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Original article

Evaluation of Risks by L-Type (5x5) Matrix Method in an Ore Concentration Structure: A Case Study

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Abstract

Workplaces are places with a dynamic structure. This situation often leaves employees vulnerable to certain risks. Occupational accidents in the workplace are caused by various reasons such as production methods, human presence and environmental factors. For this reason, the most important element of a sustainable production is to ensure occupational health and safety. Creating a safe working environment in a workplace can only be achieved with a risk assessment prepared with the participation of people with high levels of competence (employer/deputy, occupational safety specialist, workplace doctor and other persons). Risk assessment begins during the establishment or design process of a workplace. This process consists of various processes such as identifying hazards, identifying and analyzing risks, deciding on risk control measures, and documentation. The most important point to be considered while making a risk assessment is to determine the most appropriate risk assessment method for the exploitation or plant. Factors such as production method, sector, type of risks and interaction with each other are among the main determining factors in determining the hazard class of workplaces. In this study, risks were evaluated in an ore beneficiation plant. The ore beneficiation facility is an area where the conversion of the ore extracted from the underground into the final product takes place. The work area is located in a very hazard class. Considering these issues, risks were evaluated using the L Type Matrix (5x5) method in the study. The L-Type Matrix method is more advantageous than many methods in that it is easy to understand and can be applied to many processes. A total of 72 risks were identified in the study. These risks are scored; 18 low risk, 30 medium risk, 24 high risk were identified. Considering the result of the study, some solution suggestions are presented in order to provide a safer working environment in the conclusion and suggestions section of the study.

Keywords: Facility Safety, Occupational Health And Safety, L Type Matrix (5x5) Method, Risk Analysis.

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INTRODUCTION

Mining activities are a complex process consisting of different processes. These; exploration, evaluation, preparation, open or underground production methods, ore preparation-enrichment (such as crushing, screening, solvent extraction, electrolysis) melting, closure and subsequent remediation processes (Bulut and Göktepe, 2012). After the mines are recovered from the underground, they are concentrated. In this process, they are subjected to some preparation and enrichment processes. Different inorganic and organic chemicals are used to make this process easy and efficient. These substances are reactive substances and have a chemical and physical effect on the ore. Reagents are mostly used in leaching and flotation processes (Karadeniz, 1996). Figure 1 shows a simplified example of the process from extraction to operation of an iron ore mine (www.riotinto.com)

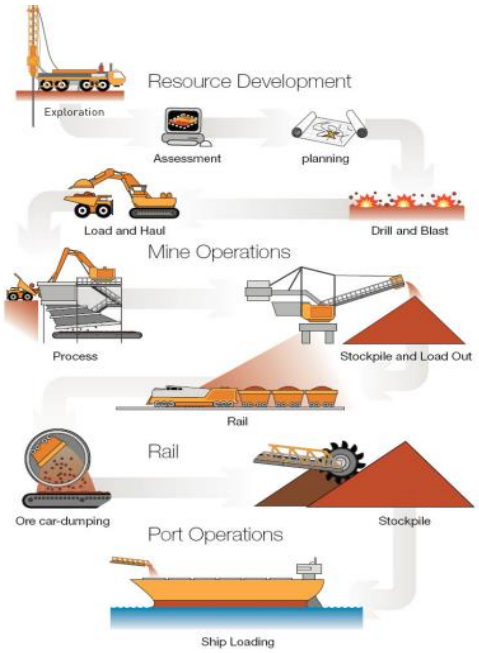

Figure 1. Simplified diagram of the extraction and processing of a mine (www.riotinto.com)

Mines are one of the most important elements of the development of the industrial industry. Before the first industrial revolution, the wood source, which was used as an energy source, was left to coal over time, which gave a serious impetus to the change. The use of coal for steam-operated machines in industry has further increased the importance of mines. It was also the determining factor in the next industrial revolution. It has become a determining factor in the evolution of technology, increasing the level of welfare and the emergence of new business lines. This situation has led to the emergence of mining and mining as a strategic power element. Due to its structure and nature, mining contains many danger elements, which has made it necessary to evaluate this sector in a different field from many other business lines. When the mining industry is examined from the past to the present, many factors such as

production processes, geographical conditions, natural events, and human factors have caused serious accidents. The mining sector is carried out in three ways: underground, surface and drilling mining. Each production process may contain various dangers in itself. For example, open pit mining is easily affected by natural events and environmental factors. In underground mining; There can be many danger elements such as toxic and explosive furnace gases, noise, vibration, pressure, poplar, furnace waters. In some cases, these hazards can occur as an integrated (static electricity-explosion-fire-dent) and spread over a much wider area. Therefore, in the mining industry; The mining industry and people working in this field should be included in the team (mining, machinery, geology, construction, etc.) that prepares risk assessment and emergency action plans (Keskin et al., 2020). The ore beneficiation facility is the place where the part of the ore with high economic value is separated from the rust. In this respect, most of the existing risks in underground or surface mines differ at this point. For example, dust, noise, vibration, presence of waste water, various chemicals, waste storage areas, electricity leaks, settling pools etc. are just some of these risks. In the facility where the study is carried out, ores such as gold, silver, lead and zinc are obtained. It is possible to come across many studies in the literature related to the mining sector and its sub-business lines. However, it is thought that the studies on the ore beneficiation plant are not at such a sufficient level and the study will be important in terms of filling the gap in the literature. In the study, risk factors arising from various reasons such as work accidents, production methods, human presence and environmental factors in a sample workplace were examined. Risks were evaluated using the study area L Type Matrix (5x5) method. As a result, 72 risks were identified and different suggestions were presented according to these risks. It is an original study in the field of study and has a high contribution to the literature, and this level will be increased even more by adding the following suggestions.

MATERIALS and METHODS

Working Area

In the study, run-of-the-mill ore produced from two different underground mining operations is transported to the enrichment facility, which is approximately 18 km away, by transport vehicles. The facility has an area of 218,000 m2. The ores brought to the facility by land are brought to the flotation unit for enrichment. The facility uses approximately 86% (750,000 tons) of its capacity. At the facility with a nominal capacity, approximately 40 thousand tons of silver, gold, zinc and lead concentrates are produced annually in the content of 650,000 tons of ore. The facility has an area with a capacity to store approximately 100,000 tons of run-of-the-mill ore. In general, the facility consists of crushing, screening, grinding, flotation, filter, chemical reagent feeding and waste storage areas.

Crushing and screening unit in the plant: Jaw crusher, bunker vibrating feeder, vibrating screen, belt conveyor etc. consists of parts. A high-tech jet-pulse dust filter was installed in order to prevent the exposure of dust emerging in these parts.

Grinding Unit: The grinding process takes place in two stages. Ball mills are used in both processes.

Flotation Unit: This unit consists of lead-zinc, copper selective circuits. There are also cylindrical flotation tanks and flotation circuits.

Filter Unit: It consists of press filters and drum filters.

Chemical Reagent Feeding Unit: There are solution preparation and feeding tanks and dosing pumps for the chemicals used in the facility.

Waste Storage Area: These areas are the areas where waste oils, waste plastics and waste paper are stored.

L-Type Methods

The L-Type Matrix (5x5) method is one of the risk assessment decision matrix methodologies. It is a method that makes sense of the connection between cause and effect (between two or more variables) in the evaluation process (Özkılıç 2005). This method is known as US military standard MIL-STD_882_D and was developed to meet the security requirement (system). In the L-Type Matrix method, it is a method that analyzes the effect between the probability of occurrence of hazards and the severity of the damage it will cause. Understandable, easy, simple, even one person can make this method advantageous compared to other risk assessments (Koltan vd. 2010). Other advantageous aspects are; The required document is very little, an analyst with intermediate experience can easily do it. The competence of the team leader is a qualitative method that can change the success rate (Özkılıç, 2005). In the L-Type Matrix (5x5) method, two factors are taken into account while obtaining the risk score. These are probability and severity. The formula below is used to obtain the risk score.

Risk = ***likelihood consequences***

The rating data needed for each element used in this calculation are given in Table 1 and Table 2.

Table 1. Probability of an Event (Özkılıç, 2005; Ünverdi and Çetinyokuş, 2021)

Possibility	Rating Stages for Probability of Appearance
1	Remote possibility
2	Low probability (once a year)
3	Possible
4	Often (once or several times a month)
5	Very often (constant-almost every day)

Table 2. Severity Rating (Özkılıç, 2005; Ünverdi and Çetinyokuş, 2021)

Scale	Definition
1	Requires first aid (no loss of working hours)
2	Requires first aid, requires outpatient treatment (no lost workdays)
3	Minor injury
4	Serious injury
5	Death

Table 3. Risk Scores (Özçelik, 2005)

	Violence				
Probability	1 (Rare)	2 (Unlikely)	3 (Possible)	4 (Likely)	5 (Almost certain)
1(Inconceivable)	1 (İnsignificant)	2(Minor)	3(Minor)	4(Minor)	5(Minor)
2 (Remote)	2 (Minor)	4(Minor)	6(Minor)	8(Moderate)	10(Moderate)
3 (Conceivable)	3 (Minor)	6(Minor)	9(Moderate)	12(Moderate)	15(Major)
4 (Possible;)	4(Minor)	8 (Moderate)	12(Moderate)	16((Major)	20((Major)
5 (Most likely)	5(Minor)	10(Moderate)	15 ((Major)	20((Major)	25 (Catastrophic)

Risk scores are calculated by considering the values specified in Table 1 and Table 2. Then, the priority ordering process is started. Beforehand, the meanings of the obtained numerical values should be known. Table 3 shows the score values and their meanings. According to this; A value of 1 indicates a nonsignificant value, a score between 2-6 represents a low level of risk, a score of 8-12 represents a moderate value, a score of 15-20 represents a high-level value, and a score of 25 represents the intolerable risk value. Considering the score values obtained, the risk factors with the highest value are the part that should be intervened in the first degree. These processes are repeated until the risks are reduced to meaningless or acceptable levels.

According to the Occupational Health and Safety Regulation issued within the scope of the Occupational Health and Safety Law No. 6331, risk assessment is updated every 6 years in less hazardous workplaces, every 4 years in hazardous workplaces and every 2 years in very hazardous workplaces according to hazard classes. According to Article 12 of the Regulation; risk assessment is updated in case of relocation of the workplace or change of building, change of material or equipment used, change of technology used in production, after a near miss or work accident, in case of changes in the limit values specified in the legislation, after ambient measurement and health surveillance, in case a new risk emerges (Occupational Health and Safety Risk Assessment Regulation, 2012).

RESULTS and DISCUSSION

Within the scope of the risk assessment made at the ore enrichment facility; Potential dangers in these areas, including the guardhouse, office environments, water tank and maneuver room, transformer, PSI device room, compressor, construction site, welding works, workshop, overhead crane, stock area, crushing unit 1-2, the possibility of dangers occurring and Table 4 was created taking into account the severity of the disease. Accordingly, the fields of activity, the danger, the risk score values of the affected persons and the measures that can be taken are specified.

Table 4. Risk Assessment Table

					Risk Assessment			
					P	**V**	**R**	
Number	**Activity**	**Danger**	**Affected Persons**	**Risk**	**Possibility**	**Violence**	**Risk Value**	Precaution
1	Gate Building	Narrow corridor	Security guards	Stuck, falling due to the narrow and material of the corridor.	**1**	**3**	**3**	Materials should not be left in the corridor.
2	Gate Building	Studies on display vehicles	Security guards	made on screened vehicles visual disturbances, low back pain in studies.	**1**	**3**	**3**	Constant checks should be made.
3	Gate Building	Insufficient fire extinguishers and their locations are not specified.	Security guards	Inability to intervene in the event of a possible fire	**1**	**5**	**5**	Periodic checks should be made when the time comes and employees should be given training on the subject.
4	Gate Building	Electrical component	Security guards	in electrical parts electric shock due to malfunctions	**1**	**5**	**5**	Electrical faults should be reported to the electrician immediately. No intervention should be allowed except by an authorized person.
5	Gate Building	Electrical component	Security guards	in electrical parts fire due to faults	**1**	**5**	**5**	Constant checks should be made.
6	Gate Building	Smoking indoors	Security guards	Possibility of health deterioration and fire as a result of smoking indoors	**3**	**3**	**9**	No smoking signs should be posted. Constant checks should be made.

7	Gate Building	Nizamiye road	Security guards	As a result of slipping and falling as a result of the icing of the Nizamiye road injury.	**2**	**4**	**8**	Constant checks should be made.
8	Gate Building	Formation of stalactites on the Nizamiye	Security guards	Injury from a stalactite fall	**2**	**4**	**8**	Constant checks should be made.
9	Gate Building	Using and leaving open fire source devices in heating.	Security guards	Fire caused by leaving open fire source devices on in heating.	**2**	**5**	**10**	Constant checks should be made.
10	Gate Building	Ground condition inside the Nizamiye	Security guards	Injuries due to tripping and falling due to ground irregularities	2	4	8	Constant checks should be made.
11	Gate Building	The situation of the gate of the Nizamiye building	Nizamiye employees and others	An accident that may occur as a result of foreign people entering if the door of the Nizamiye is not closed.	1	4	4	Constant checks should be made.
12	Gate Building	Not having the appropriate type of first aid kit in the Nizamiye building	Nizamiye employees and others	Failure to provide medical attention in an emergency	1	4	4	Missing materials should be checked and replenished continuously.
13	Gate Building	Emergency Exit Door	Nizamiye employees and others	Poisoning of personnel by not being able to escape in a possible fire, death.	1	5	5	Materials should not be left in front of the doors.
14	Office Wok	Work done in offices	Office staff	Occurrence of eye disorders in personnel due to working with computers	1	3	4	Training should be given to the personnel about working in screened vehicles, and short-term rests were given.
15	Office Wok	Work done in offices	Office staff	Muscle and joint pains due to working with computers	2	3	6	Ergonomic conditions must be provided.
16	Office Wok	Work done in offices	Office staff	Distraction to fatigue components	2	2	4	During the work, certain breaks should be given and the staff should be allowed to rest.

17	Office Wok	Work done in offices	Office staff	Injuries from electric shock from power tools	1	5	5	It should be checked continuously and possible cable faults should be replaced by qualified persons.
18	Office Wok	Work done in offices	Office staff	Muscle and joint pain due to carrying heavy office supplies	2	2	4	Materials heavier than 23.5 kg are transported by 2 people and trainings were given.
19	Office Wok	No fire extinguisher or no indication of their location	Office staff	Inability to intervene in the event of a possible fire	1	4	4	Periodic checks of the fire extinguisher should be made.
20	Office Wok	Electrical component	Office staff	in electrical parts electric shock due to malfunctions	2	5	10	Electrical faults should be reported to the electrician immediately.
21	Office Wok	Electrical component	Office staff	in electrical parts fire due to faults.	3	4	12	Electrical faults should be reported to the electrician immediately.
22	Office Wok	Using chemical disinfectants during cleaning	Staff working in the department	The chemical used poisoning as a result of gas coming out of disinfectant	2	3	6	It should be used in accordance with the instructions for use of the disinfectant used.
23	Office Wok	Using chemical disinfectants during cleaning	Staff working in the department	The chemical used disinfectants to the employee's eyes, hands, etc. injuries from splashing	2	3	6	The disinfectant used should be used in accordance with the instructions for use.
24	Office Wok	Fire	All staff	Poisoning, death by not being able to escape from the fire as a result of the emergency exit door being opened inwards	3	5	15	The emergency exit door must open outwards.
25	Office Wok	Opening the emergency exit door inward	office workers	In case of fire, poisoning, death by not being able to escape from the fire.	3	5	15	The emergency exit door must open outwards.
26	Office Wok	Work done in offices	All staff	Injuries from fire due to leakage from power tools	2	4	8	Training should be organized periodically.
27	Water Tank and Maneuvering	Material in the hallway	People around	Due to the narrow and material of the	1	3	3	It should be constantly checked.

	Room			corridor, tripping, falling				
28	Water Tank and Maneuvering Room	electrical component	People around	in electrical parts electric shock due to malfunctions	1	5	5	Electrical faults will be reported to the electrician immediately, and no one other than the electrician should be allowed to intervene.
29	Water Tank and Maneuvering Room	Water tank and maneuvering room path	People around	Injury due to slipping or falling due to icing of the water tank and maneuvering room road	2	4	8	Slippery floor signs should be placed on the sides of the water tank and maneuvering room road. Also, it should be kept clean at all times.
30	Water Tank and Maneuvering Room	Water tank and maneuvering room path	People around	As a result of tripping and falling on the pipelines passing through the water tank and maneuver room road route. injury	2	4	8	Be removed from the transit route by making necessary arrangements in the pipelines
31	Transformer Building	Insufficient fire extinguishers	People around	Inability to intervene in the event of a possible fire.	4	5	20	Periodic checks of the tubes inside the building should be made.
32	Transformer Building	Insufficient fire extinguishers	People around	Access to fire extinguishers in the event of a fire	3	5	15	Access to fire extinguishers should be easy within the building.
33	Transformer Building	State of the boards	People around	in electrical parts electric shock due to malfunctions	3	4	12	Electrical faults will be immediately reported to the authorized Electrical Engineer.
34	Transformer Building	Failure to clean the inside of the transformer building	People around	Falling, slipping due to not being cleaned.	3	3	9	Constant checks should be made.
35	Transformer Building	Not using personal protective equipment	People around	PPE of the personnel accident that may occur as a result of not using them.	3	5	15	They must be used. Constant checks should be made.
36	Transformer Building	Unauthorized persons entering the transformer building	People around	Occupational accidents caused by unauthorized persons, exposure of other personnel to the accident.	2	5	10	Constant checks should be made.

37	Transformer Building	Locations of underground cables coming out of the transformer building	People around	The location of the underground cables coming out of the transformer building Injury during excavation due to not being specified.	3	5	15	The locations of the underground cables coming out of the transformer building should be indicated with sign boards.
38	Transformer Building	Lack of warning and warning signs	People around	Accident due to lack of warning and warning signs.	2	5	10	The locations of the underground cables coming out of the transformer building should be indicated with sign boards.
39	Psi Device Room	Not using personal protective equipment	Related personnel	An accident that may occur as a result of the personnel not using their PPE.	3	4	12	Personnel should not be allowed to work without using PPE, continuous controls should be made.
40	Psi Device Room	Not using personal protective equipment	Related personnel	Injury from removing or not using the guards	3	5	15	It is strictly forbidden to remove or not use PPE during work.
41	Psi Device Room	Dealing with moving parts	Related personnel	Injury as a result of intervention during work	2	5	10	Hands and other parts of the body should be kept away from moving parts of the analyzer system to avoid crushing during normal operation.
42	Psi Device Room	No tagging and locking procedure.	Related personnel	Injury due to non-compliance with the procedure	4	5	20	Wear parts should not be replaced while the analyzer is running. Before beginning any maintenance, cleaning, troubleshooting, or repair work for the analyzer's moving parts or electrical parts, the lock-out procedure must be performed. machine during maintenance when personnel are present in potentially hazardous areas.Mechanical movements should not be operated manually.
43	Psi Device Room	Not using PPE against chemical exposure	Related personnel	Injury from chemical exposure	2	5	10	Protective clothing, goggles, and respirator against exposure to splashes, process vapors, or chemicals added to the slurry appropriate protective equipment should be used.
44	Psi Device Room	Working without disconnecting the pneumatic air valve or water shut-off valves	All staff	Pressure will be removed from the system.	4	4	16	If the pressure is not released from the pipes, it may contain compressed air even when the corresponding shut-off valve is closed. Pipe before disconnecting or touching pneumatic components.
45	Psi Device Room	Failure to dispose of wastes reliably	Related personnel	As a result of interaction with other chemicals poisoning or	3	4	12	Ensure that all waste materials are disposed of in accordance with local regulations

				injury				
46	Psi Device Room	Intervention of unauthorized persons in maintenance, repair and cleaning processes	Related personnel	Accidents caused by unauthorized persons	3	5	15	Authorized persons should be allowed to intervene in the device.
47	Psi Device Room	Wetting the main switch and electrical panels of the device during cleaning	Related personnel	Shocked electrical components as a result of water retention	5	5	25	During cleaning, the main condition must be covered. The main switch and electrical panels must be installed before the device is put into operation.
48	Compressor	Regular check of the compressor failure to do	Staff working at the construction site	Periodic control of the compressor is not performed regularly. explosion as a result.	2	5	10	Compressor should be checked periodically and deficiencies should be corrected as a result of the controls.
49	Compressor	Electrical component	Staff working at the construction site	An accident that may occur due to the involvement of unauthorized persons as a result of leaving the electrical panels open.	3	5	15	Work to be done on the panel should only be done by electricians.
50	Compressor	Condition of compressors	Staff working at the construction site	Open Compressors accident caused by explosion	3	5	15	Compressors should be kept in a closed compartment in accordance with the conditions.
51	Construction Site	Absence of a hazard warning sign in the excavator's working area	Other people	Accident that may occur as a result of not warning the people who will enter the working area of the excavator. .	2	5	10	Constant checks should be made.
52	Construction Site	Operator handling the phone while working	Loader operator and others	Risk of accident for operator using mobile phone	3	5	15	Penal action should be taken against the operator who uses a mobile phone while working.
53	Construction Site	The forklift does not have a reversing buzzer	Forklift operator and bystanders	Crushing the persons behind while the forklift is reversing .	3	4	12	The reverse gear buzzer of the forklift must be installed.
54	Construction Site	The forklift operators do not have the appropriate certificate.	Forklift operator and bystanders	Accident due to an operator who does not have the appropriate certificate and does not receive the necessary in-service training .	3	5	15	People who do not have a forklift operator license should not use it. Personnel with forklift operator certificate should be available in every shift

55	Construction Site	No hazard warning sign	Forklift operator and bystanders	Not warning the people who will enter the working area of the forklift accident that may result .	2	5	10	Warning letters and signs should be placed so that people entering the work area can see it.
56	Welding works	Welding gases	Welder	Lung disorders as a result of inhalation of gases	4	4	16	It should not be allowed to work without using a mask, and work should not be started without ventilation.
57	Welding works (Oxy-Acetylene tubes)	Outdoor storage of tubes	Workers working in the workplace	fire and explosion	4	5	20	Unused cylinders should be kept in warehouses and unused cylinders should not be kept in the facility. Cylinders should be fixed and transported in such a way as to prevent falling. .
58	Welding works (Oxy-Acetylene tubes)	Bad pressure gauges of oxy-acetylene cylinders	Workers working in the workplace	Working with high pressure	4	4	12	Constant checks should be made .
59	Atelier	Electrical component	Staff working in the workshop	in electrical parts electric shock due to malfunctions	3	5	15	It should be constantly checked .
60	Atelier	Electrical component	Staff working in the workshop	in electrical parts fire due to faults	3	5	15	It should be constantly checked .
61	Atelier	Not using personal protective equipment	Staff working in the workshop	Accident that may occur as a result of workshop personnel not using their PPE .	2	4	8	Accident that may occur as a result of workshop personnel not using their PPE.
62	Atelier	Condition of the tubes	Staff working in the workshop	Accident that may occur as a result of leaving the cylinders in the open.	3	5	15	Work should be done by fixing the tubes on wheeled vehicles.
63	Overhead Crane	Failure to perform periodic inspection of the crane	Crane operator and other workers	Crane, which is not inspected periodically, causes an accident.	3	4	12	The deficiencies determined as a result of periodic inspections should be corrected.
64	Overhead Crane	Not using parachute type seat belts when working at height	Related personnel	Falls from height and serious injury, death	4	5	20	Working at height should not be allowed without wearing the necessary PPE.
65	Storage area	Presence of persons near machines and trucks during loading.	People around the stockpile	Exposure of persons without PPE to an accident during loading	4	5	16	No one should be allowed inside the stocking area without PPE, and vehicles should not be approached more than 25 meters.

66	Storage area	Electrical component	People around the stockpile	Injuries from electric shock from power tools	4	5	20	Electrical appliances used in the container are in the socket should not be left. Continuous control should be provided, possible cable faults should be fixed by qualified persons.
67	Storage area	Construction machinery used during excavation work	People around the stockpile	Occupational accidents caused by machine failures	2	5	10	Authorized persons should be provided to intervene in malfunctions.
68	Storage area	Lifting the tipper on slopes	Storage area people around	Movement when raising and lowering the tipper on inclined surfaces resultant tipping .	4	4	16	It should be ensured that the damper does not move while it is raised, and it should be constantly checked. .
69	Storage area	Unloading material over stockpile	Around the driver and stockpile persons	Overturning as a result of the truck approaching the slope during material dumping over the stockpile	4	4	16	The sets should be constantly checked, there should be a constant presence of maneuverers in the field, training should be given to the truck drivers, and warning signs should be placed.
70	Crushing Unit 1-2	Large materials remaining in the crusher grid receiving	Crusher unit personnel	Accident during removal of large materials remaining in the crusher grid .	4	3	12	The masses on the grid should not be removed without stopping the crusher unit. The material on the sieve should be crushed by squeezing. It should be constantly checked.
71	Crushing Unit 1-2	Not using the parachute type safety belt and retractable fall arrester when breaking large pieces	Crusher unit personnel	Falling from the sieve as a result of the employee not wearing a parachute type safety belt and working without connecting the retractable fall arrester to the belt, loss of balance, injury, fractures as a result of the parasites entering between the two sieves during crushing	2	4	8	The masses on the grid should not be removed without stopping the crusher unit. The material on the sieve should be crushed by squeezing. It should be constantly checked .
72	Crushing Unit 1-2	Using and leaving open fire source devices in heating .	Crusher unit personnel and others	Fire caused by leaving open fire source devices on in heating.	3	5	15	Constant checks should be made.

Ore beneficiation facilities are areas where the ore is prepared for use in the industrial industry after various enrichment processes as a result of open or underground mining activities. As a result of

the risk assessment made at the facility using the L Type Matrix (5x5) method, 72 risks were identified. Eighteen of these risks were identified as low-level risks. While 30 of them were medium-level risk, 24 of them were determined to be high-level risk. Situations such as workplace production type, employee presence, environmental factors, technological complexity, machine fatigue, natural events (earthquake, flood, meteorite, etc.) are often factors that pose serious risks for employees. For this reason, the most important activity to be carried out for employee health and business safety in workplaces is risk assessment. A successful risk assessment can only be achieved with the participation of people who are competent in this field (employer/deputy, occupational safety specialist, workplace doctor, employee representative, etc.). There are many studies in the literature using the L-Type Matrix method. Soykan (2018) conducted a study on risk assessment and usability with L-Type Matrix Method in industrial fishing vessels. Bayraktar et al. (2019) tried to determine the possible effects of earthquake-induced nonstructural risks in schools using the L-Type Matrix method. Karaman and Topaksu (2020) evaluated the ambient measurements using the L-Type Matrix method in the textile business. Korkmaz (2020) conducted a study on risk assessment in Construction Machinery with L Type Risk Analysis Method and Finney Method. Keskin et al. (2020) used the L-Type Matrix (5x5) method in ore extraction, production and transportation processes in a metallic mining operation. Unverdi and Çetinyokuş (2021) evaluated the risks with the L Type Matrix method in the asbestos application center and SEM laboratories in a public institution.

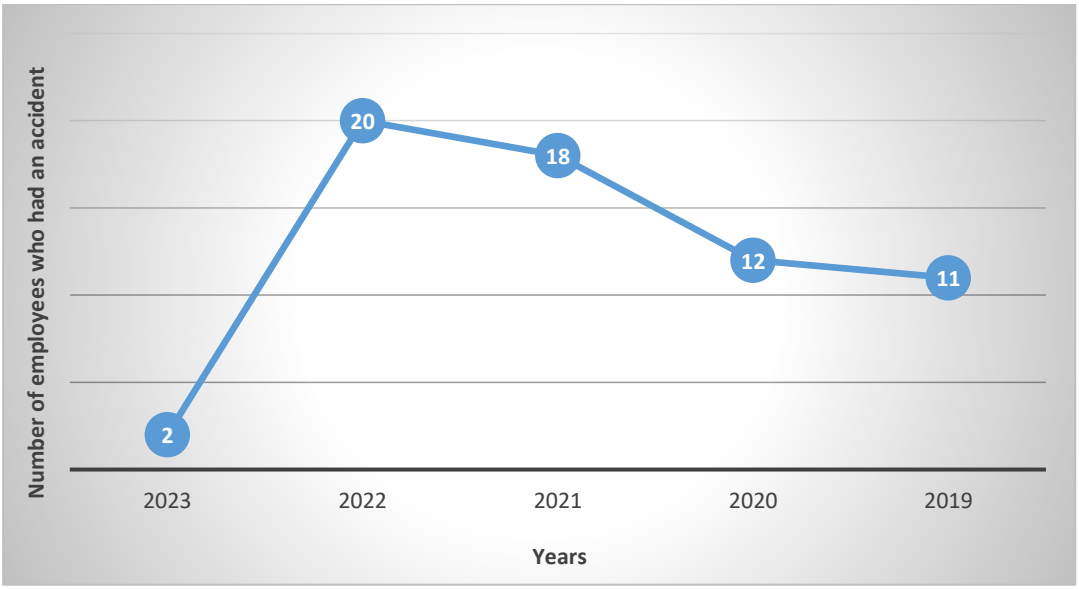

Figure 2. Occupational accidents in the facility in the last 5 years

Figure 2 shows the occupational accidents at the facility for the years 2019-2023. There are 113 employees in total at the facility. Accordingly, 11 work accidents occurred in 2019, 12 in 2020, 18 in

2021, 20 in 2022, and 2 in the first quarter of 2023. The year 2022 is the year with the highest number of work accidents. None of the accidents are fatal or loss of limbs, only minor injury accidents.

Conclusion

This study is a study carried out in the enrichment of an ore in a very dangerous class. L Type Matrix (5x5) method was used in the study. In the study, risks were grouped with four different scorings. However, medium and high-level risks were higher than expected. There have been 63 occupational accidents at the facility since 2018, none of which resulted in death. Facilities, by design, are places where many risk factors such as machinery (crusher, grinder, etc.), chemicals (flatation, leaching, etc.), electricity, lighting, dust, waste pools are found together. Therefore, it is vitally important to include comprehensive and competent people in the risk assessment team in such settings. Considering that the study is evaluated in general, it is seen that the implementation of multiple and innovative work safety practices against integrated risks, periodic training of employees (written, visual, simulation, etc.), preferring more machine-based production methods, monitoring the use of personal protective equipment, warning signs of employees The most important outputs of the study are placing them in places where they can see them and providing methodical support. These issues should be detailed and implemented in the enterprise. In addition, it may be recommended that the management and the occupational safety team determine the roadmap and support the process with new and advanced technology applications.

REFERENCES

Bayraktar, H. Sahtiyancı, E. ve Kuru, A. (2019). Determining the Possible Effects of Earthquake-Related Nonstructural Risks in Schools Using Risk Assessment Matrix Method. Journal of Disaster and Risk, 2(2), 128-152.

Bulut, G. & Göktepe, F. (2012). Chemicals Used in Mining and Mineral Processing. Journal of Eskişehir Osmangazi University Faculty of Engineering and Architecture, 25 (1), 37-56.Retrieved from https://dergipark.org.tr/tr/pub/ogummf/issue/29999/323827.

Karaman, T. ve Topaksu, A. K. (2020). Environmental measurements and risk assessment with L-Type matrix method in terms of occupational safety in textile business, Ç.Ü Journal of Science and Engineering Sciences, 39 (2).

Keskin, M. Ö., Doğan, O. & Ersoy, S. (2020). Risk Assessment in a Metallic Underground Mining, Mineral Extraction, Production and Transport Phases. Gaziosmanpaşa Journal of Scientific Research, 9 (2), 84-98.Retrieved from https://dergipark.org.tr/tr/pub/gbad/issue/57304/719221

Koltan, A., Orhon, H. Y., Yılmaz, S., Altay, M., Yılmaz, S. & Çay, İ. (2010). Evaluation of the Suitability of L-Type Decision Matrix Method Used in Risk Assessment to Occupational Health. TTB Journal of Occupational Health and Safety, 10 (38), 38-43.

Korkmaz, G. (2020). L Type (5x5 Matrix) Risk Analysis Method and Risk Assessment in Construction Machinery with Fine Kinney Method, Çankaya University, Department of Occupational Health and Safety, Unpublished Master Thesis, Ankara.

M. Karadeniz, (1996). "Ore Enrichment Plant Residues, Environmental Impacts and Measures", İstanbul Ofset Basım Yayın San. Trade Inc.

Soykan, O. (2018). Risk assessment and usability with L-type matrix method in industrial fishing vessels. Ege Journal of Fisheries and Aquatic Sciences, 35 (2), 207-217. DOI: 10.12714/egejfas.2018.35.2.15.

Ş. Ünverdi ve S. Çetinyokuş (2021). "Risk Evaluation with L Type Matrix Method in Asbestos Application Center and SEM Laboratory in a Public Institution", Karaelmas Journal of Occupational Health and Safety, c. 5, number. 2, p. 99-107. doi:10.33720/kisgd.977714.

Özkılıç, Ö. (2005). Occupational Health and Safety, Management Systems and Risk Assessment Methodologies. Access: Occupational Health and Safety, Management Systems and Risk Assessment Methodologies (Ozlemacademy.Com)

Occupational Health and Safety Risk Assessment Regulation, Official Gazette 28512 (29.12.2012). Access Address: Mevzuat Bilgi Sistemi. Access Date: 02. 10.2023.