injuries that can interfere with employee productivity and welfare

Keywords: ISO 45001, SMK₃ measurement system, occupational health and safety, MICMAC analysis..

INTRODUCTION

Analysis of ISO 45001 variables in order to realize an IT-based SMK₃ measurement system (informatics technology) is an important step to identify and analyze key aspects related to the implementation of the standard. ISO 45001 is an international standard that aims to improve occupational safety and health in the workplace (Šolc et al. 2022). In the context of SMK₃ measurement, the use of information technology can be an effective tool for managing and monitoring OSH performance in a systematic and integrated manner.

IT-based analysis of ISO 45001 variables begins with the identification of risks and hazards in the workplace. This identification involves collecting data on various factors that have the potential to threaten the safety and health of employees. In the context of IT, the use of information systems can facilitate the process of collecting and analyzing risk data, enabling organizations to identify and evaluate potential risks more efficiently (Kokina & Blanchette, 2019).

K3 performance measurement becomes an important variable in this analysis. By leveraging IT, organizations can collect OSH performance data in real-time, resulting in more accurate and up-to-date metrics. The use of an IT-based OSH management system allows organizations to more effectively track incidents of accidents, injuries, work-related illnesses, and levels of compliance with OSH policies (Lipnicka, 2020). Another variable to note is regulatory compliance. Implementation of ISO 45001 requires compliance with applicable laws and regulations. In the context of IT, the use of information systems can facilitate monitoring and reporting of compliance with K3 regulations. IT-based management systems enable organizations to

manage and track compliance with legal requirements and identify and address non-conformances more efficiently.

Employee involvement is also an important variable in realizing an IT-based SMK₃ measurement system. The active involvement of employees can increase the effectiveness of the K3 program (Khair, et al., 2022). In an IT context, organizations can leverage technologies such as employee portals, mobile apps, or collaboration platforms to engage employees in incident reporting processes, online training, security meetings, and other OSH initiatives. Internal auditing is also an important variable that needs to be considered in this analysis. Internal audits are conducted to evaluate compliance with ISO 45001 and the effectiveness of its implementation. In the context of IT, organizations can use an IT-based management system to facilitate the implementation and reporting of internal audit results. This system enables more efficient monitoring and follow-up management of audit findings.

RESEARCH METHODS

Types of research

This study used a quantitative method by filling in a questionnaire matrix of interrelationships between variables. The quantitative method was chosen because researchers wanted to obtain findings that could be measured statistically or through objective measurements (Guest et al., 2020). In the context of this research, the researcher wants to analyze the variables related to the implementation of ISO 45001 and IT-based SMK₃ measurement systems.

During the research, the researcher will follow established procedures for sustainability analysis. The analysis process will involve the use of the MICMAC

application. This application will assist researchers in analyzing the relationship between the variables obtained from the survey and identifying variables that have a significant impact on realizing an IT-based SMK3 measurement system (Riniwati et al., 2023).

By using quantitative methods, this research will provide data that can be measured and processed statistically. This will enable the researcher to draw objective conclusions based on the analysis performed. The results of this study are expected to provide useful insights for organizations in implementing ISO 45001 and an IT-based SMK3 measurement system effectively.

Respondents

The population in this study refers to all occupational safety and health experts who have knowledge and information regarding the implementation of ISO 45001 and the effective application of IT-based SMK3 measurement systems. This population includes individuals who have expertise and experience in the field of occupational safety and health and have been involved in the process of implementing ISO 45001 and measuring SMK3. Respondents were selected as a sample that was representative of this population (Lehdonvirta et al., 2021). Respondents are occupational safety and health experts who have relevant knowledge and information related to the implementation of ISO 45001 and IT-based SMK3 measurement systems. They were chosen because they have experience and special expertise in this field.

Data Collection Technique

Researchers will use an appropriate sampling method to select respondents who are representative of the population (Etikan & Babatope, 2019). This is done to ensure that the data obtained represents the views and knowledge of occupational safety and health experts as a whole.

By collecting data from selected respondents, researchers will obtain relevant information regarding the implementation of ISO 45001 and IT-based SMK3 measurement systems. Data from respondents will be analyzed to identify key factors, challenges, and best practices in implementing ISO 45001 and an IT-based SMK3 measurement system effectively. By limiting the respondents to occupational safety and health experts, this study will gain in-depth and valuable insights into the implementation of ISO 45001 and IT-based OSHMS measurement systems from the perspective of those who have specific knowledge and experience in this field.

Data analysis The MICMAC analysis method was first developed by Duperrin and Michel Godet in 1973 with the aim of making a systematic ranking of the elements of a system. The main purpose of developing this method is to provide a systematic way of categorizing or classifying the factors in a system based on their influence and dependency values.

MICMAC analysis also has the ability to capture interactions between variables and identify key variables that act as drivers in maintaining system performance on an ongoing basis (Riniwati et al., 2022). This method allows researchers to identify the relationship between variables that can appear directly between one variable and another or through an intermediary variable that connects the two variables.

In the MICMAC analysis process, the first step is to formulate the problem clearly so that both internal and external research variables can be identified. After that, an analysis of the relationship between variables can be carried out to evaluate the relationship based on the impact and dependence between the variables. This evaluation usually involves experts or stakeholders involved in the research and can be done through focus group discussions (FGD) or other data collection processes. By using the MICMAC analysis method, researchers can gain a better understanding of the relationships between variables and the patterns that may occur. This method provides valuable insights into understanding system dynamics and variables that play a key role in achieving research objectives.

Determination of possible variables in implementing ISO 45001 and an IT-based SMK3 measurement system (informatics technology). It should be noted that these variables can be adjusted according to the needs of the organization and its work environment. After determining the variables, make an abbreviation table as below: Table 1:

Table 1. Variables, abbreviations, and references

NO	Variable	Abbreviation	Journal that strengthens the argument
1	Training Effectiveness	IRB	(Bejinaru, Darabont, Burduhos-Nergis, Cazac, & Chiriac-Moruzzi, 2023)
2	Occupational Safety and Health (K3)	K3	(Morgado, Silva, & Fonseca, 2019)
3	Identification of Risks and Hazards	KR	(Asih & Latief, 2021)
4	Employee Engagement	KK	(Ahmad, et al., 2022).
5	Internal Auditing	AI	(Dziegielewska, Paulina, Konarkowska, Górny, & Adam, 2022)
6	Regulatory Compliance	PKP	(Kusuma & Madinah, 2022)
7	Related Party Involvement	KPT	(Abidin, Nurmaya, Hariyono, & Sutomo, 2021)
8	Training Effectiveness	EP	(Liu, Liu, Li, & Wen, 2023)
9	Information Technology System Performance	KSTI	(Rhamadonna & Wibowo, 2022)
10	Incident Handling	PI	(Yurizki & Ikatrinasari, 2022)

Experts or stakeholders who are directly involved can provide an assessment or evaluation by filling out a survey tool in the form of a questionnaire contained in the assessment matrix and entering a score from 0 to 3. The representation of the matrix used looks like Table 2, which has been filled in by the experts.

Table 2. Questionnaire Matrix of Interrelationships between Variables

	IRB	K3	KR	KK	AI	PKP	KPT	EP	KSTI	PI
IRB	0	0	0	0	0	0	0	0	0	0
K3	0	0	0	0	0	0	0	0	0	0

KR	0	0	0	0	0	0	0	0	0	0
KK	0	0	0	0	0	0	0	0	0	0
AI	0	0	0	0	0	0	0	0	0	0
PKP	0	0	0	0	0	0	0	0	0	0
KPT	0	0	0	0	0	0	0	0	0	0
EP	0	0	0	0	0	0	0	0	0	0
KS TI	0	0	0	0	0	0	0	0	0	0
PI	0	0	0	0	0	0	0	0	0	0

RESULTS AND DISCUSSION

In expediting the implementation of ISO 45001 and implementing an IT-based SMK3 measurement system (informatics technology), there are several relevant variables that need to be analyzed in depth. The first variable that needs attention is the identification of risks and hazards in the workplace (Bejinariu et al., 2023). It is important to identify and quantify existing risks and hazards so that appropriate prevention and mitigation measures can be taken. By using information technology, organizations can take advantage of information systems that can assist in the collection, analysis, and reporting of risk data more efficiently and accurately.

Occupational Health and Safety Performance (K3) OSH performance measurement involves monitoring and analyzing various indicators such as the number of work accidents, injuries, and work-related illnesses and the level of compliance with OSH policies (Morgado et al., 2019). By implementing an IT-based SMK3 measurement system, organizations can collect real-time OHS performance data, facilitate trend analysis, and take corrective actions quickly. Regulatory compliance is an important variable in this analysis. Organizations need to ensure that their operational activities comply with applicable laws and regulations related to OSH. In the IT context, information systems can be used to effectively monitor and manage compliance with OSH regulations (Asih & Latief, 2021). Data can be integrated and tracked more easily, making auditing and reporting easier.

Employee involvement is also a variable that should not be ignored. The active involvement of employees in the OSH program is very important in creating a strong safety culture. By using IT, organizations can provide employees with easy access to report incidents, attend online training, and participate in other OSH initiatives (Ahamad et al., 2022). This will increase employee participation and strengthen OSH awareness in the workplace. Internal audit also needs to be the variable being analyzed. Internal audits are conducted to evaluate compliance with ISO 45001 and the effectiveness of its implementation (Dzięgielewska et al., 2022). By using an IT-based information system, organizations can automate audit processes, track findings, and monitor follow-up more efficiently (Sholihah et al., 2021).

Process performance measurement related to OSH also needs to be considered. This variable involves measuring performance in terms of equipment maintenance, hazardous chemical management, work area supervision, and waste handling. By leveraging IT, organizations can use information systems to collect and monitor the

performance data of these processes, as well as identify areas that require improvement (Kusuma & Medina, 2022). The related party involvement variable is also relevant in this analysis. Organizations must involve contractors, suppliers, customers, and the surrounding community in efforts to improve OSH (Abidin et al., 2021). In the context of IT, information systems can be used to facilitate collaboration and the exchange of information between related parties and strengthen coordination and cooperation in managing OSH.

An effective OSH training program can increase employee knowledge and skills in terms of occupational safety and health (Liu et al., 2023). By using IT, organizations can provide easily accessible online training, track and evaluate the effectiveness of training, and provide opportunities for employees to increase their understanding of OSH. IT system performance variables must also be considered (Rhamadonna & Wibowo, 2022). Reliable, available, safe, and fast IT systems are key to supporting the implementation of the SMK3 measurement system. This variable includes system reliability, data availability, access speed, and information security. By using the right information technology, organizations can ensure optimal IT system performance to support efficient and effective OHS management. Incident handling is a variable that measures the effectiveness of OSH incident prevention and handling, including response time, incident reporting, investigation, and implementation of repairs (Sholihah et al., 2019).

The analysis of ISO 45001 variables in realizing an IT-based SMK3 measurement system involves various interrelated aspects. These variables provide important guidance in designing, implementing, and monitoring an effective OSHMS measurement system.

a. Questionnaire Filling Results

The results of filling out the matrix questionnaire by experts in their fields show several important findings. Experts provide their assessments and responses to the relationships between variables that are relevant in the context of this research (Limantoro et al., 2023). The experts provide their insights and knowledge about the variables that interact with each other and influence the implementation of ISO 45001 and IT-based SMK3 measurement systems. By filling out the matrix questionnaire, the experts provide their views on the level of influence, dependency, and relationships between variables that they consider important in the context of this study.

The process of filling out the matrix questionnaire involves consideration and evaluation by experts based on their knowledge and experience in the fields of occupational safety and health, the implementation of ISO 45001 standards, and information technology. The results of filling out the matrix questionnaire provide valuable information about the relationship between the variables that are the focus of this study. By using a matrix questionnaire, experts can convey their views on the extent to which the identified variables interact and have an influence on achieving the research objectives. The results of the experts' filling out of the matrix questionnaire will be the basis for analyzing and interpreting the relationship between variables in the MICMAC analysis (Figure 1).

	1: IRB	2: K3	3: KR	4: KK	5: AI	6: PKP	7: KPT	8: EP	9: KSTI	10: PI
1: IRB	0	3	3	3	2	2	1	1	1	3
2: K3	3	0	2	3	1	3	3	3	3	3
3: KR	3	3	0	2	1	1	2	3	1	2
4: KK	1	2	3	0	3	2	2	2	1	3
5: AI	2	2	2	1	0	3	2	1	3	2
6: PKP	2	3	3	3	1	0	1	2	3	2
7: KPT	2	3	2	2	2	1	0	3	1	1
8: EP	3	3	3	2	1	1	3	0	2	3
9: KSTI	2	2	2	3	3	3	1	1	0	2
10: PI	3	3	3	2	1	1	2	2	2	0

Figure 1. The results of filling out the MICMAC Questionnaire show a dependency between variables implementing ISO 45001 and implementing an IT-based SMK3 measurement system (informatics technology).

a. Map of Influence and Dependence

Each variable in the MICMAC analysis can identify its role through the use of the direct influence/dependence map. The direct influence/dependence map is divided into four quadrants, each of which describes the role of these variables.

Variables located in quadrant one are trigger variables, or variables that have a direct influence on other variables in the system. This variable has a key role in influencing overall system performance (Suryade et al., 2022). Variables located in quadrant two are variables that can affect the system if they get special intervention or action. This variable has the potential to act as a driver or modifier in the system if more attention is given or certain actions are taken. Variables located in quadrant three are variables that are affected by other variables in the system. This variable tends to be a response or result of interaction with other variables and has no direct influence on other variables in the system. Meanwhile, the variables located in quadrant four have a relatively small effect on other variables in the system. This variable may have a weaker or insignificant relationship with influencing the overall system's performance.

Through the use of the direct influence/dependence map in the MICMAC analysis, researchers can identify the role of each variable and understand the complex interactions between variables in the system being studied.

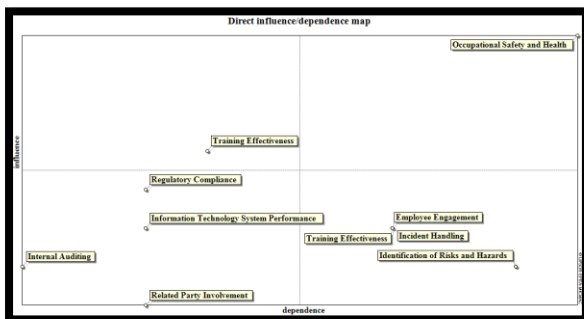


Figure 2. Map of influence and dependency between variables implementing ISO 45001 and an IT-based SMK3 measurement system (informatics technology)
Source: MICMAC Data Analysis Results (2023)

A summary of the results of the MICMAC analysis of ISO 45001 implementation variables and applying IT-based

SMK3 measurement systems (informatics technology) is given in the following table:

Table 3. Summary of Results of the MICMAC Analysis of Increasing Long-Term School Expectations (HLS) in Coastal and Non-Coastal Villages, Pasangkayu District.

Rank	Based on influence and dependence		Information
	Variable	Quadrant	
1	Training Effectiveness	1	High Influence
2	Occupational Safety and Health (K3)	2	Affects the system if it gets intervention
3	Identification of Risks and Hazards	3	Influenced or affected by other variables in the system
4	Employee Engagement	3	Influenced or affected by other variables in the system
5	Incident Handling	3	Influenced or affected by other variables in the system
6	Regulatory Compliance	3	Influenced or affected by other variables in the system
7	Process Performance Measurement	4	Not significant in affecting system performance
8	Information technology system performance	4	Not significant in affecting system performance
9	Internal Auditing	4	Not significant in affecting system performance
10	Related Party Involvement	4	Not significant in affecting system performance

In the results of the analysis, it appears that there are two variables that have a high influence in the context of the implementation of ISO 45001 and the application of an IT-based SMK3 measurement system. The first variable is training effectiveness, which has a strong influence on achieving the objectives of this study. This variable indicates that effective training in the field of occupational safety and health can contribute significantly to the successful implementation of ISO 45001 and the implementation of an IT-based SMK3 measurement system.

The second variable that has a high influence is occupational health and safety performance. This variable indicates that when there is an intervention or action taken on it, it can affect the system as a whole. Therefore, the attention given to occupational safety and health aspects can have a significant impact on the successful implementation of ISO 45001 and the implementation of IT-based SMK3 measurement systems.

Nonetheless, it is important to remember that all the variables in this study have an influence on the ISO 45001 implementation system and the application of IT-based SMK3 measurement systems, although not as much as the two variables mentioned above. The influence of other variables may be smaller on a relative scale, but it is still important to consider in order to achieve the objectives of this study.

1. The Importance of the Effect of Training Effectiveness Variables

Effectiveness Training has a significant influence in the context of implementing ISO 45001 and an IT-based SMK3 measurement system. Effective training can provide great benefits by increasing employee knowledge and skills related to aspects of occupational safety and health

(Sholihah et al., 2019). With effective training, employees will be able to understand the importance of occupational safety and health practices and implement relevant procedures and policies. They will have the necessary skills to identify risks and hazards in the workplace as well as take appropriate preventive measures.

In addition, effective training can also increase employee awareness of the importance of measuring and monitoring OHS performance (Syafrial & Ardiansyah, 2020). They will be able to follow measurement procedures correctly, report work incidents or accidents, and contribute to efforts to improve and develop the OSH system. Thus, the effectiveness of training has a crucial role in ensuring that the implementation of ISO 45001 and the IT-based SMK3 measurement system go well. Good training will increase employee competency and awareness, promote a strong safety culture, and contribute to improving overall occupational safety and health performance.

2. The Importance of Occupational Safety and Health Performance

The importance of occupational health and safety performance as the second most important variable in the implementation of ISO 45001 and the application of IT-based SMK3 measurement systems is due to its significant role in achieving the objectives of this study. Occupational health and safety performance plays a crucial role in maintaining a safe and healthy work environment for employees. This variable includes aspects such as the number of work accidents, injuries, and work-related illnesses and the level of compliance with K3 policies (Sholihah et al., 2020).

In the context of implementing ISO 45001, occupational health and safety performance is the main indicator for measuring the success of the OHS management system. Low work accident rates, minimal injuries, and high compliance rates indicate that the occupational safety and health measures implemented are effective and successful (Atmoko & Budisatria, 2021). Occupational health and safety performance also has a significant impact on employee productivity and welfare (Zebua et al., 2022). By maintaining a safe and healthy work environment, companies can reduce absenteeism due to injury or illness, increase employee motivation and satisfaction, and increase overall productivity.

Therefore, the importance of occupational safety and health performance as the second most important variable emphasizes the need to focus on efforts to prevent work-related injuries and illnesses as well as increase adherence to K3 policies. This will contribute to achieving the objectives of implementing ISO 45001 and an IT-based SMK3 measurement system effectively.

CONCLUSION

Based on the analysis of ISO 45001 variables to create an IT-based SMK3 measurement system, several important conclusions can be drawn:

1. Training effectiveness is the most important variable that has a strong influence on the implementation of ISO 45001 and the application of IT-based SMK3 measurement systems. Effective training will increase employee knowledge and skills related to occupational safety and health aspects.

2. Occupational safety and health performance is the second important variable because it affects the system if it gets intervention. A focus on OSH performance, including reducing work accidents, injuries, and work-related illnesses and increasing compliance with OSH policies, is critical to achieving the objectives of implementing ISO 45001.
3. All other variables also have an influence on the ISO 45001 implementation system and the implementation of IT-based SMK3 measurement systems, but not as much as the effectiveness of occupational safety and health training and performance.

SUGGESTION

The following are suggestions that can be made from the results of the MICMAC analysis:

1. Improvement of OSH Communication and Awareness: Improving occupational safety and health communication and awareness throughout the organization is an important step. Provide regular training to employees to increase their understanding of the importance of OSH and how to identify potential risks. In addition, encourage open communication between management and employees to report OSH issues, provide input, and encourage active participation in OSH activities.
2. Implementation of a Risk Management System: Implement a comprehensive risk management system to identify, evaluate, and control OHS risks. Carry out regular risk analysis, including hazard identification, risk assessment, and appropriate precautions. Ensure that the established risk mitigation measures are properly implemented and monitored regularly.
3. Continuous Evaluation and Improvement: Always evaluate and continuously improve the ISO 45001 implementation system and the IT-based SMK3 measurement system. Monitor OHS performance regularly and identify areas for improvement. Use the data and information collected to identify trends, understand root causes, and implement relevant corrective actions. Involve all relevant parties in the evaluation and improvement process to ensure collective commitment to OSH.

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