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A Study on the Safety Management through Potential Risk Analysis of Construction Site Metal Window Type

Eun-Hee JEON[1], Eun-Gu HAM[2]

[1]First Author Researcher, Dept. of Environmental Health & Safety, Eulji University, Korea.
Email: coco1201@naver.com
[2] Corresponding Author Professor, Dept. of Environmental Health & Safety, Eulji University, Korea.
Email: hameg@eulji.ac.kr

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Abstract

Purpose: The purpose is to identify hazardous and risk factors by utilizing the risk assessment theory implemented in construction sites, analyze repetitive accident cases and risk factors, derive risk factors by type of work, systematically analyze and evaluate them, predict and manage the possibility of accidents, and present an effective plan to reduce accidents by effectively applying them in the field. **Research design, data and methodology:** This paper targets metal window construction work being carried out at construction sites, and examines accident types, risk factors, and cases by work type, and analyzes them using statistical data. from domestic and international academic A, papers, and research institutes**. Result:** There are many volatile elements at construction sites. If we identify and analyze the risk factors at the workplace, establish risk measures, and conduct risk assessments, we can reduce industrial accidents and thus reduce productivity loss**. Conclusion:** Based on various data from construction sites, we can propose risk assessment safety measure for each type of work and improve the safety and health level of the workplace by introducing an effective safety management system.

Keywods: Metal window construction, Construction safety, Risk assessment, Risk analysis, Construction work type

JEL Classification code: L50, L59 L74,L78.L79

1. Introduction

1.1. Background and Necessity of the Research

The construction industry is one of the fields with a high incidence of occupational accidents, and the fatal accident rate is also quite high, with various causes of accidents present. A characteristic of the construction industry is that it is a cooperative system of specialized contractors who focus on various types of work. In construction projects, the client enters into a contract with a general contractor for comprehensive construction, and the general contractor

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establishes a hierarchical system by signing contracts with subcontractors who perform specialized work. Due to this structure, construction sites have a complex working environment where various types of work are continuously carried out, and there is unique accident risks associated with each type of work. And the types and causes of accidents that can occur var by construction type. For effective on-site management, it is necessary to analyze the risk factors by each type of work and conduct a systematic risk assessment. However, accidents continue to occur due to d lack of effectiveness on site. Efforts are being made to conduct effective risk assessments to strengthen. However, the risk assessment system currently implemented at domestic construction sites is applied according to a certain framework, which leads to low applicability in actual work environments. This ongoing issue raises questions about its effectiveness, making research on risk assessment techniques tailored to the characteristics of specific work types urgently necessary.

1.2. Purpose of the Study

The reason why the importance of risk assessment is emphasized is because risk assessment has a clear purpose, preventing industrial accidents. The government announced the main contents of the [Guidelines on Workplace Risk Assessment] in May 2023(effective May 22,2023), including the contents to make it easier for industries to conduct risk assessments and to ensure worker participation throughout the entire process. This can be interpreted as a quantitative expansion of risk assessment. ln order to expand and appropriately apply risk assessment, the main types of accident cases being performed at construction sites are analyzed, and the risk factors of repetitive accident types are systematically analyzed and evaluated to establish priority-based safety measures according to the risk level of the type of work, and a customized risk assessment technique is applied for each type of work to predict and manage the possibility of accidents, thereby creating a safe work environment for workers, thereby increasing work efficiency and reducing productivity loss due to accidents.

1.3. Research Subjects and Methods

In order to present the risks occurring at construction sites more quantitatively, we targeted metal window construction companies currently in construction. The research method was first to analyze risk factors and safety measures by type of work. Cases of each type of work were reviewed. Second, we investigated whether safety management activities and risk assessments were being implemented at construction sites and analyzed problems related to safety management.
Third, we conduct an analysis of prior research on risk assessment to derive key risk factors. Fourth, in order to quantitatively represent the risk of accidents, case data from risk assessment related research institutions wore used for analysis, and interviews with construction workers and safety managers were conducted to obtain their opinions.

2. Theoretical Considerations

2.1. Analysis of the Status of Industrial Accidents in the Construction Industry

According to the 2024 industrial accident status (2025.05.08/Public notice by the Ministry of Employment and Labor, Occupational Safety and Health Agency), the number of accident deaths increased by 1.8% compared to the previous year, and the number of accident victims increased by 2% compared to the previous year. The number of accidental deaths fell in the construction industry, where accidents occurred most frequently. According to the 2023 and 2024 industrial accident status announced by the Ministry of Employment and Labor, the construction industry accounts for a large proportion of deaths, and the number of accidents and deaths in other industries. By type of accident, account or a much higher proportion. The number of accidental deaths is increasing every year, causing great economic losses and harm to economic development. [Fig.1] is the number of accidents and deaths by industry surveyed by the Korea Occupational Safety and Health Agency in 2023 and 2024, and [Fig.2] is the number of by type in the construction industry.

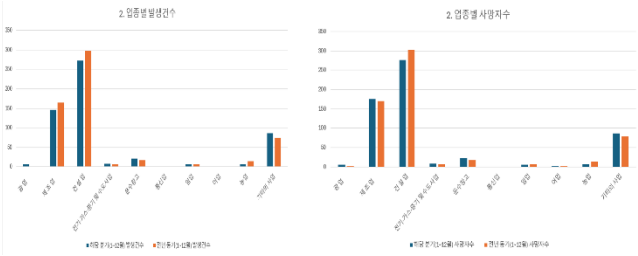

Figure 1: Number of accidents and deaths by industry (2023-2024)

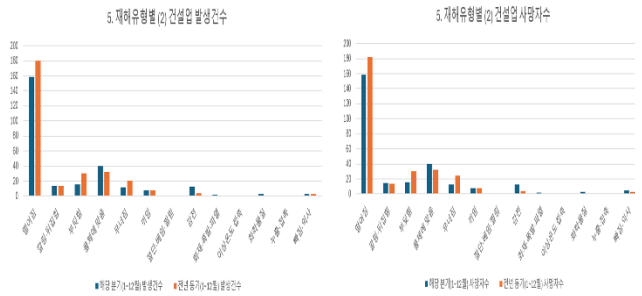

Figure 2: Number of accidents and deaths by type of accident in the construction industry (2023-2024)

2.2. Risk Assessment

2.2.1. Definition of Risk Assessment

Risk assessment is the process by which employers find out in advance what hazards of risks may cause injury or risks may cause injury or illness to workers, examine how dangerous they are, and establish and implement measures to reduce the risks It is being carried out to prevent accidents in advance by identifying the causes that may cause accidents, but currently, measures are being taken after accidents occur. The reason why the importance of risk assessment is emphasized is because risk assessment has a clear purpose of preventing industrial accidents

2.2.2. Background of introduction of risk assessment

Developed countries such as the UK and German have recognized the limitations of regulation and punishment since the 1970s and have established [self-discipline prevention systems], drastically reducing the number of fatal accidents and fatality rates. In Korea, too, following the social trend, the government presents lower-level norms and guidelines, and based on this, labor and management jointly establish their own norms that are suitable for the characteristics of the workplace, and as a key means of risk assessment, etc., identify and eliminate risk factors within the workplace, and strictly examine the appropriateness of the company's preventive efforts in the event of an accident and assign responsibility according to the results, so it was judged that this could reduce fatal accidents, and this was introduced.

2.2.3 Legal Basis for Risk Assessment

Risk assessment is a legal obligation that must be carried out at the workplace in accordance with the [Industrial Safety and Health Act] and related notices and guidelines. The legal basis is Article 36 of the Industrial Safety and Health Act (Implementation of Risk Assessment) [Article 37 of the Enforcement Regulations of the Industrial Safety and Health Act] and the Ministry of Employment and Labor's notice [Guidelines on Workplace Risk Assessment]. [Table1] is the detailed content of the guidelines of the relevant laws.

Table 1: Laws and regulations related to risk assessment

Law / Guideline Name	Main contents
Article 36 of the Industrial Safety and Health Act	Employers are obligated to identify hazardous and dangerous factors at their workplaces, take risk assessment measures, and retain records of progress.
Article 37 of the Enforcement Regulations of the Industrial Safety and Health Act	Specific procedures for risk assessment implementation and management of results, etc.
Guidelines on workplace risk assessment (Notice)	Detailed implementation methods, procedures, timing, etc. of risk assessment

2.2.4. The Need for risk Assessment

The first reason why risk assessment is necessary is to prevent industrial accidents. Through industrial preventive measures, accidents and diseases of workers can be reduced. The second is work efficiency. By creating a safe work environment, work efficiency can be increased. Compensation costs and productivity losses due to accidents can be reduced. The fourth is compliance with legal obligations. Risk assessment is required under the Industrial Safety and Health Act.

2.2.5. Risk Assessment Procedure

The risk assessment procedure is generally composed of five stages: Stage 1: Preliminary preparation, Stage 2: Identification of hazardous and risk factors, Stage 3: Estimation of risk, Stage 4: Determination of risk, Stage 5: Risk reduction measures and implementation, and is repeated until the risk level is acceptable. The results of the risk assessment must be shared in various ways so that workers' participation is essential at each stage according to legal standards and both workers' managers can easily understand and practice. [Fig. 3] shows the order of the risk assessment procedure

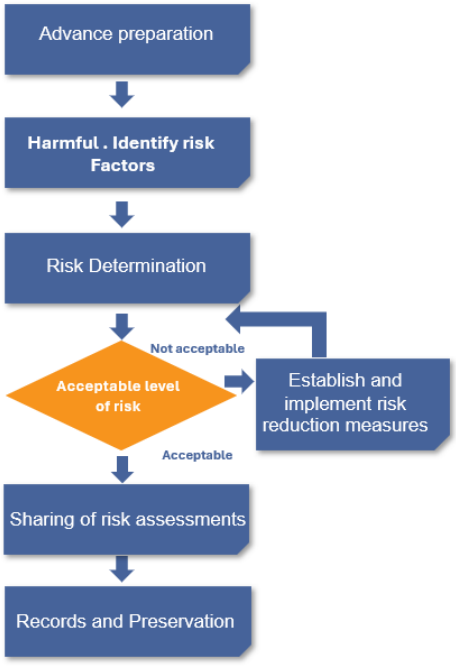

Figure 3: Risk assessment procedure

2.2.6. Risk Assessment Techniques

According to Article 50 of the Enforcement Regulations of the [Industrial Safety and Health Act], risk assessment is divided into qualitative risk assessment and quantitative risk assessment. Qualitative risk assessment is an assessment method that finds risk factors, and it is relatively quick and subjective to draw conclusions. The types of techniques include frequency, intensity, and checklist methods. Quantitative risk assessment is a method that probabilistically analyzes and evaluates risk factors, and it can produce objective and quantifiable results. There are defect tree analysis, incident tree analysis, and cause-effect analysis.

3. Risk Factors for Window Work Metal and Safety

This study investigated the risk factors and safety measures for metal window work, although there are risk factors for each type of work at a construction site.

3.1. Definition of Metal Window Type

Metal window work is the work of installing windows or doors made of various metal materials, synthetic resin, glass, etc. on buildings. The detailed work types include aluminium windows, plastic windows, and glass installation, and there are various risk factors depending on the nature of the work. The metal window installation process consists of 9 steps. Existing window removal. Window lifting. Work under the frame. Frame installation. Urethane foam installation. Glass installation. Silicone caulking. Lower masonry and fitting, hardware installation. However, the construction process is constantly changing depending on the work site and window type, and there are various risk factors at each step.

3.2. Analysis of Industrial Accident Status in Metal Window Construction

Metal window work is one of the most frequent accident types at construction sites, and various types of accidents are reported. As of 2023-2025, 3,201 cases were recorded in metal window and glass work. This figure is based on statistics on the status of risk factors by type of work from the Construction Safety Management Comprehensive Information Network. When looking at accident cases, there is a high risk of serious accidents, such as falling, falling, entrapment, and electric shock, and there are also failures to comply with basic safety rules, such as failure to install work platforms, inadequate work methods, and negligence in management and supervision.
[Table 2] is the status of accidents by type of work announced by the Construction Safety Management Comprehensive Information Network.

Table 2: Status of risk factor identification by type of work (construction 2023-2025). Source: CSI

Year	Temporary construction	Demolition and dismantling work	Construction Earthworks	Intellectual construction	Reinforced Concrete Construction	Steel construction	Masonry work	Plastering work	Waterproofing work	Metal work	Roof gutter construction	Changho Glass Construction	Tile and Stone Works	Stamping construction	Underground construction	Total
2023	2,497	111	2001	203	4026	954	333	115	298	561	67	163	96	162	347	11,454
2024	5996	291	4288	354	8732	1267	496	226	553	1052	189	291	117	346	646	24,746
2025	5274	240	4275	484	7425	1074	404	170	400	909	124	225	119	168	926	21,796
계	13767	642	10964	1041	20183	2896	1233	511	1251	2522	870	679	332	676	1499	58,026

3.3. Causes of Accidents by Type of Work

Metal window construction has unique risk factors in each of the various sub-works (window installation, lifting, transport, and lifting). Looking at the frequency of each type of accident that frequently occurs, falling accidents, falling and entrapment accidents, collisions, tipping accidents, and fire accidents occur frequently. In particular, falling accidents that occur when balcony railings fall off during window installation are highly likely to lead to fatal accidents, so safety measures are especially necessary. [Table 3] is about the causes of accidents by type.

Table 3: Causes of occurrence by accident type.

Accident type	Main causes and locations of occurrence
crash	Falls due to slipping, tripping, or lack of safety equipment on roofs, steps, ladders, openings, work platforms, etc.
fall	Materials, tools, etc. fall from above while working, causing casualties
stricture	Heavy equipment. Caught during material transport and installation process.
crash. falling	Equipment, materials, and personnel collisions. Equipment overturning.
fire	Electrical factors, refrigerant (ammonia) leaks, fires caused by carelessness, etc.

3.4. Risk Assessment of Metal Window Construction Work

The risk assessment procedure for metal window construction is conducted in the same steps as the existing risk assessment. Through the risk assessment, safety measures should be established and implemented systematically and step by step. In order to derive the risk factors for metal window construction, existing accident cases were analyzed, and various risk factors were analyzed and derived step by step based on the work currently in progress.

3.4.1 Risk assessment and risk factors of metal window construction work

Risk assessments are being conducted for each type of construction at construction sites, and the period is different for each site. The risk assessment data in Table 4 were derived based on the risk assessment conducted at the construction of metal windows during the construction of the 0000 church from September 23, 2024, to 7, 2025.

Table 4: Example risk assessment form

Large public works	Detailed work category	Work details	Risk	Wellbeing Grade			Management target
				Top	Middle	Lower	
Architecture	Metal, Scrap metal	Material entry, processing, transportation	Cutting, During processing work eye protection not worn resulting in eye damage.		○		●
Architecture	Metal, Scrap metal	Material entry, processing, transportation	개 Hardware, Flammable substances and paint during painting, Fire occurred while working with fire near hazardous materials such as thinner.	○			
Architecture	Metal, Scrap metal	Material entry, processing, transportation	Tilt and entrapment due to unconfirmed signals and loading methods during material input, transportation, and unloading.		○		●
Architecture	Metal, Scrap metal	Material entry, processing, transportation	Material drop from the opening around the lift.		○		●
Architecture	Metal, Scrap metal	Material entry, processing, transportation	Risk of overturning due to excessive material stacking			○	
Architecture	Metal, Scrap metal	Material entry, processing, transportation	The cover for the rotating part of the high-speed cutting machine for cutting metal is not installed, leading to physical injury and contact due to damage to the rotating part's cover.	○			●
Architecture	Metal, Scrap metal	Material entry, processing, transportation	Fire caused by sparks during metal cutting	○			●
Architecture	Metal, Scrap metal	Metal Fittings Installation	Damage caused by not wearing goggles when using a hand grinder.		○		
Architecture	Metal, Scrap metal	Metal Fittings Installation	Fall due to the work platform detaching while working on external scaffolding or mobile scaffolding.		○		●
Architecture	Metal, Scrap metal	Metal Fittings Installation	Not installing an automatic electric shock prevention device on the mutual arc welding machine and getting electrocuted during work.		○		●
Architecture	Metal, Scrap metal	Metal Fittings Installation	Electrocution due to using an inadequate electric drill and hand grinder.	○			
Architecture	Changho, Glass	Material entry, processing, transportation	Material dropout and overturning during transport and lifting.		○		
Architecture	Changho, Glass	Material entry, processing, transportation	개 Tilt and entrapment due to unconfirmed signals and loading methods during material input, transportation, and unloading.	○			●
Architecture	Changho, Glass	Material entry, processing, transportation	When transporting glass on a pallet, maintain left and right balance, and the pallet should be placed on an unstable ground to prevent tipping and pinching.		○		
Architecture	Changho, Glass	Material entry, processing, transportation	While cutting window hardware with a high-speed cutter, there was physical contact with the rotating part, resulting in an injury.		○		
Architecture	Changho, Glass	Installation	Falling while working without wearing safety gear during window and glass installation.	○			
Architecture	Changho, Glass	Installation	Fall due to the work platform detaching while working on external scaffolding or mobile scaffolding.	○			●
Architecture	Changho, Glass	Installation	Material falling during window or glass installation work on high floors.	○			●

Metal window work has unique risk factors in each of its sub-works (window installation, lifting, transportation, lifting, etc.). Risk factors for each sub-work were derived based on the risk assessment table [Table 4]. Metal window work consists of various sub-works such as material delivery, transportation, installation, and finishing, and various accidents occur repeatedly in these stages. We derived the representative accident types that occur in metal window sub-works by synthesizing actual accident cases and risk assessment results. [Table 5] shows the risk factors and accident types for each sub-work.

Table 5: Metal Window Glass Construction Risk Factors and Accident Types

Gongjong	Risk factors and accident types
Material transport and loading stage	*Handling heavy objects. Musculoskeletal disorders due to transporting large window frames and glass *Risk of tipping and collapse due to unstable loading of materials *High possibility of collision with workers while using forklifts, cranes, and lifts
Window processing and assembly stages	*Finger cuts and eye injuries due to flying objects when not wearing protective gear during cutting and grinding work. *Risk of fire and exposure to hazardous gases from welding and cutting work *Risk of electric shock due to contact with electrical wiring.
Window Installation and Fixing Steps	*Reading balance during work and possible pinching accident *Danger of falling during window installation on high floors *Damage to workers and pedestrians due to falling glass, tools, and materials during window frame installation
Silicone and finishing work	*Cutting and breaking due to carelessness when installing glass. Injuries due to fragments *Inhalation of chemicals and skin irritation when using silicone and adhesives *Fingers caught and crushed during window frame fixing
Final inspection and cleanup stage	*Risk of accident due to debris left on the floor *Tripping accident due to slipping while cleaning the floor

3.4.2 Safety measures to ensure the main risk Factors of metal window work.

Based on the risk factors revealed through the risk assessment of metal window construction, the risk level was calculated, and safety measures were derived. [Fig. 4] shows the risk assessment contents and the risk assessment register, and the recorded contents include the risk level and improvement measures. Based on [Fig.4], advance preparations for the entire construction process can be made through the risk assessment, and safety measures for risk factors for each detailed construction process were established. [Table 6] shows the safety measures for risk factors for each detailed metal window construction process. Purpose of the study

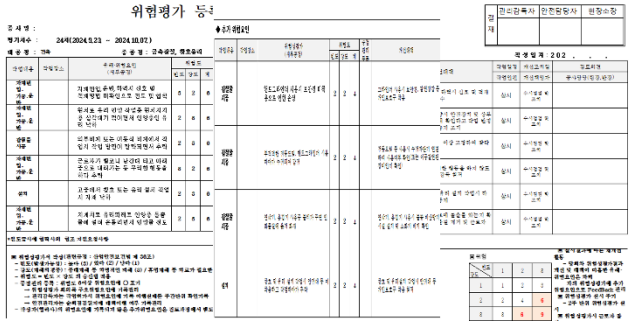

Figure 4: Risk assessment procedure

Table 6: Safety measures to ensure risk factors in metal window glass construction

Gongjong	Hazardous Factor Safety Securing Measures
Material transport and loading stage	* Apply the principle of 2 people per group. Use a lift for transport * Use fixing and support to prevent materials from falling during loading * Place a signalman during transport to prevent collisions
Window processing and assembly stages	*Check safety equipment such as safety glasses and protective gloves when using cutters and grinders *Fire prevention measures when welding (place fire extinguishers and use protective clothing) *Operate ventilation facilities in the workplace and wear a mask to prevent harmful gases
Window Installation and Fixing Steps	*Prevent entrapment by using auxiliary equipment such as levers and clamps during window fixing work *Wear a safety belt and install a safety railing when working over 2m *Proceed with work after fixing tools and materials to prevent falling objects. Install a safety fence and a falling object prevention net at the bottom of the work area
Silicone and finishing work	*Use anti-slip gloves and protective film when handling glass *Ventilate the work area and wear protective gear *Be careful about the use of operating tools and hand position when fixing window frames
Final inspection and cleanup stage	*Wear protective gloves and check the floor condition when cleaning *Clean up residual chemicals and debris *Check anti-slip signs and placement and checklist after wet cleaning

Even if safety measures are established for each detailed work type as shown in [Table 6], regular and special safety education for workers must be conducted, a safety officer must be designated and assigned on-site, and necessary measures for the safety of all personnel and facilities during construction must be taken, and continuous supervision and inspection must be conducted to ensure compliance with workplace safety rules and procedures. In addition, emergency equipment such as fire extinguishers must be placed nearby and training must be provided on how to use them, and workers must be familiar with the emergency contact network and emergency fire routes in advance.

3.5. Metal Window Construction Risk Assessment Model

In order to secure the effectiveness of risk assessment by type of work, it is necessary to improve on-site risk factors and systematically manage them, rather than through formal assessment. For systematic risk assessment, it is necessary to introduce a standardized assessment model. It is effective to utilize existing data such as the 'Construction Industry Risk Assessment Model by Type of Work' provided by the Korea Occupational Safety and Health Agency and modify and supplement it according to the characteristics. [Table 7] shows the standardized method of conducting risk assessment for metal window work.

Table 7: How to do it step by step

Risk assessment procedure	Main contents
Advance preparation	* Altitude of the work site. Narrowness of the work space * Weather and nearby hazards (high voltage lines, falling objects) survey * Check the installation status and safety of high-altitude work platforms,ladders, and gondola equipment
Identifying Hazardous and Risk Factors	* Risk factors for each stage of work such as material delivery, transportation,and installation. Identification. * Risk factors: falling, dropping, tipping, collision, electric shock, glass breakage, entanglement, handling of heavy materials. * Analyze work procedures to ensure that no risk factors are missed at eachstage.
Risk Determination	* Assess the likelihood of occurrence and severity of damage by risk * Determine whether it is acceptable
Unacceptable Risk level : Establish and implement risk reduction measures	* Establish specific and actionable measures when the allowable level isexceeded (Example: 2 people per team, wear safety belts, install safety facilities, inspect equipment, control workers) *Check worker safety training completion, skill level, health status, changes in work environment, etc. * Establish and implement measures to reduce
Acceptable Risk Level : Sharing the Risk Assessment	* Establish a response plan (emergency contact network, rescue methods, etc.) in case of an accident. * Share and sufficiently educate safety rules using TBM.
Records and Preservation	* Record and preserve the results of the risk assessment. * Re-evaluate when there are changes such as changes in the type of work, accidents, or new work.

4. Conclusions

Risk assessment and corresponding countermeasure establishment for metal window construction work are essential elements for creating a safe construction site. As analyzed in this study, there are various risk factors such as falls, falls, and collisions in metal window construction work, and systematic and effective countermeasures for these are necessary. First, a standard risk assessment model specializing for metal window construction work should be developed and distributed to ensure consistent safety management on site. Second, as new window materials and construction technologies are introduced, appropriate safety measures must be continuously studied and developed. Third, safety awareness must be raised, and an effective safety management system must be established by having field workers actively participate in identifying risk factors and establishing countermeasures. Lastly, accident cases that have occurred must be systematically analyzed and the results must be shared across the industry to prevent recurrence of similar accidents.

References

CSI. (2023–2025). *Risk factor derivation and implementation by type of work: Construction, metal work, window and glass work.*

Ministry of Employment and Labor. (2023, December 23). *End industrial accident occurrence status: Accident investigation target fatal accident occurrence status additional statistics results* (pp. 26–29).

Ministry of Employment and Labor. (2025, April 30). *End industrial accident occurrence status: Accident investigation target fatal accident occurrence status additional statistics results* (pp. 28–30).

Ministry of Employment and Labor. (2023). *Guidelines on risk assessment at workplaces* (Notice No. 2023-19). Article 36 of the Industrial Safety and Health Act (Implementation of risk assessment).

Ministry of Employment and Labor, Occupational Safety and Health Agency. (2023, April 30). *Industrial accident status table*.

Ministry of Employment and Labor, Occupational Safety and Health Agency. (2023, May). *2023 new risk assessment guide: Risk assessment procedure* (p. 8).

Ministry of Employment and Labor, Occupational Safety and Health Agency. (2023, May). *2023 new risk assessment guide: Background on the introduction of risk assessment* (pp. 26–32).

Ministry of Employment and Labor. (2024, December 18). *Guidelines on risk assessment at workplaces* (Notice No. 2021-76, partially revised).

Ministry of Employment and Labor. (2024, May 17). *Article 36 of the Industrial Safety and Health Act (Risk assessment implementation).*