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A Study for External Facade Cleaning Using Rope Access Equipment: Hazard Identification and Risk Assessment

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Abstract

Modern buildings' facades require regular facade cleaning to identified and addressed damage, extended structure life, and reduce costly repairs. Rope access window cleaning had a lowered accident risk due to improved technology and competence. Even though it had an excellent safety reputation, rope-access window washing had received its fair shared of attention throughout the years. The objective of this studied was to determine the leveled of risk involving facade cleaning used rope, used hazard identification, risk assessment, and risk controlled (HIRARC) such as fell, dangerous equipment, suspension rigging, and anchor pointed conditions. The studied utilized both primary and secondary data collection methods, including field observation, and checklists that were focus group discussions with experts and team facade cleaning. The results indicated that the HIRARC during filling identified three high-risk hazards which were strong winds over 25 knots, working at high placed, and emergencies working in a suspended situation this situation poses a risk of musculoskeletal disorders (MSDs). This researched needed controlled measures to minimize workplace accidents in the facade cleaning process by eliminating, administrative controlled and used of personal protective equipment (PPE)

1. Introduction

Malaysian buildings are made of glass, stone, wood, or metal, which could deteriorate over time due to exposure to pollutants, air, and dirt [1]. Regular facade cleaning could identify and address damage, extending the structure's life and reducing costly repairs. Rope access window cleaning was a safe method for high-access cleaning and maintenance but had drawn attention due to instances of workers falling from dangerous heights. Industry safety regulations, such as Regulation 2005-Work at Height (WAH), require rope climbing employees to receive certification and training from their employers [2]. In 15 years, 88 window-washing incidents were recorded by the Occupational Safety and Health Act (OSHA), resulting in 62 fatalities in New York.

The objective of this study was to determine the level of risk involving facade cleaning using rope, using Hazard Identification, Risk Assessment, and Risk Control (HIRARC) to identify potential hazards such as fell,

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dangerous equipment, suspension rigging, and anchor point conditions. The project aimed to improve occupational safety and health assessment, increase management and safety officers' knowledge, and direct safety procedures. The study would enhance awareness of existing hazards.

The company would focus on personnel and environmental conditions during façade cleaning, exposing industrial practices affecting employees. This improved worker safety, health awareness, and compliance with the Occupational Safety and Health Act (OSHA) of 2022, and reduced complaints, medical leave, and absenteeism.

2. Literature Review

2.1 Risk Assessment

Risk Assessment (RA) was a systematic procedure for identifying hazards and assessing risks for control and avoidance. It distinguishes between a hazard, which could cause harm, and a risk, which was the chance of harm to a person. When using an employee or contractor to clean windows or facades, a risk assessment should be conducted. Factors to consider include access apparatus, labour duration, work environment, work surface durability, employee capabilities, and safe use of cleaning substances. Safe work systems should be designed based on risk assessment, and risk assessments should be conducted by competent individuals.

2.2 Hazard Identification, Risk Assessment and Risk Control (HIRARC)

The HIRARC system was crucial for workplace safety. It involved three steps: Hazard Identification, Risk Assessment, and Risk Control. In 2008, Malaysia's Department of Occupational Safety and Health issued HIRARC recommendations to identify potential hazards, assessed the likelihood of harm, and guide employers in implementing preventive measures. These guidelines were implemented when hazards posed a significant threat, existing controls were uncertain, corrective measures were needed, system changes occurred, or organizations aimed to enhance their OSH Management System. Employers were responsible for assigning trained personnel to lead HIRARC activities [3].

2.2.1 Hazard Identification

Workplace hazards included chemical, ergonomic, physical, and psychological risks. Employers must ensure a safe working environment by removing and minimizing them. Hazard identification methods included inspections, material safety data sheets, employee consultation, and accident records. The Malaysian Occupational Safety and Health Act emphasized employer responsibility. Walk-through surveys and other methods helped identify hazards and assess their effectiveness [4].

2.2.2 Risk Assessment

When conducting a risk assessment, it was essential to consider various factors. These included the nature of the hazard that posed a risk, the possible combinations of hazard types that could result in injuries or illnesses, and the consequences of prolonged exposure to the hazard. Other essential factors to consider during the risk assessment process were the layout of the workplace and workstation, the working posture and position, the organization of work, any new work processes that may be introduced, the skill and experience level of employees, and any personal characteristics of employees that may put them at risk (such as hearing impairment). It was also crucial to consider any existing control measures in place, such as the use of clothing and personal protective equipment. (HIRARC, 2008)

Step	Action
1.	Identify the hazards

2.	Identify who can be harmed by hazards
3.	Evaluate the risk arising from the hazards and decide if the precautions already in place are adequate.
4.	Record significant findings
5.	Review assessment and revise if necessary.

Table 1 *Practical step in conducting the risk assessment (HIRARC guidelines,2008, ISO 45001, ISO31001)*

2.2.3 Likelihood of An Occurrence

The likelihood of an event occurring was determined based on employees' experience with past incidents or near-missed occurrences. Probability levels ranged from "most likely" to "inconceivable." Table 2 shows details of various probabilities and their ratings

Likelihood(L)	Example	Rating
Most likely	The most likely result of the hazard/event being realized	5
Possible	Has a good chance of occurring and is not unusual	4
Conceivable	Might be occur at sometimes in future	3
Remote	Has not been known to occur after many years	2
Inconceivable	Is practically impossible and has never occurred	1

Table 2 *Likelihood Values*

2.2.4 Severity of Hazard

Risk was described in various ways based on the analysis performed and the results obtained, which were used to make decisions regarding the implementation of risk control. Risk matrices were utilised to present the outcomes of quantitative analyses based on probability and severity. Table 3 illustrates a risk matrix used to determine the risk value.

Calculating risk with the following formula:
L x S = Relative Risk
L = Likelihood
S = Severity

	Severity				
Likelihood	**1**	**2**	**3**	**4**	**5**
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

LOW	MEDIUM	HIGH

Table 3 *Risk Matrix Values*

2.2.5 Risk Rating

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The severity and likelihood columns of a risk table help prioritize hazards and implement effective risk management measures, as illustrated in Table 4.

Risk	Description	Action
15-25	**High**	A HIGH risk requires immediate action to control the hazard as detailed in the hierarchy of control. Actions taken must be documented on the risk assessment form including date for completion.
5-12	**Medium**	A MEDIUM risk requires a planned approach to controlling the hazard and applies temporary measure if required. Actions taken must be documented on the risk assessment form including date for completion.
1-4	**Low**	A risk identified as LOW may be considered as acceptable and further reduction may not be necessary. However, if the risk can be resolved quickly and efficiently, control measures should be implemented and recorded.

Table 4 *Risk descriptions*

2.2.6 Control Measures

Control measures were essential in managing workplace hazards. They could be categorized as eliminating the risk, reducing the risk, or using backup control. Eliminating a hazard was the most effective approach, followed by replacing it with a less harmful alternative or physically removing the risk. Engineering control could be employed to eliminate the risk at its source, such as redesigning tools and equipment, isolation, automation, barriers, and ventilation systems. Administrative controls, such as scheduling and job rotations, could also help prevent exposure to hazardous equipment and processes.

3. Methodology

3.1 Data Collection Phase

This had four important stages: The introduction phase (literature research, field study), data collecting phase (primary and secondary), data processing phase (HIRARC), recommendation of control measures and conclusion. A comprehensive literature review on activities leading to hazard, risk, and HIRARC during the external facade cleaning phase of general statistics accidents worldwide, factors and causes contributed to accidents in facade cleaning. The field study was the risk assessment methods and their control measures undertaken by the company, industry guidelines, and safety and health requirements for facade cleaning undertaken.

Identify hazards using the HIRARC form, it involved primary and secondary data collection methods, including reviewing incident reports. Secondary data was collected through observation, workplace inspection, and checklists. The safety level in the workplace was linked to the number of hazards present, which could be affected by factors like work type, accident severity, work environment, employee education, and authority monitoring. The HIRARC approach was used to identify all possible risks and parameters to reduce accidents and increase safety. Figure 1 shows the framework for this process.

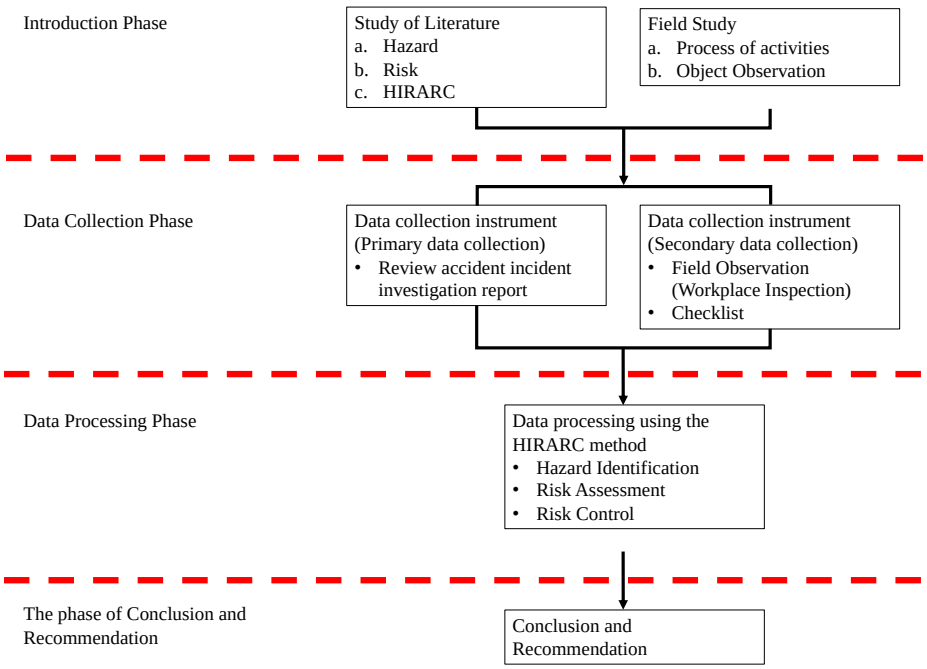

Fig. 1 *The framework for this process*

3.1.1 Review Accident Incident Investigation Report

The conducted a document review as the primary evaluation method to gather background information and develop a secondary method for this study. This involved reading and reviewing the organization's specific internal and external documents in electronic or soft copy format.

3.1.2 Field Observation (Workplace Inspection)

The study used visual observations and photographs to record the study area and activities. A walk-around inspection was conducted using the External Façade Cleaning Standard Operating Procedure. Audits focused on identified ineffective safety programs, while inspections identified hazardous conditions and assigned numerical ratings. Worksite observation was crucial in identifying workplace injury behaviours, as it considered how these behaviours interacted with the hazardous environment.

3.1.3 Checklist

A checklist was utilized to identify workplace hazards based on past experiences, such as risk assessments or incidents. There were various checklists available for different areas, but this study used the External Facade Cleaning Checklist (Inspection) and External Facade Cleaning Daily Checklist. The External Facade Cleaning Checklist (Inspection) was a tool utilized by the Department of Health, Safety, and Environment (HSE) to conduct an inspection and the External Facade Cleaning Daily Checklist would be carried out every day by the supervisor. It included a detailed list of items to inspect.

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3.2 Hazard Identification, Risk Assessment and Risk Control (HIRARC)

The risk assessment matrix of Hazard Identification, Risk Assessment and Risk Control (HIRARC) model had been used in processes facade cleaning assessment, which may be inherent to the system and was determined as a serious threat for selected activities on the project on that building. The flowchart of hazard identification, risk assessment and risk control (HIRARC) process is in Figure 2.

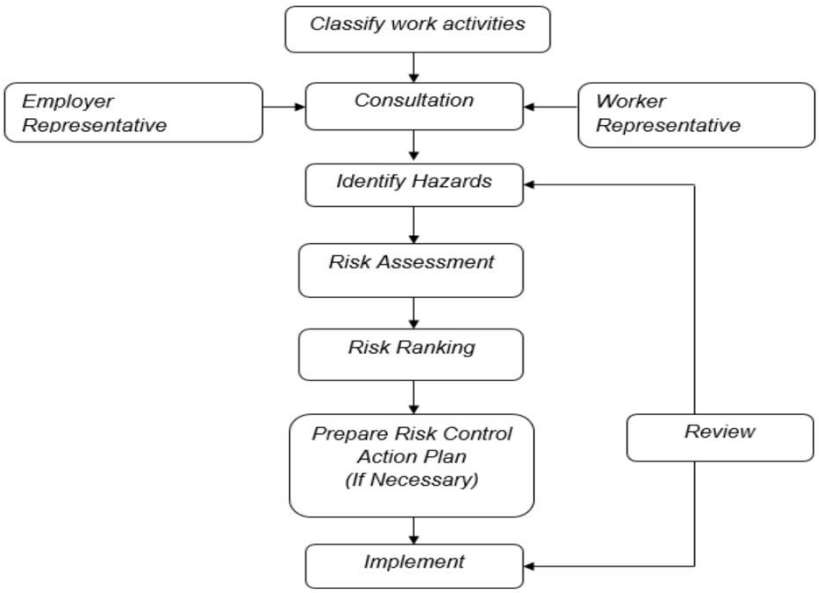

Fig. 2 *Flowchart of Hazard Identification, Risk Assessment and Risk Control (HIRARC) process*

4. Result and discussion

This study used techniques like incident investigation reports, checklists, field observations, and the Hazard Identification, Risk Assessment and Risk Control (HIRARC) risk matrix to identify and assess workplace hazards and risks. The data analysis process consisted of three parts: reviewing incident investigation reports, using checklists, and utilizing the HIRARC method to minimize worker injury. Based on the above Figure 3 illustrates the various work activities associated with facade cleaning activities on the building.

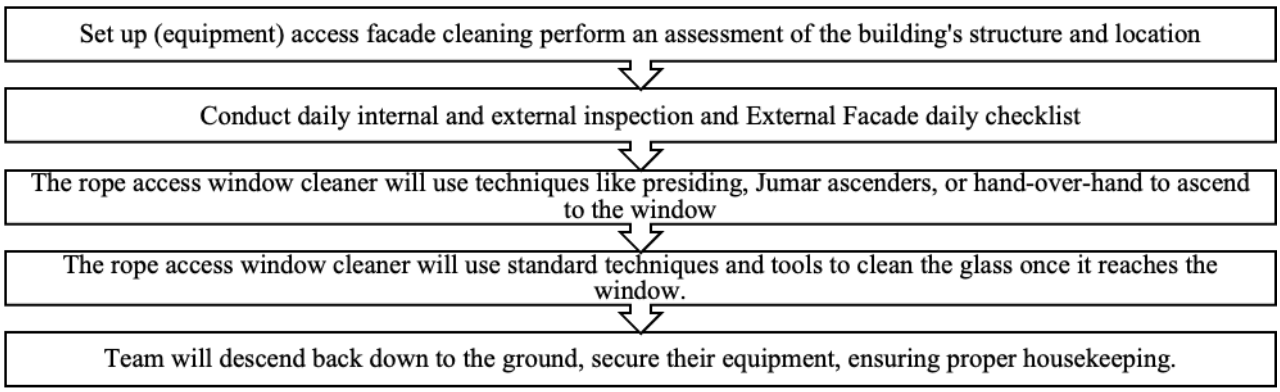

Fig. 3 *Illustrates the various work activities associated with facade cleaning activities on the building.*

This study involved a workplace inspection of the External Facade Cleaning Team, which utilized one External Facade Cleaning Checklist during the process. The checklist was specifically designed to identify potential accidents related to external cleaning operations at client premises. Safety professionals involved in the process would use the information gathered to mitigate any identified hazards. The inspection process generally took about three days to complete the checklist form. The supervision of employees engaged in a facade cleaning operation was of utmost importance. A checklist had been specifically designed for this purpose, to identify any accidents that may occur in the facade cleaning industry. The identification of hazards was conducted by observing work activities at each workstation throughout the line. Figure 4 shows the checklist for external facade cleaning.

	ITEM	PLEASE TICK (/)		DATE OF INSPECTION _____/_____/_____
	EXTERNAL FACADE CLEANING APPROVED FOR USE	**YES**	**NO**	**REMARK**
1.	Has the external facade cleaning operation been reviewed and approved by relevant regulatory authorities?	/		
2.	Have all necessary permits for external facade cleaning using ropes been obtained?	/		
3.	Has approval been obtained from the building management or owners for the facade cleaning operation?	/		FM has approved
4.	Has the safety aspect of the cleaning operation been reviewed and approved by safety authorities?	/		SHO Aida Amirah
5.	Are records of workers' training in facade cleaning and rope access up-to-date and approved?	/		
	PROJECT CONTROLS	**YES**	**NO**	**REMARK**
1.	Need for hazard studies considered (i.e. HazID, Hazop, HIRARC?)	/		HIRARC
2.	Is there a clear timeline and schedule for the entire facade cleaning project, including pre-cleaning preparations and post-cleaning activities?	/		
3.	Are there established quality control measures to ensure that the facade cleaning meets specified standards and requirements?	/		
4.	Is there a system in place for monitoring progress, and are regular reports generated to track the project's status?	/		External Facade Cleaning Checklist
5.	Is there ongoing monitoring to ensure ongoing compliance with relevant regulations and standards?	/		
6.	Is there coordination with other ongoing projects that may impact the facade cleaning operation?		/	

Fig. 4 *The checklist for external facade cleaning.*

A workplace hazard assessment matrix is designed to evaluate the risks associated with each hazardous situation. The matrix enables the identification of potential risks by assessing the likelihood of their occurrence and the severity of their impact. Once the hazards are identified, they are weighted based on various elements, including relevant data, tables, and the potential risks involved. Table 6 shows the hazard identification with each work activity in facade cleaning and table 7 shows the results of the risk assessment conducted for the facade cleaning operation.

No	Work Activity	Hazard	Impact
1.	Set up (equipment) access facade cleaning perform an assessment of the building's structure and location	Not following Standard requirement	The integrity of Rope Access Equipment
		Incompetent workers	Incident
		Site familiarization	Incident/fall from height
2.	Conduct daily internal and external inspection and External Facade daily checklist	PPE Multifunction	Incident/fall from height
		Faulty equipment	Incident/fall from height
		Failed to provide communication device	Communication Break-down & Incident
		Heavy traffic	Traffic Incident
		Strong wind > 25 Knot	Sway and hit by building structure
			Bodily Injuries
		Temperature> 40 C	Heat Stroke
			Dehydrated

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No	Work Activity	Hazard	Impact
		Miss-understand between Breaker & Cleaning Crew	Sway and hit by building structure
3.	The rope access window cleaner will use techniques like presiding, Jumar ascenders, or hand-over-hand to ascend to the window	Slippery condition	Slip & Fall
		Work at Height	Fall from height
		Manual Handling	Ergonomic Disease
			Slip & Fall
4.	The rope access window cleaner will use standard techniques and tools to clean the glass once it reaches the window.	Malfunction Rope Access Accessories	Fall from height
		Sharp edge contact with Working Line & Safety Line	Fall from height
5.	Team will descend back down to the ground, secure their equipment, ensuring proper housekeeping.	Waste	Hit by fallen object
			Slip & Fall
		Uncontrol Traffic	Hit by fallen object
		Emergency Response During Suspended	Hit by fallen object

Table 6 *The hazard identification with each work activity in facade cleaning*

Type of hazard	Hazard	Impact	Risk Evaluation		
			Severity	Likelihood	Overall Risk Ranking
Safety Hazard	Not following Standard requirement	The integrity of Rope Access Equipment	4	1	4
	Incompetent workers	Incident	4	1	4
	Site familiarization	Incident/fall from height	4	1	4
	PPE Multifunction	Incident/fall from height	4	1	4
	Faulty equipment	Incident/fall from height	4	1	4
	Failed to provide communication device	Communication Break-down & Incident	1	4	4
	Heavy traffic	Traffic Incident	3	1	3
	Strong wind > 25 Knot	Sway and hit by building structure	4	4	16
		Bodily Injuries	4	4	16
	Miss-understand between Breaker & Cleaning Crew	Sway and hit by building structure	3	4	12
	Suspended Equipment	Sway and hit by moving object	2	3	6
	Work at Height	Fall from height	4	4	16
	Manual Handling	Slip & Fall	3	3	9
	No emergency procedure	Incident	5	1	5
	Malfunction Rope Access Accessories	Fall from height	5	2	10

Type of hazard	Hazard	Impact	Risk Evaluation		
			Severity	Likelihood	Overall Risk Ranking
	Sharp edge contact with Working Line & Safety Line	Fall from height	4	3	12
	Waste	Hit by fallen object	3	3	9
		Slip & Fall	3	3	9
	Uncontrol Traffic	Hit by fallen object	3	3	9
Psychosocial Hazard	Temperature> 40 DC	Heat Stress	3	4	12
Ergonomic Hazard	Manual Handling	Ergonomic Disease	3	3	9
	Emergency Response During Suspended	Hit by fallen object Back pain	4	4	16

Table 7 *Presents the results of the risk assessment conducted for the facade cleaning operation.*

The risk assessment process during filling identified three high-risk hazards which included the strong winds over 25 knots, working at high places, and emergency response during the suspension. These hazards posed significant risks to personnel, property, and operations. Supervisors must assess weather conditions and use anemometers to measure wind speed before facade cleaning activities. Working at a height without appropriate personal protective equipment (PPE) was dangerous, as falling from a height of over 160 meters could cause immediate death or permanent disability. The risk score for fall from height was "4" (Fatal), and the probability of this risk occurring was "4" (Possible). The team responsible for the facade cleaning technique must be cautious during emergency rescues, as it poses a risk of musculoskeletal disorders (MSDs) and a potential fall. The risk score of "16" indicated a high level of risk in these areas.

The risk control hierarchy outlined effective methods for eliminating hazards, with the weakest measure being personal protective equipment. Existing measures were insufficient, highlighting the need for new control measures. The study proposed a new measure, as low as reasonably practicable (ALARP), to mitigate risks, ensuring workers' safety. Diagram 4 presented an outline of the risk control measures for every activity or hazard.

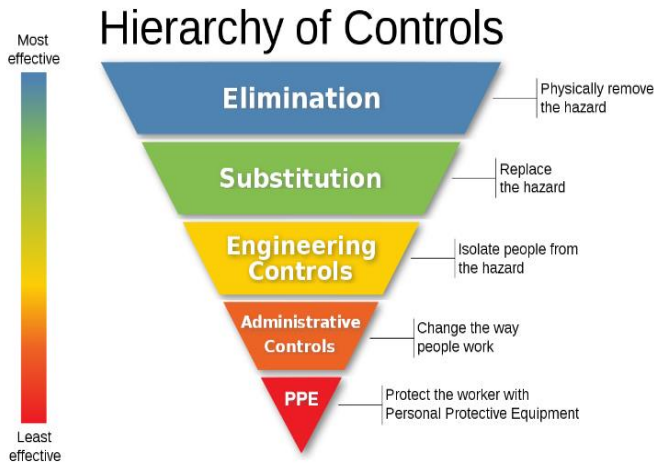

Diagram 4 *Presents an outline of the risk control measures for every activity or hazard.*

A risk assessment was conducted to identify potential hazards in facade cleaning tasks. Wind speed exceeding 25 knots was a high-risk hazard, and measures such as wind monitoring, visual inspection of weather conditions, and the use of personal protective equipment (PPE) were recommended. Rope access window cleaning methods, such as hand-over-hand, Jumar ascenders, and presiding, raise the risk of falling from the structure. Qualified employees with the right skills were needed to perform work at height, and emergency evacuation procedures should be planned. Staff should be informed about emergency protocols and ergonomic training techniques like muscular stretching.

5. Conclusion

This study aimed to conduct a HIRARC for exterior facade cleaning. Three objectives were developed: identifying safety and health hazards, ergonomic hazards, and risk assessment. Wind speeds exceeding 25 knots were high risk, causing falling from the building, and emergencies working in a suspended situation. Safety hazards include working at heights, suspended equipment, slippery conditions, malfunctioning rope access accessories, sharp edge contact, waste, and uncontrolled traffic. Ergonomic hazards included using force when cleaning facade glass, which could be painful and uncomfortable.

A risk assessment using a risk matrix was conducted to determine the level of risk involved in facade cleaning using a rope. Three hazards involving three activities were categorized under high-risk levels. Supervisors must assess weather conditions and use personal protective equipment (PPE) before starting facade cleaning activities. Falling from a height of more than 160 meters could cause immediate death and back injury. The team was responsible for a 41-story building when emergency rescue because of the danger, they needed to stabilize themselves while helping. Unfortunately, this situation poses a risk of musculoskeletal disorders (MSDs).

The third objective was recommending control measures to reduce risk levels for facade cleaning using rope access equipment using the Hierarchy of Control. The risk control proposed was presented to the safety team for further improvement.

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References

[1] Hamid, K. A. A. (2020, November 15). Building façade cleaning. LinkedIn. https://www.linkedin.com/pulse/building-fa%C3%A7ade-cleaning-khairol-azimin-abdul-hamid

[2] Ozone, T. (2021, October 7). Rope access window cleaning in Abu Dhabi. LinkedIn. https://www.linkedin.com/pulse/rope-access-window-cleaning-abu-dhabi-total-ozone/?trk=pulse-article_more-articles_related-content-card

[3] Occupational Safety and Health Administration (OSHA). As part of the U.S. Department of Labor, OSHA develops and enforces safety and health regulations in the workplace. http://www.osha.gov

[4] Javed, B. (2023, May 23). Working at Height Hazards You Need To Know. Occupational Health and Safety Blog. https://www.hseblog.com/check-the-basic-hazards-of-work-at-height/