IMPROVEMENT OF WORK SAFETY AND HEALTH IN IMPROVING THE QUALITY OF PRODUCTION PROCESS USING THE HAZARD AND OPERABILITY STUDY METHOD

(Case Study at PT. Dirgantara Indonesia Aerospace)

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ABSTRACT

Occupational safety and health is an important part of a company, especially in industrial companies. PT Dirgantara Indonesia is a company that manufactures aircraft in the CN hangar and Helicopter in the MK hangar. Every production process must pay attention to the Occupational *safety and health* applied, this will affect the quality of the product to be produced. The company applies work safety standards, but in its implementation there are still some potential that can cause work accidents. If the potential for work accidents that arise can be identified, then the number of occupational accidents can decrease. The first stage is to identify the source of hazards in the work area, then analyze the risk of occupational hazard sources using the Hazard and Operability Study method. The results of the survey in the lower production process found 8 sources of danger, namely mosukuleskeletal disorders, hearing, vision health, injuries to the hands, injuries to the head, installation on the floor, jig bumps and poor lighting. The results of this study are proposed improvements with a number of recommendations for Occupational *safety and health* support facilities. The purpose of the proposal is to improve production quality and reduce potential hazards.

Keynote; Occupational *safety and health*.

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INTRODUCTION

Companies in the manufacturing industry always want to produce good quality products in every production. This must be driven by the application of occupational safety and health in the company. A good OSH application will affect the process and quality of production output, because it is related to the work done by workers. PT Dirgantara Indonesia Persero (PTDI) is a business engaged in the aircraft and helicopter industries. The implementation of occupational safety and health in the company has not run well due to incomplete K3 supporting facilities and equipment for workers. This can cause excessive fatigue

resulting in injuries to workplace accidents that have an impact on the disruption of the production process and the quality of the products produced. The company needs to increase K3 in the production process so that it can reduce the potential for work hazards and work accidents. The following data are occupational accidents occurring on the lower production line.

Table 1. Occupational Accident Data in the Lower Production Line

No.	Nama Operator	Jenis Kecelakaan Kerja	Dampak Kecelakaan
1	Muhammad Ally Triana	Tersayat *Lower*	Luka Tangan
2	Muhammad Muzaki	Terkena *Rivet Gun*	Memar pada ibu jari
3	Andi Sumardi	Tersayat *Skin Lower*	Luka Tangan
4	Usman Saepudin	Tersayat *Lower*	Luka Tangan
5	Muhammad Sultan Suladin	Tersayat *Lower*	Luka Tangan
6	Rifky Mugni Nugraha	Tertimpa *Bucking Bar*	Luka Kepala
7	Ridwan Yudha	Terkena Bor tangan	Luka Tangan

(Source: PT Dirgantara Indonesia Aerospace, 2019)

Work accidents that occur in these 7 operators are inseparable from the lack of facilities provided by the company, the operator's self-awareness of the importance of OSH in every job and the potential hazards in the lower production area. This research was conducted in the production process of Puma Bawah II MK II AH 225/275 Bawah using the Hazard and Operability Study method. Hazard and Operability Study is a method used to identify risks associated with operating and maintaining the system, and identifying various operational problems in each process due to irregularities in the production process at the factory (Munawir, 2010). This method is used because it can produce recommendations for OHS improvement by calculating the source of hazards, risks, deviations, causes and consequences of work, otherwise it can be used to determine the level of risk from the source of the hazards found.

LITERATURE REVIEW AND FOCUS OF STUDY (QUALITATIVE)

Some definitions of occupational safety and health according to experts in the field. According to (Tasliman, 1993), occupational safety and health involve all elements involved in work activities. Concerning the subject, that is, the person doing the work, the object, that is, the objects or items being worked on, the working tools used in the form of machinery and other equipment, as well as concerning the environment, both humans and objects or goods. Personal protective equipment used by operators according to the journal Pujiono DKK, 2013 are as follows: 1). Safety Harness; 2). Safety Shoes; 2). Safety Helmet; 3). Safety Goggles; 4). Safety Gloves; 5). Mask; 6). Ear plug. Literature study in this research begins by collecting references or theories related to the method used for research. The following references or theories contain the underlying understandings of this study, as follows: 1). (Pujiono, Tama, Efranto) Analysis of potential hazards and recommendations for improvement using the HAZOP method through OHS Risk Assessment and Control ranking discussing OHS Improvement Recommendations, 2). (Restupurti, Sari, 2015) Analysis of occupational accidents using the The Hazard and Operability Study (HAZOP) method discusses recommendations for improving employee attitudes with standard operational procedures for occupational safety and health (K3), 3). (Jamilah, Yadi and Umyati.2013) Identification of Potential Dangers With the Hazard And Operability Study (HAZOP) Method in the Boiler Area of PT. XY discussed recommendations for action on potential hazards. 4). (Hamdy, Tanjung.2016) Analysis of Hazard Potential and Work Accident Control Efforts in the Adesit Stone Mining Process at PT. Dempo Bangun Mitra discusses recommendations on adding road signs and controlling road

conditions regularly and improving PPE for employees; 5). (Maiyana, Ya'umar, and Ilyas, 2013) Proposed Improvements in the Quality of Bread Products Bariton discusses recommendations for improving work so that the quality of bread products is better; 6). (Wendhiarko, 2019) Evaluation of Repair of Clothing Products at PT World Knk Surya Anugerah discusses recommendations for improvement of potential hazards to PTDI Aerospace with proposed improvements. Hazard and Operability Study means physical conditions that have the potential to cause losses, accidents, to humans and or damage to equipment, environment or buildings as well as existing and designed operating conditions but which may cause a series of incidents that harm the company, (Munawir, 2010). The terminology used to facilitate the implementation of Hazard and Operability Study, among others, is as follows: a). What process is happening or the location where the process is taking place; b). Hazard sources found in the field; c). Deviation relates to matters that have the potential to create risks; d). Cause is something that is most likely to cause irregularities; e). Consequences are the result of deviations that occur that must be received by the system; e). Action is an action divided into two groups, namely actions that reduce or eliminate the consequences (consequences); f). Severity is the expected severity. The following table is Severity criteria:

Tabel 2. Data Consequences/Severity

Consequences/Severty			
Level	Description	Severity of Injury	Working days
1	Not significant	The incident did not cause harm or injury to humans	Does not cause loss of workdays
2	Small	Causing minor injuries, small losses and does not cause a serious impact on business continuity	Can still work on the same day / shift
3	Middle	Severe injuries and hospitalized, do not cause permanent disability, moderate financial losses	Lost workdays under 3 days
4	Weight	Causing serious injury and permanent disability and large financial losses and have a serious impact on business continuity	Lost work days of 3 days or more
5	Disaster	Resulting in casualties and severe losses can even stop business activities forever	Lost work days forever

(Source: Jurnal Pujiono DKK, 2013)

g). Likelihood is the possibility of consequences with the existing safety system. The following table is the Likelihood criteria*:*

Tabel 3. Data *Likelihood*

Likelihood			
Level	Criteria	Deskripsi	
		Qualitative	Quantitative
1	Rarely happening	Can be thought of but not only in extreme circumstances	Less than once per 10 years

2	Small possibility	It hasn't happened yet but can appear at a time	Occurs 1 time per 10 years
3	Maybe	It should have happened and it might have happened	1 time per 5 years to 1 time per year
4	Most likely	Can occur easily, may occur under many circumstances	More than 1 time per year
5	Almost certainly	It often happens, is expected to appear in the most occurrences	More than 1 time per month

(Source: Jurnal Pujiono DKK, 2013)

h). Risk is the value of risk obtained from a combination of likelihood and severity possibilities. Following is the Risk Level table*:*

Tabel 4. Risk Level.

Tingkat Bahaya (*Risk Level*)							Keterangan:	
Kemungkinan (*Likehood*)	5	5	10	15	20	25	1	Resiko Ekstrim
	4	4	8	12	16	20	2	Resiko Tinggi
	3	3	6	9	12	15	3	Resiko Sedang
	2	2	4	6	8	10	4	Resiko Rendah
	1	1	2	3	4	5		
Skala		1	2	3	4	5		
		Keseriusan (*Severty/Consequences*)						

(Sumber: Jurnal Pujiono DKK, 2013)

Risk management is defined as the process of identifying, monitoring and managing potential risks to minimize the negative impacts that may be at risk to an organization. According to (Rico Tri Wardhana, 2015), to implement a risk management appropriately, several stages must be carried out by the company, namely: 1). Hazard identification; 2). Identifying forms of danger; 3). Placing the size of a hazard; 4). Locating alternatives. According to (Hudori and Jabbar, 2003), losses caused by work-related accidents cause five types of losses, namely: 1). Damage; 2). Organizational chaos; 3). Complaints and sadness; 4). Abnormalities and defects; 5). Dead; and 6). Lost Business Day.

RESEARCH METHOD

This research is based on K3 problems in the Lower Super Puma MK II AH 225/275 production process area which causes potential hazards to workers and workers productivity which is not good, besides this it causes Defect on the products produced and production time that is not according to the target. Improvements to K3 are needed to provide safety and comfort for Lower Super Puma MK II AH 225/275 production line workers. so that reduction or loss of work accident rates and increase worker productivity. The purpose of doing research on the production process of the Lower Super Puma MK II AH 225/275 is: 1). Knowing the potential dangers inherent in the production process of Lower Super Puma MK II AH 225/275 PTDI; 2). Knowing the risk from the source of danger contained in the production process of Lower Super Puma MK II AH 225/275 PT Dirgantara Indonesia; and 3). Knowing the level of risk from each source of danger found and analysis of recommendations for improvements produced by the HAZOP method contained in the production process of the Lower Super Puma

MK II AH 225/275 PTDI. Following are the data collection steps that must be done before processing data, as follows:

A. Observe where there is a potential hazard. This observation is carried out directly to the lower production line by recording the hazard findings contained in the production line that can cause work accidents
B. Conduct interviews with all operators. This interview was conducted to operators who worked on the lower production line, amounting to 15 people. This interview was carried out in depth by giving relevant questions to the findings of the danger obtained from observations.

RESULT AND DISCUSSION

Data processing is performed to determine the level of risk from each source of danger found as well as recommendations for improvements produced by the HAZOP method contained in the production process of Lower Super Puma MK II AH 225/275 PTDI. The products produced by PTDI Aerospace in the MK II Super Puma are the helicopter body parts as shown below:

Figure 1. PTDI. (Source: www.indonesian-aerospace.com)

Figure 2. Struktur *Tail Boom* MK II Super Puma. (Source: PTDI Aerospace)

Figure 2. is the product of PTDI Aerospace (Persero) in the MK II Super Puma. The first is the Tail Boom, the tail section of the super puma helicopter body that functions as a balance point on the helicopter and directs the helicopter while being operated.

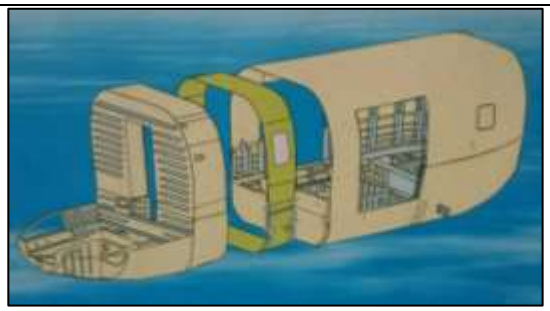

Figure 3. Struktur *Upper* MK II Super Puma. (Source: PTDI Aerospace)

Figure 4. Struktur *Lower* MK II Super Puma. (Source: PTDI Aerospace)

Figure 3. is the product of PTDI Aerospace in the MK II Super Puma. The first is the Upper Structure which functions as the base for the helicopter engine, while the other function is as the helicopter roof. Figure 4. is the product of PTDI Aerospace in the MK II Super Puma. The first is the Lower Structure which functions as a base for the helicopter's fuel and

in addition as an area for passengers or pilots. The following data processing steps that must be done before recommending improvements are as follows:

A. Make a description of the hazard findings. Based on the risk of any hazard found. The purpose of this description is to determine the risk of each hazard finding.
B. Classification of hazard findings by using Likelihood criteria. Aim to find out the level of how often the possibility of potential danger. This Likelihood Criteria contains 5 criteria based on the likelihood of the occurrence or magnitude of the event and a description of the 5 existing criteria. The data used are the results of interviews of 15 operators regarding hazard findings.
C. Classification of hazard findings by using Concequences criteria. Aim to find out the level that indicates the severity of the injury and the loss of workdays. Criteria Concequences have 5 levels of impact from deviations made from insignificant to disasters in addition to containing a description of the severity of injuries and the impact of injuries on workdays. This stage is carried out by means of discussion with the K3LH regarding the findings of the hazard and the severity of the injury caused if a work accident occurs.
D. Rank the hazards that have been identified using the Risk Matrix. This ranking is done to determine the level of risk from each source of danger found in the production process of the Lower Super Puma MK II AH 225/275 PTDI. The Risk Matrix is used to calculate the risk score or risk level of a potential hazard. The color of the risk matrix serves to distinguish the risk score or risk level. Red indicates extreme risk, yellow for high risk, green for moderate risk, and light blue for low risk.

The following is the SOP of Personal Protective Equipment obtained from the interview results of PTDI Aerospace staff of the MK II Super Puma section.

Table 5. SOP Personal Protective Equipment PTDI Aerospace MK II Super Puma

Standar Operating Procedure Alat Pelindung Diri PT Dirgantara Indonesia Aerospace MK II Super Puma	
No.	Alat Pelindung Diri
1	*Safety Hat*
2	*Ear Plug*
3	*Ear Mole*
4	*Safety Goggles*
5	*Safety Gloves*
6	*Wearpack*
7	*Safety Shoes*

(Source: Hasil wawancara dengan Staf MK II Super Puma)

Hazard finding table data and Hazard deviations obtained from observations made on the MK II Super Puma Assembly Lower hangar.

Table 6. Hazard's findings are in Hanggar MK II Super Puma *Assembly Lower*

No.	Untuk Temuan *Hazard*	No.	Penyimpangan
1	Gangguan *Muskuloskeletal*	1	Proses teknik tidak benar
2	Gangguan Pendengaran	2	Operator tidak Menggunakan APD: *Ear Plug*
3	Luka bagian Tangan	3	Operator tidak Menggunakan APD: *Safety Gloves*
4	Gangguan Kesehatan Pengelihatan	4	Operator tidak Menggunakan APD: *Safety Goggles*
5	Luka bagian Kepala	5	Operator tidak Menggunakan APD: *Safety Hat* atau *Safety Helmet*
6	Instalasi di lantai	6	Peletakan perkakas/alat tidak baik
7	Terbentur *JIG*	7	Tidak *Update* lantai *JIG*
8	Pencahayaan kurang Baik	8	Pencahayaan cahaya kurang Baik

(Source: Hasil Observasi pada MK II Super Puma)

The data obtained in this study came from observations, interviews and documentation. The three data collection tools are used to identify the danger sources that exist in the lower assembly work area of the MK II Super Puma Hangar PTDI Aerospace. Observations

were made by direct observation and poured in the form of notes. Interviews were conducted with Operators at the Lower assembly. Documentation is done by taking pictures directly in the field.

The table below is a description of the hazard findings obtained from the observations of researchers in the lower Super Puma assembly area in the MK II AH 225/275 hangar, the data contains the findings of the hazard along with the risks resulting from the source of the hazard. The determination of risk is described based on the respective hazard findings.

Table 7. Lower Matrix Assembling Analysis Results

Process	No	Description of Hazard's Findings	Risk	Hazard Resources	Deviations	L*	C*	Risk Level	
Lower	1	Musculoskeletal Disorders	a. Excessive fatigue. b. Pain or pain in the joints experienced by the operator. c. Injury to joints experienced by the operator	Body position	Incorrect body position	5	2	10	High
	2	Hearing disorders	a. Hearing health disorders. b. Incorrect communication.	The source of noisy Rivet Gun's boom	Operators do not use: Ear Plug	4	1	4	Middle
	3	Hand Injury	a. Sliced Lower component. b. Exposed Preasure from Rivet Gun.	Lower Components, Rivet Gun, Drill	Operators do not use: Safety Gloves	3	3	9	High
	4	Vision Health Disorders	a. Impaired vision health due to exposure to the Rivet. b. Impaired vision health due to exposure to the Bucking Bar.	*Rivet* and *Bucking bar*	Operators do not use: Safety Goggles	4	3	12	High
	5	Head Injury	a. Injury due to parts of the head hit the Lower component. b. Head injury due to exposure to the Bucking Bar	Lower and Bucking Bar Components	Operators do not use: Safety Hat or Safety helmet	4	3	12	High
	6	Floor Installation	a. Tripping cables that are in the work area can hamper the course of the	Computer Cables, Rivet Gun	Laying cabling is not good	3	2	6	Middle

			production process if an accident occurs to the operator. b. A short circuit occurs when the cable that has an electric current is damaged due to being displaced by a workpiece or being trampled	Cables and Drill Cables					
	7	*Jig*	a. Injury can befall the working operator if they trip over the jig while doing work. b. Difficult work in the Jig area can cause suboptimal results from the operators who work	*Jig*	Not updating the Jig form	2	2	4	Low
	8	Poor Lighting	a. The assembly did not go well because the operator did not work optimally due to lack of light in the work area. b. Poor lighting can endanger the Bucking Bar operator due to incorrect targets on the Rivet Gun and Drilling operators	Lower production area lights	Poor utilization of light	3	4	12	Extreme

Keterangan : L = Likelihood, C* = Consequences, R* = Risk Level*

Table 7. is a risk level table generated from processing using observation data and interview data. This classification is done by selecting the most answers from 15 interview transcripts for each hazard finding. The consequences of deviations made and the consequences of working days from the Concequences table are risk tables consisting of 5 classes, ranging from insignificant, small, medium, severe, and disaster. There are 8 risk level points that are divided at each different hazard source. The determination of the classification of Concequences is done by discussing with the person or the K3LH regarding the findings of the hazard and the magnitude of the consequences arising from each of the hazard findings. Processing data generated from the risk level is 1 low category, namely the Jig hazard findings, 2 moderate categories, namely hearing loss and installation on the floor. 4 High categories namely musculoskeletal disorders, hand injuries, vision health problems and head injuries. There is an extreme category which is the source of the danger of poor lighting. The highest percentage is a high risk that is actually 50%, followed by a medium category that is 25% and a low risk of 12.5% and an extreme risk of 12.5%. This is due to the presence of sources of danger in the production area that can have a significant impact, so it is necessary to improve K3 located in the Lower Super

Puma MK II AH 225/275 production area so that the production process runs better than before.

CONCLUSION

Hazard analysis is carried out by using analysis tools, namely root cause failure analysis, among others:

1. Musculoskeletal disorders. Musculoskeletal disorders resulting from the hazard worksheet produce a high level of risk, this is caused by the wrong position when the operator does his work. Activities should not be carried out until the risk has been reduced. This will adversely affect operators and companies described using root cause failure analysis tools:

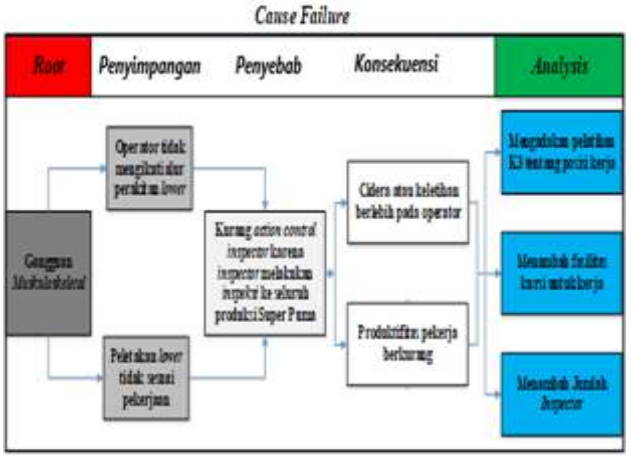

Figure 5. Root Cause Failure Analysis Musculoskeletal Disorders

2. Health problems and injuries to the body. Health disorders and injuries to the body indicate a moderate level of risk that is necessary to reduce the risk within the specified time period and a high risk level that is the activity should not be carried out until the risk is reduced or lost. This will adversely affect operators and companies described using root cause failure analysis tools:

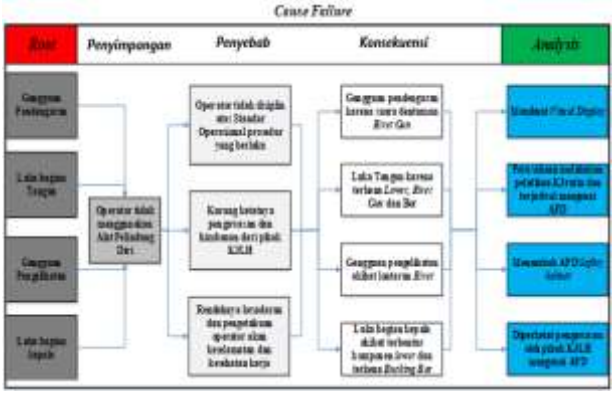

Figure 6. Root Cause Failure Analysis Health problems and injuries to the body

3. Installation on the floor. Installation on the floor resulting from the hazard worksheet produces a moderate level of risk that is necessary to reduce the risk within the specified time period. This will adversely affect operators and companies that are described using the root cause failure analysis tools:

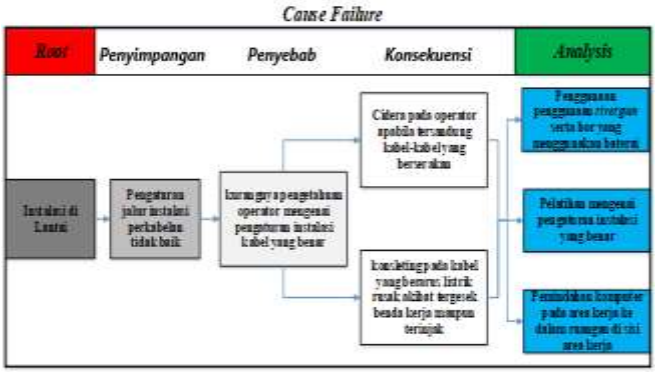

Figure 7. Root Cause Failure Analysis Installation on the floor

4. Hit the Jig. Jigs indicate a low level of risk that is acceptable risk, additional control is not needed, monitoring is needed to ensure that the control is maintained and properly implemented. This will adversely affect operators and companies described using root cause failure analysis tools:

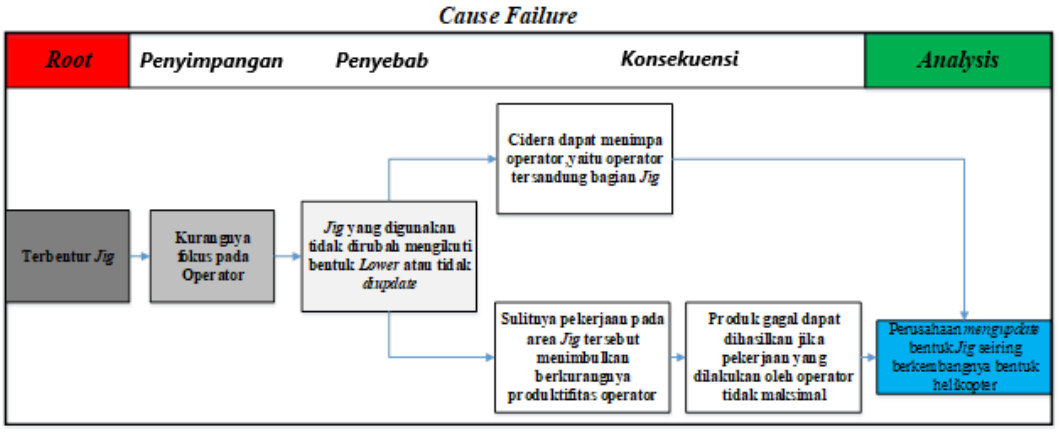

Figure 8. Root Cause Failure Analysis hit by Jig

5. Poor lighting. Poor lighting indicates extreme risk levels, ie activities should not be carried out or continued until the risk has been reduced. If it is not possible to reduce risk with limited resources, work cannot be carried out which can have a very significant impact when work accidents occur at this source of danger. This will adversely affect operators and companies described using the root cause failure analysis tools:

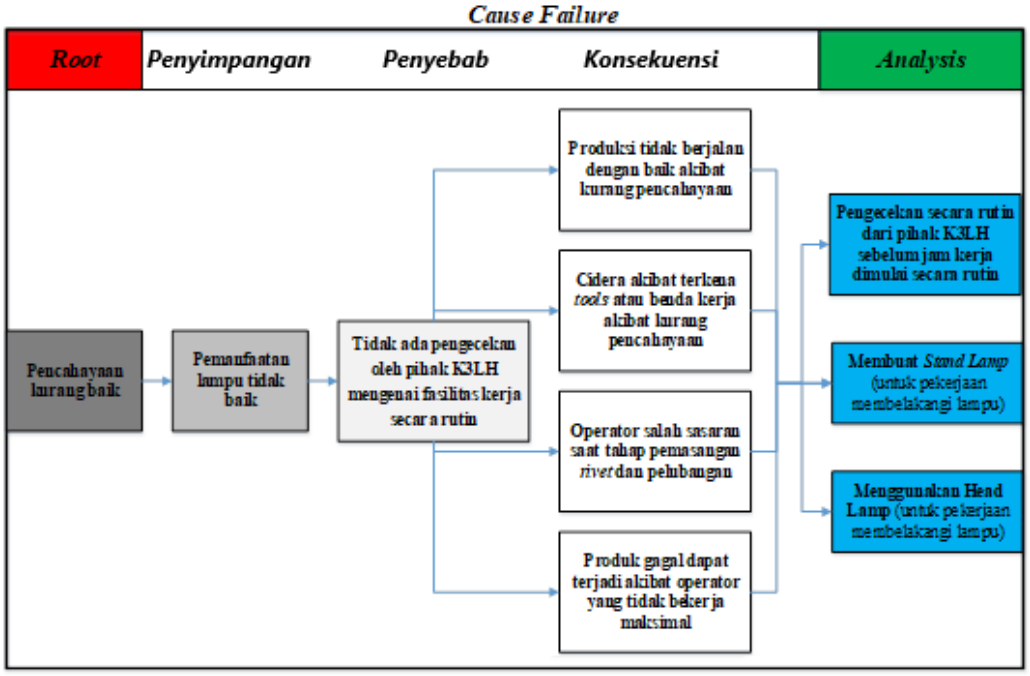

Figure 9. Root Cause Failure Analysis Poor lighting

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