

**RISK MITIGATION OF WORKPLACE ACCIDENTS IN OIL  
PALM PLANTATION USING THE HIRADC AND FTA  
APPROACHES  
(CASE STUDY: PT. XYZ)**

**LAPORAN TUGAS AKHIR**

Diajukan sebagai Salah Satu Syarat Untuk Memperoleh Gelar Sarjana Teknik  
Pada Program Studi Teknik Industri Fakultas Sains dan Teknologi Universitas Islam  
Negeri Sultan Syarif Kasim Riau

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(CASE STUDY: PT. XYZ)**

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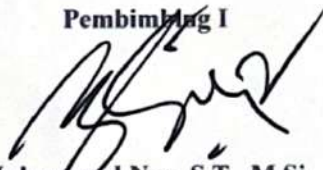
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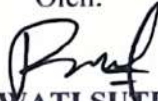


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Segala puji bagi Allah SWT atas segala Rahmat, Karunia serta Hidayah-Nya, sehingga penulis dapat menyelesaikan laporan tugas akhir ini dengan judul “**Risk Mitigation of Workplace Accidents in Oil Palm Plantation Using the HIRADC and FTA (Case Study: PT. XYZ)**”, sesuai dengan waktu yang ditetapkan. Shalawat dan salam semoga terlimpah kepada Nabi Muhammad S.A.W.

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Penulis menyadari dalam penulisan laporan ini masih banyak terdapat kekurangan serta kesalahan, untuk itu penulis mengharapkan adanya masukan berupa kritik maupun saran dari berbagai pihak untuk kesempurnaan laporan ini. Akhirnya penulis mengharapkan semoga laporan ini dapat berguna bagi kita semua.

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# Risk Mitigation of Workplace Accidents in Oil Palm Plantations Using the HIRADC and FTA Approaches (Case Study: PT. XYZ)

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## Abstract

This study addresses the mitigation of occupational accident risks in oil palm plantations using the Hazard Identification, Risk Assessment, and Determining Control (HIRADC) and Fault Tree Analysis (FTA) approaches. A case study was conducted at PT. XYZ with the aim of identifying potential hazards, assessing risk levels, and determining effective control measures to reduce workplace accidents. The HIRADC method was used to identify and assess the risk levels of various work activities in the plantation, while FTA was applied to analyze the root causes of workplace accidents in depth. The results of the study indicate that the main hazards in the plantation include the use of heavy equipment, contact with chemicals, and hazardous environmental conditions. The proposed mitigation measures include safety training, the use of appropriate personal protective equipment (PPE), and enhanced supervision in operational procedures. The implementation of HIRADC and FTA has proven effective in significantly reducing the level of workplace accident risks.

**Keywords:** Risk Mitigation, Workplace Accidents, Oil Palm Plantation, HIRADC, FTA, PT. XYZ.

## 1. Introduction

The oil palm plantation industry plays a crucial role in the national economy, particularly in Indonesia, which is one of the world's leading producers. Despite its significant contribution to national income, this sector also faces serious challenges in terms of occupational safety. Workplace accidents in oil palm plantations can be fatal for workers and cause substantial losses for companies.

Workplace accidents do not occur by chance but are caused by specific factors that need to be investigated and identified. These findings serve as a basis for corrective actions to address the root causes, enabling preventive measures in the future. According to the domino theory, the causes of accidents are classified into two main categories: unsafe acts and unsafe conditions, as well as unsafe interactions between humans and machinery. Modern occupational safety approaches aim to eliminate the root causes of workplace accidents. Unsafe behavior is a major contributor to workplace accidents, accounting for 80-85% of cases due to human factors. Therefore, improving human behavior in the workplace is essential to reducing or even preventing workplace accidents, in addition to implementing mechanical techniques and ensuring a safe working environment (Rini et al., 2021).

PT. XYZ holds a land-use permit (HGU) covering 4,235.58 hectares, divided into two regions and four divisions (afdelings). A region is a work area consisting of several divisions, while a division encompasses a work area of approximately 1,000 hectares (flat terrain) or 800 hectares (hilly terrain). PT. XYZ operates as an agribusiness company focusing on oil palm production. The company generates an average daily yield of 2.7 tons per division, making oil palm one of its primary products and operations.

In observations of the working environment in the oil palm plantation section of PT. XYZ, various tools with potential workplace accident risks were identified, including egreks, tojoks, dodos, gancus, machetes, axes, and wheelbarrows. PT. XYZ has yet to implement a Standard Operating

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Procedure (SOP) for Occupational Health and Safety (OHS). The government mandates that all organizations or companies implement an Occupational Health and Safety Management System (SMK3) in accordance with applicable regulations and standards. This requirement aims to enable companies to proactively improve occupational health and safety performance within the workplace, preventing accidents and negative health impacts, including occupational diseases (Purwanto et al., 2021).

Workplace accidents result in worker injuries, disrupting the harvest production process and reducing productivity. Each worker faces varying levels of risk, influenced by non-compliance with company regulations and unsafe working conditions. To minimize these risks, companies should commit to protecting their workers by implementing OHS SOPs.

The function of Standard Operating Procedures (SOPs) includes streamlining work units, serving as a legal basis in case of deviations, clearly identifying obstacles and making them easy to trace, guiding employees to maintain discipline, and providing a framework for carrying out routine tasks (Zubaidah et al., 2023).

**Table 1. Workplace Accident Data for PT. XYZ Plantations (2020–2023)**

Year	Month	Number of Accidents
2020	January – December	39
2021	January – December	24
2022	January – December	35
2023	January – December	27
Total		125

(Source: PT. XYZ, 2024)

Survey results indicate that workplace accident cases at PT. XYZ from 2020 to 2023 involved 125 workers, ranging from minor to severe injuries, with the total number of incidents recorded as 39 cases in 2020, 24 cases in 2021, 35 cases in 2022, and 27 cases in 2023. Workplace accidents in PT. XYZ's oil palm plantations include incidents such as puncture wounds from thorns, being struck by fresh fruit bunches (FFB), being hit by fronds, injuries from egreks, and other types of accidents as detailed in the appendix.

In 2020, the number of workplace accidents at PT. XYZ reached 39 cases but decreased to 24 cases in 2021. However, the number rose again to 35 cases in 2022. Several factors contributed to this increase, including inadequate safety training for workers, a lack of understanding of the proper use of personal protective equipment (PPE), and unsafe work procedures. Unsafe environmental conditions, such as slippery terrain, uneven roads, or landslide-prone areas, also played a role. Additionally, extreme weather conditions, such as heavy rain or strong winds, impacted workplace safety.

One recorded case of a workplace accident at PT. XYZ occurred on August 10, 2023, when a harvester sustained a laceration injury from an axe while clearing oil palm fronds. Immediate first aid was provided by coworkers and the foreman, after which the victim was taken to PT. XYZ's clinic for medical treatment.

The impacts of workplace accidents at PT. XYZ include the inability to meet daily production targets due to a shortage of labor, unachieved tonnage or work quotas, reduced attendance premiums because of absenteeism, and the company needing to hire temporary workers to complete the work left by injured harvesters.

**Table 2. Plantation Production Tonnage at PT. XYZ (2020–2023)**

Year	Target Tonnage Production (Ton)	Tonnage Revenue Production (Ton)	Information
2020	92,496.51	86,021.92	Not Achieved
2021	89,159.56	86,328.00	Not Achieved
2022	90,616.43	95,831.27	Achieved
2023	101,283.90	108,827.43	Achieved

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(Source: PT. XYZ, 2024)

As shown in Table 2, PT. XYZ's production tonnage increased by only 0.36% from 2020 to 2021. This limited growth was influenced by workplace accidents, which were the highest among all recorded cases over the past four years at PT. XYZ.

Several factors contributed to the failure to achieve production tonnage targets, including unmet output, ineffective working hours, extreme weather conditions, labor shortages, and a high rate of workplace accidents. One of the primary causes of these accidents was employees' lack of awareness regarding the importance of Personal Protective Equipment (PPE).

To address these issues comprehensively, detailed mitigation steps are necessary. These steps include identifying hazards, assessing risks, reducing risks, and understanding the root causes of workplace accidents. This approach is grounded in the application of the Hazard Identification Risk Assessment and Determining Control (HIRADC) and Fault Tree Analysis (FTA) methods. The HIRADC method is used to identify potential hazards, evaluate associated risks, and formulate controls to reduce or eliminate these risks. Meanwhile, the FTA method provides a systematic and structured analysis of the fundamental causes of workplace accidents, offering clearer insights into the most effective mitigation measures to implement. By integrating these two methods, it is expected that the primary causes can be identified, and effective preventive measures can be applied to manage workplace accident risks.

Based on this background, a study entitled "Risk Mitigation of Workplace Accidents in Oil Palm Plantations Using the Hazard Identification Risk Assessment and Determining Control (HIRADC) and Fault Tree Analysis (FTA) Approaches at PT. XYZ" is proposed.

## 2. Method

### Research Stages

This study was conducted at PT. XYZ, an oil palm plantation company located in Riau. The research subjects include harvesting and loading employees. The data used in this research span the years 2020–2023. The research stages are as follows:

1. Preliminary study: Identifying issues related to workplace accident risks at PT. XYZ through direct observation of the site.
2. Literature review: Gathering theories related to the research problem or subject.
3. Problem formulation: Formulating problems as questions that the research aims to address.
4. Objective setting: Defining goals to answer the core issues under investigation.
5. Data collection: Gathering data to process, which will significantly impact the overall research results.
6. Data analysis: Analyzing the processed data to gain accurate insights and a comprehensive understanding.
7. Conclusion and recommendations: Drawing conclusions and providing suggestions based on the research findings.

### Data Collection

To produce scientific and accountable research, data plays a crucial role. Therefore, the data collected must be accurate and authentic, not fabricated. Data represents facts or figures, and in this study, data was obtained through various methods to form a concrete dataset ready for processing and testing.

1. Primary Data: Primary data is collected directly by the researcher without intermediaries through observation and interviews. Observation: Conducted by directly observing the objects under study to gather data for processing. Interviews: Conducted by interviewing harvesting employees, loading employees, and division assistants of PT. XYZ to identify potential hazards and workplace accident risks.



**Table 3. Hazard Identification at PT. XYZ**

No	Stages of Work	Work Process	Potential Danger
1	Oil Palm Frond Cutting	Cut the palm fronds before cutting the fruit using axes and machetes	Hit by palm fronds, scratched by palm frond thorns, hit by dodos, hit by machete and axe, eye stabbed by dodos handle
2	Cutting of Oil Palm Fresh Fruit Bunches	Harvesting oil palm fruit by cutting the fruit from the branches using tools such as dodos, tojok, axes and machetes.	Impaled by palm thorns, hit by a sledgehammer, hit by palm oil FFB, palm dust in eyes
3	Transportation of FFB to TPH (Place Pengumpulan Hasil)	Transporting TBS (Fresh Fruit Bunches) using wheelbarrows, motorized vehicles, or manually	Back pain due to overloading, falling and slipping at the market, being stabbed by a palm thorn, foot in a hole
4	Loading of oil palm FFB into dump trucks	The process of loading oil palm FFB from TPH using a tojok into the dump truck body	Hit by a corner, hit by oil palm fruit bunches, eyes hit by oil palm pollen, stabbed by oil palm thorns, caught in the door of a dump truck
5	Unloading of oil palm FFB on a pontoon (barge)	Unloading oil palm FFB and stacking them onto a pontoon (barge)	Impaled by a palm thorn, impaled by a corner

**Risk Assessment**

The next step is to conduct a risk assessment of the potential hazards that have been identified. The following is a risk assessment that can be seen in the table below.

**Table 4. Risk Assessment**

No.	Work activity	Potential danger	L	S	RS	RL
1	Palm Frond Cutting Process	Hit by palm frond	3	3	9	High
		Scratched by palm leaf thorns	4	1	4	Medium
		Hit by a machete and an axe	3	3	9	High
		Hit by dodos	3	3	9	High
		Eyes pierced by dodos handle	3	1	3	Low
2	Cutting of Oil Palm Fresh Fruit Bunches	Impaled by palm thorn	4	2	8	High
		Hit by a egrek	3	3	9	High
		Hit by oil palm fruit bunches	3	3	9	High
		Palm oil powder in eyes	4	1	4	Medium
3	Transportation of TBS to TPH	Back pain	3	1	3	Low
		Fell and slipped at the market	3	1	3	Low
		Feet go into the hole	3	1	3	Low
		Impaled by palm thorn	4	2	8	High
4	Loading of oil palm FFB into dump trucks	Stabbed by a knife and a stick	3	3	9	High
		Hit by oil palm fruit bunches	3	3	9	High
		Palm oil powder in eyes	4	1	4	Medium
		Impaled by palm thorn	4	2	8	High
		Stuck in the dump truck door	3	3	9	High
5	Unloading of oil palm FFB on a pontoon (barge)	Impaled by palm thorn	4	2	8	High
		Hit by a corner and a hook	3	3	9	High

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**Control Measures (Determining Control)**

The identified potential hazards can be managed by first determining a priority scale, which helps in selecting the appropriate risk control measures, known as the hierarchy of risk control. To reduce risks, efforts focus on minimizing the likelihood of hazards occurring and reducing the severity of the consequences resulting from high-risk activities (Cholil, Santoso, Syahrial, Sinulingga, & Nasution, 2020).

Risk control measures are guided by the risk hierarchy according to ISO 45001, which consists of five levels of risk control: Elimination, Substitution, Engineering Controls, Administrative Controls, and Personal Protective Equipment (PPE) (Ihsan, Safitri, & Dharossa, 2020).

**Table 5. Hazard Risk Control for Palm Frond Cutting Process**

No.	Potential Hazard	Hierarchical Control Solutions	Elimination	Substitution	Engineering Controls	Administrative Controls	PPE
1	Falling Palm Fronds	Ensure the work area is clear of fallen palm fronds and use protective equipment for vulnerable body parts.	✗	✗	Installation of automatic barriers to hold falling fronds, such as protective nets or supports.	Work area arrangement and inspection of palm fronds before cutting.	Helmets, body protectors, safety shoes.
2	Hit by Machete or Axe	Ensure machetes and axes are in good condition and used safely.	✗	✗	Use machetes and axes with ergonomic handle designs and sharp edge protectors.	Supervise the use of machetes and axes, and provide clear work instructions.	Protective gloves, safety shoes, leg guards.
3	Scratched by Palm Frond Thorns	Use protective equipment like sturdy gloves that resist thorn penetration.	✗	✗	Install automatic barriers to hold falling fronds, such as protective nets or supports.	Clear division of work areas to avoid injuries while clearing debris.	Protective gloves, body protectors, safety shoes.
4	Hit by Dodos	Use dodos with secure grips and ensure the tool is in good condition.	✗	✗	Redesign dodos with ergonomic grips and additional blade guards to prevent direct contact.	Clear task allocation to avoid crowding or accidents.	Protective gloves, body protectors, safety shoes.
5	Eyes Struck by Dodos Handle	Use dodos with handles equipped with guards or safer handle designs.	✗	✗	Redesign dodos handles with safer materials and ergonomic shapes to reduce eye injury risks.	Supervise and regulate proper tool usage by workers.	Safety goggles, face shields.

**Table 6. Controlling the Risk of Hazards in the Oil Palm FFB Cutting Process**

No.	Potential Hazard	Hierarchical Control Solutions	Elimination	Substitution	Engineering Controls	Administrative Controls	PPE
1	Hit by Falling Oil Palm FFB	Use safety helmets during the harvesting process.	✗	✗	Implement automatic harvesting systems for falling FFBs, such as conveyor systems or catching devices.	Identify hazardous zones and avoid them, ensuring safe walking paths within the plantation.	Safety helmet, body protector, safety shoes.
2	Hit by Egrek	Use egrek with secure grips and ensure the tool is in good condition.	✗	✗	Redesign egrek with ergonomic grips and additional blade guards to prevent direct contact.	Assign clear tasks to avoid crowding or accidents.	Protective gloves, body protector, safety shoes.
3	Eyes Exposed to Palm Dust	Use face shields or safety goggles to protect eyes from palm dust or debris.	✗	✗	Use cutting tools with an automatic dust-catching system or more effective protective devices.	Provide designated cutting areas far from other zones to reduce risks.	Safety goggles.

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4	Pricked by Palm Thorns	Use protective equipment, such as sturdy gloves resistant to thorns.	×	×	Implement automatic harvesting systems for falling FFBs, such as conveyor systems or catching devices to avoid direct contact with thorns.	Use gloves made of materials like synthetic or genuine leather to resist thorn penetration.	Gloves, safety shoes.
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**Table 7. Controlling Hazard Risks in Transporting TBS to TPH**

No.	Potential Hazard	Hierarchical Control Solutions	Elimination	Substitution	Engineering Controls	Administrative Controls	PPE
1	Back Pain	Use transportation tools with appropriate capacity, such as wheelbarrows or larger vehicles.	×	×	Design wheelbarrows or vehicles with automatic load distribution systems for better weight distribution.	Even distribution of loads and supervision to prevent overloading.	Protective back support belt, safety shoes.
2	Slipping in Carrying Path	Use safety shoes with non-slip soles.	×	×	Install wheelbarrows or vehicles with automatic braking systems to prevent shifting when stationary.	Ensure safer paths and carrying areas, with regular inspections of harvest point conditions.	Anti-slip safety shoes, knee protectors.
3	Foot Falling into Ground Hole	Use portable work platforms or cover boards for areas with holes.	×	×	Create movable work platforms for uneven ground areas.	Regular inspections of harvest and carrying areas, and closing off areas with holes.	Safety shoes.
4	Pricked by Palm Thorns	Use protective equipment, such as sturdy gloves resistant to thorns.	×	×	Implement automatic harvesting systems for FFB, such as conveyor belts or catching devices to avoid direct contact with palm thorns.	Use gloves made of synthetic or genuine leather to resist thorn penetration.	Gloves, safety shoes.

**Table 8. Controlling the Risk of Hazards in the Process of Loading Palm Oil Fruit Bunches into Dump Trucks**

No.	Potential Hazard	Hierarchical Control Solutions	Elimination	Substitution	Engineering Controls	Administrative Controls	PPE
1	Pricked by sharp tool	Use safety shoes with steel-toe material.	×	×	Equip tools with automatic protective covers for sharp parts when not in use.	Provide training on proper tool usage and maintenance, and inspect tools before use.	Protective gloves, safety shoes.
2	Hit by falling oil palm FFB	Use safety helmets during the harvesting process.	×	×	Implement an automatic harvesting system for FFB, such as conveyor belts or catching devices.	Identify and avoid hazardous zones, and use safe paths when moving within the plantation.	Safety helmet, body protector, safety shoes.
3	Eyes exposed to palm dust	Use face shields or safety glasses to protect eyes from dust or palm debris.	×	×	Use cutting tools equipped with automatic dust catchers or more effective protective devices.	Provide designated areas for cutting that are distant from other zones to reduce risks.	Safety glasses.
4	Pricked	Use protective	×	×	Use automatic	Use gloves made of	Gloves, safety

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by palm thorns	body equipment, such as durable gloves resistant to thorns.			harvesting systems for FFB, such as conveyor belts or catching devices to avoid direct contact.	synthetic or genuine leather to resist thorn penetration.	shoes.
Pinched by dump truck door	Use safety locks or warning signs.	×	×	Install hydraulic opening systems for truck doors to prevent sudden movements.	Display warnings such as "Caution! Do not stand near the truck door."	Protective gloves, safety shoes.

**Table 9. Controlling the Risk of Hazards in the Process of Unloading Oil Palm Fresh Fruit Bunches on Pontoons (Barges)**

No	Potential Hazard	Hierarchical Control Solutions	Elimination	Substitution	Engineering Controls	Administrative Controls	PPE
1	Pricked by palm thorns	Use protective body equipment, such as durable gloves resistant to thorns.	×	×	Implement an automatic harvesting system for oil palm FFB, such as conveyor belts or catching devices to avoid direct contact with palm thorns.	Use gloves made of synthetic or genuine leather to resist thorn penetration.	Gloves, safety shoes.
2	Pricked by sharp tool	Use safety shoes with steel-toe material.	×	×	Equip tools with automatic protective covers for sharp parts when not in use.	Provide training on proper and safe tool usage, and inspect tools before use.	Protective gloves, safety shoes.

**After Risk Control is Conducted in Each Process**

The next step is to conduct brainstorming sessions to evaluate whether there is a reduction in the risk levels of the identified hazards. Through these sessions, comparisons can be made between the conditions before and after implementing the control solutions. The new risk assessment results show a significant reduction in the risk levels of all identified hazards. When control solutions are effectively applied to each activity, the overall risk level decreases from moderate to low. Similarly, hazards previously categorized as high risk have been reduced to moderate risk levels.

Based on the analysis conducted, seven hazards were identified as high-risk categories. These include: Pricked by palm thorns, Hit by falling palm fronds, Struck by falling oil palm fresh fruit bunches (FFB), Injured by machetes and axes, Pricked by sharp tools (e.g., spikes and gancu hooks), Hit by harvesting tools (e.g., dodos and egrek), and Trapped by dump truck tailgate doors.

These hazards require special attention and effective control measures to reduce the risk levels and ensure worker safety.

**Proposed Risk Control for Workplace Accidents Using the FTA (Fault Tree Analysis) Method**

At this stage, risk control proposals are developed using the Fault Tree Analysis (FTA) method. This method is utilized to identify the root causes of each hazard that could lead to workplace accidents. FTA aids in analyzing the relationships between various causal factors and presents them in a logical tree diagram to determine effective control measures.

- a. Fault Tree Analysis for Pricked by Palm Thorns. In this analysis, various factors contributing to workers being pricked by palm thorns are identified, including tool conditions, work methods, and the work environment. These factors are analyzed to design effective control measures.

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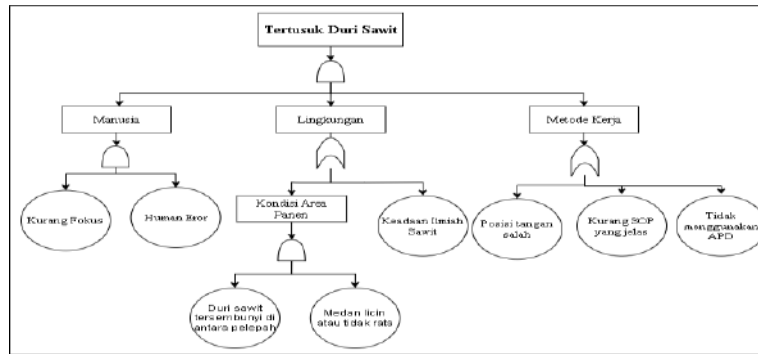


Figure 1. Fault Tree Analysis for Pricked by Palm Thorns

b. Fault Tree Analysis for Being Hit by Palm Fronds

This analysis aims to identify the root causes of workers being struck by palm fronds, focusing on safety factors during the cutting and felling of fronds, as well as workers' awareness of surrounding risks.

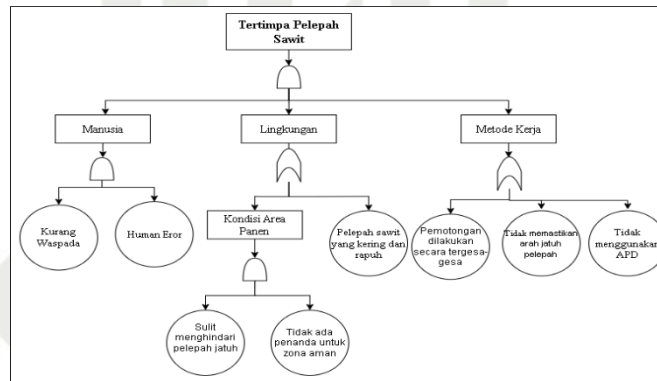


Figure 2. Fault Tree Analysis for Being Struck by Palm Fronds

c. Fault Tree Analysis for Being Struck by Palm Oil Fruit Bunches (FFB)

Through this analysis, the main causes of workers being struck by FFBs are mapped, ranging from transportation techniques to work positioning arrangements, in order to significantly reduce this risk.

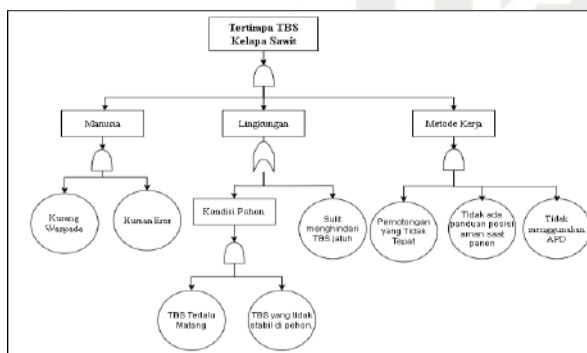


Figure 3. Fault Tree Analysis for Being Struck by Palm Oil Fruit Bunches (FFB)

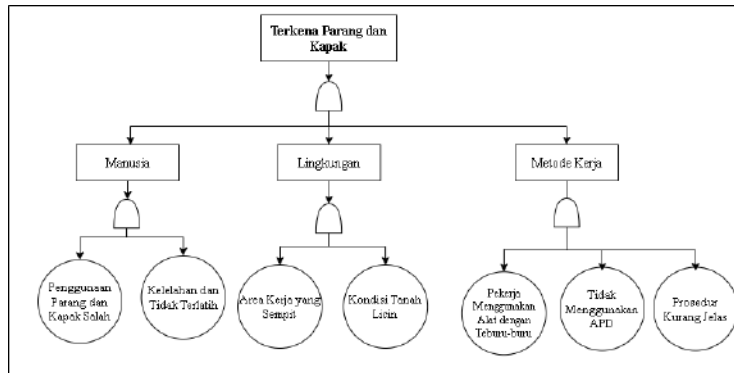
d. Fault Tree Analysis for Injury from Machetes and Axes

This analysis aims to identify the root causes of accidents caused by the use of machetes and axes in the workplace, as well as to pinpoint factors that increase the risk of injury to workers.

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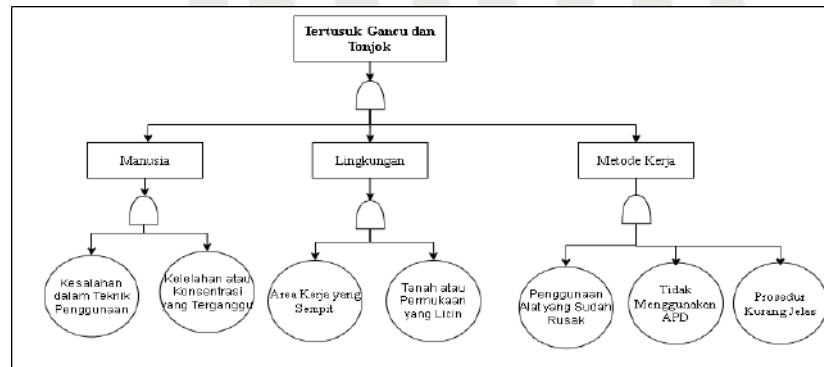
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**Figure 4. Fault Tree Analysis for Injury from Machetes and Axes**

**e. Fault Tree Analysis for Puncture from Tojok and Gancu**

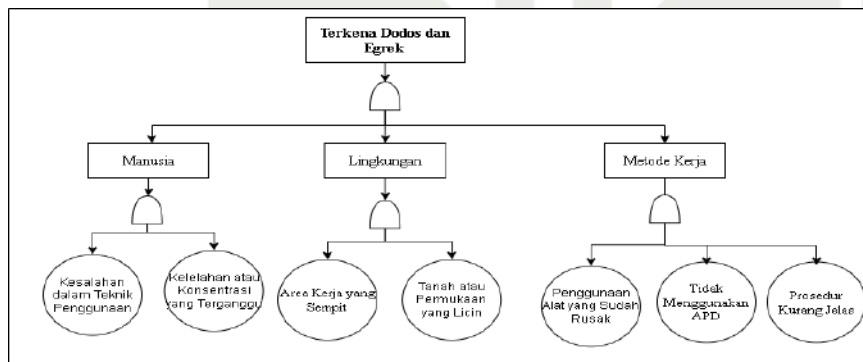
This analysis aims to identify the root causes of accidents caused by punctures from the tojok or gancu, as well as to evaluate the factors that contribute to injuries among workers when using these tools.



**Figure 5. Fault Tree Analysis for Puncture from Tojok and Gancu**

**f. Fault Tree Analysis for Injury from Dodos and Egrek**

This analysis aims to identify the root causes of accidents resulting from injuries caused by dodos and egrek, as well as to find the underlying causes of injury risks in the use of these tools in the field.



**Figure 6. Fault Tree Analysis for Injury from Dodos and Egrek**

**g. Fault Tree Analysis for Pinched by Dump Truck Tailgate**

This analysis aims to identify the root causes of accidents caused by workers being pinched by the dump truck tailgate, as well as to identify preventive measures that can be applied to reduce the risk of injury.

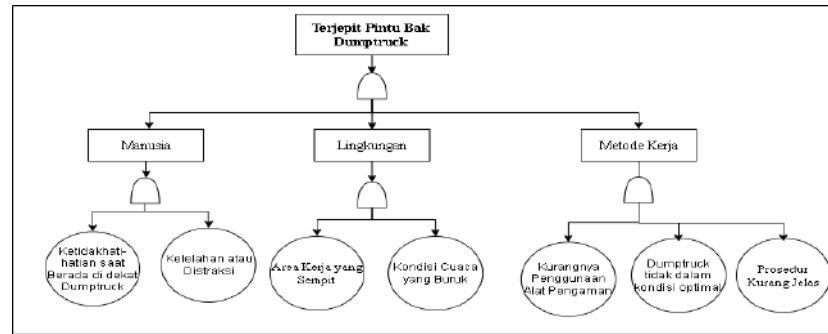


Figure 7. Fault Tree Analysis Trapped in Dump Truck Door

#### 4 Conclusion

Based on the research conducted, the following conclusions can be drawn:

##### 1. Risk Assessment Findings Using the HIRADC Approach:

Seven potential workplace hazards were identified in the palm oil plantation of PT. XYZ, classified as high-risk. These hazards include injury from palm thorn punctures, falling palm fronds, falling Fresh Fruit Bunches (FFB), being struck by machetes and axes, punctured by tojok and gancu, injuries from dodos and egrek, and being pinched by the dump truck tailgate. The following are proposed improvements that can be implemented to reduce or eliminate these hazards:

##### a. Palm Thorn Puncture:

To reduce the risk of palm thorn punctures, it is essential to ensure that all workers use adequate personal protective equipment (PPE), such as thorn-resistant gloves. Regular training on proper PPE use is also necessary to ensure workers understand the importance of using PPE effectively.

Human error and lack of focus are major contributors to this risk. Therefore, the company should conduct comprehensive training for workers, which should include information on the dangers of palm thorns, safe work practices, and correct PPE usage. This training should be conducted regularly, at least once a month. Additionally, implementing a work rotation system can help reduce fatigue, which contributes to decreased concentration. Daily supervision by field supervisors should also be conducted to provide direct feedback on unsafe work practices. The condition of the harvest area, such as hidden thorns among fronds, slippery terrain, and palm tree condition, requires intervention through workplace maintenance. Preventive actions include regular cleaning of pruned palm fronds to reduce the risk of workers unintentionally touching hidden thorns. Furthermore, harvest paths should be leveled and anti-slip materials used, particularly in high-sloped areas, to reduce the risk of slipping. Simple sensing tools, such as lightweight thorn detection sticks, can help workers identify potentially hazardous areas before transporting palm fruit bunches.

A clear and standardized SOP must be designed and implemented for all processes in the palm plantation. This SOP should cover how to transport fruit bunches, proper hand positions when using tools, and correct use of tools like tojok and egrek. SOP documentation should be published in work areas in the form of visual guides that are easy for all workers to understand. Additionally, periodic evaluations of SOP implementation are required to ensure that field practices align with the established procedures. Work scenario simulations focusing on safe body and hand positions should also be incorporated into regular training.

Using PPE, such as Kevlar gloves and anti-slip boots, should be mandatory for all field workers. To improve compliance, the company can provide high-quality PPE for free and ensure an adequate supply. Additionally, regular inspections and maintenance of tools like tojok and egrek should be part of the safety management program. Broken or dull tools must be repaired or replaced immediately to prevent accidents from using faulty equipment. As an additional measure, innovations such as polymer transport containers can be implemented to minimize direct contact with palm thorns. These containers should be designed ergonomically to facilitate safe transport without compromising worker safety.

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b. **Falling Palm Fronds:**

To address the risk of falling palm fronds, it is crucial to improve safe cutting techniques in accordance with established procedures. Training workers on proper cutting techniques will help prevent this hazard. Additionally, regular monitoring of the work environment is necessary to ensure that the work area is free from hazards like falling palm fronds. Lack of worker awareness during harvesting activities is a major cause of accidents involving falling palm fronds. Therefore, the company should hold routine training to increase awareness of this danger. The training should include lessons on environmental observation techniques, identifying hazard zones, and safety procedures before cutting fronds. Scenario simulations of falling fronds can be conducted to train workers in quickly avoiding dangerous situations. Moreover, implementing a communication system using voice or visual signals among workers will help improve coordination, especially when cutting fronds.

A work area without a clearly marked safe zone poses a significant risk. To address this, the company must implement a system of marking work zones using safety tape or visible signs. Before cutting begins, workers must mark the area where fronds will fall within a certain radius to ensure no other workers are in that area. Furthermore, the work environment should be periodically organized to avoid piling up dry fronds, which could create additional hazards like slipping or increasing the workload during removal. This organizing should be supervised by personnel qualified in safety management.

Cutting techniques that do not consider the direction of falling fronds are a primary cause of accidents. Therefore, the company should develop and socialize an SOP for safe cutting techniques. The SOP should explain the optimal cutting angles to ensure the fronds fall in a controlled manner and do not harm workers. Additionally, using tools such as frond hooks or supports can help direct the fronds to a safe location. These tools also enhance worker control over the direction of the falling fronds, especially when working with tall or hard-to-reach trees. Regular inspections of these tools should be conducted to ensure their functionality. Appropriate PPE, such as safety helmets and anti-slip boots, must be applied to all workers involved in harvesting. The company must ensure that sufficient PPE is available and that workers wear it at all times while working. Additionally, field supervision by safety officers should be enhanced to ensure compliance with SOPs and PPE usage. This supervision will also provide direct evaluations of the implementation of taught cutting techniques and correct unsafe practices. Periodic evaluations of the effectiveness of these measures should be conducted to ensure continuous improvement in workplace safety.

c. **Falling Fresh Fruit Bunches (FFB):**

To reduce the risk of falling FFB, an improvement is implementing safe FFB transport procedures. The use of appropriate transport equipment, such as trucks or transport vehicles that are strong and stable, can reduce the likelihood of accidents during FFB transportation. Workers should also be trained on safe transport methods, including how to properly load and manage the weight to prevent uncontrolled transportation and accidents.

Intensive safety training should be a priority to prevent accidents caused by inattention or human error. This training should include recognizing signs of overripe or unstable FFB on trees at risk of falling. Workers should also be taught techniques for assessing the environment before starting the harvesting process, ensuring a safe position away from the risk of falling FFB. To enhance awareness, the company can provide a simple alarm system using whistles or visual signals, which workers can use to alert colleagues when FFB is about to be cut. A safe work environment is crucial for reducing the risk of injury. The company should ensure that only FFB with optimal ripeness is harvested to reduce the risk of overripe fruit falling by itself. Regular monitoring of tree conditions should be carried out by dedicated personnel to assess the stability of FFB. Additionally, work paths around harvest areas should be designed to be free from obstacles and equipped with signs indicating safe positions for workers. This step can minimize potential injuries from mispositioning or accidentally being under a tree at risk of falling fruit.



The development and socialization of an SOP for FFB cutting is an important step in preventing accidents. This SOP should include guidelines for safe positions during harvesting, correct cutting techniques to prevent uncontrolled FFB falls, and steps to take if FFB begins to move. Tools such as extended poles with supports or collecting baskets should also be provided to ensure FFB does not fall directly onto the ground or workers. Workers should receive regular training on how to implement these SOPs, and field supervision should be conducted to ensure compliance with the procedures.

Workers are required to use PPE designed to protect from falling FFB. Safety helmets with additional impact-absorbing protection should be standard equipment. Additionally, the company needs to provide transport vehicles with added safety features, such as load restraints made of mesh or strong tarpaulins, to ensure FFB does not fall during transport. Routine inspections of the transport equipment should be conducted to ensure structural integrity. This inspection should also cover transport paths to ensure there are no obstructions or terrain conditions that could increase accident risks.

d. Pinched by Dump Truck Bed Door

To prevent accidents caused by being pinched by a dump truck bed door, the first step is to ensure the presence of a clear Standard Operating Procedure (SOP) regarding the operation of the bed door. Dump truck operators should be trained to open and close the bed door carefully and check for the presence of other workers around the vehicle before continuing their operations. Additionally, the use of communication tools, such as whistles or radios, will help operators coordinate with workers on the ground to avoid accidents.

The first step is to implement safe work procedures for opening and closing the dump truck bed door. It is recommended that this process be carried out by more than one person to ensure proper control and reduce the risk of accidents. Alternatively, the use of automation technology, such as hydraulic systems or automatic hinges, could be a safer solution. This system allows the door to be opened and closed without direct human involvement, thus avoiding the potential for pinching that often occurs due to accidents or lack of coordination.

Workers interacting with the dump truck door must be equipped with appropriate Personal Protective Equipment (PPE). The use of anti-slip safety shoes is crucial to prevent workers from falling or slipping when near the dump truck bed door. Additionally, upper body protection (such as vests or chest protectors) can help reduce the impact of injuries if pinched. This PPE must always be worn by any worker interacting with the dump truck, whether opening or closing the bed door.

Workers must receive specialized training covering safe methods for opening and closing the dump truck bed door and how to act when near a moving door. This training should include the proper techniques for using safety tools and avoiding risky positions when close to the bed door. Additionally, workers need to be educated on the importance of maintaining a safe distance and always adhering to the established safety procedures.

Regular inspections of the dump truck's condition are essential to prevent potential accidents caused by equipment failure. Components related to the opening and closing of the bed door, such as hinges, hydraulic systems, and door locking mechanisms, should be inspected regularly to ensure everything is functioning properly. If damage or wear is found, immediate repairs or replacement of components should be carried out to prevent accidents that could harm workers. The area around the dump truck bed door must be kept clean and free of obstacles or objects that could obstruct the door when it is opened or closed. Before opening the door, ensure that no objects block the door's movement. By maintaining cleanliness and orderliness in the work area, the likelihood of obstacles that could cause the door to malfunction is minimized. Strict supervision is also needed to ensure that all safety procedures are correctly implemented. Supervisors should always monitor dump truck operations to ensure that workers are wearing protective equipment and following safe procedures when interacting with the dump truck bed door. With consistent supervision, the potential for accidents can be reduced, and workplace safety will be better ensured.

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**Author: Nur Rachmawati Sutriono Putri, Muhammad Nur, Suherman, Nazaruddin,  
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