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RISK ASSESSMENT IN 13-STORY BUILDING PROJECTS WITH THE FAILURE MODE AND EFFECT ANALYSIS (FMEA) METHOD AND THE DOMINO EFFECT

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ABSTRACT

The building construction project is one of the activities that can pose a safety risk. Work safety risk assessment can be done using the Failure Mode and Effect Analysis (FMEA) method and looking at the Risk Priority Number (RPN) value. The purpose of this research is to take a case study of the building Office in determining the highest RPN and provide recommendations on its management. This project consists of 13 earthworks, passenger hoist, tower crane, scaffolding jobs, ironworks, formwork work, foundry work, mechanical, electrical plumbing (MEP) work, welding work, and floor wall doing works, and ceramic installation work. The highest RPN from the observations occurred in Iron Fabrication which can cause fingers hit by a bar cutter and bender. In this case, personal protective equipment (PPE) is significant in preventing these impacts from occurring in the project work area.

Keywords: Risk Assessment, Effect Analysis Method, Domino Effect

INTRODUCTION

Construction projects are activities that are carried out once and are generally short-term. The construction of construction projects, especially building construction, is an activity that contains risks. The risk can hinder the smooth running of the project and endanger the safety of the workers involved in the project (Junaedi& Joko, 2013). It is estimated that globally there are 60,000 fatal work accidents per year, about 1 in 6 fatal accidents reported in the construction sector (ILO, 2015).

In the world and Indonesia, work accidents in the construction sector are still an issue and require attention from all parties. With the number of work accidents and death tolls still serious, the work safety program in the construction sector needs more attention.The building Office Suites Project in Jakarta is an ongoing building construction project with a high risk of work accidents. The project is planned to have 17 floors consisting of 4 basements and 13 floors. At the time of the research, the work had entered the upper structure and finishing stages of construction. With the high number of work accidents in the construction sector, workplace safety management is needed to construct BUILDING Office Suites. Work safety

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management is part of management to prevent work accidents. Work accidents can be prevented by controlling work accidents with a high risk of consequences, the likelihood of occurrence, and ease of detection (Apriyan et al., 2017). Work accidents can be caused by various potential hazards originating from multiple aspects, ranging from work equipment to its users. If the risk of this hazard occurs, it can result in injury to death. The way to prevent work accidents is to control risk in a construction project. The first step in risk control is to conduct a risk assessment.

Various methods have been introduced as methods that can be used to identify the risk of work accidents, including Failure Mode and Effect Analysis (FMEA), Job Safety Analysis (JSA), What-if Analysis, Checklist, Hazard Operability Study (HAZOPS), and Fault Tree Analysis (FTA). The methods used include the Failure Mode and Effect Analysis (FMEA) method and the Domino method. The FMEA method was chosen because, based on ISO 31010:2009, FMEA has an excellent ability to identify, analyze, and evaluate risks to provide complete analysis results and display the priority level or dominant risk. The FMEA method is used to identify risks and determine the prevailing threats in construction projects. In contrast, the domino method is used to identify and analyze the causes of work accidents (Aftortu et al., 2019). Based on the description above, this study aims to identify and analyze the causes of occupational accident risk and provide recommendations for controlling the BUILDING Office Suites project in Jakarta using the FMEA and Domino methods.

METHOD

The research that will be carried out is in the form of field research which directly makes observations to obtain the necessary information. A literature study is used as a goal in conducting a risk analysis of work accidents. Furthermore, primary and secondary data were collected. The data includes the results of field observations, interviews, construction work data, and work accident data. After all, information is collected, risk analysis can be carried out using FMEA and Domino methods. After the analysis process is carried out, get the work results with the dominant risk seen from the highest RPN value. Furthermore, an analysis using the Domino method was carried out to determine the cause of work accidents. At the final stage, an evaluation will be carried out to draw conclusions and present suggestions so that the risk of work accidents can be avoided.

Primary data was obtained through observations and interviews related to the risk of work accidents to respondents (Site Manager, Safety Engineer, Safety Engineer Staff, and Field Staff) for the Building Office Suites construction project. Observations are made to identify and determine the risk of accidents in the project under review. At the same time, interviews were conducted to assess the magnitude of the value of severity, occurrence, and detection.

The secondary data used is in the form of job list data consisting of job type data, the number of workers data, and activity stage data in each type of work. In addition to job list data, data on work accidents that have occurred and are at risk of appearing in

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development projects and data on the implementation of health and safety that have been applied to the BUILDING Office Suites development project are also used.

After obtaining the required data through observation, questionnaire sheets, and interviews, data processing is carried out using the FMEA method, whose preparation. Suppose the analysis using the FMEA method has been completed, and the dominant risk is obtained. In that case, the analysis using the Domino method can be carried out to identify and analyze the causes of the prevalent risk using the results from the study of the FMEA method. The following are the stages in conducting data analysis:

1. Determine the project activities to be identified.
2. Identify the risk of work accidents that can occur.
3. Determine the severity value (Severity) in the range of values 1 – 5
4. Identify the causes of accidents that can occur.
5. Determine the value of the probability of an accident occurring (Occurrence) in the range of values 1 – 5.
6. Identify the control measures that have been implemented to anticipate the accident.
7. Determine the value of the control action ability to detect or control the potential for accidents that may occur (Detection) in the range of deals from 1 to 5.
8. Calculation of the Risk Priority Number (RPN) value to determine the dominant occupational accident risk
9. Describe the results of a dominant risk factor that occurs using the domino method.
10. Provide recommendations for handling work accident risks and are expected to minimize or eliminate these risks.

RESULT AND DISCUSSION

The scope of work for the upper structure stage and finishing construction on the BUILDING Office Suites project during the research consisted of:

1. Earthworks
2. Passenger Hoist
3. Tower Crane
4. Scaffolding Jobs
5. Ironworks
6. Formwork Work
7. Foundry Work
8. Mechanical Electrical Plumbing (MEP) work
9. Welding Work
10. Floor Work
11. Wall Making Works
12. Ceramic Installation Work
13. Gondola

In each of these jobs, there is a risk of work accidents that can endanger the safety of construction workers. The following is an analysis of the risk of work accidents for each job contained in the Building Office Suites project. Based on identifying existing accident risks, conducting discussions and interviews with the HSE Manager of the Building Project, the risk assessment results using the FMEA method are as follows Table 1. It was found that the fabrication work had the two highest RPN values, namely the risk of fingers being hit by a bar cutter and a finger being exposed to a bar

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bender. After knowing work with the highest RPN value, it is necessary to carry out a risk evaluation to reduce the RPN value.

Table 1. Analysis of risk assessment using the FMEA method

No	Item	Accident Risk	Sev	Cause of Accident	Occ	Cause of Accident	Det	RPN
1	**Pekerjaangaliantanahdenganalatberat**							
1.1	Tool check	injured hand	2	Not using full PPE	4	Provide PPE and carry out safety inspections	1	8
		slip	1	Workers are not alert	3	Install warning signs in the work area	2	6
1.2	Operation	Worker hit/hit excavator	4	Doing work inside the backhoe area	3	Installing a safety line in the work area of heavy equipment	1	12
		Buried by landslide	5	Do not cover the ground with tarpaulin	2	Installing a safety line in the work area of heavy equipment	1	10
		Got electric shock	5	Electric current hits the roof of the excavator	2	Ensuring a safe work area	1	10
2	**Passenger Hoist (PH)**							
2.1	Operation	Drop tool	5	Soil below PH cracks	2	Carry out routine checks	1	10
		Workers fall while trying to get in and out	5	Workers not wearing safety harness	2	Provide briefing regarding work at height and conduct a safety inspection	1	10
		Got electric shock	5	The cable is chipped and exposed to water	2	Conduct periodic checks	1	10
3	**Tower Crane (TC)**							
3.1	Operation	The houses of residents/workers are hit by material	5	Load loose / wire rope broken	2	Conduct periodic checks	1	10
		TC collapsed	5	The soil under TC suffered cracks	2	Carry out routine checks	1	10
3.2	Periodic check	Workers fall	5	Safety harness is not installed properly	2	Supervised by a safety man	1	10
4	**Pekerjaan scaffolding**							
4.1	Material preparation	Pinched	2	Workers not concentrating	4	Provide direction to workers	1	8
4.2	Installation / disassembly	Scaffolding collapsed	3	Clamp is not installed properly	3	Provide regular socialization	1	9
		Workers fall	4	Not using a safety harness	3	Provide briefing regarding work at height and conduct safety inspection	1	12
		Material hit	3	Workers not wearing helmets	3	Provide socialization during toolbox meetings and conduct safety inspections	1	9
5	**PekerjaanPembesian**							
5.1	Material placement	Pinched hands, tripped	2	Workers are not careful	4	Install warning signs	1	8

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No	Item	Accident Risk	Sev	Cause of Accident	Occ	Cause of Accident	Det	RPN
5.2	Iron Fabrication	Legs/hands caught in an iron	3	Workers don't understand how to work well	3	Provide a briefing on how to work well and safely	1	9
		Hand hit by a piece of iron	3	Workers don't wear gloves	4	Provide regular socialization	1	12
		Fingers hit by a bar cutter	5	Workers don't understand how to work well	3	Provide a briefing on how to work well and safely	2	30
		Fingers hit by bar bender	4	Workers don't understand how to work well	3	Provide a briefing on how to work well and safely	2	24
6	**PekerjaanBekisting**							
6.1	Material placement	Hit the formwork	4	Hit the formwork	3	Provide socialization during toolbox meetings and conduct safety inspections	1	12
		Hit by nails	2	Hit by nails	2	Provide guidance on the hazards in the job	2	8
		Hands hit by sharp objects	2	Hands hit by sharp objects	4	Provide guidance on the hazards in the job	1	8
6.2	wood fabrication	Hit by hammer/saw	2	Hit by hammer/saw	3	Provide regular socialization	1	6
		Hit the nail	2	Hit the nail	2	Provide socialization during toolbox meetings and conduct safety inspections	2	8
		Stumbling on wood	1	Stumbling on wood	4	Provide regular socialization	2	8
		Scaffolding collapsed	3	Scaffolding collapsed	3	Provide briefing regarding work at height and conduct safety inspection	1	9
		Fall	3	Fall	4	Provide briefing regarding work at height and conduct safety inspection	1	12
7	**PekerjaanPengecoran**							
7.1	Casting with Truck Mixer	The truck fell	4	The truck fell	3	Using a runway that exceeds the width of the rear tire	1	12
		Worker hit by truck	5	Worker hit by truck	2	Security officers assist in monitoring when trucks enter the project area	1	10
7.2	Concrete pump	Workers stuck	4	Workers stuck	3	Provide adequate lighting in the work area	1	12
7.3	Wall casting	Eyes get mixed	2	Eyes get mixed	3	Provide regular socialization	1	6
		Iron clamped	3	Iron clamped	3	Provide regular socialization	1	9
		Falls while casting	4	Falls while casting	3	Provide briefing regarding work at height and conduct safety inspection	1	12
7.4	Emergency Ladder Casting	Eyes get mixed	2	Eyes get mixed	3	Provide regular socialization	1	6
		Iron clamped	3	Iron clamped	3	Provide regular socialization	1	9
		Falls while casting	4	Falls while casting	3	Provide regular socialization	1	12
8	**Pekerjaan MEP**							
8.1	Ducting Fabrication	Noise	1	Workers do not wear earplugs	5	Provide earplugs, provide socialization during toolbox meetings, and conduct safety inspections	1	5
		Injured	2	Scattered material	4	Doing clean Friday activities	1	8

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No	Item	Accident Risk	Sev	Cause of Accident	Occ	Cause of Accident	Det	RPN
		hands/feet						
		Material fall	2	Workers do not wear helmets	3	Install warning signs	1	6
8.2	Ducting Installation	Got electric shock	4	Employees are not alert	3	Install warning signs	1	12
		Noise	1	Workers do not wear earplugs	5	Provide earplugs, provide socialization during toolbox meetings, and conduct safety inspections	1	5
		Falling from Scaffolding	3	Workers do not use safety harnesses	3	Provide briefings regarding work at heights and conduct safety inspections	1	9
8.3	Hydrant Pipe Installation	Got electric shock	4	Workers do not use safety harnesses	3	Provide briefings regarding work at heights and conduct safety inspections	1	12
		Falling from Scaffolding	3	Workers do not use safety harnesses	3	Provide briefings regarding work at heights and conduct safety inspections	1	9
		injured hand	2	Scattered material	4	Doing clean Friday activities	1	8
		Noise	1	Workers do not wear earplugs	5	Provide earplugs, provide socialization during toolbox meetings, and conduct safety inspections	1	5
8.4	Plumbing Pipe Installation	Got electric shock	4	Workers do not use safety harnesses	3	Provide briefings regarding work at heights and conduct safety inspections	1	12
		Falling from Scaffolding	3	Workers do not use safety harnesses	3	Provide briefings regarding work at heights and conduct safety inspections	1	9
		Noise	1	Workers do not wear earplugs	5	Provide earplugs, provide socialization during toolbox meetings, and conduct safety inspections	1	5
		injured hand	2	Workers do not wear gloves	4	Provide socialization during toolbox meetings and conduct safety inspections	1	8
9	**PekerjaanPengelasan**							
9.1	Welding	Fire	4	Sparks on combustible materials	3	Clean the work area before starting a job	1	12
		Eye irritation	2	Workers don't wear glasses	3	Install warning signs	1	6
		Respiratory disorders	3	Workers not wearing masks	3	Provide socialization during toolbox meetings and conduct safety inspections	1	9
10	**Pekerjaan Lantai Kerja (Waterproofing)**							
10.1	Cleaning	Respiratory disorders	3	Not wearing a mask and goggles	3	Provide socialization during toolbox meetings and conduct safety inspections	1	9
		Material hit	3	Not wearing a helmet	3	Provide socialization during toolbox meetings and conduct safety inspections	1	9
		Eye irritation	2	Workers don't wear glasses	3	Conducting socialization during a safety morning talk	1	6
10.2	Soak test	slip	1	Unsafe work area	4	Provide socialization during toolbox meetings and conduct safety inspections	2	8
		Material hit	2	Workers not wearing helmets	3	Provide socialization during toolbox meetings and conduct safety inspections	1	6
11	**PekerjaanPemasanganDinding (Hebel atau Batu bata)**							

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No	Item	Accident Risk	Sev	Cause of Accident	Occ	Cause of Accident	Det	RPN
11.1	Material placement	Stumble	1	Placement of material is not according to procedure	4	Provide socialization during toolbox meetings and conduct safety inspections	1	4
11.2	Hebel installation	Hebel fell on the workers	3	Workers are not alert	3	Providing socialization during toolbox meetings	1	9
		Workers fall	2	Workers do not use safety harness	3	Provide briefing regarding work at height and conduct a safety inspection	1	6
		Scratched hands	2	Workers don't wear gloves	4	Provide socialization during toolbox meetings and conduct safety inspections	1	8
		Scaffolding collapsed	3	The clamp is not installed properly	3	Conduct periodic checks	1	9
		Wall pair falling	3	Getting hit by a passing worker	2	Installing a safety line in the work area	1	6
11.3	Plaster and wall plaster	Scaffolding collapsed	3	Clamp is not installed properly	3	Conduct periodic checks	1	9
	Material placement	Falling off the Scaffolding	4	Workers do not use safety harness	4	Provide briefing regarding work at height and conduct a safety inspection	1	16
12	**PekerjaanPemasanganKeramik**							
12.1	Material placement	Stumbled on material	2	Placement of material is not according to procedure	4	Provide socialization during toolbox meetings and conduct safety inspections	1	8
12.2	Cutting	Got electric shock	5	The cable is chipped and exposed to water	2	Providing socialization during toolbox meetings	1	10
		Respiratory disorders	3	Not wearing a mask	4	Provide briefing regarding work at height and conduct safety inspection	1	12
		Scratched material	1	Workers are not careful	4	Provide socialization during toolbox meetings and conduct safety inspections	1	4
		Eye irritation	2	Get hit by shards of ceramic shards	4	Conduct periodic checks	1	8
		Noise	1	Workers do not use ear plugs	4	Installing a safety line in the work area	1	4
		Hit by the cutting machine	4	Workers not concentrating	3	Conduct periodic checks	1	12
12.3	Installation	Leg injured by ceramic shards	2	Workers do not wear safety shoes	2	Provide briefing regarding work at height and conduct safety inspection	1	4
		Scratched material	1	Workers are not careful	4	Provide socialization during toolbox meetings and conduct safety inspections	1	4
13	**Gondola**							
13.1	Operation	Falling from a height	5	Safety harness is not installed properly	2	Provide socialization during toolbox meetings and conduct safety inspections	1	10
		Got electric shock	5	Cable chipped	2	Conduct periodic checks	1	10
		Material hit	3	Splattered material	3	Carry out clean Friday activities and install safety decks	1	9

Soil excavation work is carried out with heavy equipment called excavators. Earth excavation work begins with the excavator bucket extended in front of the excavation. Then when the bucket is in the desired position, the bucket is swung or hosed down

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with the bucket arm rotated upwards. After the bucket is filled with soil, the bucket is lifted and swung to the desired place.

The risk of accidents in excavation work is that workers can slip due to slippery ground, workers can hit a bucket, operators can be electrocuted if there is electricity/cables that hit the tool. Workers can be buried in the background if a landslide occurs. This project has taken control measures, among others, by installing warning signs in the work area, installing safety lines so that no workers work or enter the excavation area, and consistently convey the importance of using Personal Protective Equipment (PPE).

Filling out the FMEA tab above results from a joint discussion with the HSE Manager of the BUILDING Office Suites project. In the item checking work item with the risk of injured hands, the severity rating of 2 is due to the risk that it can result in minor injuries. Furthermore, for the cause of the accident, namely, not using complete PPE, the value of occurrence four is given because the reason has a high probability of occurring several times under normal conditions. In the controlled act of providing PPE and conducting safety inspections, the value of detection one is given because the control action is considered very practical so that no chance causes may arise.

A passenger hoist (PH) means transportation or an artificial lift that makes it easier for workers to work on a project. This tool can be used to transport workers, building materials, and more. The causes of work accidents on the Passenger Hoist include workers not wearing PPE, lock pins are not installed properly when installing sections, capacity exceeds the carrying load, and the soil under the PH is cracked. This project has carried out various control measures, among others, by requiring operators to have an OHS license, ensuring a safe workplace, installing warning signs in the work area, conducting safety inspections, and checking and inspecting equipment regularly. Controls that must be carried out are wearing personal protective equipment, limiting load capacity, conducting routine inspections in the field, and applying programs to impose sanctions on workers who do not use PPE (Pardyani, 2014).

Filling out the FMEA tab above results from a joint discussion with the HSE Project Manager BUILDING Office Suites. On the work item operating equipment with the risk of the tool falling, the severity rating of 5 is because the risk is fatal and can result in death. Furthermore, for the cause of the accident, namely, the soil below the PH has cracks, the value of occurrence two is given because the reason has a small probability level. In the control action of carrying out routine checks, the importance of detection one is given because the control action is considered very practical so that there is no chance that the cause may appear.

A tower crane (TC) is a liaison between the lowest and highest levels and the area on one side of the building. The mechanism works with the principle of ropework to lower the load to a predetermined place. The causes of the accident included lock pins not being installed, workers not wearing safety harnesses, broken wire ropes, and cracked ground under the TC. The BUILDING Office Suites project has taken control measures to prevent work accidents by installing safety decks, ensuring lock pins are correctly installed, and conducting safety inspections and routine inspections. To control the disconnected wire rope, it is possible to replace it, check before and after

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the operation, and lift the load's weight according to capacity (Mayasari, 2011).

Filling out the FMEA tab above results from a joint discussion with the HSE Manager of the BUILDING Office Suites Project. On the item of operating work with the risk of a resident's house/worker being crushed by material, the severity rating of 5 is due to the chance being fatal and can result in death. Furthermore, for the cause of the accident, namely, the load is detached / the wire rope is disconnected. The value of occurrence two is given because the reason has a small probability level. In the control action of carrying out routine checks, the importance of detection one is given because the control action is considered very practical so that there is no chance that the cause may appear.

Based on the Regulation of the Minister of Manpower and Transmigration No. PER. 01/MEN/1980 concerning Occupational Safety and Health in Building Construction, scaffolding or scaffolding is temporary building equipment (platform) used to support workers, tools, and equipment for building construction work. The causes of work accidents on scaffolding include the clamp not being installed correctly, workers not wearing a safety harness, not concentrating, and not wearing a helmet. Control measures that have been carried out by BUILDING are by periodically checking the existing scaffolding, providing socialization to workers regarding the importance of using safety harnesses for work at heights, and conducting safety inspections to supervise current work.

Filling out the FMEA tab above results from a joint discussion with the HSE Manager of the BUILDING Office Suites Project. In material preparation work items with the risk of being pinched, the severity rating of 2 is due to the chance of minor injury. Furthermore, for the cause of the accident, namely the worker not concentrating, the value of occurrence four is given because the reason can occur several times under normal conditions. In the control action of carrying out routine checks, the importance of detection one is given because the control action is considered very practical so that there is no chance that the cause may appear.

Formwork is a construction aid that can be used as a mold or part of the required reinforced concrete (Daryanto, 2008). The formwork work on the structural work begins with the assembly of the formwork mall. Workers use a saw to cut wood/plywood according to the planned size. The pieces of plywood are then connected with nails using a hammer to form the required shape.

The risk of accidents is that workers' hands can be injured due to negligence in cutting wood using a saw, stabbed by nails, needles hit by hammers/hammers, and workers fall. According to the Regulation of the Minister of Manpower and Transmigration Number PER.08/MEN/VII/2010 concerning Personal Protective Equipment, Article 5 states, "Workers/laborers and other people who enter the workplace are required to wear or use PPE following the potential hazards and risks" in this work. The required PPE includes helmets, shoes, vests, and gloves. When installing the formwork at a height, workers may fall if they do not use a safety harness (Septianingrum, 2012).

Casting work is the work of pouring fresh concrete into reinforcing iron molds/formwork. Before the casting begins, workers must ensure that the reinforcing iron molds/formwork have been installed

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according to the plan. The risk of accidents in foundry work is that the truck can fall, the eyes of workers can be exposed to mortar, feet or hands are caught in the formwork iron and fall from a height.

The cause of work accidents in foundry work is caused by workers who are not alert, do not concentrate, are not careful, and do not wear a safety harness. Given these risks, the BUILDING project has taken control measures. Such actions are like conducting socialization during toolbox meetings to understand the existing risks and concentrate on working. In addition, the BUILDING project conducts safety inspections to supervise workers always using personal protective equipment and ensure the work area is safe.

Mechanical Electrical Plumbing (MEP) work consists of ducting, hydrant pipe, and plumbing pipe installation. Such work may pose a risk of work accidents, including workers experiencing noise, injured workers' hands/feet, electrocution, workers falling material, and falling from scaffolding.

The causes of accidents in MEP's work include workers not wearing earplugs, scattered materials, workers not wearing safety harnesses. Based on the existing risks and causes of accidents, the BUILDING project has taken control measures such as installing warning signs in the work area, conducting clean Friday activities to clean the work area, and conducting socialization about work risks during toolbox meetings.

Welding work is to connect metal or other materials in a melting state. In the BUILDING Office Suites project, the welding work, among others, is to connect stair railings and fabrication. The risks of work accidents in welding work include fire, eye irritation, and respiratory problems in workers.

The causes of these work accidents include sparks on flammable materials causing fires, workers not wearing helmets and masks. The BUILDING project has taken control measures, requiring a safe work area before carrying out work, installing warning signs in the work area, and conducting safety inspections.

Floor work begins with cleaning the work floor, floor hardener, screed, and finally, a soak test. This work is done to protect and maintain the durability of the work floor. The risk of accidents in work on the work floor is that workers can trip, slip, experience eye irritation, hit material, and injured feet/hands.

The causes of work accidents in waterproofing work include workers not wearing masks and goggles, workers not wearing PPE, and scattered materials. Control measures that have been carried out are conducting safety inspections, conducting clean Friday activities, and conducting safety inspections.Making walls begins with installing Hebel or bricks and continues with wall plaster to get additional strength on the walls.

The risks of accidents in the construction of walls include the worker tripping over the material, the Hebel falling on the worker, the worker's hand being scratched by the Hebel, the wall collapsing to hit the worker, and the worker falling from the scaffolding. The causes of the accident included the placement of materials that were not following procedures, not wearing PPE, not wearing safety harnesses, and clamps were not installed correctly.

Ceramic installation work aims to increase the floor's strength, simplify the maintenance and cleanliness of the floor, and as a floor decoration. The result has a risk of work accidents. Workers can trip

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over materials, get electrocuted by cutting tools, experience noise, eye irritation, injured workers' feet by ceramic shards, and damage by being hit by a ceramic cutting machine.

The cause of the accident was the placement of materials that were not following procedures, and workers did not concentrate at work, workers did not use earplugs and did not use masks. Based on these risks and causes, the BUILDING project has taken control measures to prevent work accidents by conducting safety inspections, checking work tools regularly, installing warning signs, and providing socialization during toolbox meetings.

Filling out the FMEA tab above results from a joint discussion with the HSE Manager of the BUILDING Office Suites Project. In the case of material placement work items with the risk of tripping, the severity rating of 2 is due to the risk that it can result in minor injury. Furthermore, for the cause of the accident, namely the placement of the material not according to the procedure, the value of occurrence four is given because the cause has a high probability of occurring several times under normal conditions. In the controlled act of conducting a safety inspection, assigning a detection value of 1 is because the control action is considered very effective. There is no chance that a cause may arise.

A gondola is a tool for handling maintenance problems upstairs to downstairs on the outer walls of the building. The maximum number of workers who can use the gondola at one time is two people. Before being used, the gondola has gone through testing to meet the requirements of applicable laws and regulations, obtain an operating license, test feasibility, check strength, prove stability in operation, and prevent and even eliminate the risk of work accidents.

The risks of work accidents include workers falling from a height, being hit by material from above, and being electrocuted. Some of the things that can cause these accidents are that the safety harness is not installed correctly to be released, the material on the upper floor is scattered so that the wind can carry it away, and the cable is peeled or exposed to water. Based on the existing risks, BUILDING has taken control measures to prevent work accidents, including socialization during toolbox meetings, checking gondolas regularly, and installing safety decks to restrain materials that fall from above.

Filling out the FMEA tab above results from a joint discussion with the HSE Manager of the BUILDING Office Suites Project. On items of operating work with a risk of being hit by material, the severity rating of 3 is due to the chance that it can cause serious injury to workers. Furthermore, for the cause of the accident, namely scattered material, the value of occurrence three is given because the reason is included in the probable, possible level category or can occur under normal conditions. In the control action of carrying out clean Friday activities and installing a safety deck, the value of detection one is given because the control action that has been carried out is considered very effective. There is no chance of a possible cause appearing.

Lack of control does not provide training to workers, does not apply sanctions, and lack of supervision can lead to basic causes, namely sleepy workers and lack of knowledge of workers about good and safe working methods. The basic cause resulted in an immediate cause: the workers were

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careless and did not wear personal protective equipment. As a result of the immediate cause in the form of an incident, the worker's finger is injured due to being hit by a tool so that it creates a loss in the form of serious injury/disability, lost work time, and decreased productivity.Figure 1 is an arrangement of dominoes which if one card falls, a domino effect will occur so that it overwrites the other cards.

Figure 1. An overview of the results of the domino method analysis

CONCLUSION

Based on the FMEA method, it can be concluded that the dominant accident risk in the BUILDING Office Suite project is in the iron fabrication work item. The risk of accidents is that the workers' fingers are injured because of being hit by a bar cutter and bar bender tool. These accidents can occur due to workers' lack of knowledge about the importance of using complete PPE, understanding the risks of accidents in work, and the absence of safety signs in the work area. The control recommendations are that management needs to provide training to iron fabrication workers, supervise workers to do their work following the existing Standard Operating Procedures, and apply sanctions to workers who are not disciplined in using PPE.

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