

Analysis of Factors Causing Work Accidents in Steel Plate Production with FTA and PDCA Methods at PT. XYZ

M. H. N. Islamsyah ^{1*}, R. N. Sari ²

^{1,2} Program Studi Teknik Industri Fakultas Teknik dan Sains Universitas Pembangunan Nasional “Veteran” Jawa Timur
21032010039@student.upnjatim.ac.id ^{1*}, rizqi.novita.ti@upnjatim.ac.id ^{2*}

Abstract

The identification of work accidents in the steel plate production process poses a serious risk to workers and disrupts operational activities. This research analyzes the factors causing work accidents at PT XYZ in the steel plate production process using the Fault Tree Analysis (FTA) method and the Plan-Do-Check-Act (PDCA) method. FTA is applied to identify and decipher the root causes of accidents, while PDCA serves as a framework for continuous improvement. Data were collected through accident reports, observations. The results showed that human error, including being pinched by a plate, hit by a ganco, and exposed to sparks were the main contributors to the occurrence of accidents. Through the PDCA cycle, several preventive measures were proposed, including enhancing worker training, improving equipment maintenance, and strengthening safety protocols. This study provides actionable insights to improve workplace safety and reduce the risk of accidents in the steel plate production process.

Keywords: Use about five key words or phrases in alphabetical order, Separated by Semicolon

1. Introduction

Work accidents are one of the main challenges faced by the manufacturing industry, including in the steel plate production process [7]. Steel plate production is a process that involves high-pressure machinery and heavy equipment, so it has the potential to cause accident risks if not properly anticipated. Based on data from the Ministry of Manpower, the number of work accident cases in Indonesia in the period January to May 2024 was recorded at 162,327 cases, the manufacturing sector has a high number of work accidents, where human factors, machine conditions, and unsafe work environments are the main causes of these incidents [6]. As the need for productivity and efficiency increases, work safety factors are often neglected, which can actually result in fatal accidents, serious injuries, and even death [8]. This condition requires companies to pay more attention to risk management. Observations at the company show that several work accidents that often occur include being pinched by plates, hit by ganco, and exposed to sparks. These accidents are potentially serious and require quick handling to avoid financial and non-financial losses, to overcome these problems, it is necessary to analyze work accident prevention actions, one of which is through the application of the Fault Tree Analysis (FTA) and PDCA (Plan-Do-Check-Act) methods.

It is common to identify the main causes of accidents by hazard identification by constructing a fault tree diagram with the FTA method. This method helps to outline the various causes of work accidents that may occur during the steel plate production process, such as equipment failure, operator negligence, or inadequate environmental conditions. With in-depth analysis using the FTA method, root causes can be identified, so that more effective preventive measures can be taken [3].

After analyzing the sources of problems on the production line, of course, it requires system improvement using the PDCA method which focuses on continuous improvement through four stages, namely planning (plan), implementation (do), inspection (check), and corrective action (act) [10]. In the context of occupational safety, PDCA helps companies implement structured and continuous safety measures, and ensures that any accident prevention measures are based on careful evaluation. By combining these two methods, companies are expected to be able to prevent workplace accidents more systematically, both from a technical and managerial perspective.

This article will discuss how analysis using the FTA method will identify potential risk factors causing accidents that often occur at pt xyz, and improvement using the PDCA method will be a framework for implementing and evaluating preventive actions. The application of these two methods is expected to improve work safety, reduce accident rates, and create a safer and more productive work environment in the steel plate production sector [11].

2. RESEARCH METHODS

Data collection in the study was carried out from work accident reports, and observations to find out some work accidents that often occur in the production process. The data customized is the last 3 years of data from 2021-2023. Accident reports provide historical data on the

frequency, type, and cause of work accidents, while observations provide insight into current safety practices and machine operations. Observations are conducted to collect detailed information on safety culture, equipment handling, and employee perceptions of workplace risks [9]. The variables to be used include independent variables and dependent variables, for the dependent variable itself contains the number of work accidents, for the independent variable contains the condition of machinery and equipment, the work environment, human factors, and work processes. The data processing stage uses the FTA and PDCA methods, for FTA itself functions to systematically analyze the root causes of work accidents by developing a fault tree of a process, this research decomposes the main accident events into several layers of causal factors, which include human error, equipment failure, environmental conditions, and procedural deviations [1]. Each factor is further analyzed to determine its likelihood and impact on workplace accidents. Meanwhile, the PDCA method itself is applied as a framework for continuous improvement. Based on the FTA results, specific corrective actions are designed in the Plan phase. These actions are implemented in the Do phase, with regular monitoring of their effectiveness in the Check phase. Adjustments and refinements are made in the Act phase to ensure continuous improvement in workplace safety [4]. The following are the problem-solving steps:

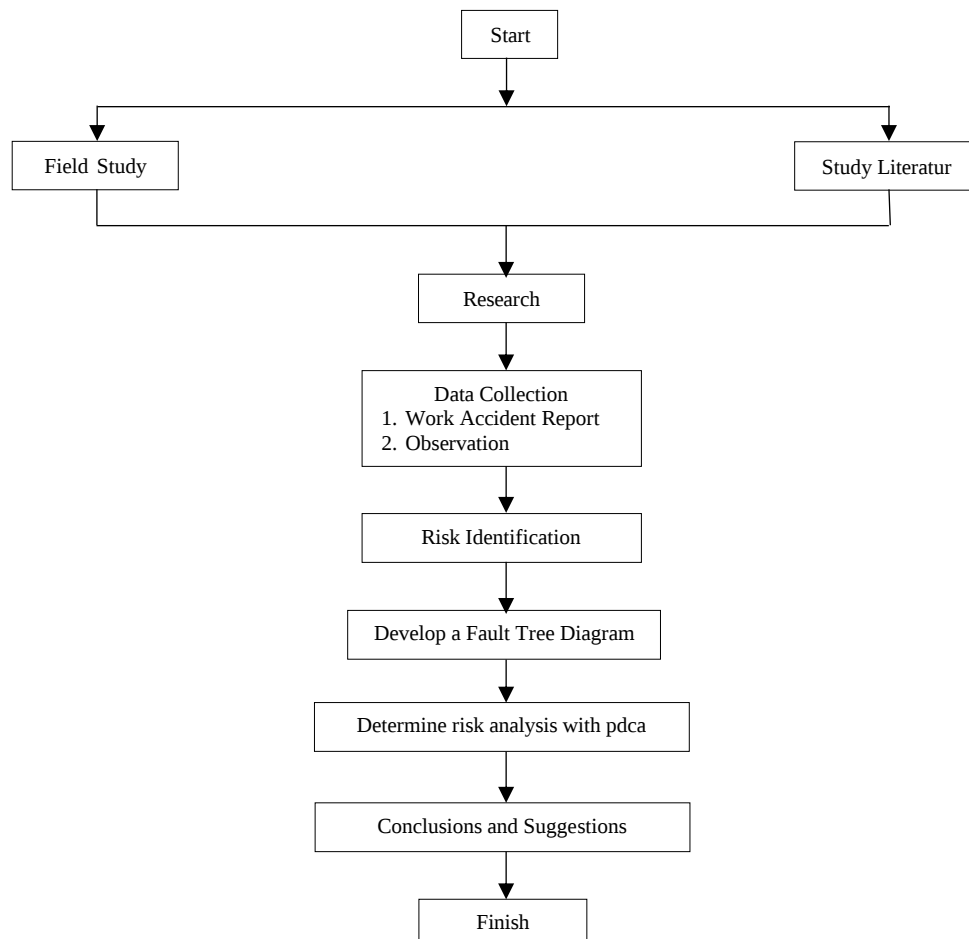


Fig. 1: Flowchart

From the results of the analysis that has been carried out, the next step is data collection through observation and interviews to obtain the results of hazard identification in the plate production process. The observed processes include slab cutting, plate transportation, and the risk of hitting the ganco. Slab cutting is the process of cutting slab raw materials which are then measured according to production specifications to be processed into plate sheets. Plate transportation involves moving the finished plates from the finishing area to be arranged in the warehouse according to the plate type and code. As for the risk of hitting the ganco, the ganco is a tool used to hold the plate connected to the crane to facilitate the process of moving the plate. The results after hazard identification in the plate production process can be seen in Table 1.

Table 1: Hazard identification results of the plate production process

Risk	Factors	Details	Activity Process
Pinched plate	Material	Plate wedge is too deep	Tilted load
		Ganco on crane is not up enough.	Tilted ganco
	Human	Miscommunication between crane operator and worker	Fatigue
		Lack of caution	Lack of attention to surrounding conditions
Bumped by ganco	Environment		Noise
	Equipment		Unstable movement
	Human	Careless operator	Rushing
		Lack of focus	Fatigue
Exposure to sparks	Environment	Obstructed view (stack of plates)	Limited movement space
	Engine	Lack of maintance	Overheat
	Human	Fatigue	Negligent use of

	Incorrect operation	Negligent use of PPE
		Stress
Environment	Unsafe	Hot ambient temperature

3. Results and Discussion

The purpose of determining the causal factors of this accident is to facilitate the preparation of the structure on the FTA (Fault Tree Analysis) chart. structure on the FTA (Fault Tree Analysis) chart. In addition, we can also know the sequence of work accidents systematically based on the factor data that has been summarized.

3.1. Risk Assessment

The following risk assessment results on the plate production process are shown in Table 2.

Table 2: Risk assessment results on plate production

Risk	Factors	Details	Activity Process	Risk Assesment		
				L	C	RR
Pinched plate	Material	Plate wedge is too deep	Tilted load	2	4	Medium
		Ganco on crane is not up enough.	Tilted ganco	3	2	Medium
	Human	Miscommunication between crane operator and worker	Fatigue	3	1	Low
		Lack of caution	Lack of attention to surrounding conditions	1	1	Low
			Noise	5	2	High
Bumped by ganco	Environment		Unstable movement	5	4	Extrem
	Equipment		Rushing	2	2	Low
	Human	Careless operator	Fatigue	3	2	Medium
		Lack of focus		5	4	Extrem
	Environment	Obstructed view (stack of plates)	Limited movement space	5	4	Extrem
Exposure to sparks	Engine	Lack of maintance	Overheat	3	2	Medium
	Human	Fatugue	Negligent use of	2	1	Low
		Incorrect operation	Negligent use of PPE	2	4	Medium
			Stress	2	1	Low
	Environment	Unsafe	Hot ambient temperature	5	2	High

Based on table 2, the data on the causes of the above accidents were obtained from report data, field observations made by researchers [5]. The results of the calculation of the risk matrix of the level of possibility obtained the biggest result is in hitting the ganco, then the next step will be described in the form of an FTA graph in Figure 2 below:

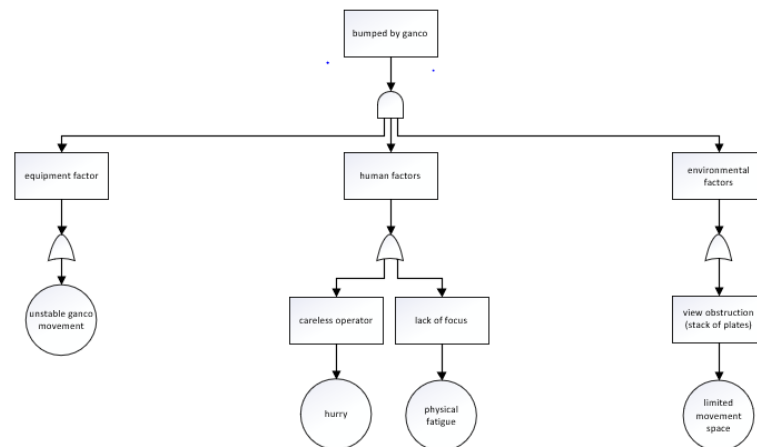


Fig. 2: Fault tree analysis (FTA) chart of the case of hitting the ganco

FTA analysis results:

There are three factors that cause work accidents, namely equipment factors, human factors, and environmental factors [2]. In the equipment factor, the main cause is the unstable movement of the ganco. This occurs because during use, one side of the ganco is on the workpiece while the other side hangs freely, causing uncontrolled movement of the ganco. For human factors, the cause is operator negligence due to haste. When workers place the ganco, they must always pay attention to the direction in which the ganco is moving, as the ganco is directly connected to the crane hook which has a 360-degree rotation. In addition, lack of focus due to physical fatigue is also a factor, where workers need to always coordinate with the crane operator to avoid miscommunication. As for environmental factors, the main obstacle is the limited view due to the narrow space for movement. This is due to the large pile of plates and the lack of space available during ganco operations to lift or move plates.

Entire document should be in Times New Roman. The font sizes to be used are specified in Table 1.

3.2. PDCA Analysis

3.2.1 Plan

Table 3: Plan about the factors of hitting the ganco

Equipment factor	Human factors	Environmental factors
Regular checks are carried out to ensure the condition and position of the ganco remains stable during use. Operators are also trained on the correct technique of using the ganco, so that they can maintain their balance when moving objects. Safer operating procedures are also implemented, including standards to ensure the ganco is in a stable position before use.	Work schedules are reviewed to ensure workers have adequate rest periods, reducing the risk of overexertion. Safety training was provided so that workers understood the importance of being careful and not rushing through work. Additional procedures to increase vigilance were also introduced, so that operators are more careful in placing the ganco.	Ganco's operating area was expanded to provide more space for operators, allowing them to work more safely and freely.

3.3.2 Do

Table 4: Do about the factors of hitting the ganco

Equipment factors	Human factor	Environmental factors
Operators or maintenance teams regularly check the condition of the ganco to ensure the equipment remains in good condition and stable during use. Operators also receive detailed technical training on the use of the ganco, including how to maintain balance and proper positioning during work. In addition, new safer operating procedures have been socialized to all workers using the ganco, with special emphasis on stability and safety during operation.	Work schedules are rearranged to ensure workers have adequate rest periods, keeping them fresh and focused at work. Safety training is provided to raise operators' awareness of the risk of accidents that may occur due to fatigue or rushing. In addition, supervisors are asked to be more vigilant in noticing signs of fatigue or rushing in workers, and provide additional breaks or reprimands where necessary.	Work areas are demarcated, so workers have adequate space and are free from distractions. This allows workers to work more freely and feel safer in carrying out their duties.

3.3.3 Check

Table 5: Check about the factors of hitting the ganco

Equipment factor	Human factors	Environmental factors
Incident monitoring is carried out by evaluating work accident data to see if there is a decrease in incidents related to unstable ganco movement. Direct observation was also applied by monitoring whether operators were following the procedures correctly and ensuring that the ganco was in a stable position when in use. Feedback from operators was collected to assess the comfort and ease of the new procedures, as well as the effectiveness of the training provided.	Observations are made to monitor whether human factor accidents are reduced following schedule adjustments and training. Worker satisfaction is also surveyed through their feedback, to find out if the changes implemented make them feel safer and less rushed. Direct supervision from supervisors is conducted to ensure workers adhere to safety procedures and exercise caution during operations.	Direct observation by supervisors checks whether the new arrangement of the work area gives operators a clearer view and more space to move around. In addition, the frequency of accidents was checked to see if there was a decrease in incidents caused by obstructed vision or limited space. Feedback from operators was collected to assess the comfort and safety of the work environment after the changes were implemented.

3.3.4 Act

Table 6: Action about the factors of hitting the ganco

Equipment factor	The human factor	Environmental factors
New safety procedures are permanently implemented and become part of company standards. If the ganco is still unstable, options to repair or replace the equipment are considered. Training is also organized regularly to ensure operators understand the correct and consistent use of the ganco.	Customized work schedules and training are formalized as a permanent policy, along with ongoing training to keep workers focused on safety. Incentives are also given to workers who maintain safety standards in their work, and if there is a need for further improvement, the schedule or training will be updated.	Infrastructure upgrades are continuous, with work areas expanded where necessary to ensure adequate space. Operators provide regular feedback, and work area layouts are adjusted when necessary to ensure comfort and safety in operations.

4. Conclusion

Based on the results of the calculation of the risk matrix, there are 3 criteria for work accidents, it is obtained that the work that has the greatest risk is hitting the ganco, then risk analysis is carried out using the FTA method and improvements are made to each factor with the PDCA method, obtained from the equipment factor, consisting of ganco instability that occurs due to its unbalanced position, so it is necessary to implement safer use procedures and periodic checks. Then the human factor includes operators who are less careful and experience fatigue, who often work in a hurry and lose focus. To reduce this risk, it is necessary to adjust work schedules, safety training, and stricter supervision. As for environmental factors, the limited space for movement and the view obstructed by the stack of plates

interfere with the visibility and flexibility of operators while working. Reorganizing the layout of the work area, adding lighting, and marking safe areas are the main steps to overcome these environmental constraints.

Through the application of PDCA to each factor, improvements were made in stages - from planning, to implementation, to inspection, to follow-up actions. The evaluation showed that each stage brought positive results in reducing ganco collision accidents. In conclusion, by combining FTA analysis to identify the causes of accidents and the PDCA approach for improvement, the risk of accidents can be minimized through continuous improvement efforts in the aspects of equipment, workforce management, and work environment arrangements.

5. Acknowledgement

The author would like to take this opportunity to express his deepest gratitude for the completion of this journal writing. My deepest gratitude goes to my supervisors who have provided valuable direction, support, and guidance throughout the process of writing this journal. My gratitude also goes to the person in charge of the field for the opportunity and valuable information provided, so that this research can be carried out properly.

I also greatly appreciate the help and input from friends who have provided constructive suggestions, thus enriching and improving the content of this journal. The support and motivation from all parties has been a driving force for me to complete this journal as well as possible. Hopefully this work can provide benefits for readers and contribute to the development of science. Thank you.

References

- [1] Fauziah, S. R., & Renosori, P. Identifikasi penyebab terjadinya kecacatan pada produk induktor toroidal dengan menggunakan metode fault tree analysis (FTA) di CV. Cipta Karya Mandiri. In *Bandung Conference Series: Industrial Engineering Science* (Vol. 2, No. 1, pp. 91-99), 2022
- [2] Isniah, S., Purba, H. H., & Debora, F. Plan do check action (PDCA) method: literature review and research issues. *Jurnal Sistem dan Manajemen Industri*, 4(1), 72-81, 2020
- [3] Kusnendar, A. R., & Herwanto, D. Analisis penerapan keselamatan dan kesehatan kerja (k3) dengan metode fault tree analysis (fta) guna meningkatkan produktivitas kerja di pt. Ciptaunggul karya abadi. *Jurnal Ilmiah Wahana Pendidikan*, 8(11), 365-378, 2022
- [4] Maulana, M. R., Fatmawati, W., & Bernadhi, B. D. Analisis pengendalian kualitas produk cacat dengan metode plan, do, check, action (pdca). *Jurnal Logistica*, 1(1), 30-38, 2022
- [5] Melani, Y. I., & Mahmud, M. Penilaian resiko pada sistem monitoring kegiatan belajar mengajar di perguruan tinggi swasta. *JURTEKSI (Jurnal Teknologi dan Sistem Informasi)*, 7(1), 23-32, 2020
- [6] Nuryono, A., Kurnia, H., Tambunan, E. B., & Wiyatno, T. N. Analisis kinerja keselamatan dan kesehatan kerja (k3) pada proses produksi saus dengan metode fault tree analysis. *J. Ilm. Tek. Ind*, 11(2), 141-154, 2023
- [7] Ramadhan, R. M., & Suseno, A. Analisis pengendalian risiko kecelakaan kerja menggunakan metode hirarc pada area produksi CV. Artana Engineering. *TEKNIKA: Jurnal Ilmiah Bidang Ilmu Rekayasa*, 15(1), 115-130, 2021
- [8] Suhartoko, C., & Mas' ud, M. I. Implementasi k3 dalam meningkatkan produktivitas kerja dengan pendekatan fault tree analysis di PT SA. *Jurnal Ilmiah Teknik Mesin, Elektro dan Komputer*, 1(3), 115-125, 2021
- [9] Syarifuddin, S., Anwar, A., & Indori, P. Analisis kesehatan dan kecelakaan kerja dengan metode fault tree analysis (fta) pada area stasiun pengumpul di pt pertamina ep asset 1 rantau field. *Industrial Engineering Journal*, 9(2), 2020
- [10] Yunan, A., Raya, D., & Rosihan, R. I. Analisis upaya menurunkan cacat produk crank case lh pada proses die casting dengan metode pdca dan fmea di pt. Suzuki indo mobil/motor. *Journal of Industrial and Engineering System*, 1(1), 1-10, 2020
- [11] Yunitasari, E. W. Perbaikan sistem belajar mahasiswa pada mata kuliah statistik industri dengan metode plan do check action (PDCA). *IEJST (Industrial Engineering Journal of The University of Sarjanawiyata Tamansiswa)*, 3(2), 2019