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Are the guidelines for HIRARC 2008 effective for managing workplace hazard?

Wilson Lee Wui Siang[ab] ✉ | **Mohd Rafee Bin Baharudin**[a] | **Anita binti Abdul Rahman**[a] | **Nor Halim bin Hasan**[b]

[a]Faculty of Medicine, Department of Community Health, University Putra Malaysia, UPM Serdang, Malaysia.
[b]Department of Occupational Safety and Health Malaysia, Malaysia.

Abstract In 2008, the Guidelines for Hazard Identification, Risk Assessment, and Risk Control (HIRARC) were introduced in Malaysia to provide a structured approach for organizations to identify potential workplace hazards, evaluate associated risks, and apply appropriate control measures to ensure the health, safety, and well-being of workers. Despite their widespread use, the extent of their effectiveness across sectors remains underexplored. This study aims to assess the relationship between HIRARC implementation and improvements towards workplace risk management, and to determine the primary factors that influence its implementation. This research employs a cross-sectional design involving 390 Occupational Safety and Health (OSH) practitioners who are registered with the Department of Occupational Safety and Health (DOSH), representing six regions throughout Malaysia. A structured questionnaire evaluated HIRARC implementation, with content validation by ten OSH experts. Spearman correlation analysis was conducted to examine the association between the application of HIRARC and better workplace OSH risk management outcomes. Additionally, simple logistic regression was used to assess the association of HIRARC implementation and reduction of workplace accidents by sectors. The odds ratio for HIRARC application in relation to the reduction of workplace accidents was also evaluated. The analysis showed a significant positive association between HIRARC implementation and improvements in workplace risk management. Additionally, the study observed a significant positive relationship between the application of HIRARC and reductions in workplace incidents and work-related illnesses where the logistic regression analysis revealed a good model fit with moderate effect size. The odds ratio suggested that practitioners who implemented HIRARC were 10.27 times more likely to experience a reduction in workplace accidents and health-related illnesses. Notably, three key factors were identified as significantly influencing the effectiveness of HIRARC implementation. They are identified as active organizational involvement, adequate allocation of resources, and adherence to technical guidance outlined in the HIRARC guidelines. The findings show that the implementation of HIRARC improves workplace safety and health, as well as reduces occupational accidents across all sectors.

Keywords: effectiveness, OSH, risk control, risk management, risk assessment

1. Introduction

Managing OSH risks is a critical component in preventing workplace incidents and mitigating hazards. A structured approach enables organizations to take proactive steps to assess risks systematically and implement appropriate control measures to minimize them (Ismail et al., 2017). Implementing risk management not only enhances safety performance and reduces costs, but it also plays a vital role in improving operational performance, securing competitive advantages, and enhancing an organization's reputation (Glette-Iversen et al., 2023; Khalid et al., 2021; Liu et al., 2023).

The stark reality in Malaysia is reflected in the 2022 statistics, which revealed 34,216 workplace accidents and 317 fatalities, averaging approximately 94 accidents and 1 fatality per day (Department of Occupational Safety and Health, 2024a). In response to these alarming figures, the DOSH Malaysia introduced the Guidelines for HIRARC in 2008. This guideline aims to assist industries in adopting a structured approach to managing workplace hazards (Marzuki et al., 2023).

The risk management approach outlined in the guidelines adopts a systematic methodology that includes recognizing, assessing, and quantifying risks, followed by a thorough evaluation of the outcomes (Liu et al., 2023). This guideline is intended to apply to all sectors and organizations, regardless of size, as specified in the Occupational Safety and Health Act (OSHA). Moreover, the HIRARC guidelines share conceptual similarities with ISO 45001, a globally acknowledged standard for OSH Management established by the International Organization for Standardization (Sugito et al., 2021).

Although many studies recognize HIRARC as practical, user-friendly, and widely adopted (Kuang et al., 2010; Department of Occupational Safety and Health, 2008; Liandar et al., 2023; Priyanka & Basaria, 2023), challenges persist in its

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implementation. Some organizations encounter difficulties in identifying all potential hazards or incorrectly classifying risk levels, which may lead to the application of ineffective control strategies (Afroh & Basaria, 2023; Khalid et al., 2021).

Despite being introduced over a decade ago, limited research has been conducted to assess HIRARC's overall effectiveness in improving OSH performance in Malaysia. This issue is particularly notable among small and medium-sized enterprises (SMEs), where awareness and implementation of structured OSH risk management systems remain low. Such systems are vital for guiding organizations in hazard control and informed decision-making regarding workplace safety. A review of existing literature shows that most research on HIRARC has focused on case-specific applications, rather than broad evaluations of its impact and influencing factors. Prior studies conducted by Afroh & Basaria (2023), Kuang et al. (2010), Ghahramani and Salminen (2019), Hanum et al. (2023), and Liandar et al. (2023) focused mainly on the manufacturing and construction sectors. Furthermore, studies by Khor and Surienty (2018) and Marzuki et al. (2023) were confined to SMEs. Hence, these studies were often focused on specific sectors or organizational sizes, leaving a gap in understanding how HIRARC functions across diverse organizational contexts. This research seeks to bridge that gap by quantitatively assessing the effect of HIRARC implementation on OSH performance and identifying the main factors that contribute to its effectiveness. The findings are expected to provide insights that will encourage more widespread and effective adoption of risk management practices across all sectors. The primary objective of this study is to evaluate how effective HIRARC guidelines are in improving workplace risk management and reducing accidents. Additionally, we will investigate the implementation of HIRARC across various sectors and assess the odds ratio for effective HIRARC implementation in relation to the reduction of workplace accidents.

1.1. Determinants of Effective HIRARC Implementation

Previous research has highlighted three key elements that play a significant role in the successful implementation of HIRARC to improve workplace OSH. They are (1) organizational participation, (2) sufficient resource allocation, and (3) HIRARC implementation in accordance with the guidelines for conducting risk assessment effectively.

The conceptual basis for these factors draws from Heinrich's Domino Theory of accident causation and Wernerfelt's Resource-Based Theory. According to the Domino Theory developed by Heinrich et al. (1980), workplace accidents occur when a series of five interconnected conditions are met. HIRARC serves as an intervention at the third condition in this domino effect, breaking the sequence by mitigating unsafe behaviours or removing physical hazards (Albanesi et al., 2023; Kuang et al., 2010). In addition, the Resource-Based Theory, developed by Birger Wernerfelt, has been extensively applied in OSH research to explore how internal organizational capabilities contribute to safety performance (Khor & Surienty, 2018; R. Liu et al., 2023; Wernerfelt, 1984). This theory highlights the importance of having and strategically utilizing resources such as training, financial capability, and manpower to enable organizations to implement effective OSH risk management.

1.1.1. Organizational Participation

Previous research highlights that the effectiveness of OSH risk management is heavily influenced by the active engagement of the organization, particularly through the commitment of both employers and employees. It is crucial for employers to recognize the importance of implementing HIRARC and demonstrate a strong commitment to enforcing the control measures identified in risk assessments. In this regard, employers play a key role in setting OSH risk management priorities, better planning of high-risk work activities, allocating sufficient resources for OSH-related initiatives, monitoring safety performance, and providing incentives to support safety practices (Afroh & Basaria, 2023; Marzuki et al., 2023; Park et al., 2023; Priyanka & Basaria, 2023; Ismail & Ramli, 2023; Zulkifly et al., 2023). Equally important is the participation of employees through a safety and health committee, which typically includes safety personnel, representatives from the employees, representatives from the management and other relevant stakeholders. Their participation in the HIRARC process fosters effective communication regarding hazards, control strategies, safety protocols, and other workplace safety-related issues throughout all organizational levels (Afroh & Basaria, 2023; Marzuki et al., 2023; Ismail & Ramli, 2023).

1.1.2. Sufficient Resource Allocation

Research indicates that the effective implementation of HIRARC within organizations significantly depends on sufficient resources. These resources include financial support, training related to HIRARC, and assigning specific personnel responsible to conduct risk assessments. Studies have shown that limited access to these resources can hinder an organization's ability to carry out effective occupational risk control.

Previous studies have identified that financial resources, HIRARC-related training, and the appointment of qualified personnel to conduct risk assessments greatly contribute to the effective implementation of HIRARC within organizations (Rhaffor et al., 2018; Khor & Surienty, 2018; Marzuki et al., 2022). This challenge is generally observed among SMEs, which often face budget constraints that prevent them from investing in safety improvements. Implementing such measures usually incurs financial expenditures for safety enhancements or alterations to processes and equipment, investments that many SMEs hesitate to make (Khor & Surienty, 2018; Marzuki et al., 2022; Ismail & Ramli, 2023; Yusof & Misnan, 2019).

In addition to financial challenges, research has revealed that employers, senior management, and employees involved in risk assessments often lack sufficient training and expertise, particularly in SMEs. This deficiency can lead to incomplete hazard identification and substandard risk assessments (Afroh & Basaria, 2023; Marzuki et al., 2022; Priyanka & Basaria, 2023). Moreover, inconsistent assignment of risk ratings across projects involving similar hazards and work activities has been reported, mainly due to insufficient safety expertise among those conducting the assessments (Liandar et al., 2023). High employee turnover discourages some employers, particularly in SMEs, from investing in HIRARC training, making it difficult to retain trained personnel (Marzuki et al., 2023). Consequently, without proper training, personnel often self-interpret HIRARC processes and terminology, leading to inaccurate or inconsistent risk assessments.

Another common limitation is the lack of dedicated staff for OSH-related tasks. SMEs often find it challenging to assign full-time personnel to safety-related roles, resulting in staff having to manage HIRARC duties alongside other job responsibilities. This multitasking often leads to poor-quality assessments, which some prepared merely to fulfill documentation requirements rather than to drive real safety improvements (Rhaffor et al., 2018; Marzuki et al., 2022; Surienty, 2012; Yusof & Misnan, 2019).

Research suggests that organizations with dedicated, well-trained personnel who possess sufficient OSH knowledge are more capable of implementing HIRARC effectively, resulting significant improvements in workplace safety performance (Afroh & Basaria, 2023; Fathullah et al., 2021; Jabbari et al., 2022; Marzuki et al., 2022).

1.1.3. HIRARC Implementation in Accordance to the Guidelines

The successful implementation of HIRARC depends heavily on clarity, practicality, and being well-organized. A well-designed framework with straightforward and user-oriented instructions enhances users' understanding of key terms, assessment procedures, and risk evaluation techniques. In a study by Fathullah et al. (2021), risk assessments were carried out on five case studies related to accidents in the manufacturing and construction industries, using the HIRARC guidelines as reference. The findings indicated that the HIRARC guidelines were effective in identifying relevant hazards and recommending practical control measures aligned with the prioritization of risk levels.

Furthermore, the use of HIRARC in the context of a hydroelectric power generation facility showed that it supports a logical and structured approach for conducting both primary and secondary hazard analyses, accurately categorizing risks, and selecting effective preventive strategies (Saedi et al., 2014). Pramudya et al. (2022) noted that conducting HIRARC is relatively straightforward, not very time-consuming, and allows for the prompt implementation of control measures. These conclusions align with earlier research, which has demonstrated that HIRARC can be utilized across diverse sectors, including power generation facilities, ports, educational institutions, and mining (Arifin et al., 2023; Ismail et al., 2017; Kadir et al., 2017; Liandar et al., 2023).

However, challenges remain, particularly among SMEs. Marzuki et al. (2022) emphasized that many SMEs struggle to understand the terminology and methodology outlined in the HIRARC guidelines. As a result, assessments conducted by these organizations tend to be inaccurate, often due to reliance on self-learning and individual interpretation without formal training or technical support.

2. Materials and Methods

2.1. Research Design and Instrument

This study employs a cross-sectional research design, and data collection carried out over approximately eight weeks from June to July 2025. The data were gathered using a structured questionnaire that consisted of two key sections. The first section included respondents' socio-demographic information, whereas the second section consists of an assessment of the effectiveness of risk management practices based on the implementation of the HIRARC guidelines. Section one included twelve items focused on demographic characteristics, while Section two contained twenty-six items aimed at evaluating risk management performance. The items in Section two were developed through a comprehensive review of relevant literature, as detailed in Table 1. A five-point Likert scale was used to capture respondents' levels of agreement, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

To establish content validity, the questionnaire was reviewed by a panel of ten experts, including academic researchers, regulatory officials, and industry professionals actively involved in OSH, all with at least ten years of experience in the field. This selection process is in-line with the validation framework by Sekaran and Bougie (2010). The instrument was assessed using the Content Validity Ratio (CVR) and the Content Validity Index (CVI). The CVR scores ranged from 0.80 to 1.00, while the itemized CVI (I-CVI) scores varied from 0.90 to 1.00. Both the CVR and CVI surpassed the minimum thresholds of 0.62 for CVR and 0.7 for I-CVI, as recommended by Lawshe (1975), Gilbert and Prion (2017), and Zamanzadeh et al. (2015). Additionally, a pilot test was conducted to evaluate the instrument's reliability. Cronbach's Alpha was used to assess the internal consistency of the questionnaire. The score of 0.912 indicates strong internal reliability and consistency across the items.

2.2. Research Sampling

Table 1 Variables and items to measure the effectiveness of HIRARC guidelines based on four thematic categories.

Characteristics	Items	Description	Source
Organizational Participation	1	Employer recognizes the importance of risk management	Ismail & Ramli (2023); Park et al. (2023); Liu et al. (2023); Marzuki et al. (2023); Priyanka and Basaria (2023); Afroh and Basaria (2023)
	2	Effective risk management is determined by the commitment level of employers	
	3	Employers strongly support the implementation of proposed risk control measures	
	4	Employers actively support and provide HIRARC training	
	5	The Safety and Health Committee plays a critical role in enhancing risk management	
Sufficient Resource Allocation	6	Availability of organizational resources affects HIRARC implementation	Khairul Shaleh Md Asari and Mutalib Leman, (2016); Ismail & A. Ramli (2023); Marzuki et al., (2023); Liandar et al., (2023); Rhaffor et al. (2018); Yusof and Misnan, (2019)
	7	Safety and Health Officers ensure the effective organizational risk management	
	8	Comprehensive HIRARC training is vital	
	9	HIRARC training improves the quality of risk assessments	
	10	Employers should undergo HIRARC training to strengthen OSH risk management knowledge	
HIRARC Implementation in Accordance to the Guidelines	11	Risk assessment based on HIRARC guidelines methodology	Afroh and Basaria, (2023; Hanum et al., (2023), Rhaffor et al. (2018), Koh et al., 2022, Marzuki et al., (2022)
	12	The guidelines provide a thorough process flow of HIRARC implementation	
	13	Terminologies are clearly defined	
	14	The guideline outlines the HIRARC process in a structured manner	
	15	The methodology for HIRARC implementation is clearly presented	
	16	The guideline provides examples to enhance understanding and usability	
	17	Instructions for preparing a Job Hazard Analysis are clearly explained	
	18	Risk matrix selection and usage are well articulated	
	19	Revising the guideline every 5 years is necessary	
	20	The guideline would benefit from further improvements	
Measuring OSH Performance	21	The guideline is applicable across all industry types	Afroh and Basaria, (2023), Hanum et al., (2023), Khalid et al., (2021b), Koh et al., (2022), Liandar et al., (2023), Park et al., (2023)
	22	HIRARC is effective in managing workplace hazards	
	23	HIRARC implementation reduces the rate of occupational accidents and workplace-related illnesses	
	24	The guideline helps identify workplace hazards	
	25	The hierarchy of control principle is effective	
	26	Control measures recommended by the guideline are effective	

This study focused on a target population comprising safety and health practitioners registered with the DOSH Malaysia. A stratified random sampling technique was employed to ensure representation across various regions. Eligibility criteria included practitioners who were actively engaged in workplace OSH, involved in OSH risk assessments, and had a safety and

health committee in their organizations. The sampling frame was obtained from the DOSH Malaysia registry through the MYKKP system, which records all OSH competent persons. As of May 2024, the registry listed 134,243 practitioners across eighteen competency categories (Department of Occupational Safety and Health, 2024b). The majority of these competent persons are located at central region (33.71%), followed by southern region (19.42%), northern region (14.83%), east coast (12.43%), Sarawak (11.74%), and Sabah (7.87%). Using the sample size determination method by Krejcie and Morgan (1970), a minimum of 384 participants was identified as statistically adequate for this population size. Additionally, a G*Power analysis (v3.1.9.7) indicated that the minimum sample size required was 103 respondents, based on a confidence level of 0.80 as suggested by prevalence studies (Arifin et al., 2023). For this study, the Krejie and Morgan sample size estimation was preferred as it provides a larger sample size, which inreases the likelihood of detecting signification relationships (Hair et al., 2019).

Survey questionnaires were distributed both in person and through email, accompanied by a cover letter that outlined the study's objectives, emphasized voluntary participation, and assured respondents that their data would remain confidential. Data collection took place across six regions in Malaysia, which included (1) northern region (Kedah, Penang, Perlis, Perak) (2) central region (Putrajaya, Kuala Lumpur, Selangor), (3) east coast region (Terengganu, Kelantan, Pahang), (4) southern region (Johor, Malacca, Negeri Sembilan), (5) Sarawak, and (6) Sabah.

2.3. Data Screening

Before analysis, the data were screened to identify and exclude any missing values, as well as to determine potential outliers to ensure high-quality results (Hair et al., 2010). To address potential common method bias associated with self-reported survey data, both procedural and statistical remedies were implemented. Procedural steps included anonymity and clarifying that responses would remain confidential. Statistically, Harman's single-factor test was conducted to assess any undue influence of common method variance. The results of Harman's single-factor test indicated that one factor accounted for 38.09% of the total variance, which is below the 50% threshold. This finding suggests that common method bias is not present.

2.4. Data Analysis

In this study, the data were analysed using the Statistical Package for the Social Sciences (SPSS) v25.0. The analysis focused on assessing the relationship between the application of the Guidelines for HIRARC 2008 and improvements in workplace risk management. The assessment was also conducted to assess the relationship of HIRARC and reductions in work-related accidents and work-related illnesses.

A binary logistic regression analysis was conducted to examine the association between HIRARC implementation and its impact on minimizing workplace accidents and work-related illnesses. The statistical analyses in this study were carried out with a significance threshold set at 0.05 (p = 0.05). In this model, a single predictor was used, where continuous variables were dichotomized at the median to allow for balanced group comparisons. Respondents were classified into high and low HIRARC implementation groups based on the median value of the variable. Those with scores equal to or above the median were categorized as the "high" group, while those with scores below the median formed the "low" group. This approach aligns with previous OSH risk management studies by Wurzelbacher and Jin (2011), which suggest that categorizing respondents into "low" and "high" groups provides clearer practical implications for evaluating the effectiveness of workplace OSH based on HIRARC implementation. Furthermore, respondents were grouped into ten categorical sectors based on the classifications outlined in OSHA 1994 to assess whether these sectors had any association with a reduction in workplace accidents.

3. Results

3.1. Socio-Demographic Characteristics of Respondents

Out of 604 practitioners approached, 390 completed and returned the questionnaires, resulting in a response rate of 64.56%. In terms of gender distribution, 82.30% of respondents were male, while 17.69% were female. The majority of respondents were identified as Safety and Health Officers (87.69%), followed by OSH Coordinators (7.69%), Site Safety Supervisors (2.31%), Occupational Health Doctors (0.77%), Steam Engineers (0.51%), Authorized Gas Tester and Entrant Supervisors (0.51%), Hygiene-Technicians (0.26%), and Ergonomics Trained Persons (0.26%). The largest portion of participants, approximately 35.13% had between seven and ten years of OSH experience. Five respondents were currently unemployed. In terms of organization size, 60.52% of respondents worked in large enterprises, 28.83% in medium-sized firms, and 10.65% in small enterprises. The construction industry accounted for the largest sectoral representation at 40.52%, followed by manufacturing at 38.18%. Geographically, 34.10% of the participants were situated in the central, 19.74% in the northern, 17.95% in the southern, 13.33% in the east coast, 8.21% from Sabah, and 6.67% from Sarawak. A summary of the respondents' demographic information is provided in Table 2.

3.2. Normality Test

Table 2 Demographic Characteristics of Participants (390 respondents).

Category	Number of samples	Percentage (%)	Characteristics	Number of samples	Percentage (%)
Gender			Type of Competency		
Male	321	82.30	SHO	342	87.69
Female	69	17.69	ETP	1	0.26
			Steam Engineer	2	0.51
OSH experience			OSH-C	30	7.69
0 to 3 years	34	8.72	OH-D	3	0.77
4 to 6 years	71	18.21	SSS	9	2.31
7 to 10 years	137	35.13	Hygiene Tech	1	0.26
11 to 15 years	92	23.59	AGTES	2	0.51
16 to 20 years	33	8.46			
≥ 20 years	23	5.90	Type of Sectors		
			Construction	156	40.52
Size of Organization			Manufacturing	147	38.18
Large	233	60.52	Financial, Insurance, Real Estate and Business Services	20	5.19
Medium	111	28.83			
Small	41	10.65	Utilities	15	3.90
			Public Service and Statutory Authorities	14	3.64
Workplace Location (Region)					
Central	133	34.10	Transportation, Storage and Communication	12	3.12
Northern	77	19.74			
Southern	70	17.95	Agriculture, Forestry and Fisheries	11	2.86
East Coast	52	13.33	Mining and Quarries	5	1.30
Sabah	32	8.21	Trade, Wholesale and Retail	4	1.04
Sarawak	26	6.67	Hotel and Restaurant	1	0.26

Note: SHO: Safety and Health Officer, ETP: Ergonomic Trained Person, OSH-C: OSH Coordinator, OH-D: Occupational Health Doctor, SSS: Site Safety Supervisor, AGTES: Authorized Gas Tester and Entry Supervisor

This study involved two statistical analyses. The first analysis examined the relationship between the implementation of the HIRARC and improved workplace OSH risk management, which includes the reduction of work-related accidents and occupational illnesses. The second analysis applied simple logistic regression to calculate the odds ratios reflecting the effectiveness of HIRARC implementation in minimizing these incidents.

Before conducting the main analyses, preliminary data screening was carried out to identify potential outliers using Mahalanobis distance (D^2), as suggested by Tabachnick and Fidell (2013). Two multivariate outliers were detected and excluded, resulting in 388 usable responses for subsequent analyses. A normality assessment was then conducted, and as shown in Table 3, the results indicated that the data were not normally distributed.

Table 3 Results of Normality Test based on 388 respondents.

	Kolmogorov-Smirnov[a]			Shapiro-Wilks		
Variable	Statistic	*df*	Sig.	Statistic	*df*	Sig.
Application	0.09	388	< 0.001	0.96	388	< 0.001
Improvements in OSH Risk Management	0.13	388	< 0.001	0.94	388	< 0.001

3.3. Correlation Analysis on the Implementation of HIRARC towards Improved OSH Risk Management

A non-parametric test using Spearman's correlation coefficient was performed to evaluate the relationship between the implementation of HIRARC and the improvement of OSH risk management. The level of Guidelines for HIRARC 2008 implementation was assessed using twenty questionnaire items (item 1 to 20), while improvements in OSH risk management were measured using five items (item 21, 22, and 24 to 26).

As presented in Table 4, the analysis revealed a statistically significant positive correlation between the extent of HIRARC implementation and perceived improvements in workplace OSH risk management ($r_s = 0.82$, $p < 0.001$).

Table 4 Correlation between HIRARC Application and Improved OSH Risk Management.

Analysis	n	Correlation Coefficient	Sig. (2 tailed)
Spearman's rho	388	0.82	< 0.001

3.4. Implementation of HIRARC Guidelines and Reduction of Work-Related Accidents and Illnesses

Further analysis was performed to explore the relationship between the application of the HIRARC guidelines and the reduction of work-related accidents and illnesses. This outcome was assessed using a specific questionnaire (item 23), which evaluated respondents' perceptions of how HIRARC contributed to mitigating on workplace accidents and occupational health issues.

As shown in Table 5, the results from the Spearman's correlation analysis indicate a significant positive relationship between HIRARC implementation and the reduction of workplace accidents and occupational health illnesses (r_s = 0.67, p < 0.001), suggesting that greater application of HIRARC is associated with improved safety outcomes.

Table 5 Correlation between HIRARC Implementation and Reduction in Workplace Incidents.

Analysis	n	Correlation Coefficient	Sig. (2 tailed)
Spearman's rho	388	0.67	< 0.001

3.5. Logistic Regression on HIRARC Implementation

To evaluate effectiveness of HIRARC guidelines in reducing work-related accidents and illnesses, a logistic regression analysis was conducted. For the purpose of this analysis, participants were dichotomized into two groups based on their median scores. Individuals with scores equal to or exceeding the median were categorized as the first group, while those with scores below below the median formed the second group.

The overall application of the HIRARC guidelines was measured using a total of twenty items, resulting in a median score of 87. The logistic regression analysis demonstrated a strong and statistically significant positive relationship between comprehensive implementation of HIRARC and reductions in workplace incidents (B = 2.33, SE = 0.24, $Wald$ = 92.02, p < 0.001). As presented in Table 6, the odds ratio indicates that organizations with a comprehensive HIRARC implementation were 10.27 times more likely to achieve reductions in occupational accidents and illnesses (Exp(B) = 10.27, 95% CI = 6.38–16.53). Furthermore, the Hosmer and Lemeshow goodness-of-fit test indicated a non-significant p-value (HL = 4.34, p = 0.630), as illustrated in Table 7, suggesting that the logistic regression model linking HIRARC implementation to accident reduction is a good fit. Additionally, the Nagelkerke R^2 values of 0.44 indicates that the model explains 44% of the variance, which is considered moderate. In terms of HIRARC implementation by sector, there is no significant association regarding its impact on reducing workplace accidents (p = 0.685). This means that all sectors exhibited a similar effect in reducing workplace accidents.

Table 6 Logistic Regression: Effect of HIRARC Implementation on Workplace Accidents and Occupational-related Illnesses.

Item	*B*	*SE*	*Wald*	*df*	Sig.	Exp (B)	95% CI Upper	95% CI Lower
HIRARC reduces workplace accidents	2.33	0.24	92.02	1	<0.001	10.27	6.38	16.53
Sector			6.54	9	0.685			

Table 7 Test of Goodness-of-fit for the final model.

Item	Chi Square	*df*	Sig.	Nagelkerke R^2
Step 1	4.34	6	0.630	0.44

4. Discussion

This study explored the association between the effective application of the Guidelines for HIRARC 2008 and its influence on enhancing workplace hazard management, as well as minimizing work-related accidents and occupational-related illnesses. The analysis focused on three main areas in relation to (1) assessing the relationship between HIRARC guidelines implementation and improved workplace OSH risk management, (2) examining the relationship between HIRARC application and the reduction of workplace incidents and health hazards, and (3) evaluating the likelihood of work-related incident reduction resulting from HIRARC application.

The results revealed a strong, statistically significant positive association between the application of HIRARC and improved OSH risk management. Likewise, a substantial positive correlation was observed between the execution of HIRARC guidelines and reduced cases of workplace accidents and illnesses. These findings underscore the importance of proactive involvement across all levels within the organization, sufficient allocation of resources, and conformance to the technical instructions outlined in the HIRARC guidelines.

These results are consistent with Uayan (2024), who found that HIRARC implementation in thermal power plants was associated with improved hazard identification and reduced risk levels. The strong association observed reflects HIRARC's structured approach, which guides users through hazard identification, risk assessment, and provides practical control measures. These outcomes align with previous research emphasizing HIRARC's role in helping organizations identify hazards and making informed decisions based on risk assessment outcomes (Fathullah et al., 2021; Hanum et al., 2023; Marzuki et al., 2023; Othman et al., 2019; Saedi et al., 2014).

Furthermore, effective HIRARC implementation was associated with a reduction in accidents and health-related issues, thereby contributing to a safer working environment. This finding is consistent with the work of Fathullah et al. (2021), who

reported fewer accidents in workplaces that implemented HIRARC. A safer workplace fosters greater employee morale, minimizes absenteeism, and boosts organizational productivity, as noted by Foo and Wong (2015), Khalid et al. (2021b) and Koh et al. (2022).

The logistic regression analysis also showed a significant positive relationship between HIRARC implementation and reductions in workplace incidents (B = 2.33, SE = 0.24, $Wald$ = 92.02, $p < 0.001$). The Nagelkerke (R^2) statistic suggested that the model explained a significant portion of the variance in accident reduction, and the Hosmer–Lemeshow test indicated a good model-fit. Notably, the logistic regression results showed that comprehensive adoption of the HIRARC increased the likelihood of reducing workplace accidents and illnesses by approximately 10.27 times across all sectors. This finding is in line with Bakri (2008), who reported that construction sites implementing HIRARC experienced accidents five times less frequently than those that did not. Additionally, López-arquillos and Rubio-romero (2016) noted fewer injuries in automotive repair workshops that implemented risk assessment. They also highlighted that small companies face higher injury risks, leading to increased accident rates due to limited resources and inadequate prioritization of employee health and safety, particularly in small workshops. Locally, similar findings have emerged, indicating that SMEs were hesitant to comply with the OSH legal requirements due to financial constraints and being understaffed in handling OSH-related matters (Marzuki et al., 2022; Yusof & Misnan, 2019).

This study involved respondents from all ten setors covered under OSHA 1994, with greater representation from the construction and manufacturing sectors, as respondents registered with DOSH are primarily engaged in high-risk activities within these sectors. The findings align with prior studies indicating that HIRARC implementation is closely associated with improved workplace risk management in various sectors, including mining, ports, and educational facilities. Sapulete et al. (2023) has reported that HIRARC was particularly useful in assessing risks associated with hazards in gold mining activities. Additionally, Kadir et al. (2017) and Hassan et al. (2020) found that risk assessment using HIRARC was both practical and effective in managing hazards in port and educational institutions, respectively.

Risk assessment is closely associated to international OSH standards, particularly ISO 45001, which demonstrates how a structured risk assessment framework integrates with clauses on hazard identification, risk management, and continual improvement. While obtaining accrediation for OSH management systems is not mandatory in Malaysia, countries like Indonesia has made it a requirement through government regulations (Sugito et al., 2021). Studies have shown that having certification for OSH management systems enhances workplace safety culture and OSH performances (X. Liu et al., 2023; Uhrenholdt Madsen et al., 2020). This indicates that systematically addressing workplace hazards has positive effects.

Although this study shows a strong statistical association between HIRARC implementation and a reduction in workplace accidents and illnesses, it is important to note that the cross-sectional design does not allow for causal inference. Therefore, the findings should viewed as correlations rather than definitive cause-and-effect relationships. This limitation underscores the need for future longitudinal or experimental research to establish causal pathways.

When compared with recent multi-sector OSH literature, the findings are generally consistent, although they vary in magnitude across different industries. For instance, sector-specific studies in construction (Hanum et al., 2023) and manufacturing (Marzuki et al., 2023) reported significant improvements in hazard identification and incident reduction following HIRARC implementation. In constrast, studies in the healthcare and service sectors (Koh et al., 2022) emphasized the moderating role of workforce training and organizational culture. Compared to these multi-sector outcomes, the odds ratio of 10.27 observed in this study appears relatively high, which may be attributed to methodological differences, the crude dichotomization of HIRARC scores, or contextual factors unique to the workplaces surveyed.

From a theoretical standpoint, by contextualizing these results, this study reinforces Heinrich's Domino Theory and Wernefelt's Resource-Based View. It illustrates that eliminating hazards disrupts the crucial links in the causation chain of accidents, while effectively utilizing vital organizational resources can prevent workplace accidents and occupational health risks.

5. Conclusions

The findings of this study demonstrate that implementing risk management according to the procedures outlined in Guidelines for HIRARC 2008 serves as a practical and effective way to manage OSH risks, and for mitigating workplace accidents and health-related issues. To fully realize its benefits, organizations must promote active engagement from both management and employees, allocate sufficient resources, and implement the risk assessment according to the HIRARC guidelines.

One limitation of this study is its focus solely on practitioners registered with the DOSH. Future research could broaden to include other key stakeholders, such as managers, business owners, and workers, who are actively involved in workplace OSH. This would provide a more holistic view of how OSH risk management practices are implemented across different organizational levels.

While this study uses simple logistic regression to analyze the relationships, future research may consider using more advanced statistical methods such as multivariate analysis or partial least squares structural equation modelling (PLS-SEM). These methods could offer deeper insights into causal relationships and better reflect the complexities of OSH risk management implementation.

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Ethical considerations

This study protocol was registered and approved by Ethics Committee for Research Involving Human Subjects (JKEUPM), JKEUPM REF NO: JKEUPM-2024-1039

Conflict of Interest

The authors declare no conflicts of interest.

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