Original Article

Evaluation of Occupational Safety and Health (OSH) Compliance among Ice Industry Operating using Ammonia Ice Refrigeration System in Selangor

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Article history

Received 15/01/2020
Accepted (Panel 1) 20/02/2020
Accepted (Panel 2) 07/02/2024

ABSTRACT: *Most ice plants in the refrigeration industry use ammonia as a coolant in their refrigeration systems. Ammonia is hazardous and toxic. Ammonia release events have been alarming in the past few years and persist regardless of numerous inspections and audits. Therefore, by investigating the lack of awareness about ammonia use, this study aims to assist the relevant statutory authorities and the ice-manufacturing industry in recommending best practices in and approaches to occupational safety and health (OSH) compliance among ice plants, in accordance with the Occupational Safety and Health Act 1994. This study also proposes a novel audit checklist for assessing companies in the not-to-comply category under the Control of Industrial Major Accident Hazard regulations introduced in 1996. The survey involved distributing questionnaires to 55 respondents in 14 selected ice-manufacturing companies located in Selangor, Malaysia, and the results obtained were analysed using the Statistical Package for Social Sciences statistical software. The results indicated that the level of OSH compliance in ice plants is low. The results were attributed to inadequate OSH knowledge regarding risk assessment, ineffective OSH practices and approaches, and the poor implementation of safe operating procedures. Therefore, relevant risk assessment tools, specifically those based on the hazard identification, risk assessment and risk control process, should be considered in the legislation or regulation of the industrial code of practice or the non-major hazard installation (NMHI) audit checklist. New guidelines regarding ammonia use should be developed and implemented, and OSH training should be conducted based on an emergency response plan. As a recommendation, the Department of Occupational Safety and Health, Malaysia, should implement safe operating procedures throughout the ice-manufacturing industry by ensuring that ice plants are upgraded to the NMHI category through administrative orders.*

Keywords: *OSH Compliance, Risk Assessment, Safe Operating Procedures, Training.*

1.0 INTRODUCTION

In Malaysia's ice-manufacturing industry, most ammonia leakage incidents occur in ice plants. Consequently, numerous inspections and audits have been conducted. According to the control of industrial major accident hazard (CIMAH) regulations introduced in 1996, every manufacturing company that uses chemical substances, including ice-manufacturing companies, must submit the notification of industrial activity form, as specified in Schedule 5 (JKKP 5), to determine whether such companies fall under major hazard installation (MHI), non-major hazard installation (NMHI), or not-to-comply (NTC) categories. Most ice-manufacturing companies fall under the NTC category because their threshold quantity of ammonia falls below the requirement (100 tons) for the MHI category and below 10% of the threshold quantity (10 tons) for the NMHI category.

Two main frameworks have been employed to evaluate the levels of occupational safety and health (OSH) compliance: workers' safety practices and human resource practices. The five aspects of discussion under workers' safety practices are as follows: (1) OSH compliance in the ice-manufacturing industry; ensuring comprehensive safety practices according to OSH compliance guidelines regarding the ice-manufacturing industry involves addressing industry-specific hazards related to ice production, storage, and transportation, while implementing broader occupational safety measures to protect workers from accidents and injuries, (2) OSH Awareness; the management should make use of the most suitable form of employee participation to facilitate cooperation between them and their employees, thereby enhancing OSH in the workplace (Surienty et al., 2011), (3) Attitude and Compliance; throughout their work activities, employers should ensure that occupational accidents and injuries in the workplace are avoided by complying with safety standards, procedures, and regulations (Reinhold et al., 2015), (4) Procedure and Process; according to the safety management perspective, occupational accidents primarily result from human error (Bottani et al., 2009), which can be reduced when employers set up proper safety systems (Gordon et al., 2005), (5) OSH Assessment and Evaluation; evaluation of performance may be defined as the process of quantifying the effectiveness of actions (Neely et al., 2005).

Regarding human resource practices, three pivotal elements are considered, as follows: (1) Supervisory Support; the cornerstone of achieving excellence in OSH compliance lies in robust supervisory support throughout the organisational hierarchy. The positive impact of effective supervisory support resonates with enhanced employee satisfaction and performance, as documented by Gottlieb et al. (2003) and Gagnon and Michael (2004), (2) Management Commitment; attaining OSH objectives necessitates active involvement and commitment from the management, as emphasised by Cooper (2006). Management commitment is instrumental in steering an organisation towards a culture of safety and health, (3) Safety Training; safety training is imperative in any workplace. The absence of proper safety training has frequently been identified as the primary cause of workplace accidents, as highlighted by Jaselskis et al. (2005) and Buchanan et al. (2005). Hence, investing in comprehensive safety training programs is essential for fostering a secure and accident-free work environment.

As reported by the public and in newspapers, in three years, the Department of Occupational Safety and Health (DOSH) recorded and documented over five incidents of ammonia-related accidents within companies in the ice-manufacturing industry. Specific cases of accidents involving ammonia leakage in Malaysian ice-manufacturing companies over three years are listed in Table 1.

Table 1 Accident Cases Related to Ammonia Leakage among Ice Plants in Malaysia (2016–2018)

No	Accident case	Date	Accident details
1	Ammonia leakage at Everest ice factory, Shah Alam	13 Aug 2018	2 fatalities, 24 workers injured
2	Ammonia leakage at an ice factory in Taman Sri Maju, Kuala Kangsar	25 Apr 2017	3 workers injured
3	Ammonia leakage at an ice factory in Penampang, Sabah	10 Oct 2017	1 worker injured
4	Ammonia leakage at an ice factory in Perlis	14 Aug 2018	2 workers injured
5	Ammonia leakage at Nekmat Ice Tube Factory, Semambu, Pahang	26 Jan 2016	3 workers at a nearby pump station injured

(Sources: DOSH Malaysia and Newspapers 2016–2018)

This safety issue emphasises the high number of occupational accidents resulting from a lack of safety culture and noncompliance with the requirements outlined in the Occupational Safety and Health Act (OSHA) of 1994 (Ali et al., 2017). These cases included various incidents with varying causes, such as human error and negligence, instrumentation failure, and poor maintenance. Moreover, according to the results of an OSH audit conducted by the DOSH, 79.9% (115 out of 144 companies) of ice-manufacturing companies throughout Malaysia comply with C, D, E, and Not Available (unregistered) grading, as shown in Figure 1.

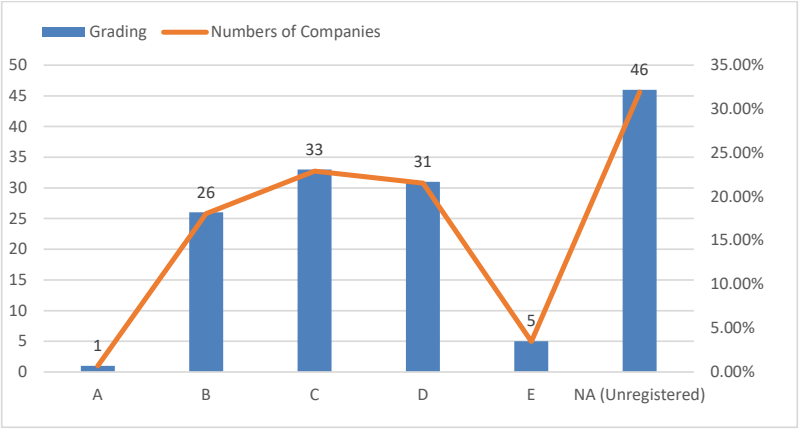

Figure 1: Results of an OSH Audit of Malaysian Ice-manufacturing Companies Conducted by the DOSH (2010–2018)

To address ammonia release events, this study aimed to enhance OSH practices within the ice-manufacturing industry in Malaysia. Despite the ice-manufacturing industry's exemption as that in the NTC category under the CIMAH regulations of 1996, this study prioritised OSH compliance, specifically under the OSHA, 1994. Through an assessment of OSH awareness among employers and the factors influencing compliance, this study sought to guide the improvement of safety measures and the implementation of OSHA regulations in the ice-manufacturing industry. Additionally, this study aimed to contribute to increased OSH awareness across the ice-manufacturing sector in Malaysia.

2.0 METHODS

Both primary and secondary sources were used for data collection. Immediate information was acquired by observing the locations and conducting a survey of staff and employers at ice-manufacturing companies. Secondary data were collected from the DOSH and the Ministry of Health, Malaysia. This study involved 15 ice-manufacturing companies in Selangor that operate using ammonia refrigeration systems. The study's sample size was determined by estimating 20% of a total population of 288 participants. Both parties involved employees and workers, making up 58 correspondents. According to a previous study, generally, in a sample, the number of respondents acceptable for descriptive research should be 10% of the target population for the study. However, if the target population is small, 20% is required to ensure in-depth analyses and accurate results (Cohen, 1988; Gay & Diehl, 1992). A questionnaire survey was conducted among ice-manufacturing companies in Selangor, Malaysia. The questionnaire was divided into five sections, as shown in Table 2.

The collected data were analysed using the Statistical Package for Social Sciences statistical software, and reliability was assessed using Cronbach's alpha, followed by two normality tests evaluating the normality of the collected data, as follows: (1) a histogram bell curve and (2) skewness and kurtosis for the Z-value. Regarding the evaluation of the demographic information and the identification of hazards, two types of analysis were conducted: descriptive analysis and frequency analysis. Factors associated with awareness of hazards and other variables were identified using dependent-

variable models formulated and evaluated through multiple linear regression analysis. Finally, the findings were interpreted into the structural model of the standardised coefficient determining the β- and p-values.

Table 2 Sections in the Questionnaire

Section	Consists of:
1. **Section A:** General/demographic information	Company and general information (age, gender, education level, and workforce)
2. **Section B:** Health and safety awareness and attitude survey	Management commitment, supervisory support, and employees' compliance to rules
3. **Section C:** Safety and health program evaluation	OSH training program, managers' roles, supervisors' roles, employees' obedience, safety, and health committee and safety and health inspection
4. **Section D:** Safety and health issues/legislation	Identification of work activities, procedures and processes, and accident reporting
5. **Section E:** Knowledge regarding and understanding of safe practices	Management of change in work task or process, OSH communication and effectiveness, active and effective organisation/OSH committee, response in investigation issues, priority in conducting risk assessment (HIRARC or JSA) and safe operating procedures, and implementation of risk assessment and control of risks

3.0 RESULTS

As shown in Figure 2, the identified types of hazards (chemical and explosion hazards) were 32.73%; the number of physical hazards was 12 (21.82%), that of fire hazards was 5 (9.09%), and that of hot surface hazards was 2 (3.64%). Although the percentages of chemical and explosion hazards are the same, the percentage of the explosion hazards mentioned above results from chemical hazards in the event of an accident in an ice plant, whereby the leakage of ammonia results in the failure of the ice refrigeration system, thereby causing an explosion.

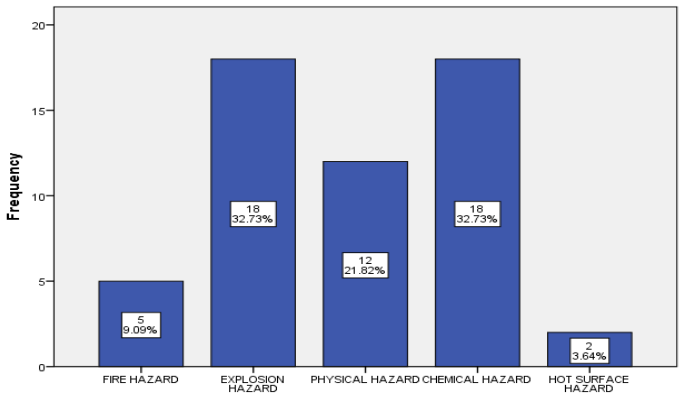

Figure 2: Types of Hazards in the Ice-manufacturing Industry

The results of the data analysis, as presented in Figure 3, demonstrate that best practices in and approaches to OSH compliance among ice-manufacturing companies with the highest to those with the lowest mean values above 3.50 points are as follows: 1) the hazard identification, risk assessment and risk control (HIRARC) process should be implemented in all organisations (mean value = 4.055), 2) Job safety analysis (JSA) should be conducted in all organisations (mean value = 3.927). Both the HIRARC process and JSA are considered the best practices that should be implemented across all organisations to ensure safety and health, in compliance with the law, 3) Notifying the management of hazards shows that early response could save lives, property, and the environment in cases of potentially unwanted and unsafe conditions, 4) Safe operating procedures (SOPs) are essential in preventing existing workplace risks. A high understanding of the risks and safety practices among workers and employers significantly enhances the implementation of the HIRARC process and JSA.

Ensuring OSH compliance by conducting training and implementing SOPs for every activity throughout the ice-manufacturing process in every factory would enable compliance with OSH laws and regulations in Malaysia.

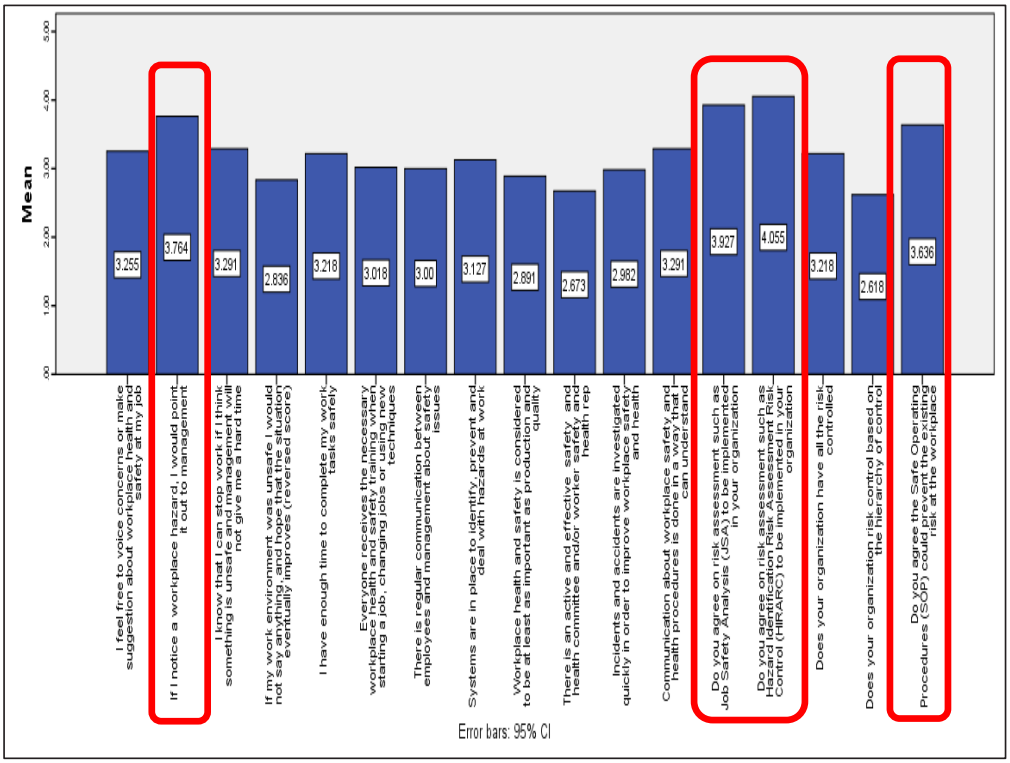

Figure 3: Questionnaire Results on Knowledge and Understanding regarding Safe Practices

Table 3 shows that the overall OSH compliance levels across all organisations in the ice-manufacturing industry are low. This study shows that the current state of OSH compliance throughout the ice-manufacturing industry in Selangor is shocking. Therefore, in the future, drastic measures must be taken by all agencies and authorities engaged in raising awareness and passing legislation regarding OSH compliance in Malaysia's ice-manufacturing industry.

Table 3 Descriptive Statistics of OSH Compliance Levels

Elements	Mean	OSH compliance levels
I carry out a risk assessment before conducting a work activity	1.6727	Low
Dangerous occurrences (e.g., failure of lifting equipment, fire in the workplace) must be reported	1.8909	Low
Occupational diseases reported	1.1091	Low
Work-related injuries/accidents reported	1.4364	Low
First aid services (e.g., first aider, first aid box, first aid room) are present at the workplace	1.9455	Low
Periodic maintenance and inspection of first aid facilities is done at the workplace	1.3636	Low
Training and re-training of workers/supervisors for emergency responses (e.g., fire, chemical spills) are conducted at the workplace	1.8182	Low
Training/orientation programmes of workers on safe and healthy work practices	1.6545	Low
Management of hazardous chemicals	1.4364	Low
Ergonomics assessment was conducted	1.0364	Low
A written policy for safety and health is available at work	1.5636	Low
Are there OSH objectives stated in the safety and health policy in your organisation?	1.4364	Low
Does the organisation conduct hazard identification at the workplace?	1.5091	Low
Does the organisation conduct risk assessment at the workplace?	1.4000	Low
Are the identification, evaluation, and measures to eliminate, prevent, or reduce exposure to workplace hazards conducted?	1.2727	Low
Is the training on and assessment of personal protective equipment usage, including fit testing and monitoring on correct use, conducted?	1.5455	Low
Is hygiene monitoring (e.g., noise and chemical health risk assessment) conducted?	1.2909	Low
Is the information on workplace hazards and risks communicated to the managers/supervisors responsible for implementing prevention and control measures?	1.5273	Low
Is information regarding the possible workplace hazards and risks communicated to the employees?	1.4000	Low
Is the information on physical and psychological health communicated to the employees?	1.1636	Low
Valid N (list wise)		
Average	1.390	Low

4.0 DISCUSSION

Based on the data analysis presented above, many OSH elements must be included in the OSH audit checklist. Although the OSH-WA checklist is used in enforcement activities, it does not cover all critical OSH elements for ice-manufacturing companies in the NTC category. Therefore, the existing NMHI checklist could be used to ensure OSH compliance throughout the ice-manufacturing industry, and we recommend including the HIRARC process to this checklist in future studies.

Additionally, to ensure OSH compliance among all organisations in the ice-manufacturing industry throughout Malaysia, all the government agencies mandated with ensuring OSH compliance must ensure that all ice-manufacturing companies adhere to the following:

i. All companies in the ice-manufacturing industry must conduct practical OSH compliance training on-site to ensure that all the employees and employers in such organisations achieve enhanced awareness about OSH compliance and to improve the attitude of the employees and employers towards emergency action plans and SOPs.

ii. All employees working in ice-manufacturing companies must be trained in OSH compliance in accordance with the regulations set out in the OSHA, 1994.

iii. All organisations in the ice-manufacturing industry should establish and implement the HIRARC process and implement JSA. Risk assessment tools based on the HIRARC process, as well as the NMHI Checklist, should be considered when formulating legislation or regulations associated with such companies.

iv. All ice-manufacturing companies that use ammonia as a coolant in their refrigeration systems should be upgraded to the NMHI category, which is a higher category under the CIMAH regulations introduced in 1996. This is because, based on the descriptive-data statistical analysis of the questionnaire employed in this study, the overall OSH compliance levels among ice-manufacturing companies in Malaysia are low.

v. The DOSH should develop and enact new rules regarding ammonia use throughout the ice-manufacturing industry in Malaysia.

5.0 CONCLUSION

This study's results can be attributed to inadequate knowledge and insufficient awareness about the implementation of OSH practices within companies in the ice-manufacturing industry, thereby resulting in noncompliance with the OSHA of 1994 (OSHA, 1994). The primary sources of the issues addressed in this study include a lack of understanding regarding safety and health, improper management of information during emergencies, and failure to recognise exposure to unique hazards in the workplace. Improving knowledge about the risks and best practices among workers and employers is crucial for enhancing OSH compliance. This can be achieved through comprehensive OSH training, implementing SOPs in alignment with OSH legislation, and strict adherence to regulations in Malaysia.

Based on this study's findings and the limitations reported, we propose the following recommendations to enhance future research on this subject:

i. Further studies on ice-manufacturing or refrigeration companies focusing on cold rooms should be conducted. This is because the amount of ammonia used in cold room operations is higher than that in the scope of this study. Many of them are categorised as NMHI under the CIMAH regulations of 1996 or as SME chemical companies under the NTC category.

ii. Regarding the ice-manufacturing industry in Malaysia, no studies have been conducted to assess major hazardous incidents involving ammonia dispersion in the workplace and the surrounding communities, thereby highlighting a critical gap in research. Relevant authorities should address this issue in future studies.

iii. Related government authorities must effectively enforce and evaluate the effectiveness of existing emergency response plans in workplaces that use ammonia.

iv. Conducting an in-depth examination of the repercussions of the threshold quantity of ammonia and its potential contribution to major hazardous incidents presents a valuable opportunity for enhancement, thereby prompting the need for the DOSH in Malaysia to formulate and develop pertinent laws and regulations.

In conclusion, there is a prospect for the future assessment and implementation of the recommendations outlined in this study to enhance and ensure adherence to OSH compliance standards within ice-manufacturing companies.

ACKNOWLEDGEMENTS

This study was supported by the Department of Occupational Safety and Health, Malaysia, and used in the Department's formulation of the ammonia cooling system guidelines. The authors thank Ir. Hatta Zakaria, Ir. Ibrahim Dol, Ir. Roslenda, and Mr. Shairadzi at DOSH, Putrajaya, and DOSH, Selangor, for their efforts and assistance with this study.

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