ITEJ June-2025, Volume 10 Nomor 1 Page 132 - 140

ITEJ
Information Technology Engineering Journals
eISSN : 2548-2157

Url : https://syekhnurjati.ac.id/journal/index.php/itej
Email : itej@syekhnurjati.ac.id

Risk Analysis in the Palm Oil Harvesting Process Using the Mix Method and Miles and Hubbermand Data Analysis Techniques (Case Study at PT XYZ South Kalimantan)

Rahyang N. W. Kencana
Faculty of Engineering and Science
UPN "Veteran" East Java
Surabaya, Indonesia
21032010029@student.upnjatim.ac.id

Iriani
Faculty of Engineering and Science
UPN "Veteran" East Java
Surabaya, Indonesia
irianiupn@gmail.com

Abstract – The harvesting process in oil palm plantations is one of the critical stages that greatly affects productivity. PT. XYZ is a business group engaged in various sectors, including agribusiness, financial services, and property. PT XYZ has various subsidiaries operating under the XYZ brand. The company continues to strive to control and mitigate risks in every part of the company, especially in the harvesting process in oil palm plantations. The current problem is the risks that arise in harvesting in oil palm plantations, both from operational risks, environmental risks, and human resource risks can have an impact on productivity. This study aims to determine the level of risk in the harvesting process of oil palm products at PT XYZ South Kalimantan and to find out the proposed improvements that are in accordance with the problems using the mixed method, which combines qualitative and quantitative techniques. The results of the study showed that there were three levels of risk with the highest risk value ranking. First, the risk of work accidents with a risk value of 20 and a high risk level, second, the risk of damage to harvesting equipment with a risk value of 10 and a moderate risk level, and third, the risk of replacing harvesting equipment with a risk value of 10 and a moderate risk level. The third risk is a risk with priority handling. The proposed improvements that are in accordance with the problems are the focus on human control and SOP, control of tools and procedures, and change management.

Keywords – Palm Oil, Mix Method, Harvesting Process, Risk.

I. Introduction

Oil palm as a plant that produces oil and palm kernel is one of the prima donnas of plantation crops that is a source of non-oil and gas foreign exchange for Indonesia. The bright prospects of palm oil commodities in the world vegetable oil trade have encouraged the Indonesian government to encourage the development of oil palm plantation areas. Oil palm has the lowest production costs of all vegetable oils in the global commodity market, and can meet the increasing global demand of 240 million tons in 2050 [1]. Two types of vegetable oil are extracted from oil palm fruit: crude palm oil (CPO) and palm kernel oil (PKO). Palm oil and palm kernel oil are an important part of the global vegetable oil market. Its main uses are as cooking oil and product ingredients, as well as biodiesel [2].

The palm oil industry in Indonesia is very important to the economy, contributing greatly to state revenues, job creation, and exports. The main part of this industry is plantation activities and the production of Fresh Fruit Bunches (FFB), which affect product quality and production

efficiency. PT XYZ, which operates in oil palm plantations, faces various risks in the market. Risks during harvest include climate, human, and operational factors, which can reduce productivity. Oil palm cultivation contains many challenges and complexities that can affect work safety and operational efficiency.

A systematic approach is needed to identify and analyze potential risks that arise during the harvest process. Potential risks are complex and involve many operational aspects during the harvest process. To understand these risks comprehensively, an approach is needed that does not only rely on quantitative data that is numerical and measurable, but also qualitative data that is able to describe the perceptions, experiences, and views of workers in the field. Therefore, this study uses a mixed method to obtain a comprehensive and in-depth picture. The quantitative approach is used to measure the level of risk and frequency of occurrence, while the qualitative approach is used to explore the causal factors and subjective understanding of the actors in the harvest process [3]. The use of this mix method is expected to be able to produce a risk analysis that is not only accurate, but also relevant and applicable in the operational context in the field. By conducting a comprehensive risk analysis, it is hoped that the company can increase the effectiveness of the harvest process, ensure work safety, and maintain the consistency of the quality of the harvest results.

II. Related Works

A. Palm Oil

Palm oil plantations and their processing units are expected to grow rapidly, the advancement of science and technology is very fast along with sophisticated equipment created to simplify and accelerate a production process in palm oil factories, one of which is the palm oil seed breaker Cake Breaker Conveyor which functions to break or separate the core from the shell in the processing of palm oil seeds [4]. The progress of the palm oil industry in Indonesia is developing rapidly. The Palm Oil Entrepreneurs Association reported that CPO exports are expected to continue to grow by 4% - 5% in 2019, although domestic CPO demand is expected to grow with the B20 program which combines fuel with 20% biodiesel [5].

B. Palm Oil Harvest Process

Harvesting done properly can improve the quality of the results, while errors in the harvesting process can reduce the results obtained. Fruit that is harvested too young or too ripe can reduce the quality of the oil produced, which in turn will affect the profitability of production. A common problem in oil palm plantations is the high level of loss during the harvesting process [6]. The manual harvesting technique at PT KSI is carried out using manual tools such as dodos, gancu parang, tojok and angkong. Harvesters use ganju to move FFB from the plate to the angkong and deliver them to the TPH (Results Collection Place). This technique requires skill, precision, and the use of personal protective equipment to maintain safety during the harvesting process. The mechanized harvesting method applied at PT KSI uses mechanical tools to facilitate the process of collecting fresh fruit bunches (FFB). Harvesters are only tasked with cutting and placing FFB on the plate around the tree, then the transporter enters the plantation area to collect the harvested fruit. The name of the transporter tool at PT KSI is gingga. The transporter is controlled by one operator with the help of a tojok force that moves the TBS from the plate to the bin. The tool used has a capacity of 350 kg per bin and uses crawler-type wheels, so it can operate on peat and hilly land. The transporter is capable of moving at a speed of 1.5 to 5 km/hour [7].

C. SOP for the Harvest Process

Basically the number of harvesters and threshers is calculated as 1:1, in the low crop production period the number of threshers can be less than the number of harvesters. Harvesters and threshers are attempted to be permanent employees (SKU). Harvesting equipment used for plants <8 years old uses dodos (age 4-5 years dodos eye width 8 -12.5 cm, age 5 - 8 years dodos eye around 14 cm). Plants aged > 8 years use egrek. Fruit forecasts are needed to determine the

supply of Fresh Fruit Bunches (FFB) in the garden in the future which are used in production planning, harvesting labor needs, transportation, processing plans in the factory [8].

D. Management

Etymologically, management comes from the English word to manage, synonym to hand means to take care of, to control (check), to guide means to lead. While in terms of terminology, the definition of management is the science and art of utilizing human resources and other resources in planning, organizing, implementing, and supervising activities, which are carried out effectively and efficiently by actively involving the role of all members in achieving the specified goals [9].

E. Quality Management

Total Quality Management is also called Integrated Quality Management. TQM is a combination of all management functions, all parts of the organization and all holistic philosophies based on quality, teamwork, productivity and customer satisfaction [10]. Operational management is considered to provide convenience for business actors to design productivity stages, supervise product management stages, and distribute or market the results of products that have been managed until they are received by consumers [11].

F. Risk Management

Effective risk mitigation strategies, such as diversification, hedging, insurance, and contingency development, can reduce the negative impact of identified risks [12]. In order to maintain consumer satisfaction and trust, companies can try to eliminate defective products and maintain their performance. So, to reduce these problems, companies can also implement risk management to find out what risks are identified in their products and processes [13].

G. Risk Analysis

Risk is the possibility of an accident or injury or illness occurring during a certain period of time. The likelihood of this event occurring, and its severity, is determined by the frequency and severity of accidents that have occurred in the past [14]. In the SWIFT work report, there is a risk assessment carried out by calculating the RRN (risk rating number) value. From the results of this RRN calculation, the potential hazards with the highest risk value (high risk) to the lowest risk value (low risk) are known, so that appropriate handling can be carried out to prevent work accidents, and provide suggestions as recommendations for improvement [15].

H. ISO

ISO certification can have a positive impact on performance, finances, quality and customer satisfaction, especially for companies that provide products or services. A quality management system is a basis used by an organization to continuously improve its performance [16]. To achieve ISO 9001 certification, an organization must establish a QMS, document it, implement it, and undergo an audit by a certification body. This certification is valid for three years, subject to annual surveillance audits [17].

I. RPN Theory (Risk Priority Number)

The Risk Priority Number (RPN) method is used to mitigate the risks that occur. Risk priority is determined based on the results of the Risk Priority Number (RPN) value. The RPN value can help decide which risks should be prioritized [18]. After analyzing the existing conditions, calculate the risk priority number (RPN). RPN is determined by three parameters: the severity of the failure impact, the probability of occurrence, and the ease of detection for each failure mode [19]. After determining the Risk Priority Number (RPN) value and proposing solutions as improvement steps. The RPN value is obtained from the multiplication of the Severity (S), Occurrence (O) and Detectability (D) values [20].

J. Qualitative and Quantitative Theory (Mix Method)

The mixed method concurrent embedded method, which combines qualitative and quantitative techniques in unequal proportions, runs in parallel but independently [21]. The primary approach used is qualitative, while the quantitative approach acts as secondary support. The methodological approach adopted in this study is a mixed method, which combines elements of qualitative and quantitative research. The mixed research design chosen is a Sequential Exploratory Design, where the initial phase is carried out with a qualitative approach followed by a quantitative phase at a later stage [22].

Several mixed method designs are formed to explain the differences between quantitative and qualitative phases (or vice versa). Theoretically, the philosophical basis of these two research techniques is different, qualitative and quantitative can be implemented in one complete research framework in mixed methods if first; both methods can be combined but used alternately, second; research methods cannot be combined at the same time, but only data collection techniques can be combined. So several mixed method designs are formed to explain the differences between quantitative and qualitative phases (vice versa) [23].

K. Previous Research

Davide Settembre-Blundo, Rocı´o Gonza´lez-Sa´nchez, Sonia Medina-Salgado, and Fernando E. Garcı´a-Muin˜a. conducted a study entitled Flexibility and Resilience in Corporate Decision Making: A New Sustainability-Based Risk Management System in Uncertain Times. This study aims to develop a new framework that integrates risk management with sustainability management to improve the flexibility and resilience of companies in the face of uncertainty, such as the COVID-19 pandemic. This study uses analytical and empirical methods. With the results of the study, a new conceptual model was built that connects risk management and sustainability through an interpretive approach and is oriented towards long-term sustainability. A multi-level risk matrix (micro, meso, macro) was compiled that contributes to the sustainable development goals (SDGs). The case study shows that; pandemic risk accelerates the emergence of other risks (economic, social, environmental, operational), companies need to adopt a holistic approach to risk and integrate it into business strategy, and the importance of organizational flexibility to deal with sudden crises and build resilience. The proposed framework is able to; link risk analysis with sustainability pillars, helping companies in designing more adaptive and responsive strategies in the future [24].

Olowaseun Oladeji Olaniyi, Olajide Oyebola Omogoroye, Folashade Gloria Olaniyi, Adegbenga Ismaila Alao, and Tunbosun Oyewale Oladoyinbo conducted a study entitled CyberFusion Protocols: Strategic Integration of Enterprise Risk Management, ISO 27001, and Mobile Forensics for Advance Digital Security in the Modern Business Ecosystem. This study aims to examine how the integration of Enterprise Risk Management (ERM), ISO 27001, and mobile forensics can form a cohesive strategy in managing digital security in the modern business environment. Assess the impact of this integration on the organization's ability to identify, assess, and mitigate digital risks more effectively than separate approaches. Determine how the integration can improve information security management practices, including compliance, data protection, and incident response. Evaluate the contribution of integration to improving the effectiveness and efficiency of digital crime investigations, especially in the context of mobile devices. This study uses quantitative methods based on surveys, and Partial Least Squares Structural Equation Modeling (PLS-SEM). With the results of the integration of ERM, ISO 27001, and mobile forensics research significantly; improving the strategic management of organizational digital security, strengthening the ability to identify, assess, and mitigate digital risks, improving compliance, data protection, and incident response effectiveness, improving the efficiency of digital crime investigations, especially those involving mobile devices. All constructs (ERM, ISO, MF, DSM) show; high reliability (*Cronbach's Alpha* dan *Composite Reliability* > 0.90), good convergent and discriminant validity, the relationship between ERM → DSM ($\beta = 0.42$), ISO → DSM ($\beta = 0.38$), MF → DSM ($\beta = 0.45$), all significant ($p < 0.001$) [25].

Marjiatul Maghfiroh, Dira Ernawati, and Nur Rahmawati conducted a study entitled Analysis and Mitigation of Risk in Green Supply Chain Management with Integration of House of Risk and Fuzzy Logic Methods at PT XYZ. This study aims to analyze the risks in Green Supply Chain Management (GSCM) activities at PT XYZ. Identifying the main risk events and causes. Developing risk mitigation strategies using the House of Risk (HOR) method integrated with fuzzy logic, so that PT XYZ can realize a zero waste system more efficiently and environmentally friendly. This study uses the House of Risk (HOR) method. With the results of the study, 18 risk events were found caused by 22 risk agents in green supply chain activities. Based on the Pareto analysis, there are 12 dominant risk agents that contribute 82.68% of the total risk and need to be prioritized. 13 mitigation strategies are designed to address dominant risks, including; utilization of chicken bone waste as an environmentally friendly by-product (highest ranking), daily chsecklist for H_2SO_4 tank inspection, replacement of plastic with food-grade materials and recycled paper, operator training and routine machine maintenance. Mitigation strategies with the highest ETDk are prioritized for implementation because they are the most effective and easiest to do [26].

III. Method

The method used in this study is the mix method. Data collection is carried out qualitatively and quantitatively. Qualitative data collection is carried out through interviews and observations. While quantitative data is obtained from internal data and documents. The collected data will be processed using data analysis techniques based on Miles and Hubbermand to analyze risks in the oil palm harvesting process. So that the causes of the risks are found, then determine the priority risks based on the risk priority number, and provide suggestions for improvements that are in accordance with the problems experienced.

IV. Result and Discussion

Qualitative risk analysis is carried out by identifying potential hazards, causes, and impacts that may arise from each risk in the palm oil harvesting process.

Table 1.
Risk Identification and Analysis

No	Type of Risk	Sources of Risk	Potential Impact
1	Operational risk	• Work accident incidents • Damage to harvesting equipment • Maintenance and replacement of harvesting equipment • Targets and realization of harvest results • Number of fruits left behind • Lost fruit	• Decreased harvest productivity • Delays in transporting FFB to the factory • Financial losses due to wasted time and costs • Decreased quality of FFB due to late harvest • Accumulation of FFB in the field which is at risk of rotting
2	Environmental risk	• Climate change • Pest and disease attacks	• Crop damage that can result in decreased harvest yields • Disruption to the harvest process due to unsafe/unreachable field conditions • Increased land maintenance and repair costs • Total loss of harvest yields in the affected area • Long-term environmental damage that can result in decreased soil fertility
3	Human resource risks	• Lack of workforce competence • Work accidents • Decreased worker productivity • Worker health problems • Violation of work procedures (SOP)	• Harvesting activities are delayed or not optimal • The quality of the harvest decreases (damaged fruit due to incorrect cutting) • Increased costs due to accidents or retraining

No	Type of Risk	Sources of Risk	Potential Impact
		• SOPs and policies that are not fully implemented • High employee turnover	• High absenteeism resulting in reduced efficiency • Non-compliance with SOPs resulting in potential losses and negative audits

Risk is calculated based on the level of likelihood and impact on a scale of 1-5, then entered into a risk matrix. The risk level of a hazard is classified into 3 levels, namely low, medium and high. The low risk level has a risk value between 1-4, the medium risk level has a risk value between 5-12, while the high risk level has a risk value between 15-25 [27].

Table 2.
Risk Matrix

No	Risk	*Likehood* (L)	Impact (I)	Risk Value (R = L x I)	Risk Level
1	Work accidents	4	5	20	High
2	Harvesting equipment damage	5	2	10	Medium
3	Replacement of harvesting equipment	5	2	10	Medium
4	SOP and policies are not running properly	3	3	9	Medium
5	Not in accordance with targets and harvest results	2	4	8	Medium
6	Fruit left behind	3	2	6	Medium
7	Loss of harvest results	3	1	3	Low
8	Harvest failure	1	3	3	Low

Table 3.
Priority Risk Determination

No	Risk	Risk Value	Risk Level
1	Work accidents	20	High
2	Harvesting equipment damage	10	Medium
3	Replacement of harvesting equipment	10	Medium
4	SOP and policies are not running properly	9	Medium
5	Tidak sesuai target dan realisasi hasil panen	8	Medium
6	Fruit left behind	6	Medium
7	Loss of harvest results	3	Low
8	Harvest failure	3	Low

There are 3 priority risks that must be addressed first. The first is the risk of work accidents with a risk value of 20 and a high risk level. The second is the risk of damage to harvesting equipment with a risk value of 10 and a medium risk level. The third is the risk of replacing harvesting equipment with a risk value of 10 and a medium risk level.

Based on the data collection and analysis results that have been carried out, there are 3 priority risks that need to be addressed first so that the impact does not get worse. These risks are the risk of work accidents, damage to harvesting equipment, and replacement of harvesting equipment. The first is the risk of work accidents with an impact that if not handled will cause harvesting activities to be delayed or not optimal, the quality of the harvest results to decrease (damaged fruit due to incorrect cutting), increased costs due to accidents or retraining, high absenteeism rates resulting in decreased efficiency, and non-compliance with SOPs that have the potential for losses and negative audits. The second is the risk of damage to harvesting equipment with an impact that if not handled will cause decreased harvest productivity, delays in transporting FFB to the factory, financial losses due to wasted time and costs, decreased quality of FFB due to late harvesting and accumulation of FFB in the field which is at risk of rotting. The three risks of changing harvesting equipment with impacts if not handled will cause a decrease in harvest efficiency, a decrease in harvest quality, an increase in operational costs, the risk of disruption to the production process in the factory, and loss of productivity.

V. Conclusion

Based on the results and discussion in the previous section. It can be concluded that the level of risk in the palm oil harvesting process at PT XYZ South Kalimantan is as follows, it was found that there are three levels of risk with the highest risk value. Namely the risk of work accidents with a risk value of 20 and a high risk level, the risk of damage to harvesting equipment with a risk value of 10 and a moderate risk level, and the risk of replacing harvesting equipment with a risk value of 10 and a moderate risk level. These three risks are risks with the main priority level of handling.

Furthermore, for the proposed improvements that are in accordance with the problems faced, they are as follows. For the risk of work accidents, namely safe harvest K3 training (simulation), installation of safe position signs, mandatory use of PPE, and re-socialization of harvest SOPs every month. These proposals are included in the focus of human control and SOPs. For the risk of damage to harvesting equipment, namely daily equipment inspection before work, provision of spare equipment, direct damage reporting system to the foreman, equipment maintenance schedule (specifically for dodos and egrek 1x/week). These proposals are included in the focus of equipment and procedure control. For the risk of changing harvesting tools, training and technical socialization of the use of new tools, a 2-week trial evaluation, and gradual procurement starting from the block with the most damage. The proposal is included in the focus of change management.

VI. Acknowledgements

Thank you to all parties involved, directly or indirectly in the completion of this research that cannot be mentioned one by one. Finally, hopefully what the author has obtained and completed can be useful and beneficial for the future. May the blessings and pleasure of Allah SWT always accompany the author.

REFERENCES

[1] R. H. V. Corley, “How Much Palm Oil do we need,” Journal Environmental Science and Policy, vol. 12, no. 2, pp. 134-139, 2009, doi: https://doi.org/10.1016/j.envsci.2008.10.011

[2] U. A. Hanifah, S. I. Nastiti, and I. Andes, “Penerapan Produksi Bersih pada Industri Kelapa Sawit di PT YZ,” Jurnal Teknologi Industri Pertanian, vol. 32, no. 1, pp. 1-11, 2022, doi: https://doi.org/10.24961/j.tek.ind.pert.2022.32.1.1

[3] A. Muhamad, and M. D. Desak, “Strategi Komunikasi Pemasaran Digital dalam Meningkatkan Minat Pariwisata Pulau Pari (Mix Method: Exploratory Sequential Design),” Jurnal Ekonomi dan Manajemen Teknologi (EMT), vol. 6, no. 2, pp. 342-350, 2022, doi: https://doi.org/10.35870/emt.v6i2.689

[4] H. Legisnal, et. al.., “Penerapan Metode Reliability Centered Maintenance (RCM) pada Mesin Cake Breaker Conveyor di Pabrik Kelapa Sawit (PKS),” Jurnal Teknik Industri Terintegrasi, vol. 4, no. 2, pp. 21-28, 2021, doi: https://doi.org/10.31004/jutin.v4i2.3220

[5] S. Rizky, and Sofiyanurriyanti, “Analisis Pengendalian Mutu pada Asam Lemak Bebas Minyak Kelapa Sawit Menggunakan Metode SQC,” Jurnal Teknik Industri, vol. 8, no. 1, pp. 59-66. 2022, doi: 10.55826/tmit.v2i2.71

[6] S. A. Efi, et. al., “Pelatihan Teknis Penentuan Matang Panen Kelapa Sawit untuk Mahasiswa,” Jurnal Deputi : Derma Pengabdian Dosen Perguruan Tinggi, vol. 5, no. 1, pp. 366-373, 2025, doi: 10.54123/deputi.v5i1.402

[7] M. Hermanto, and W. Edi., “Analisis Efisiensi Metode Panen Manual dan Mekanisasi pada Produksi Kelapa Sawit,” Botani : Publikasi Tanaman dan Agribisnis, vol. 2, no. 2, pp. 1-11, 2025, doi: https://doi.org/10.62951/botani.v2i2.288

[8] Agronomy. *SOP for the Harvest Process*, PT XYZ, Jakarta, Indonesia: MCAR, 2012, pp. 1-22.

[9] R. N. Wahida, “Konsepsi Manajemen, Manajemen Mutu dan Manajemen Mutu Pendidikan,” ALACRITY: Journal of Education, vol. 2, no. 1, pp. 26-34, 2022, doi: https://doi.org/10.52121/alacrity.v2i1.53

[10] N. R. Alvi, B. Arrizqah, and E. R. Dyah, "Analisis Total Quality Management (TQM) dalam Meningkatkan Mutu Manufaktur dan Jasa pada PT. Dahana (Persero) Subang," Jurnal Ilmiah Bidang Sosial, Ekonomi, Budaya, Teknologi, dan Pendidikan, vol. 1, no. 12, pp. 2917-2926, 2022, doi: https://doi.org/10.54443/sibatik.v1i12.475

[11] M. Dewi, et. al. "Implementasi Manajemen Operasional Terhadap Penyelesaian Masalah di PT Toyota Motor Manufacturing Indonesia," Jurnal Ilmiah Ekonomi Global Masa Kini, vol. 13, no. 02, pp. 115-124, 2022, doi: https://doi.org/10.36982/jiegmk.v13i2.2566

[12] R. Hayatur, A. Karina, and H. Abdurrazzaq, "Optimalisasi Manajemen Risiko untuk Keberlanjutan Perusahaan Industri di Era Digital," Jurnal Industri, Manajemen, dan Rekayasa Sistem Industri, vol. 3, no. 1, pp. 37-40, 2024, doi: https://doi.org/10.56211/factory.v3i1.559

[13] A. U. Anita, and I. Taufiq, "Analisis Manajemen Risiko dengan Penerapan ISO 31000 pada Proses Machining (Studi Kasus: Perusahaan AB)," Integrasi Jurnal Ilmiah Teknik Industri, vol. 6, no. 2, pp. 42-52. 2021, doi: https://doi.org/10.32502/js.v6i2.3986

[14] A. P. Maulana, W. R. Akhmad, and Hidayat,"Analisis Risiko K3 pada Pekerjaan Fabrikasi Konstruksi di CV. Arfa Putra Karya dengan Metode JSA (Job Safety Analysis)," Jurnal Teknik Industri, vol. 8, no. 2, pp. 314-323, 2022, doi: http://dx.doi.org/10.24014/jti.v8i2.19569

[15] B. A. Muhamad, "Analisis Risiko Keselamatan dan Kesehatan Kerja (K3) pada Pengoperasian Reciprocating Compressor Menggunakan Merode Swift (Structured What If Technique)," Jurnal Teknik Industri, vol. 11, no. 1, pp. 49-58, 2021, doi: https://doi.org/10.36040/industri.v11i1.3413

[16] S. Suardi, A. Fakhruddin, and K. D. Nurika, "Perkembangan Internasional Standard of Organization," Jurnal Ilmiah Universitas Batanghari Jambi, vol. 23, no. 3, pp. 2625-2630, 2023, doi: http://dx.doi.org/10.33087/jiubj.v23i3.3411

[17] Nucleus, *ISO 9001 – Quality Management System*, India, 2022

[18] S. Arsyad, A. P. Bahariandi, and S. Ganda, "Mitigasi Risiko pada Proses Produksi Tahu Menggunakan Pendekatan Metode Failure Mode and Effect Analysis dan Risk Priority Number," Jurnal Surya Teknika, vol. 11, no. 1, pp. 40-45, 2024, doi: https://doi.org/10.37859/jst.v11i1.7084

[19] S. D. Ratna, et. al. "The Implementation of Operational Risk Management for Reducing the Risk Priority Number in the Metalworking Company," Jurnal Teknik Industri, vol. 14, no. 3, pp. 130-139, 2024, doi: https://doi.org/10.25105/jti.v14i3.21404

[20] M. A. F. Kemas, "Menghilangkan Keluhan Pelanggan dengan Menggunakan Teknik POKA-YOKE Sederhana Berbiaya Murah," Jurnal Teknik Industri, vol. 17, no. 3, pp. 168-173, 2022, doi: https://doi.org/10.14710/jati.17.3.168-173

[21] M. Darwin, et. al, *Metode Penelitian Pendekatan Kuantitatif*, Media Sains: Indonesia, 2021

[22] Dahmiri, K. Idham, and O. Auliza, "Optimalisasi Strategi Pengembangan Industri Kecil Menengah Kreatif dengan Model Quintuple Helix Terintegrasi Teknologi Digital untuk Penguatan Smart City Berkelanjutan," Jurnal Manajemen Terapan dan Keuangan, vol. 13, no. 4, pp. 1229-1241, 2024, doi: https://doi.org/10.22437/jmk.v13i04.37128

[23] A. Muhamad, and M. D. Desak, "Strategi Komunikasi Pemasaran Digital dalam Meningkatkan Minat Pariwisata Pulau Pari (Mix Method: Exploratory Sequential Design)," Jurnal Ekonomi dan Manajemen Teknologi (EMT), vol. 6, no. 2, pp. 342-350, 2022, doi: 10.35870/emt.v6i2.689

[24] S. B. Davide, et. al., "Flexibility and Resilience in Corporate Decision Making: A New Sustainability-Based Risk Management System in Uncertain Times," Global Journal of Flexible Systems Management, vol. 22, no. 2, pp. 107-132, 2021, doi: https://doi.org/10.1007/s40171-021-00277-7

[25] O. O. Oluwaseum, et. al., "CyberFusion Protocols: Strategic Integration of Interprise Risk Management, ISO 27001, and Mobile Forensics for Advance Digital Security in the

Modern Business Ecosystem," Journal of Engineering Research and Reports, vol. 26, no. 6, pp. 31-49, 2024, doi: 10.9734/jerr/2024/v26i61160

[26] M. Marjiatul, E. Dira, and R. Nur, "Analisis dan Mitigasi Risiko pada Green Supply Chain Management dengan Integrasi Metode House of Risk dan Fuzzy Logic di PT XYZ," Jurnal Integrasi Sistem Industri, vol. 12, no. 1, pp. 1-12, 2025, doi: https://doi.org/10.24853/jisi.12.1.1-12

[27] M. K. Fajar, D. F. Lina, and A. P. Theresia, "Analisis Risiko Kecelakaan Kerja dengan Metode HIRARC (Studi Kasus: CV. Jaya Makmur, Samarinda)," Jurnal Ilmiah Teknik Industri dan Informasi, vol. 10, no. 2, pp. 66-74, 2022, doi: 10.31001/tekinfo.v10i2.1329