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RISK ANALYSIS OF OCCUPATIONAL HEALTH AND SAFETY IN THE ROOF TILE INDUSTRY IN INDONESIA

ANALISIS RISIKO KESEHATAN DAN KESELAMATAN KERJA PADA INDUSTRI GENTENG DI INDONESIA

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A B S T R A C T

Background: *One of the Occupational Health and Safety (OHS) efforts to minimize risk is by carrying out risk management. The challenge in informal industries is that comprehensive risk analysis has not been carried out, so there is no control program to prevent work accidents. There have been work accidents in the roof tile industry due to various potential dangers that were not controlled beforehand.* ***Purpose:*** *To analyze the risks that exist in the roof tile manufacturing process.* ***Method:*** *This research uses descriptive research with a quantitative approach. This research was conducted in one of the roof tile industries in Indonesia. The units of analysis in this research are the process of mixing raw materials, grinding, molding, drying, and burning. The type of OHS risk analytical used is HIRARC, one of the implementations of ISO 31000 : 2018 for company risk management. HIRARC consists of hazard identification, risk assessment, risk evaluation, and risk control.* ***Result:*** *There are 89 potential hazards in the roof tile manufacturing process from. Most of the risks are low-level though there are still two categorized as very high. The results of the risk evaluation are categorized as "Acceptable". Controls are carried out, starting from elimination until the use of Personal Protective Equipment (PPE).* ***Conclusion:*** *The most commonly identified hazards are physical hazards. Most risks fall to "Low and Acceptable'"category. However, there are still some risks that fall to "Unacceptable" category. Therefore, risk controls still need to be implemented based on hierarchy of controls.*

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A B S T R A K

Latar belakang: Salah satu upaya Kesehatan dan Keselamatan Kerja (K3) untuk meminimalisir risiko adalah dengan melakukan manajemen risiko. Tantangan pada industri informal adalah belum dilakukannya analisis risiko secara komprehensif sehingga belum ada program pengendalian untuk mencegah kecelakaan kerja. Telah terjadi kecelakaan kerja pada industri genteng akibat berbagai potensi bahaya yang tidak dikendalikan sebelumnya. **Tujuan:** Menganalisis risiko-risiko yang ada pada proses pembuatan genteng. **Metode:** Penelitian ini merupakan penelitian deskriptif dengan pendekatan kuantitatif. Penelitian ini dilakukan disalah satu industri genteng di Indonesia. Unit analisis dalam penelitian ini adalah proses pencampuran bahan baku, penggilingan, pencetakan, pengeringan, dan pembakaran. Jenis analisis risiko K3 adalah HIRARC, salah satu implementasi ISO 31000 : 2018 untuk manajemen risiko perusahaan. HIRARC terdiri dari identifikasi bahaya, penilaian risiko, evaluasi risiko dan pengendalian risiko. **Hasil:** Terdapat 89 potensi bahaya pada proses pembuatan genteng. Risiko tersebut sebagian besar berada pada tingkat rendah dan masih terdapat dua risiko yang berkategori sangat tinggi. Hasil evaluasi risiko sebagian berada pada kategori "*Acceptable*". Pengendalian dilakukan mulai dari eliminasi hingga Alat Pelindung Diri (APD). **Kesimpulan:** Bahaya yang paling banyak ditemukan adalah bahaya fisik. Sebagian besar risiko termasuk dalam kategori "Rendah dan Dapat Diterima". Namun, masih ada beberapa kategori risiko yang "Tidak Dapat Diterima". Oleh karena itu, pengendalian risiko tetap perlu dilakukan dengan hierarki pengendalian.

Kata kunci:
HIRARC, Kesehatan dan keselamatan kerja, Analisis risiko, Manajemen risiko, Industri genteng

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INTRODUCTION

Occupational safety is an effort that is intended to protect workers and company resources by controlling potential hazards that cause work accidents. *Occupational Health and Safety* (OHS), is an effort to protect workers from hazard that causes work accidents and work-related diseases. Nevertheles, work accidents and occupational illness continue to occur frequently in both the formal and informal sectors. Work accidents are unwanted and unexpected events that cause loss of time, property, or assets, and loss of life (Tarwaka, 2016). Work accidents continue to increase in Indonesia. Based on Social Security Administrator for Employment data, there were 114.000 work accidents in 2019. Then this number increased in 2020, from January to October, to 177.000 cases (Ministry of Manpower of the Republic of Indonesia, 2021). Then in the following two years from January to September there were 82.000 new work accident cases (ILO, 2022).

Work accidents were also reported in the tile industry. According to research by Fatemi *et al.* (2020) in the construction material industry including tile, workers were exposed to sharp objects. Occurrence of Occupational Disease was also reported as a musculoskeletal disorders experienced by tile industry workers in 15 construction materials industry workplaces in Iran (Cheraghi *et al*., 2019). Occupational accidents also occurred in the sandstone excavation process in Pejaten - Tabanan Village. Thirteen workers experienced work accidents, resulting in four fatalities and nine others being physically injured, both minor and serious. The worker died due to dizziness from the hot sun and then slipped and were crushed by sandstone (Negara and Sutjana, 2020). The causes of work accidents are related to production processes or activities (Tarwaka, 2008). In addition, other studies conducted across several building construction businesses in Nigeria proved that the accident rate and the magnitude of the risk were associated with differences in activities and operating processes within different building industries (Okoye, 2018). The risk of work accidents and work-related diseases has negative impacts. As in research that focused on impact on decreasing productivity on workers (Bakhshi *et al*., 2021). This will certainly affect the performance and productivity.

One of the OHS efforts can be conducted through a risk assessment to identify the source of the hazard and develop control measures. These risks can be minimized through risk management. ISO 31000 : 2018 is a guide for organizations or industries to manage risks, one of which is OHS risk to achieve organizational goals and improve performance. The risk management process consists of establishing context, risk assessment, risk control, communication, and consultation, as well as monitoring and evaluation. Previous research related to risk assessment was conducted in the informal industry in the brick molding process in Gudang Village similar stages like roof tiles. This research revealed that the greatest risk in the medium category lies in the process of taking raw materials, printing, drying, and burning (Noor *et al*., 2018). Therefore, there is a risk of occupational safety and health in industrial processes like roof tiles.

Preliminary studies were carried out in the Jember Regency. Based on interviews with the surrounding community, there are several tile industries in the area. However, the industry involved in this research is one of the largest and most rapidly growing tile industries 80 workers. It has three production locations and tile distribution has reached nearly all of East Java and Bali. The tile manufacturing process has steps that have potential hazards and risks of work accidents and work-related diseases. These steps consist of mixing raw materials, milling, printing, drying, and firing. There are dominant potential hazards in tile making, such as the printing machine used, manual processes, the workstation is not ergonomic, non-ergonomic work station, unnatural position, repetitive motion, combustion smoke, sparks, and heat. There is no control over hazards and most workers do not use *Personal Protective Equipment* (PPE). Interview with the business owner indicated that several accidents have occurred such as electric shock, hand injuries from tile prints, resulting in scratched and severed fingers, and the eyes sore due to the tile burning process. As a result of the accident, a worker lost a finger and was not able to work for more than a month and cost expensive medical expenses for more than a month and cost expensive medical expenses due to routine treatment and wound care.

Based on this description, the researcher formulated the problem of how to analyze the OHS risk in the tile manufacturing process with the *Hazard Identification, Risk Assessment, and Risk Control* (HIRARC) method. The research aims to describe the OHS risks in the tile manufacturing process. The expected benefit is to provide information related to OHS risks that exist in the process of making roof tiles to the public and to recommend control efforts that can be implemented. The OHS risk analysis process is carried out according to ISO 31000 : 2018 guidelines after knowing the existing risk levels. Efforts are made to develop OHS risk controls that can be applied to workers and the work environment in the tile manufacturing industry.

MATERIAL AND METHOD

This research has received ethical approval from the Health Research Ethics Committee of the Faculty of Public Health, University of Jember (Certificate No.313/KEPK/FKM-UNEJ/II/2023). This research is descriptive with a quantitative approach. The unit of analysis is the process of making roof tiles, namely mixing raw

materials, milling, printing, drying, and burning. The research was conducted in Tamansari Village, Wuluhan District, Jember Regency, East Java from October 2022 to March 2023. The risk assessment method used was HIRARC which refers to the risk management process according to ISO 31000 : 2018 as presented in Figure 1. HIRARC is an identification of hazards in the workplace, followed by determining the level of likelihood and severity and recommending controls (Xiaojun *et al*., 2021).

Referring to Minister of Manpower Regulation No. 5 of 2018 concerning the work environment, the scope of the work environment identified in this research is physical, chemical, biological, ergonomic, and psychological hazards. The selection of respondents was random sampling combined with purposive sampling, where respondents were determined by certain considerations based on research objectives (Sugiyono, 2019). The provisions of respondents are workers who are tasked with supervising 'foreman' workers, have been working for more than one year, and have a minimum education level of high school. Data collection techniques included observation and interviews to identify hazards and unsafe behavior, brainstorming for risk assessment as well as documentation to document every tile manufacturing process. Observation was carried out when researchers follow each step of making roof tiles to collect data related to existing hazards and risks. Then, interviews were conducted to obtain additional information regarding the hazard, as well as probability and severity values to determine the level of risk. Documentation was taking pictures to identify hazards and worker behavior from these pictures. Data analysis was carried out regarding the risk analysis process in ISO 31000 : 2018 in Table 1, Table 2, and Table 3.

Table 2 presents the risk matrix. The risk level criteria use a combination of Likelihood (L) and Consequence (C). The risk matrix used in this risk assessment process refers to ISO 31000 : 2018, which consists of 5 scales for likelihood and consequence. Scale 1 - 5 (Blue) is Low (Priority 5), scale 6 - 8 (Green) is Low - Medium (Priority 4), scale 9 - 12 (Yellow) is Medium - High (Priority 3), scale 15 - 16 (Orange) is High (Priority 2), and scale 20 - 25 (Red) is Very High (Priority 1) (Susilo, Leo J. and Kaho, 2018).

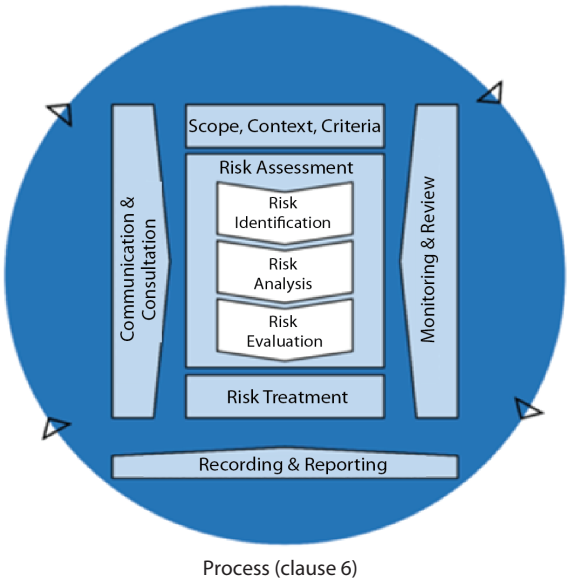

Figure 1. Risk management process (Source: ISO, 2013)

Table 1. Likelihood and consequence scale

Scale	Likelihood	Consequence
1	Very small (almost impossible)	Insignificant (very small or insignificant impact and unnecessary or little concern)
2	Minor (less likely to occur)	Minor (not very important, not serious and does not cause damage and problems
3	Moderate (equal likelihood of it happening and not happening)	Moderate (big enough and has influence to get attention)
4	Major (most likely to occur)	Major (seriously, really bad and causing unwanted damage)
5	Very big (almost certain to happen)	Disaster (an impact that thwarts the achievement of objectives)

Source: Susilo,Leo J. and Kaho (2018)

Table 2. Risk matrix (Source: Susilo, L. J. and Kaho, 2018)

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

Table 3. Risk evaluation

Risk level	Risk evaluation	Evaluation category
Low	Risk is acceptable and does not need control	Risk is accepted and tolerated, no need for control (Acceptable)
Low - Medium	Risk is unacceptable but controls are in place	Unacceptable and tolerable risk, need ALARP control (Tolerable)
Medium - High	The risk is unacceptable and requires preventive controls	Risk is unacceptable, not tolerated, and needs control and review (Unacceptable)
High	The risk is unacceptable and requires preventive and corrective controls	
Very high	The risk is unacceptable and needs immediate control	

Source: Susilo, Leo J. and Kaho (2018)

RESULT

Hazard identification found a total of 89 hazards with some risks remaining consistent throughout the process. Types of hazards found were (a) Physical hazards as many as 36 (40.45%), (b) Chemical hazards (6, or 6.67%), (c) Biological hazards (5, or 5.62%), (d) Ergonomic hazards (21, or 23.60%), (e) Psychological hazards (5, or 5.62%), and (f) Unsafe behavior (16, or 17.98%). Furthermore, these hazards were recapitulated, producing 43 distinct risks, which then underwent a risk assessment. The hazard and risk identifications are presented in Table 4.

Based on Table 4 it is known that most of the tile manufacturing processes have a low level of risk. The details of these risk levels are as follows: (a) Low - risk level (29, or 67.44%), (b) Low - Moderate (4, or 9.30%), (c) Medium - High (7, or 16.28%), (d) High (1, or 2.33%), and (e) Very High (2, or 4.65%). There are two very high risk categorized hazards, namely being hit by a printing press and being injured from contact with firewood (Figure 2). Following hazard identification, a risk assessment was carried out, where risks categorized as low are considered acceptable. The results of the risk category are as follows: (a) Acceptable (29 or 67.44%), (b) Tolerable (4 or 9.30%), and (c) Unacceptable (10 or 23.26%).

Risk control was carried out for categories considered unacceptable, based on priority. Control measures were emphasized on the ten unacceptable risks. Risk management is implemented based on the management hierarchy, among others: a) Elimination, such as cleaning up scattered tiles, stones, and other unused items, b) Substitution, such as replacing peeled of cables with new ones and replacing manual work processes with the help of tools or carts, c) Technical engineering, such as providing safety cover (e.g. wire on gears or rotating objects), providing a long brush for applying oil on the molding machine, covering the chipped wires, isolating the sound source with carpet cloth or soundproofing material, covering each blunt or sharp end of the machine with rubber material, d) Administrative control, such as putting on simple signs or warning labels on dangerous machines or processes, socializing OHS or safe work practice, monitoring and supervising worker behavior by the foreman, stretching during intercalary breaks, setting working hours, registering social security (BPJS), increasing knowledge related to 5R culture, ensuring appropriate work rotation, implementing simple rules, such as the rules for carrying loads and the maximum number of tile stacks and stacking forms (e.g. forming pyramids so they don't fall), e) P*ersonal Protective Equipment* (PPE) intervention by providing PPE such as ear plugs, masks, and protective goggles in the burning area to prevent long-term occupational diseases.

Table 4. Recapitulation of hazard identification and risk assessment results

No	Hazards and unsafe behavior	Risk	L*	C^	Risk level	Risk category	Evaluation risk	Process
1.	Use of hoes, talking to co-workers,	Incised wound on the leg due to being hit by a hoe	3	3	9	Medium - High	Unacceptable	Mixing of ingredients
2.	Use of shovel	Scratch/slash wound on leg due to shovel use	2	1	2	Low	Acceptable	Mixing of ingredients
3.	Hot working environment temperature	Dehydration and heat (heat stress)	5	2	10	Medium - High	Unacceptable	Material mixing, milling, printing, drying, and burning
4.	The number of items scattered/ scattered on the floor area	Feet tripping	4	1	4	Low	Acceptable	Material mixing, milling, printing, drying, burning
5.	Slippery ground surface, hoeing the slope of the ground, running and walking backward when carrying a cart, the ground surface has spilled diesel fuel	Feet slipped and fell due to slippery	3	1	3	Low	Acceptable	Material mixing, milling, printing
6.	The ground surface is uneven	Workers fall due to stepping on uneven ground	3	1	3	Low	Acceptable	Material mixing, milling, printing
7.	Exposure to the noise of machines around	Impaired hearing and communication in the mixing area	3	1	3	Low	Acceptable	Mixing of ingredients
8	Disturbance of small animals and insects	Stung and bitten by animals/ insects	2	1	2	Low	Acceptable	Material mixing, milling, printing and firing
9	Too much load to carry	Feet of falling material (land) carried	5	1	5	Low	Acceptable	Mixing of ingredients
10	Carrying loads that are too high, manual transport, bending too much, workers' chairs without backrests, repeated movements when printing tiles, when tidying up the printout	Pain in the back, waist and limbs	5	2	10	Medium - High	Unacceptable	Material mixing, milling, printing
11	Standing too long (± 5 hours) when hoeing, grinding materials, printing tiles, transporting raw materials, tiles, and manually.	Pain in the legs	5	2	10	Medium - High	Unacceptable	Material mixing, milling, printing

L* = likelihood and C^ = consequence

The continuation of Table 4

No	Hazards and unsafe behavior	Risk	L*	C^	Risk level	Risk category	Evaluation risk	Process
12	The physical workload is too much, colleagues are not cooperative	Working lazily (too many interlude breaks)	2	1	2	Low	Acceptable	Mixing of ingredients
13	Uncomfortable work environment	Lack of motivation	2	1	2	Low	Acceptable	Material mixing, milling, and printing
14	Carrying the load on the head	Pain in hands and head	4	2	8	Low - Medium	Tolerable	Mixing of ingredients
15	Engine noise and handlebar scraping	Hearing loss and noise	5	1	5	Low	Acceptable	Milling
16	Vibration engine and handlebar dores	Vibration disturbances in the hands and tingling	2	1	2	Low	Acceptable	Milling
17	The angled side of the machine	Workers hit and bruised/bruised due to the machine	2	1	2	Low	Acceptable	Milling
18	The use of sendat when tidying up the tile	Hands have scratches or cuts due to slipping	5	1	5	Low	Acceptable	Milling
19	In the mixer part of the dores machine, the worker puts his hand into the machine	The hands are wrapped around the molen part	1	1	1	Low	Acceptable	Milling
20	The gears on the dores and printing machines, the workers joke, the workers don't concentrate	Hands twisted and injured due to gear parts	1	1	1	Low	Acceptable	Milling and printing
21	Solar use	Diesel vapor inhalation	5	1	5	Low	Acceptable	Milling
22	Engine exhaust gas	Inhaled engine exhaust gas	5	1	5	Low	Acceptable	Milling
23	Bringing "andang" (brick dough before the tiles are printed) is too much	Material fall leg (andang)	1	1	1	Low	Acceptable	Milling
24	Worker sitting under dores machine	The worker's head hit the machine and fell to the ground	3	1	3	Low	Acceptable	Milling
25	Automatic tile printing machine (drolis), workers daydreaming, joking with colleagues while printing tiles	Cracked hands, broken, broken, broken	5	5	25	Very high	Unacceptable	Printing
26	Crowbar for manual printing machines	The crowbar's feet fall	5	1	5	Low	Acceptable	Printing

L* = likelihood and C^ = consequence

The continuation of Table 4

No	Hazards and unsafe behavior	Risk	L*	C^	Risk level	Risk category	Evaluation risk	Process
27	The power cord is frayed	The workers were electrocuted	2	3	6	Low - Medium	Tolerable	Printing
28	Cables frayed on ceilings and walls	electrical short	3	1	3	Low	Acceptable	Printing
29	Stacks of tile trays	The body fell from a pile of tile trays	3	1	3	Low	Acceptable	Printing
30	Slices for smoothing tile	Sliced scratched hand	3	1	3	Low	Acceptable	Printing
31	The use of press oil to lubricate the roof tiles by hand and diesel oil to burn firewood	Hand irritation	1	1	1	Low	Acceptable	Printing and burning
32	Transporting tile trays is too much	The foot of the tile tray falls	2	1	2	Low	Acceptable	Printing
33	Too much tile after printing, when it will dry, and when it will burn	Feet exposed or falling tile	2	1	2	Low	Acceptable	Printing, drying, burning
34	Looking down too much when smoothing tile molds with slices	Pain in the neck from bending down	5	2	10	Medium - High	Unacceptable	Printing
35	Lots of untied bamboo in the work area	Falling bamboo worker body	2	1	2	Low	Acceptable	Printing
36	Place of steps	Workers tripped and fell on the steps	4	2	8	Low - Medium	Tolerable	Drying
37	Women's double workload	Work balance with homework	5	1	5	Low	Acceptable	Drying
38	Sparks, smoldering coals on wood	Burns to workers' hands	3	3	9	Medium - High	Unacceptable	Combustion
39	Transporting and loading wood into the furnace,	Scratched wood	3	1	3	Low	Acceptable	Combustion
40	Smoke and wood dust when burning	Inhaled wood dust and smoke	5	2	10	Medium - High	Unacceptable	Combustion
41	Burning smoke	Respiratory disorders (coughs and runny nose)	4	2	8	Low - Medium	Tolerable	Combustion
42	Many scorpions piled firewood	Stung by a scorpion so it swells	4	4	16	High	Unacceptable	Combustion
43	Too much wood is carried into the stove, the coals of the firewood fall when putting the wood into the stove, do not concentrate, and stick their hands into the stove	Worker's feet fall of firewood or tiles	5	4	20	Very high	Unacceptable	Combustion

L* = likelihood and C^ = consequence

Figure 2. (A) Worker's feet injure by firewood, (B) Worker's fingers cut off

DISCUSSION

Based on the results of the risk assessment, it is known that every roof tile-making step had a risk of work accidents and occupational diseases caused by the existing hazards and the attitude of workers. In accordance with the results of research conducted in the roof tile industry, it is known that there were several sources of danger found in the brick industry center in Cikarang, which included printing machines, kilns, lifting and transport processes, and worker attitudes (Rudyarti, 2022).

The results of the risk assessment showed that 29 of the 43 risks were in the low category. These included scratches/cuts on the feet due to using a shovel, tripping of the foot, slipping and falling due to slippery feet, and workers falling due to stepping on uneven ground. This is in accordance with previous research injuries that often occur in men, such as shoveling to collect soil (33.2%) and carrying bricks (41.7%) (Das, 2020). There were 4 (9.30%) risks that fell into the Low - Medium category, consisting of pain in the hands and head, and the worker was thrown by an electric shock. A research in the construction industry showed a similar result, where the results of the highest *Risk Priority Number* (RPN) assessment, showed that accidents are caused by electric shocks due to the presence of electrical tools (Hussain *et al*., 2018). However, the same result was not shown in another research by Fatemi *et al*. (2020), where in general, accidents included bruises (30%) and cuts (28.7%), while electric shock (0.7%) was a type of injury that rarely occurs.

The most common hazards found in the tile manufacturing process were physical hazards. Physical hazards originate from the physical conditions of the work environment such as heat in the working environment, engine noise, while mechanical hazards originate from the machines and tools used which can injure workers. In accordance with research in the brick industry, which has a similar process, it was proven that there was a potential hazard for workers to suffer cuts due to being hit with a fairly sharp hoe due to the physical condition of the clay, which remained hard because it had not been mixed with water (Rudyarti, 2022).

The next most common hazards were ergonomic hazards related to manual transportation, repetitive movements, non-ergonomic work area designs, unnatural worker positions, and heavy workloads. One of the chemical hazards came from the smoke and dust of burning wood. Short symptoms experienced by workers were sore eyes and coughing. Research conducted on 342 brick kiln workers in three villages in Banjarnegara District showed that more than 50% of these workers in the three villages experienced *Acute Respiratory Infections* (ARI) (Widodo *et al*., 2020). There was also a biological hazard from scorpion stings and insects. Workers stung by scorpions was the only high risk. Workers revealed that they were stung by scorpions when they work at night to fill the firewood in the stove. Scorpions are active both during the night and day, and are found under rocks, wood, or on the ground. Symptoms of a scorpion sting include hot and stinging sensations, pain, and convulsions (CDC, 2018).

In addition, there were psychological hazards such as a lack of motivation and a double burden on women workers. Lastly, the unsafe behavior found included daydreaming workers, joking with colleagues, and a lack of concentration. The existence of unsafe behavior in workers can be caused by a lack of knowledge of the importance of OHS. Workers or laborers in the informal industry, have very little exposure to OHS-related knowledge, including the hazards in the tile manufacturing process and its controls in the workplace. Previous findings revealed that most workers in the tile industry had poor knowledge of the occupational health hazards that exist in tile factories (Fouad, 2019). At the time of the study, workers said they had never received training related to OHS and considered work accidents at work to be common place.

Most of the risks belong to the low category. One of the risks that workers often complained about, which is included in the Medium - High category, was inhalation and eye irritation due to wood dust and burning smoke. In the long term it can cause respiratory problems. Another study on brick kiln workers in the Sintuk Toboh Gadang sub-district, Padang Pariaman Regency, showed that there was a positive relationship between length of work and use of PPE with the incidence of respiratory problems (Lastri *et al*., 2019). Though most of the risks were in the low-category, there were still two risks that fell into the very high risk category, namely being hit by a printing press causing cracks, breaking or breaking, sprawl, and feet being injured by contact with firewood. One of the steps in the tile-making process that was determined as the highest priority was the printing process (Noor *et al*., 2018).

Other studies in the roof tile industry that use automated machines also showed that the use of these machines had the highest risk based on a risk assessment using *Job Safety Analyzer (*JSA). The impacts of the automatic tile printing machine were scratches, finger cuts, wounds, broken hands, and broken bones (Hussain *et al*., 2018). The printing process is a very high-risk process. research conducted on the modern tile industry, at PT. Sinar Laut Indah showed that one of accidents in the high category was in printing. Nevertheless, the highest risk of *Occupational Diseases* (OD) was respiratory problems and skin or eye irritation (Desianna and Yushananta, 2020).

Most of the risk evaluations were in the low category. Risk evaluation is the process of prioritizing risks that have been identified and assessed. This aims to find out which risks must be immediately addressed and prioritized based on the results of the risk matrix (UNDP, 2015). The final process in the HIRARC method is compiling risk controls based on the results of the risk evaluation. Unacceptable risks need to be controlled immediately. Risk control is carried out in the form of a control hierarchy consisting of elimination, substitution, engineering, administrative control, and PPE. The control hierarchy is the ranking of hazard controls and risk management strategies (Lyon and Popov, 2019). At the highest risk level, it is necessary to carry out effective risk control efforts with a control hierarchy. The most effective is the elimination method, the implementation of control can be combined with other methods such as administrative control and the use of PPE (Gonawan and Othman, 2022). Control measures can also use the ALARP concept. The ALARP concept is risky i.e. the tolerable category should be reduced to the lowest possible level. In other words, all control efforts must be implemented until the costs outweigh the benefits that can be realized (Maselli *et al*., 2021).

CONCLUSION

The most common type of hazard in the process of making tiles is physical hazard. Most of the risks include a low level of risk. However, there are still two very high risk levels, namely the worker's hands are affected (pinched, squashed, cut fingers, and cracked) due to the printing press, and the worker's feet are fallen by firewood. It is known that most of the risk evaluation includes categories "Acceptable".

Risk control is generally prioritized by category unacceptable namely by eliminating, substituting, engineering, administrative control, and PPE. It is recommended for related parties to put labels or simple signs on dangerous areas or machines, optimize the foreman's role, make simple rules such as how to work properly, transport materials, stretch, give warnings or sanctions for workers who behave unsafely, and provide PPE in certain areas. In addition, related agencies such as the *Health Service to activate the Occupational Health Post* (POS UKK) in the area to increase OHS efforts in the informal sector.

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