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Application of the hazard identification risk assessment and risk control method in the welding frame body process (a case study in Indonesia company)

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ABSTRACT

PT X is an Indonesian manufacturing industry company that manufactures, assembles, and distributes motorcycles, which was established in 1971. PT X uses machinery, and heavy equipment in its production process, and accidents can occur during the process. Therefore, this study aims to identify potential hazards, analyze the level of risk and risk control, and provide recommendations for control measures that can be applied by PT X, especially in the welding frame body process. By using the Hazard Identification Risk Assessment and Risk Control (HIRARC) method. The results of this study indicate that there are 19 potential hazards and 19 risks, where the level of risk in the extreme category is 2, the high category is 6, the medium category is 8, and the low category is 3. Based on the risk control implemented by PT X, it can reduce the of level extreme category risk from 2 to 0, high category from 6 to 0, medium category from 8 to 5, and increase the level of category from 3 to 14. Risk control recommendations that can be implemented by PT X to reduce the level of risk are replacing cotton gloves with leather gloves, using a double mask, changing welding goggles to a welding mask, and using a leather apron.

Keywords: HIRARC, welding frame body, risk level

1. INTRODUCTION

In the current era of globalization, many industries are growing rapidly, such as the manufacturing industry. The manufacturing industry can be defined as an industrial company that converts raw materials, spare parts or other components into a finished product that meets certain specification standards that are produced in large quantities and sold to the public for profit [1]. According to (BPS, 2008), the manufacturing industry is a company that processes raw materials into finished products or semi-finished products so that they have added value that is processed using machines or without using machines [2]. Examples of well-known manufacturing companies in Indonesia are PT Unilever Indonesia Tbk, PT Gudang Garam Tbk, PT Astra International Tbk, and so on. Some components that can affect the development of a manufacturing industry company are human systems, tools or machines used, raw materials, and workplaces. The four components are interrelated and cannot be separated. For example, if there are no production tools or machines, the product will not be made because there is no production process [3][4].

According to the Domino Effect Theory by HW Heinrich, an accident or injury arises from a causal relationship that is interrelated so that it can cause an accident or injury and other losses.

All accidents that occur must have a cause, not a single accident that occurs without a trigger. Accidents can be prevented by eliminating the cause [5].

According to the Employment Social Security Administration Agency (BPJS), in 2021 the number of work accidents in Indonesia will be 234,270 cases. This number increased by 5.65% compared to the previous year, which was 221,740 cases. As can be seen in the graphic image above, the number of work accidents in Indonesia in the last five years has continued to increase. Since 2017, there have been 123,040 work accident cases [6]. This number increased by 40.94% to 173,415 cases in 2018. One year later, work accidents increased by 5.43% to 182,835 cases. According to BPJS Ketenagakerjaan, most of these work accidents occur at work locations in the morning from 06.00 to 12.00.

Every company must have an Occupational Safety and Health (K3) policy because Law No. 13 of 2003 mandates workers' rights to protect their safety and health to achieve optimal productivity [7]. Occupational Safety and Health (K3) is an idea and effort to guarantee the integrity and perfection of the physical and mental workforce in a company (Mangkunegara, 2002). Law No. 1 of 1970 also contains Occupational Safety and Health (K3) making company managers responsible for carrying out the prevention of accidents and occupational diseases [8][9].

Occupational accidents occur not only due to a lack of understanding of the importance of OSH but can be caused by human error [10]. Human error or human error is a decision or human action that is not appropriate so that it can reduce or reduce the effectiveness, safety or performance of the system and hurt the company's performance (McCormick, 1993) [11]. Two factors can affect human error, namely internal factors and external factors [12]. These internal factors arise from characteristics within humans, such as psychological conditions or stress caused by excessive workload. External factors arise which are influenced by external factors, such as the environment which is dirty, noisy, lacking equipment, and improper use of the method [13][14].

The manufacturing industry that assembles motor vehicles is part of the automotive industry which is responsible for the manufacture of motor bodies, welding, painting, assembling spare parts, re-checking, and distribution to the public. One of the manufacturing industry companies that assemble motorized vehicles to distribute to the public is PT X One of the production processes at PT X is the welding process [15].

Welding or welding is a process of joining a type of metal through chemical bonds resulting from heat and pressure [16]. Welding activities at PT X include the manufacture of body frames and fuel tanks for motorized vehicles. Occupational accidents that occur in the welding process are usually caused by careless workers and improper use of personal protective equipment. In the welding frame body process at PT X there are also logistical activities, such as moving material from one station to another and transferring the finished frame body from the welding section to the painting section which will be further processed.

Therefore, it is necessary to identify potential hazards to minimize work accidents. One method that can be used is Hazard Identification Risk Assessment and Risk Control (HIRARC).

2. METHOD

Figure 1 Research methodology is the main method used by researchers to achieve their goals and find solutions to the issues raised [17]. The method used in this research is as follows.

1. A Literature Study
   Literature study is conducted to explore and obtain information from various sources such as books, previous research journals, as well as relevant theories related to the topic of the problem raised.
   a. Occupational Health and Safety (K3)
      According to the International Labor Organization (ILO), occupational safety and health is an effort to improve and maintain the highest level of physical, mental, and social well-being for all workers in all types of work which is useful for preventing health problems caused by work, reducing factors that can affect health, protecting

workers in all activities from risks that arise, maintaining a work environment that suits the physiological and psychological conditions of workers, and to match workers with the work and tasks of each individual [18][19].

b. Hazard Identification Risk Assessment and Risk Control (HIRARC)
This HIRARC is to identify all factors that can result in work accidents or work-related illnesses, to consider the likelihood and severity of risks, and to plan and implement preventive measures so that these risks can be controlled. There are three stages of implementing the HIRARC method, namely hazard identification, risk assessment, and risk control [20][21].

2. Field Observations
Field observations were carried out by direct observation of the welding frame body department in line 2 to obtain the required data by looking at the actual conditions. By conducting field observations, researchers get a general idea of the production process flow.
3. Interviews
Interviews were conducted to obtain data and information from sources by asking directly to parties related to the research topic raised.

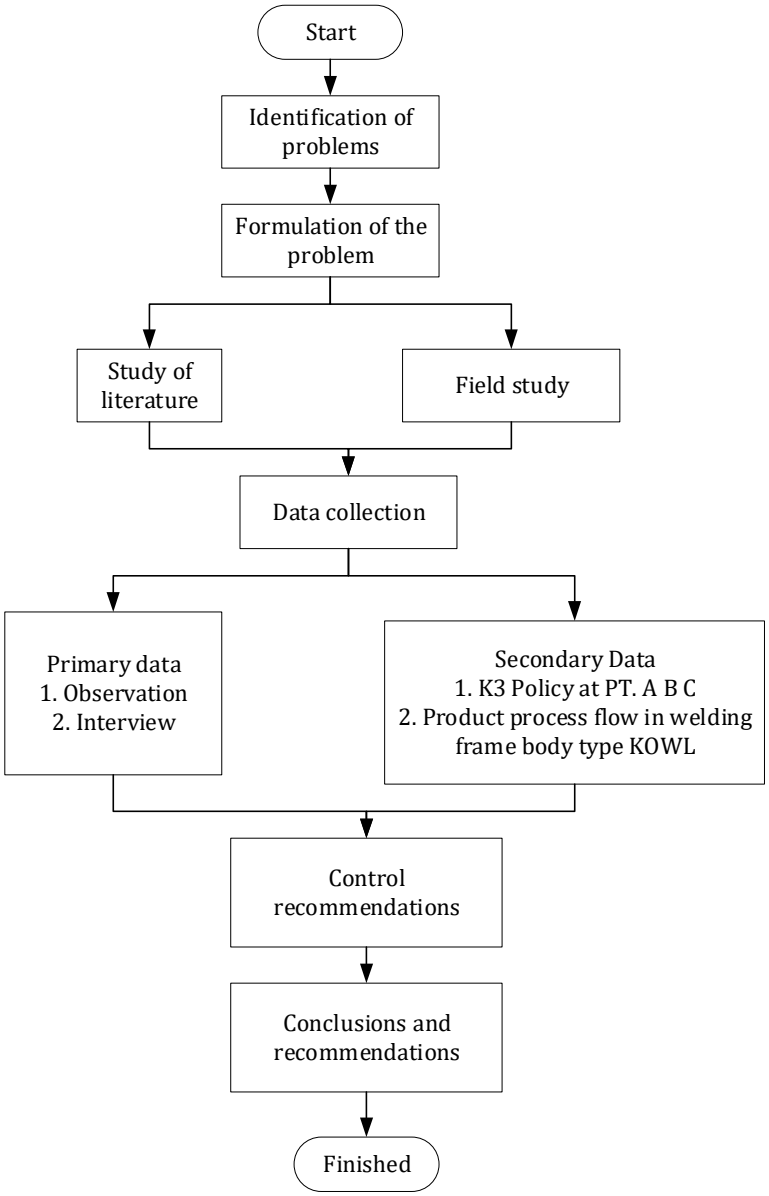

Figure 1. Research flow chart

3. RESULTS AND DISCUSSION

a. Hazard Identification

Hazard identification is a way to find out what potential hazards exist in work activities and can help us to be more careful and alert when working and take safety precautions to avoid these accidents. At this hazard identification stage, the method used is the interaction method which is carried out by interviewing the section heads at the welding frame body department in line 2 and also by using the inspection method. This hazard identification was obtained by conducting field observations, interviews with the employees concerned, and literature studies. The following are potential hazards in the welding process at PT X which can be seen in Table 1.

Table 1. Hazard Identification

No	Work Area	Activity	PotencyDanger	Impact
1.	ST. General Assy & Rear Frame	Unites the rear frame and front frame	1. Scratched hands rear/front end frames	Wounded
			2. Hands exposed to welding sparks	Burns
			3. Inhalation of welding fumes	Out of breath
			4. Hit by rear/front frame	Bruises
			5. Electric shock	Burns
			6. Eyes exposed to welding fumes and light ultraviolet and infrared	Eye irritation
			7. The skin is exposed to ultraviolet rays and infrared	Skin cancer
			8. Welding machine noise	Hearing disorders
			9. Tripping over welding material	Fallen
			10. Too longstanding	Pain in the shoulders and waist
			11. Hand exposure to hot iron	Burns
			12. The cable position is not neat	Fallen
			13. Hot workplace conditions	Dehydration to the point of fainting
			14. Slippery workplace conditions	Slip
			15. Poor cable condition well maintained (peeled)	Electric shock
			16. Welding sparks hit objects which is flammable	Burnt
2.	Permanent Assy Stay	Installation of 6 stays on the rear frame and front frame	1. Scratched hands rear/front end frames	Wounded
			2. Hands exposed to welding sparks	Burns
			3. Inhalation of welding fumes	Out of breath
			4. Hit by rear/front frame	Bruises
			5. Electric shock	Burns
			6. Eyes exposed to welding fumes and light ultraviolet and infrared	Eye irritation
			7. The skin is exposed to ultraviolet rays and infrared	Skin cancer
			8. Welding machine noise	Hearing disorders
			9. Tripping over welding material	Fallen
			10. Too longstand	Pain in the shoulders and waist
			11. Hand exposure to hot iron	Burns
			12. The cable position is not neat	Fallen
			13. Hot workplace conditions	Dehydration to the point of fainting
			14. Slippery workplace conditions	Slip
			15. Poor cable condition well maintained (peeled)	Electric shock
			16. Welding sparks hit objects which is flammable	Burnt
3.	Permanent Robot	Completes the whole welding	1. The rear/front end of the hand is scratched frames	Wounded
			2. Hands exposed to welding sparks	Burns

No	Work Area	Activity	PotencyDanger	Impact
			3. Inhalation of welding fumes	Out of breath
			4. Hit by rear/front frame	Bruises
			5. Electric shock	Burns
			6. Eyes exposed to welding fumes and light ultraviolet and infrared	Eye irritation
			7. The skin is exposed to ultraviolet rays and infrared	Skin cancer
			8. Welding machine noise	Hearing disorders
			9. Stumblingwelding material	Fallen
			10. Standing too long	Pain in shoulders and waist
			11. Hand exposed to hot iron	Burns
			12. The cable position is not neat	Fallen
			13. Workplace conditions hot	Dehydration to the point of fainting
			14. Slippery workplace conditions	Slip
			15. Poor cable condition well maintained (peeled)	Electric shock
			16. Welding sparks hit objects	Burnt
4.	Finishing Welding 1	Complete welding the left part of the body frame	1. The rear/front end of the hand is scratched frames	Wounded
			2. Hands exposed to welding sparks	Burns
			3. Inhalation of welding fumes	Out of breath
			4. Hit by rear/front frame	Bruises
			5. Electric shock	Burns
			6. Eyes exposed to welding fumes and light ultraviolet and infrared	Eye irritation
			7. The skin is exposed to ultraviolet rays and infrared	Skin cancer
			8. Welding machine noise	Hearing disorders
			9. Stumblingwelding material	Fallen
			10. Standing too long	Pain in shoulders and waist
			11. Hand exposed to hot iron	Burns
			12. The cable position is not neat	Fallen
			13. Workplace conditions hot	Dehydration to the point of fainting
			14. Slippery workplace conditions	Slip
			15. Poor cable condition well maintained (peeled)	Electric shock
			16. Welding sparks hit objects	Burnt
5	Finishing Welding 2	Complete the welding of the right side of the body	1. Hand-scratched at rear/front edge frames	Wounded
			2. Hands exposed to welding sparks	Burns
			3. Inhalation welding fumes	Out of breath
			4. Hit by rear/front frame	Bruises
			5. Electric shock	Burns
			6. Eyes exposed to welding fumes and light ultraviolet and infrared	Eye irritation
			7. The skin is exposed to ultraviolet rays and infrared	Skin cancer
			8. Welding machine noise	Hearing disorders
			9. Tripping over welding material	Fallen
			10. Standing too long	Pain in the shoulders and waist
			11. Hand exposed to hot iron	Burns
			12. The cable position is not neat	Burns
			13. Condition of the premises hot work	Dehydration to the point of fainting
			14. Slippery workplace conditions	Slip

No	Work Area	Activity	PotencyDanger	Impact
6.	Checkman	Cleans up bad welding results and provides information if there are incomplete parts	15. Poor cable condition well maintained (peeled)	Electric shock
			16. Welding sparks hit objects	Burnt
			1. Scratched edge of framebody which sharp	Wounded
			2. Hit by the body frame	Bruises
			3.Standing too long	Pain in the shoulders and waist
			4. Hands get spatter	Wounded
			5. Hands exposed to hot iron	Burns
			6. The cable position is not neat	Fallen
			7. Condition of the placehot work	Dehydration to the point of fainting
			8. Slippery workplace conditions	Slip
			9. Poor cable condition well maintained (peeled)	Electric shock
			10. Spattered eyes	Eye irritation
7.	Numbering	Provide a code number, and check the body frame so that it is straight	1. Scratched the edge of the body frame sharp	Wounded
			2. Hit by the body frame	Bruises
			3. Electric shock	Burns
			4. Standing too long	Pain in the shoulders and waist
			5. Hands exposed to hot iron	Burns
			6. The cable position is not neat	Fallen
			7. Hot workplace conditions	Dehydration to the point of fainting
			8. Slippery workplace conditions	Slip
			9. Poor cable condition well maintained (peeled)	Electric shock
8.	Jig Inspection	Thorough check	1. Scratched the edge of the body frame sharp	Wounded
			2. Hit by the body frame	Bruises
			3.Standing too long	Pain in the shoulders and waist
			4. Hands exposed to hot iron	Burns
			5.Hands clamped inspection jig	Bruised or injured
			6. The cable position is not neat	Fallen
			7. Hot workplace conditions	Dehydration to the point of fainting
			8. Slippery workplace conditions	Slip
			9. Poor cable condition well maintained (peeled)	Electric shock
9.	Docking	Position the stay points that are still tilted	1. Scratched the edge of the body frame sharp	Wounded
			2. Hit by the body frame	Bruises
			3.Standing too long	Pain in the shoulders and waist
			4. Hands exposed to hot iron	Burns
			5. Hand scratched jig repair	Wounded
			6. The cable position is not neat	Fallen
			7. Hot workplace conditions	Dehydration to the point of fainting
			8. Slippery workplace conditions	Slip
			9. Poor cable condition well maintained (peeled)	Electric shock

1. Risk assessment

The purpose of the risk assessment is to determine the value of the potential risk of work accidents (risk level). Determination of this risk level is based on the likelihood of an event occurring (probability)

and the potential severity of the event (severity). Table 2 the results of this risk assessment were obtained by conducting interviews with employees involved in the welding process. Below are the results of the risk assessment [22].

Table 2. Risk assessment

No	PotentialHazard	Work Area	Basic Risk			
			Impact	Probability	Severity	Risk Level
1	Scratched handsend of rear frame/front frame/frame body	In all work areas	Wounded	4	3	High
2	Hand exposed to welding sparks	ST. General Assy & Rear Frame, Permanent Assy Stay, PermanentRobot, Finishing Welding 1, and Finishing Welding 2	Burns	4	4	Extreme
3	Inhaledwelding fumes	ST. General Assy & Rear Frame, Permanent Assy Stay, PermanentRobot, Finishing Welding 1, and Finishing Welding 2	Out of breath	4	4	Extreme
4	Hit by rear frame/frontframe/ frame body	In all work areas	Bruises	3	2	Medium
5	Eye caught welding fumes as well as ultraviolet and infra rays red	ST. General Assy & Rear Frame, Permanent Assy Stay, Permanent Robot, Finishing Welding 1, and Finishing Welding 2	Irritation of eye	4	3	High
6	The skin is exposed to ultraviolet and infrared rays red	ST. General Assy & Rear Frame, Permanent Assy Stay, Permanent Robot, Finishing Welding 1, and Finishing Welding 2	Skin cancer	3	3	High
7	Noise welding machine	ST. General Assy & Rear Frame, Permanent Assy Stay, Permanent Robot, Finishing Welding 1, and Finishing Welding 2	Hearing disorders	4	2	High
8	Tripping of welding material	ST. General Assy & Rear Frame, Permanent Assy Stay, Permanent Robot, Finishing Welding 1, and Finishing Welding 2	Fallen	2	2	Medium
9	Too longstand	In all work areas	Pain in the shoulders and waist	4	2	High
10	Hand exposed to hot iron	In all work areas	Burns	2	3	Medium

Based on the table above, 19 potential hazards have been identified that can cause work accidents and 19 risks, consisting of 2 extreme risk categories, 6 high risk categories, 8 medium risk categories, and 3 low risk categories. in the picture below is the percentage of risk assessment using a pie chart.

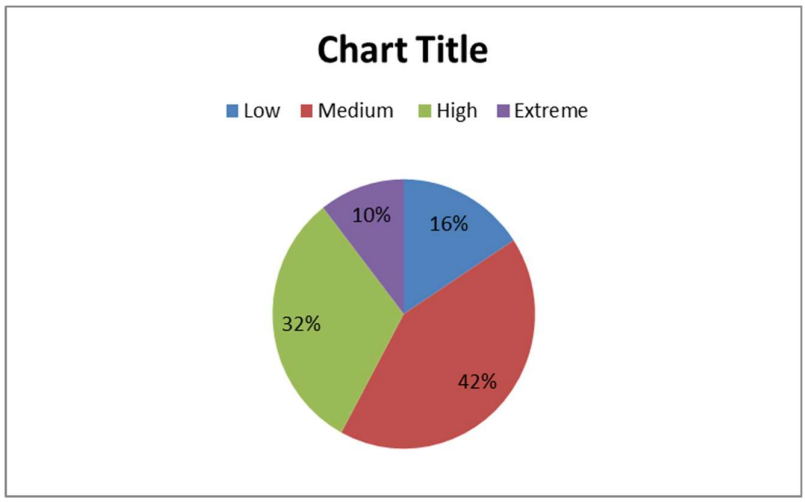

Figure 2. Pie chart of risk assessment results

2. Risk Control

Risk control is carried out by prioritizing all identified hazards in the hazard identification process by considering the risk assessment and how to control it. The following are the results of risk control which can be seen in the Table 3.

Table 3. Risk control

No	Potential Hazard	Work Area	Basic Risk				Current Control	Residual Risk			Control Recommendation	Predicted Risk		
			Impact	Probability	Severity	Risk Level		Probability	Severity	Risk Level		Probability	Severity	Risk Level
1	The hand scratched the edge of the rear frame/front frame/frame body	In all work areas	Wounded	4	3	High	Use cotton gloves	1	2	Medium	Useleather gloves	1	2	Low
2	Hand exposed to welding sparks	ST. General Assy &Rear Frame, Permanent Assy Stay, Permanent Robot, Finishing Welding 1, and Finishing Welding 2	Burns	4	4	Extreme	Use cotton gloves	2	2	Medium	Useleather gloves	1	2	Low
3	Inhaledwelding fumes	ST. General Assy &Rear Frame, Permanent Assy Stay, Permanent Robot, Finishing Welding 1, and Finishing Welding 2	Out of breath	4	4	Extreme	Useface mask	2	2	Medium	Usedouble mask	1	2	Low
4	Overwrittenrear frame/front frame/body frame	In all areasWork	Bruises	3	2	Medium	Use of safety shoes	1	2	Low	Usesafety shoes	1	1	Low

No	Potential Hazard	Work Area	Impact	Basic Risk			Current Control	Residual Risk			Control Recommendation	Predicted Risk		
				Probability	Severity	Risk Level		Probability	Severity	Risk Level		Probability	Severity	Risk Level
5	The eyes are exposed to welding fumes as well as ultraviolet and infrared rays	ST. General Assy & Rear Frame, Permanent Assy Stay, PermanentRobot, Finishing Welding 1, and Finishing Welding 2	Irritation ofeye	4	3	High	Use of welding glasses	2	2	Medium	Useweldi ng mask	1	2	Low
6	The skin is exposed to ultraviolet and infrared rays	ST. General Assy & Rear Frame, Permanent Assy Stay, PermanentRobot, Finishing Welding 1, and Finishing Welding 2	Skin cancer	3	3	High	Wear long sleeves and gloves cotton	2	2	Medium	Wear long-sleeved clothes and leather gloves and an apron skin	1	2	Low
7	Welding machine noise	ST.General Assy & Rear Frame, Permanent Assy Stay, Permanent Robot, Finishing Welding 1, and Finishing Welding 2	Hearing disorders	4	2	High	Use of ear plugs or earmuffs	1	2	Low	Use ear plugs or ear muffs	1	2	Low
8	Tripping of welding material	ST. General Assy & Rear Frame, Permanent Assy Stay, PermanentRobot, Finishing Welding 1, and Finishing Welding 2	Fallen	2	2	Medium	Tidy up welding material s regularly	1	2	Low	Tidy up welding materials regularly	1	2	Low
9	Too longstandin g	In all areas Work	Pain in the shoulder s and waist	4	2	High	Stretch before work and use a trim belt	1	1	Low	Stretch before work and use a trim belt	1	1	Low
10	Hand exposed to hot iron	In all areas Work	Burns	2	3	Medium	Use of leather gloves	1	2	Low	Useleather gloves	1	2	Low

Based on the results of the hazard potential analysis and risk assessment using the HIRARC method described above, this is illustrated in Figure 2. This is a bar chart showing basic risk, residual risk, and predicted risk. The basic risk level or basic risk is a risk level that has not considered the hazard control aspects that have been implemented by the company. From the results of this analysis, the risk level with the extreme category is 2, high is 6, medium is 8, and low is 3. Figure 3 while the residual risk level is the result of a re-analysis of the risk level and takes into account the aspects of risk control that have been implemented by the company resulting in a significant change in the level of risk. The existence of controls carried out by the company can reduce the level of risk in the extreme category from 2 to 0, the high category from 6 to 0, the medium category from 8 to 5, and increase the level of risk in the low

category from 3 to 14. Due to the presence of a medium risk category, the author makes a predicted risk or a predicted risk level.

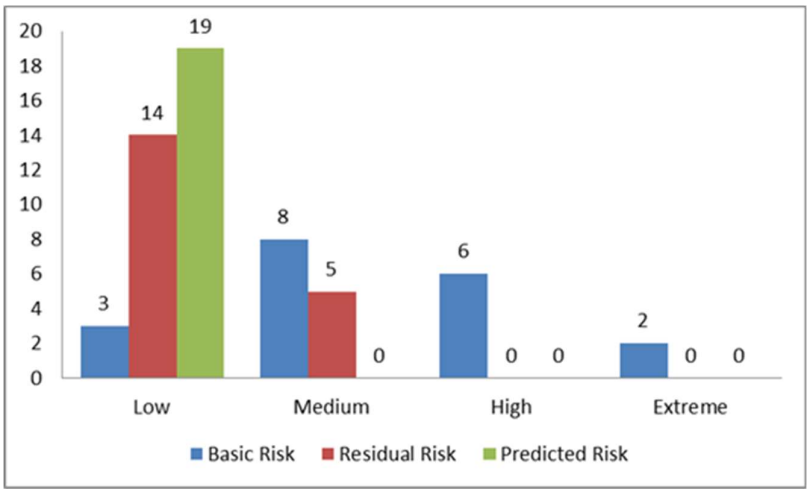

Figure 3. Risk level bar chart

After providing recommendations for control efforts, there will be advantages and disadvantages of these control efforts. Table 4 shows recommendations for control efforts along with their advantages and disadvantages.

Table 4. Control recommendations along with its advantages and disadvantages

No	Potential hazard	Current Controls	Controls Recommendations	Excess	Lack
1	Hand scratched at rear end frame/front frame/frame body	Use glove scotton	Use leather gloves	The material is thicker and more heat resistant	The costs incurred are more
2	Hand exposed to welding sparks	Use glove scotton	Use leather gloves	The material is thicker and more heat resistant	The costs incurred are more
3	Inhalation of welding fumes	Use face mask	Using a double mask	Welding fumes are not easy to inhale	The costs involved are more expensive and difficultto breathe
4	Hit by rear frame /fron tframe/frame body	Use safety shoes	Use safety shoes	-	-
5	Eyes affectedwelding fumes as wellultraviolet and infrared rays	Use of welding glasses	Using a welding mask	Eyes are not fast irritation due toprotected from welding fumes and ultraviolet rays and infrared	The costs incurred are more
6	Skin exposed to light ultraviolet and infrared	Wearing sleeved shirts longand cotton gloves	Wear long sleeves and gloves leather and leather apron	The skin is protected from ultraviolet rays andi nfrared	The costs incurred are more

No	Potential hazard	Current Controls	Controls Recommendations	Excess	Lack
7	Engine noise welding	Useearplugs or earmuffs	Using earplugs or earmuffs	-	-
8	Stumble welding material	Smooth out the welding material routinely	Tidy up welding materials regularly	-	-
9	Too longstand	Stretchbefore work and use trim belt	Stretchbeforeworking and using the trim belt	-	-
10	Hand exposed to hot iron	Use of leather gloves	Use leather gloves	-	-
11	Hand hitspatter	Use of leather gloves	Use leather gloves	-	-
12	Hands caught in the jig inspection	More workersunderstand SOP and use of gloves cotton	Workers better understand SOPs and use cotton gloves	-	-
13	Cable position is not neat	Tidy up scattered cables routinely	Tidy up scattered cablesroutinely	-	-
14	Condition of place Workthe hot one	Use exhaust fans	Use exhaust fans	-	-
15	Condition of placesmooth work	Install warning signs	Put up a warningsign	-	-
16	Poor cable conditionwell maintained (peel off)	Maintenanceequipment periodically	Regular maintenance of equipment	-	-
17	Welding sparks hit objects easilyburnt	Distanceflammable objects and installing warning sign	Keep easy objects away caught fire and put up a warning sign	-	-
18	Hand scratched repair jig	Use glovesskin	Use leather gloves	-	-
19	Eyes affected spatter	Using welding glasses	Using welding glasses	-	-

5. CONCLUSION

Based on the results of hazard identification, risk assessment, and risk control as well as recommendations for control measures, the following conclusions can be drawn. Based on the results of hazard identification, potential hazards are obtained: the hand is scratched at the end of the rear frame/front, frame/body frame, the hand is by welding sparks, inhaled welding fumes, overwritten rear frame/front frame/frame body, and the eyes are exposed to welding fumes as well as ultraviolet and infrared rays. Besides them, the skin is exposed to ultraviolet and infrared rays, welding machine noise, tripping of welding material, standing too long, hand exposed to hot iron, hand spattered, hand clamped jig inspection, poor cable position, and hot working conditions. Also, slippery working conditions, the condition of the cable is less maintained (peeled), welding sparks on flammable objects, hand-scratched jig repair, and spatter hitting the eye. Based on the results of the risk assessment, it was obtained that the percentage of risk levels in the frame body welding area in line 2 was 19 risks with

10% extreme risk level category, 32% high-risk level category, 42% medium risk level category, and 16% risk level category low. The control system that has been implemented by PT X has succeeded in reducing the basic risk level in the extreme category from 2 to 0, the high category from 6 to 0, the medium category from 8 to 5, and the low category risk level from 3 to 14. Several control recommendations can be carried out by PT. X, namely by using leather gloves, a double mask, safety shoes, a welding mask, long-sleeved clothes leather gloves, and a leather apron.

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