Original Article

Chemical Health Risk Assessment of Cleaning Activities in an Office Building

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Article history

Received 17/6/2021
Accepted (Panel 1) 20/9/2021
Accepted (Panel 2) 26/10/2021

ABSTRACT : *The use of chemicals is a necessity in the workplace. Chemicals are used in office buildings, restaurants, schools, laboratories, manufacturing factories, jewelry shops, and many more places. Chemicals are one of the hazards in a workplace. In Malaysia, it is observed that poor chemical handling has led to tragedies and chemical incidents. Under the Occupational Safety and Health Act (OSHA) 1994, it is one of the main responsibilities of the employer to protect and safeguard employees from the adverse effects of chemicals at the workplace. This study aims to assess the types and hazards of chemical handling and storage chemicals for cleaning activities in an office building. The method used in this study is by conducting Chemical Health Risk Assessment (CHRA) according to the Manual of Recommended Practice Assessment of the Health Risks Arising from the Use of Chemicals Hazardous to Health at Workplace Third Edition First Reprint 2018 published by the Department Occupational Safety and Health (DOSH) Malaysia towards chemical handling and storage of chemical activities in a building. The interactions between office cleaners and eleven (11) types of chemicals are involved in this study. Among the challenges faced were the incomplete chemical Safety Data Sheet provided by the suppliers and the chemical storage room which is not readily provided in the building. To overcome the obstacles, the Safety Data Sheet is directly requested from the chemical suppliers, and a chemical storage area is designated in the building. From the assessment conducted, the current control measures are inadequate and improvements in terms of ventilation, storage, and Personal Protective Equipment are needed. It is expected that this study will later demonstrate the risk assessment of hazardous chemicals in the building that are significant to human health and current control measures that can be further improved to provide a safe and healthy working environment for the office cleaners.*

Keywords - *Chemicals, CHRA, Cleaning, Handling, Storage*

1.0 INTRODUCTION

The use of chemicals is necessary for a workplace, such as office buildings, restaurants, schools, laboratories, manufacturing factories, jewellery shops, and other locations. For example, cleaning services requires hundreds and thousands of liters of chemicals. It is estimated that an average cleaning worker uses approximately 110 kg of hazardous chemicals annually. (Barron *et al.*, 1999). According to the Occupational Safety and Health (Use and Standards of Exposure of Chemicals Hazardous to Health) Regulations 2000, chemicals are defined as chemical elements or compounds or mixtures, whether natural or synthetic, but do not include micro-organisms. Chemicals are widely used as cleaning products, catalysts, polishers, perfumes, fertilizers, and others. When this chemical is used in our daily lives, many workers are exposed to the adverse effects of chemicals. Aliyu *et al.* (2006) defined occupational hazards as any condition of a job that can result in illness or injury, endangerment, jeopardy, peril, risk, a source of danger, and a possibility of income loss or misfortune which includes all forms of departure from health among workers caused by their working conditions.

Chemicals are indeed a silent killer to human health. Wolkoff *et al*. (1998) state a complex pattern of exposure to cleaning agents, which results in health problems, such as allergies and asthma, reported among cleaners. Blatter and Zielhuis (2016) conducted a recent study and are convinced that multiple chemical agents are suspected of causing menstrual disorders among hairdressers who are exposed to the chemical agents. Generally, workers involved in cleaning have the highest rate of contact dermatitis (Caroe *et al.*, 2014). In addition, they also have an increased risk of asthma and rhinitis. (Folleti *et al.*, 2013). Building cleaners are among the prominent group of workers who experience diverse occupational hazards resulting in health problems. A previous study was conducted by Charles *et al.* (2019) to identify the health outcomes and associated hazards in the cleaners' work environment\. The results were astonishing as respiratory diseases(n=17) and dermatologic diseases (n=9) were the most common and significantly associated with exposure to cleaning agents. In a previous study conducted by Zock *et al.* (2001), the asthma risk of home cleaners was mainly associated with kitchen cleaning and furniture polishing, using sprays. The use of cleaning products results in exposure to various chemicals, including Volatile Organic Compounds (VOCs), and causes more than 10% of all cases of adult-onset asthma (Quirce and Barranco, 2010). Unintentional chemical poisoning also occurs, which has been commonly reported to occur among children who were found to be exposed to household chemical products. (Adnan *et al.*, 2013).

In occupational health, prevention is better than cure. It is really important to identify the root causes of near misses or incidents. In Malaysia, it is observed that poor chemical handling has led to tragedies and chemical incidents. The recent incident in Malaysia was the explosion that happened in an integrated waste management center at Negeri Sembilan, Malaysia. According to The Star (2015), the fire was seen razing from the chemical store, which involves flammable liquids and combustible materials. Another chemical-related incident that happened was a building lockdown at Taman Tampoi Indah 2, Johor Bharu. The incident happened following a chemical spill in the laboratory at 4.20 pm, 21st March 2019. Based on a report by the Malay Mail (2019), a chemical spill in the laboratory involving sulphuric acid led to a building lockdown. Concentrated sulphuric acid is extremely corrosive and causes burns when not handled properly. According to Adane *et al.* (2012), accidents involving chemicals have been reported worldwide for several reasons, such as an absence of Personal Protective Equipment (PPE), limited experiences, mishandling of chemicals, and lack of knowledge about the proper actions that needs to be taken during an emergency event. One of the effective methods to prevent accidents in many industries is improving the workplace's safety culture. (Gong, 2018).

The use of a chemical is extremely crucial to ensure a smooth workplace operation. Office cleaners are among the occupations in contact or exposed to the use of cleaning chemicals in their daily routine, whether through inhalation or dermal contact. Chemicals are one of the hazards in a workplace. According to Taheri *et al.* (2018), risk assessment is one of the measures to prevent the hazardous effects of chemicals on human health. The enforcement of Chemical Health Risk Assessment (CHRA) is as stated in the Occupational Safety and Health Act 1994, which emphasise employers must conduct risk assessment to work activities that involve the use of chemicals at the workplace. The assessment is essential to evaluate the potential risks to employees due to exposure to hazardous chemicals. For that reason, CHRA will look into the availability and adequacy of control measures at the workplace. Control measures act as barriers against hazardous chemicals from being in contact with the employees. There are four (4) routes where chemicals can get into contact with the employees and subsequently enter into the body. These are through inhalation, skin contact, ingestion, and rarely inoculation. (Ahmad, 2017). Although this enforcement was introduced in 2000, cases concerning chemical incidents are still reported by the Department

of Occupational Safety and Health. Based on the Hierarchy of Control, Standard Operating Procedures (SOP) are one of the control measures under the Administration Control. This SOP is documented, reviewed, updated, and maintained year by year. SOP is the ultimate key or the first barrier to ensuring a safe work method when dealing with chemicals. However, how effective is the current SOP? Does it have any gaps with the current regulations and guidelines? The SOP should be opaque enough and cover the safety aspect from all processes involved when office cleaners handle the chemicals.

The study aims to identify the types and hazards of chemical handling and storage chemicals for cleaning activities in an office building. Then, the chemical hazards will be analyzed through Chemical Health Risk Assessment. The assessment needs to be continuously conducted and the findings reported to create and increase awareness among office cleaners. When awareness is embedded in the culture, it is shown and portrayed among their daily practice. In a study conducted by Miyagawa (2010), the likelihood of unfortunate events can be minimized if chemicals are used and stored properly with strict safety regulations and rules. The safe work practice must be recorded in documented information such as standard operating practice, which must be made available. SOPs act as a guideline in the workplace. This study also aims to propose strategies to resolve the shortcomings by improving the current SOPs of chemical handling and storage for the cleaning activities for the office building.

2.0 METHOD

The chemical health risk assessment is a process that utilizes a systematic approach, namely identifying the hazardous chemical use and management, evaluation of the hazard risk, the adequacy and the effectiveness of current control measures, and identifying the level of risk at the workplace. The assessment is based on the Department of Occupational Safety and Health guideline, Manual of Recommended Practice Assessment of the Health Risks Arising from the Use of Chemicals Hazardous to Health at Workplace Third Edition First Reprint 2018. The assessment involves risk assessments carried out among office cleaners who are directly exposed to the risk of chemicals. In addition, work procedures and SOPs of chemical handling are reviewed. Furthermore, Safety Data Sheets are the main document reviewed to assess the chemical health risk. Based on the guideline, there are a few steps to conduct the assessment. This method is chosen based on the previous studies that had adopted the same methodology for chemical handling and storage. Such studies are the Chemical Health Risk Assessment (CHRA) in a Wet Assay and Fire Assay Laboratory research conducted by Arif Susanto *et al.* (2020). Furthermore, this method provides practical guidance and advice for conducting an assessment of risk to health related to the use of chemicals hazardous to health at the workplace for the compliance to the requirements of the Occupational Safety and Health (Use and Standard of Exposure of Chemicals Hazardous to Health) Regulations 2000.

Conducting a Chemical Health Risk Assessment (CHRA) involves a few parameters observed in the daily routine of office cleaners. A total of 15 office cleaners were monitored during cleaning activities at a 12-storey office building in Putrajaya. The observation includes understanding how the cleaners handle the cleaning chemicals and the type of Personal Protective Equipment worn during the chemical handling. In addition, the observation includes how long the cleaners were exposed to the chemicals during cleaning. The outcome of the observation is recorded and determined by referring to Table 2.1 to Table 2.7. The frequency of chemical exposure to cleaners significantly affects the degree of exposure. For instance, twice the frequency would yield a two-fold increase in exposure. The frequency of potential exposure can be estimated from observing the work activities and feedback from the workers and management. Frequency Rating (FR) is used and is determined from Table 2.1. Another parameter of measurement is the duration of exposure. It has a significant effect on exposure. Twice the duration will result in twice the exposure. Therefore, the average duration is used to determine the duration of exposure. Duration of exposure can be determined from Table 2.2, which is the Duration Rating (DR). From FR and DR, the Frequency-Duration Rating (FDR) can be found as in Table 2.3. All these structured tables are taken from the Department of Occupational Safety and Health, Manual of Recommended Practice Assessment of the Health Risks Arising from the Use of Chemicals Hazardous to Health at Workplace Third Edition First Reprint 2018.

The Magnitude Rating (MR) is determined by the chemical's physicochemical properties and human interface during chemical handling. It is assessed by estimating the degree of chemical released or presence and the degree of chemical inhaled, as shown in Table 2.4. However, MR value can be modified by other factors such as bad work habits, poor personal hygiene, complaints of ill effects, biological monitoring results, or other related diseases or illnesses. In addition, MR value can depend on the conditions of the working area or the way chemicals are being handled. Therefore, it may increase or decrease in terms of the risk involved. Either way, the final MR assigned should not exceed rating of 5 or less than a rating of 1. Based on the Frequency-Duration Rating (FDR) and Magnitude Rating (MR) value, the Exposure Rating (ER) value can be determined from Table 2.5 Exposure Rating (ER).

Table 2.1 Frequency Rating (FR)

Rating	Description	Definition
5	Frequent	Exposure one or more times per shift or per day
4	Probable	Exposure greater than one time per week
3	Occasional	Exposure greater than one time per month
2	Remote	Exposure greater than one time per year
1	Improbable	Exposure one per year or less

(Source: DOSH, A Manual of Recommended Practice on Assessment of Health Risks Associated with the Use of Hazardous Chemicals in the workplace, 3rd Edition, 2018).

Table 2.2 Duration Rating (DR)

Rating	Duration of exposure per shift (x)
5	$x \geq 7$ hours
4	$4 \leq x < 7$ hours
3	$2 \leq x < 4$ hours
2	$1 \leq x < 2$ hours
1	$X < 1$ hour

(Source: DOSH, A Manual of Recommended Practice on Assessment of Health Risks Associated with the Use of Hazardous Chemicals in the workplace, 3rd Edition, 2018).

Table 2.3 Frequency – Duration Rating (FDR)

		Frequency Rating (FR)				
		1	2	3	4	5
Duration Rating (DR)	1	1	2	2	2	3
	2	2	2	3	3	4
	3	2	3	3	4	4
	4	2	3	4	4	5
	5	3	4	4	5	5

(Source: DOSH, A Manual of Recommended Practice on Assessment of Health Risks Associated with the Use of Hazardous Chemicals in the workplace, 3rd Edition, 2018).

Table 2.4 Magnitude Rating (MR)

		Degree of Inhaled		
Degree of Release/ Presence		Low	Moderate	High
	Low	1	2	3
	Moderate	2	3	4
	High	3	4	5

(Source: DOSH, A Manual of Recommended Practice on Assessment of Health Risks Associated with the Use of Hazardous Chemicals in the workplace, 3rd Edition, 2018).

Table 2.5 Exposure Rating (ER)

		Magnitude Rating (MR)				
Frequency-Duration Rating (FDR)		1	2	3	4	5
	1	1	2	2	2	3
	2	2	2	3	3	4
	3	2	3	3	4	4
	4	2	3	4	4	5
	5	3	4	4	5	5

(Source: DOSH, A Manual of Recommended Practice on Assessment of Health Risks Associated with the Use of Hazardous Chemicals in the workplace, 3rd Edition, 2018).

2.1 Risk Determination

The level of risk is determined by using Risk Rating (RR), which is derived from the Hazard Rating (HR) and Exposure Rating (ER), as shown in Table 2.6. The risk rating is determined by using the following equations:

Risk Rating = Hazard Rating X Exposure Rating

RR=HR x ER

Where:

RR is risk rating (1 to 25) indicates the likelihood of injury or illness;

HR is hazard rating (1 to 5) indicates the severity of adverse effects; and

ER is the exposure rating (1 to 5) indicates the chance of overexposure to the chemicals.

Table 2.6 Level of Risk Determination

Hazard Rating (HR)	Exposure Rating (ER)					
		1	2	3	4	5
	1	RR=1	RR=2	RR=3	RR=4	RR=5
	2	RR=2	RR=4	RR=6	RR=8	RR=10
	3	RR=3	RR=6	RR=9	RR=12	RR=15
	4	RR=4	RR=8	RR=12	RR=16	RR=20
	5	RR=5	RR=10	RR=15	RR=20	RR=25
		Low Risk			RR=1 to RR=4	
		Moderate Risk			RR=5 to RR=12	
		High Risk			RR=15 to RR=25	

(Source: DOSH, A Manual of Recommended Practice on Assessment of Health Risks Associated with the Use of Hazardous Chemicals in the workplace, 3rd Edition, 2018).

After determining the Exposure Rating (ER), the Action Priority (AP) can be assigned. Action Priority is identified in each action that needs to be taken. The action priority is used to prepare the action plan for implementing identified control measures. The action priority is assigned based on the level of risk and adequacy of control measures, as shown in Table 2.7. There are three (3) levels of action priority that can be concluded from the assessment. Firstly, Action Priority 1 (AP-1) is where the Risk Rating (RR) is at or above 15 (RR. ≥15) and inadequate control measures or where the Hazard Rating (HR) or Exposure Rating (ER) could not be determined. The second level is Action Priority 2 (AP-2), where the RR is less than 15 (RR<15) and inadequate control measures. Thirdly, Action Priority 3 (AP-3) is an adequate control measure irrespective of the Risk Rating (RR).

Table 2.7 Action Priority Determination

Level of Risk	Adequacy of Control	Action Priority (AP)
High	Inadequate	1
HR or ER could not be determined	-	1
Moderate / Low	Inadequate	2
High/Moderate/Low	Adequate	3

(Source: DOSH, A Manual of Recommended Practice on Assessment of Health Risks Associated with the Use of Hazardous Chemicals in the workplace, 3rd Edition, 2018).

Where:

AP – 1 call for immediate action to be taken

AP – 2 remedial actions still need to be taken

AP – 3 Maintain existing control measures

HR – Hazard Rating

ER – Exposure Rating

2.2 Justification of Methodology

This study employs a strategy of a descriptive research design because this research has a clear aim of the topic of the study. Therefore, the researcher is solely interested in describing the situation or case under their research study in a descriptive design. It is a theory-based design method that is created by gathering, analysing, and presenting the collected data. This allows a researcher to provide insights into the why and how of the research. In addition, descriptive design helps others understand the need for the research better. Thus, the output of the study is the improved Standard Operating Procedure that incorporates the control measures from the Chemical Health Risk Assessment conducted. Furthermore, this study uses the qualitative method since this is the first assessment conducted at the building as it is a new building. Thus, this assessment is crucial to analyze the chemical risks and provide the best safe work practice to prevent any incidents in the future.

3.0 RESULTS AND DISCUSSION

From Table 3.1 Technical Control table and the risk assessment conducted, there are 11 types of chemicals used in chemical handling and storage for the cleaning activities in the office building. One (1) chemical poses a health risk to office cleaners through inhalation. In contrast, another ten (10) chemicals pose a risk via dermal contact. The risk level of risk is simplified in the Technical Control Table below.

Table 3.1 Technical Control

Job or Task	Name of Chemical	Route of Entry (ROE)	Current Technical Control	Current Risk	Recommendation on Technical Control	Level of Risk
Housekeeping - Cleaning	Pledge Furniture Polish with Natural Lemon Oil	Inhalation	Blower, N95 Mask	4 (Low)	Install exhaust fan, Change to R95 Mask	1 (Low)
	JIS Scouring Cream	Dermal	Blower	6 (Moderate)	Install exhaust fan	3 (Low)
	EQ MP	Dermal	Blower	6 (Moderate)	Install exhaust fan	3 (Low)
	EQ PINE Extra	Dermal	Blower	6 (Moderate)	Install exhaust fan	3 (Low)

	AF-QUAT E / AF-DRAKYA / AF-GEM FRESH Air Freshener	Dermal	Blower	6 (Moderate)	Install exhaust fan	3 (Low)
	Savonn Carpet Shampoo	Dermal	Blower	6 (Moderate)	Install exhaust fan	1 (Low)
	IMEC Metal Polish	Dermal	Blower	6 (Moderate)	Install exhaust fan	1 (Low)
	Floor Degreaser	Dermal	Blower	6 (Moderate)	Install exhaust fan	3 (Low)
	EQ Hand Soap - Apple Flower / Floral	Dermal	Blower	6 (Moderate)	Install exhaust fan	3 (Low)
	EQ Scenic V Glass Cleaner	Dermal	Blower	6 (Moderate)	Install exhaust fan	1 (Low)
	EQ Cocorex	Dermal	Blower	6 (Moderate)	Install exhaust fan	3 (Low)

Based on Table 3.1 Technical Control, the current control measures are inadequate and there is a need to improve ventilation, storage, and Personal Protective Equipment. These controls are identified as gaps in the current SOPs. The requirements are listed under Guidelines on Storage of Hazardous Chemicals: A Guide for Safe Warehousing of Packaged Hazardous Chemicals, DOSH, 2005. The current PPE used is the N95 mask which is not suitable and should be substituted with the R95 mask. The current ventilation system and administration control, such as awareness training, must be improvised based on the guideline. These improvements shall be implemented and outlined in the current SOP.

3.1 Substitution of Personal Protective Equipment

Personal Protective Equipment, which is commonly referred to as 'PPE', is an equipment worn by workers at any workplace to minimize exposures to hazards that exist in the workplace that may cause severe injuries and illnesses. These injuries or diseases may result from any contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. Personal Protective Equipment may include gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators, coveralls, vests, and full bodysuits. Current Personal Protective Equipment (PPE) used in the workplace for this study are N95 respirators. N95 respirators are provided to workers to be used in the chemical storage room. The N95 mask can be substituted to enhance protection against workplace hazards, which are hazardous chemicals, with R95 respirators, which are more suitable for chemical handling. N95 respirators are protective inhalation equipment for chemicals or particles not resistant to oil, whereas R95 respirators are used as protective inhalation against organic vapors such as solvents, degreasers, or resins. R95 respirators provide more protection for the workers during the process of chemical handling. Studies have shown that the use of PPE varies from 10 to 82% depending on the accessibility, adequacy, affordability, and fitness to the user and its discomfort. (Tadesse *et al.*, 2016). Training also plays a significant role in increasing knowledge about the PPE and health problems these cleaners are at risk. (Kalu *et al.,* 2013)

3.2 Proper Ventilation

A chemical storage room or area should be well ventilated according to the chemical products stored. Good ventilation is necessary to keep the levels of gases or vapors from reaching the lower flammability limit or concentration hazardous to health. Ventilation may be afforded by natural or mechanical means. Currently, the storage room uses a blower to provide air circulation in the storage room. The blower shall be replaced by installing an exhaust fan to comply with Guidelines on Storage of Hazardous Chemicals: A Guide for Safe Warehousing of Packaged Hazardous Chemicals, DOSH, 2005.

3.3 Training

For administration control it is recommended that cleaners need to be constantly given safety briefings and awareness training. These programmes can enhance their knowledge and skills in chemical safety. For instance, they are provided training on the correct way to wear PPEs, spillage kit training, chemical handling, chemical labeling, and other topics. Apart from that, safety regulations, posters, and signages should be displayed at strategic locations, particularly in the chemical storage room. Chemical exposure is controlled by using preventive measures such as keeping workspaces clean at all times and supplying cleaners with PPE.

3.4 Standard Operating Procedure

A Standard Operating Procedure (SOP) is a step-by-step instruction developed by employers to help workers conduct routine jobs and activities. SOP aims to boost productivity, quality output, and performance consistency while reducing misunderstanding and noncompliance with industry regulations. In addition, SOP outlines safety measures between processes to minimize workplace hazards while doing work activitise. The current SOP shall be reviewed to emphasize the selection of suitable PPE according to findings of the CHRA.

4.0 CONCLUSION

The study found out that current control measures are inadequate and need to be improved in terms of ventilation, storage, and Personal Protective Equipment. These controls are identified as gaps in the current SOP. The requirements are listed under Guidelines on Storage of Hazardous Chemicals: A Guide for Safe Warehousing of Packaged Hazardous Chemicals, DOSH, 2005. The current ventilation system and administration control, such as awareness training, must be improvised based on guidelines. These improvements shall be implemented and outlined in the current SOP. The CHRA conducted concludes that the current practice is Action Priority 2 (AP-2), whereby the assessment finds that the current procedure has moderate or low risk and requires remedial actions to be taken. Among the study's limitations was the incomplete Chemicals Safety Data Sheet provided by the suppliers and the chemical storage room was not readily provided in the building. To overcome the obstacles, Safety Data Sheet is requested directly from the chemical suppliers, and a chemical storage area is designated in the building. Based on the findings, suggestions for improvement must be made to reduce chemical health risks and enhance workplace occupational safety and health performance. This study can be further improved for future works by enhancing data availability for document review and more researchers involved as observers.

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The authors fully acknowledge the Ministry of Higher Education Malaysia (MOHE) and Universiti Teknologi Malaysia for the research grant (Q.K130000.3556.05G58) that aided in funding the research works. Special thanks to all the reviewers for their valuable comments and constructive suggestions.

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