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IMPLEMENTATION OF THE PDCA-EIGHT STEPS STRATEGY IN HANDLING MISRUN DEFECTS IN HATCHBACK GASOLINE CAR PISTON CASTINGS AT PT XYZ

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Abstract
This study aims to analyze and implement corrective actions for misrun defects in the casting process of gasoline pistons for hatchback-type vehicles at PT XYZ. During 2024, the company produced approximately 45,000 piston units monthly, with misrun defects accounting for 52.56% of total defects the highest defect category. Specifically, gasoline piston type X contributed 9.84% to the overall misrun rate, significantly impacting production efficiency and material waste. To address this issue, the PDCA (Plan, Do, Check, Action) method was systematically applied using the Eight Steps approach. Root cause identification was conducted through fishbone diagram analysis and 5 Why methodology, revealing issues in mold ventilation, cooling processes, and gas flow direction. The implemented solutions included: (1) addition of extra gas vents on the mold, (2) repositioning of gas vents on the flip core, (3) introduction of a standard operating procedure (SOP) for cooling mold inspection, and (4) modification of the argon gas spray direction. Following these improvements, the misrun defect rate decreased to 5.16%, achieving a reduction effectiveness of 47.5%, which exceeded the company's target of 40%. These results demonstrate that the PDCA method with the Eight Steps approach is effective in reducing defect rates and improving product quality in piston casting processes. Practically, this research provides a replicable framework for defect reduction in precision casting industries, while theoretically, it validates the integration of PDCA with structured problem-solving tools in manufacturing contexts. The reduction translates to decreased material costs, improved delivery schedules, and enhanced customer satisfaction

Keywords: Misrun Defect, Metal Casting, PDCA Cycle, Eight-Step Approach, Quality Improvement.

INTRODUCTION

The growth of the automotive industry in Indonesia has driven an increase in demand for motor vehicles, particularly hatchback cars, which are popular due to their compact and efficient design. One of the important components in a vehicle is the piston, which functions as a receiver of combustion pressure and plays a role in the power transmission system from the combustion process to the motion mechanism. PT XYZ is one of the manufacturing companies in Indonesia engaged in the production of automotive components, including gasoline pistons for hatchback cars.

The production process at PT XYZ applies metal casting technology using the gravity die casting method. However, during 2024, various types of production defects were found in the piston components produced, with misrun defects accounting for the largest proportion, namely 52.56% of the total defects. Specifically, the Gasoline X type piston product recorded the highest misrun defect rate of 9.84%, making it the main focus of quality improvement efforts.

Defect misrun occurs when molten metal solidifies before the mold cavity is completely filled, causing certain parts of the product to not form properly. This problem not only affects product quality, but also increases production costs due to repair and recasting processes. Therefore, systematic and continuous improvement measures are needed. PT XYZ reported that in 2024 there were 37,315 misrun defects with an average defect percentage of 9.84% over 1 year, as shown in Table 1.

This study uses the PDCA (Plan-Do-Check-Action) method with an Eight Steps Problem Solving approach to analyze the root causes and implement solutions to misrun defects. The identification process was carried out through observation, interviews, fishbone diagram analysis, and 5 why analysis. The solutions designed include the creation of additional gas holes, adjustment of the gas hole position on the flip core, addition of a cooling mold checking SOP, and modification of the argon gas jet direction.

The purpose of this study is to identify the main causes of misrun defects in X gasoline pistons, design and implement corrective solutions, and evaluate their impact on reducing product defect rates. Through this approach, the study is expected to contribute to improving the quality of the production process and serve as a reference for quality control in the manufacturing industry.

Pistons are important components in internal combustion engines, functioning to receive combustion pressure and transmit it to the crankshaft via the connecting rod. Piston materials generally use aluminum-silicon alloys due to their heat resistance and good casting properties (Hermawati et al., 2020). In their manufacture, a casting manufacturing technique is used to mold molten metal into a mold according to the desired shape. One commonly used method is gravity die casting, which is the casting of metal using gravity to flow molten metal into a mold (Sucahyono, 2021).

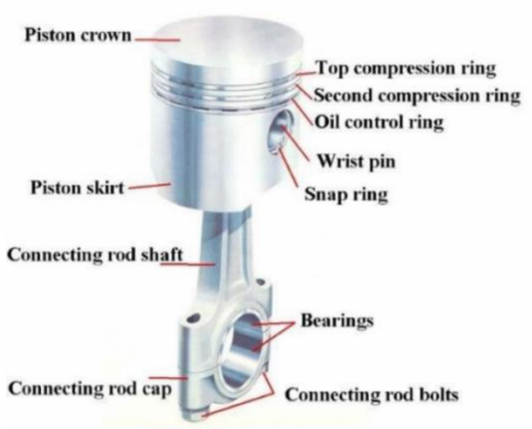


Figure 1. Piston (Sucahyono, 2021)

One of the main problems in the casting process is the appearance of defects, namely flaws in the cast product. Misrun is a type of defect that occurs when molten metal does not completely fill the mold due to premature solidification or poor metal flow. Misrun can cause structural damage such as holes, cracks, or low material strength (LearnMech, 2023). Factors that cause misrun generally include the design of the metal inlet (gating system), unstable mold temperature, poor ventilation, and metal oxidation due to exposure to air.

The PDCA (Plan-Do-Check-Action) method is a continuous improvement cycle used in quality management to solve problems systematically (Fatah & Al-Faritsy, 2021). In the context of manufacturing, the PDCA approach is often combined with Eight Steps Problem Solving to increase effectiveness. The eight steps consist of determining the theme, setting targets, analyzing conditions, analyzing causes and effects, planning improvements, implementing improvements, evaluating results, and standardizing solutions (Wahjoedi, 2020).

Several previous studies have shown the effectiveness of the PDCA and eight steps methods in reducing defect rates. Setiawan & Safitri (2022) successfully reduced defect rejection in plate R to 100% through tool modifications. Fatah & Al-Faritsy (2021) noted a 22.95% reduction in production defects in refrigerators. Wahyudi & Ferdiansyah (2024) also showed that improvements in gate design and coating thickness settings were able to reduce misrun defects by 35% in cylinder head production. Based on the existing literature, it can be stated that the combination of the PDCA method and the eight steps approach can provide systematic and measurable improvement solutions in overcoming quality problems in the manufacturing industry. This study reinforces this approach by focusing on reducing misrun defects in X gasoline piston products, thereby contributing to quality control and production efficiency.

RESEARCH METHOD

Research Method

This study uses a mixed method approach combining quantitative and qualitative methods. Quantitative methods are used to measure the level of misrun defects before and after repairs using simple statistical analysis, while qualitative methods are used to understand the root causes of defects through observation and in-depth interviews. The research was conducted at PT XYZ, a piston manufacturing company located in Cileungsi, Bogor Regency. The object of the research was the gravity die casting process for type X gasoline piston products, which had the highest misrun defect rate during 2024.

Research Location and Object

The research was conducted at PT XYZ, a piston manufacturing company located in Cileungsi, Bogor Regency. The object of the research was the gravity die casting process for type X gasoline piston products, which had the highest misrun defect rate during 2024.

Population and Sample

The study population comprised all type X gasoline pistons produced during the evaluation period from January to December 2024. The sample included defect data from three months with the highest misrun rates (identified through Pareto analysis) for pre-improvement analysis, and three months following intervention implementation for post-improvement evaluation. Census sampling was used for defect data collection, where all misrun defects occurring during the selected periods were recorded and analyzed.

Types and Collection of Data

This study utilized two data types: primary data acquired through direct production process observation and structured interviews with machine operators, casting supervisors, and relevant division heads; and secondary data derived from internal company reports encompassing production and defect data for 2024. The research methodology comprised field observation for identifying actual production conditions and detecting potential defect causes, structured interviews with relevant stakeholders to explore in-depth causal factors of misrun occurrences, and documentation review for collecting historical data and production process records.

Research Analysis

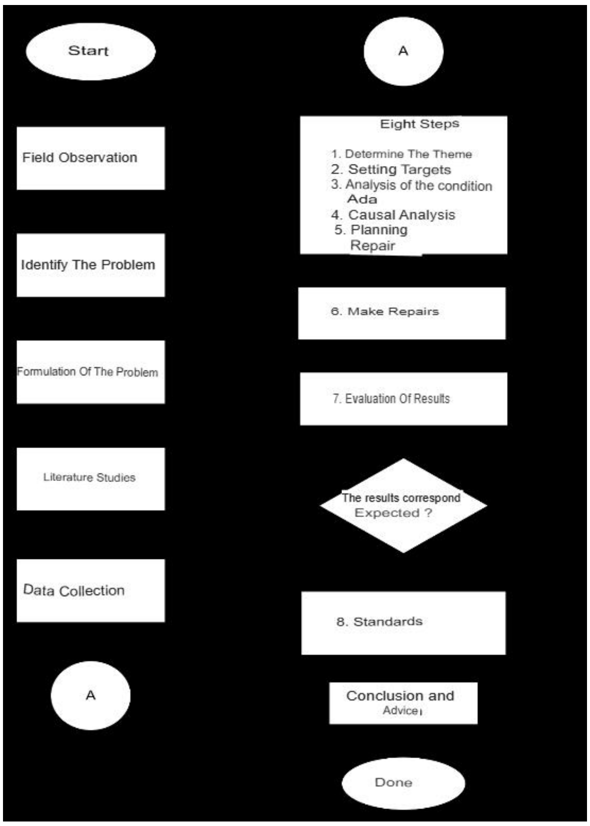


Figure 2. Research Flow Diagram

This study aims to reduce misrun defects in X gasoline pistons. Data obtained from field data collection was then processed in several stages, as shown in Figure 2. The research flowchart can be seen in Figure 2, with further explanations as follows.

Field observations were conducted in this study to identify problems occurring in the field, followed by problem identification within the company where defects were found in piston products, particularly misrun defects which had the highest defect rate compared to other types of defects. Problem formulation was then carried out in the study to collect existing problems, while the author conducted a literature study from books and journals as references to strengthen supporting theories and discuss ways to overcome misrun defects. Data collection was performed by the author to support the research, where the data was used as the basis for analysis.

Theme determination in the eight-step method in this study was conducted to determine the time period and type of piston with the highest misrun defect rate, with the misrun defect reduction target established based on the company's standard target calculations. Analysis was then conducted in the field to identify factors that may cause misrun defects using the 4M + 1E method (man, machine, material, method, and environment), by examining aspects that did not comply with the applicable SOPs. Cause and effect analysis was carried out with the assistance of fishbone diagrams and why-why analysis tables to find the root causes of identified problems.

In the subsequent stage, an improvement plan was formulated to address existing problems using the 5W + 1H method to develop solutions based on the root causes of the problems, which were then implemented according to the established solutions. The improvement results were evaluated to determine whether there were changes, whether targets had been achieved, and whether the work met standards or still had shortcomings. The final stage was standardization, where standards were established as a reference for work procedures to ensure that the same problems would not recur in the future.

RESULT AND DISCUSSION

The analysis was conducted using the PDCA (Plan-Do-Check-Action) approach as a systematic framework for continuous improvement. In the Plan phase, the research theme was determined, defect reduction targets were established, and root causes were identified through fishbone diagrams and 5 Why analysis to ensure comprehensive understanding of the problems. The Do phase involved implementing solutions based on the formulated improvement plan, including mold modifications and work procedure adjustments to address the identified root causes. Subsequently, in the Check phase, the effectiveness of improvements was evaluated by comparing defect levels before and after corrective actions, providing quantitative evidence of the intervention's impact. Finally, the Action phase ensured improvement sustainability through standardization of successful solutions by developing additional SOPs and disseminating them to operators to prevent defect recurrence in subsequent production cycles.

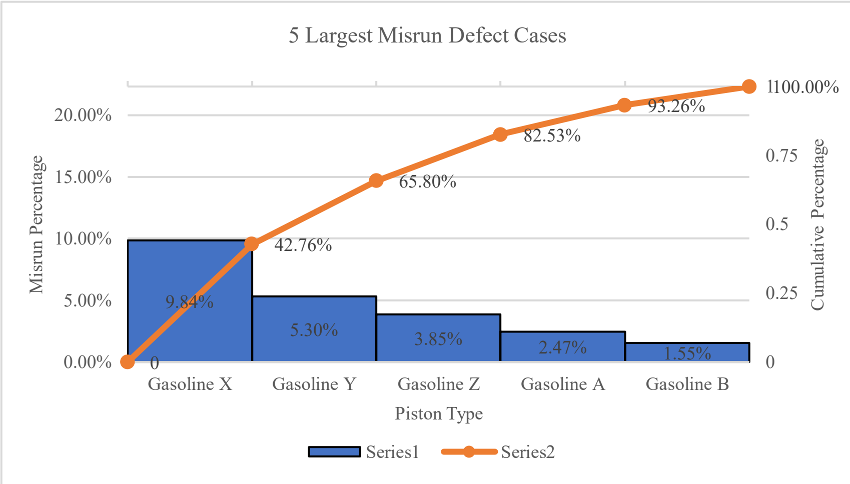


Figure 3. Pareto Diagram of Data for the 5 Largest Misrun Defect Cases in 2024

The Pareto chart is used to determine problem priorities, while the effectiveness of improvements is calculated based on the percentage decrease in misrun defects using the company's internal formula. Based on an analysis of PT XYZ's production data for 2024 as shown in Figure 3, it was found that the most dominant type of defect in the hatchback gasoline piston casting process was misruns, accounting for 52.56% of total casting defects. Of the five gasoline piston variants, the Gasoline X type recorded the highest misrun rate of 9.84% of its total production, making it the main focus for quality improvement.

Material Composition

The main material used to produce gasoline pistons X is A351. This material specification is a standard requirement from the customer. The material composition data shows that the total aluminum content for A351 material is 80.6%, which is an aluminum-silicon alloy. This alloy has good casting properties and is resistant to heat and corrosion. Table 1 shows the material composition.

Table 1. Composition of A351 Material

Symbol	**Si**	**Fe**	**Cu**	**Mn**	**Mg**	**Cr**	**Zn**	**Ti**	**Na**	**Ca**	**Ni**	**Pb**	**P**	**Al**
A351	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Min (Standard)	12,00	-	4,50	-	0,800	-	-	0,100	-	-	0,700	0	0,0030	-
Max (Standard)	13,50	0,300	5,50	0,100	1,20	0,050	0,100	0,200	0,003	0,0050	1,30	0,05	0,010	-

Symbol	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Na	Ca	Ni	Pb	P	Al
Testing result	12,21	0,159	4,79	0,0085	1,09	0,0026	0,0089	0,128	0,0006	0,00013	0,974	0,0015	0,0036	80,6

Analysis of Existing Conditions

This analysis of existing conditions was conducted directly in the field to analyze several actual conditions that occurred, whether they were in accordance with standards or not, using several factors identified using the 4M + 1E method. Table 2 is the 4M+1E table.

Table 2. Root Cause Analysis Using 4M+1E Method

Factor	Item Cek	Ideal Condition	Findings	Judge
Machine	Mold condition	The mold does not cause misruns.	Misrun occurs in the head area.	Influential
		The mold does not cause misruns.	Misrun occurs in the ecoform area.	Pengaruh
		The mold temperature is stable.	Mold temperature is unstable.	Influential
Material	Material composition	The material composition complies with standards.	Material composition is in accordance with standards.	No Influential
Material	Argon gas installation	The argon gas functions properly and does not cause misruns.	Argon gas installation is not functioning optimally and causes misrun in the skirt area.	Influential
Human	Operator skills	Operator skills comply with standards	Operator skills are in accordance with standards.	No Influential
Method	Pouring material into the mold	The pouring method complies with standards.	Pouring method is correct and in accordance with standards.	No Influential
Environment	Lighting of the product viewing area	Lighting complies with standards.	Visual area lighting is in accordance with standards.	No Influential

Cause and Effect Analysis

The identification of cause-and-effect relationships was carried out using a fishbone diagram and a 5 Whys analysis in table form to trace the root cause of the problem based on actual conditions in the field. Figure 4 presents a visualization of the fishbone diagram that illustrates the misrun defect problem in the X-type gasoline piston. Table 3 is a 5 Whys analysis table used to find the root cause of the problem. From the results of this analysis, four root causes were obtained, consisting of three causes originating from the engine aspect and one from the material aspect.

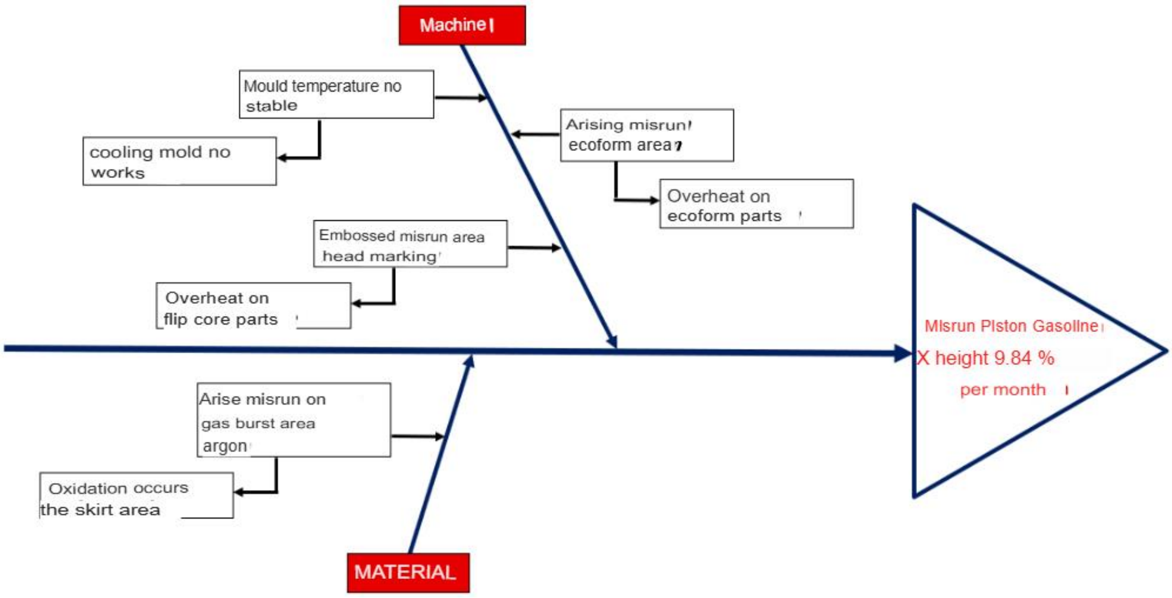


Figure 4. Pareto Diagram of Data for the 5 Largest Misrun Defect Cases in 2024

Table 3. Why Analysis

Factor	Problem	Why 1	Why 2	Why 3	Why 4	Why 5
Machine	Overheat area ecoform	Hot air is trapped inside the ecoform area.	There is no outlet or flow for hot air.	There are no gas holes in the ecoform section.	The gas holes in the ecoform area have not been made.	-
	Overheat area flip core	Hot air is trapped inside the flip core area.	The release of hot air from the flip core does not run smoothly.	The gas holes in the flip core are not working effectively.	The position of the gas holes on the flip core is not aligned with the misrun area.	-
	Cooling mold tidak berfungsi	Damage has occurred to the cooling mold.	The damage was not detected from the start.	The cooling mold function is not checked regularly.	No schedule has been set for checking the cooling mold.	-
Material	Terjadi oksidasi pada area skirt	The skirt area is not exposed to argon gas.	The argon gas does not protect the entire side surface of the mold evenly.	The argon gas flow distribution does not reach the entire skirt area.	The argon gas is only installed on the upper side of the mold.	-

Through fishbone diagram and 5 Why analysis, four primary root causes of misrun were identified, namely the absence of gas holes in the ecoform mold area, misaligned gas hole positions on the flip core with areas frequently experiencing misruns, lack of routine cooling mold inspection schedule, and insufficient argon gas flow coverage across the entire mold area due to suboptimal installation positioning.

Improvement Implementation

Based on the identification results, improvements were implemented in accordance with the PDCA-Eight Steps method, including the creation of two new gas holes in the ecoform area with a diameter of 1 mm to reduce overheating and improve metal flow, repositioning of gas holes on the flip core to align with the misrun area, development and implementation of SOPs for routine cooling mold inspection at each shift change, and modification of argon gas jet direction to reach the skirt area more evenly.

Result Evaluation

After the implementation stage, a re-measurement of the misrun defect rate was conducted during one month of production in May 2025. The results showed a decrease in the misrun percentage from 9.84% to 5.16%, or a decrease of 47.5%, exceeding the company's target of 40%, as shown in Figure 6.

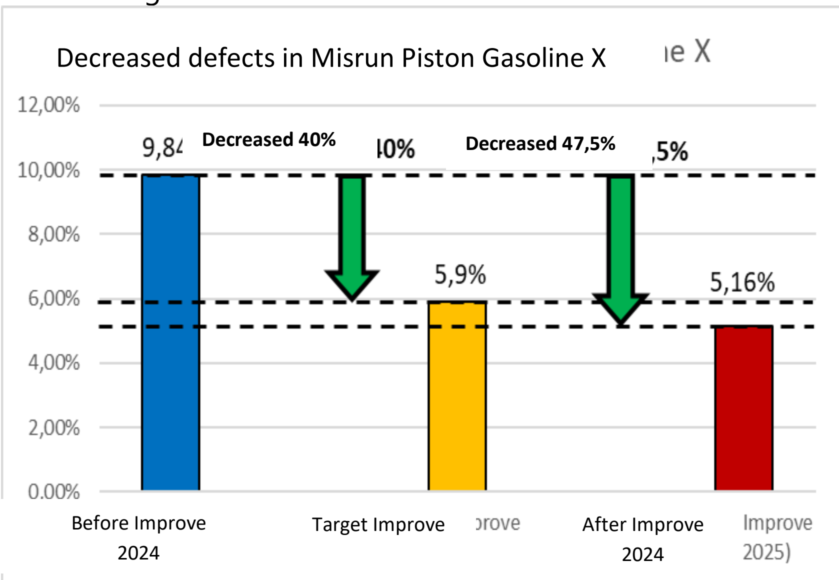
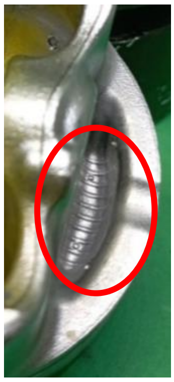


Figure 5. Graph of Misrun Defect Reduction

A visual comparison of the product before and after improve also shows the elimination of misrun defects in the previously problematic areas, namely the ecoform, head, and piston skirt.

Table 4. Comparison Before and After Repair

No	Before Improve	After Improve
1.		
2.		
3.		

Standardization

At this stage, standards are established as a reference for work procedures so that the same problems do not recur in the future. The standardization carried out is the creation of additional SOPs regarding the checking of cooling molds.

CONCLUSION

The systematic PDCA-Eight Steps approach successfully reduced misrun defects in gasoline pistons X from 9.84% to 5.16% surpassing the 5.9% target with a 47.5% reduction rate by addressing four critical root causes: ecoform gas hole absence, misaligned flip core positioning, irregular cooling mold inspection, and suboptimal argon gas flow. This demonstrates that structured problem-solving methodologies yield measurable quality improvements in Indonesian metal casting operations when rigorously applied.

However, the one-month evaluation period and single-product focus limit generalizability. Future research should extend validation periods to 6-12 months, employ DOE or CFD simulations for broader product line applications, and quantify economic impacts to strengthen implementation justification. Establishing continuous monitoring systems and cross-product SOP standardization will ensure sustained improvements and scalability across similar manufacturing contexts.

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REFERENCES

Fatah, A., & Al-Faritsy, A. Z. (2021). Peningkatan dan Pengendalian Kualitas Produk dengan Menggunakan Metode PDCA (Studi Kasus pada PT. X). Jurnal Rekayasa Industri (JRI), 3(1), 21–30. https://doi.org/10.37631/jri.v3i1.288

Haq, A., Nasution, S., & Hasugian, M. Y. (2024). Implementasi PDCA pada produk crude palm oil. *Jurnal Ilmiah Teknik, 3*(2), 70–81. https://doi.org/10.56127/juit.v3i2.1433

Hermawati, L., Mujiarto, I., Kundori, K., & Hariyadi, S. (2020). Analisa pengukuran cylinder liner dan piston pada overhoul diesel engine. Accurate: Journal of Mechanical Engineering and Science, 1(2), 6–12.

IQS Directory. (2023). *Permanent mold castings*. Retrieved from https://www.iqsdirectory.com

Khaerudin, D., & Rahmatullah, A. (2020). Implementasi metode PDCA dalam menurunkan defect sepatu tipe Campus di PT. Prima Intereksa Industri (PIN). *Jurnal Sains dan Teknologi, 20*(1), 34. https://doi.org/10.36275/stsp.v20i1.228

Kurniawan, C., & Azwir, H. H. (2019). Penerapan metode PDCA untuk menurunkan tingkat kerusakan mesin pada proses produksi penyalutan. *JIE Scientific Journal of Research and Applied Industrial System, 3*(2), 105. https://doi.org/10.33021/jie.v3i2.526

Malabay. (2016). Pemanfaatan diagram fishbone untuk mendukung kebutuhan proses bisnis. *Jurnal Ilmu Komputer, 1*(2), 150–154.

Rachmanda, M. R., Widjaja, F. N., & Tedjakusuma, A. P. (2024). Pengendalian kualitas produk cacat elpiji 3 kg dengan menggunakan siklus PDCA pada SPPBE PSO PT. Win Med Indonesia. *Journal of Economic Assets and Evaluation, 1*(4), 1–15.

Sasando, A. F., & Apsari, A. E. (2024). Analisis pengendalian kualitas batu bata di UMKM Anugrah Jaya dengan metode PDCA dan usulan perbaikan 5W+1H. *JCI (Jurnal Cakrawala Ilmiah), 3*(10), 2843–2850.

Silitonga, M. P. R., & Khoirunnisa, R. (2024). Evaluasi kualitas pendidikan di Jurusan Teknik Mesin pada masa pasca pandemi COVID-19 dengan metode Eduqual terintegrasi IPA dan QFD. *Edukatif: Jurnal Ilmu Pendidikan, 6*(1), 888–898. https://doi.org/10.31004/edukatif.v6i1.6395

Susilawati, M., Silitonga, M. P. R., Nurmahadi, Munizu, M., & Bakri, A. A. (2024). Pengaruh profitabilitas, biaya operasional dan manajemen laba terhadap pajak penghasilan pada perusahaan manufaktur. *El-Mal: Jurnal Kajian Ekonomi & Bisnis Islam, 5*(9),4459. https://doi.org/10.47467/elmal.v5i9.5017

Taufiqurrahman, M., et al. (2023). Analisis mekanik dan termal piston mesin pembakaran dalam menggunakan software Ansys 2023. *Jurnal Teknologi Mesin dan Energi Industri, 2*(3), 143–154.

Wahyudi, W., & Ferdiansyah, R. (2024). Menurunkan Reject Misrun Area Dinding Chain pada Cylinder Head Tipe X di Produksi LPDC Perusahaan Otomotif. Integrasi: Jurnal Ilmiah Teknik Industri, 9(1), 49–56. https://doi.org/10.32502/js.v9i1.7816

Zakaria, P. R. (n.d.). Perbaikan mesin digester dan press untuk menurunkan oil losses di stasiun press dengan metode PDCA. *Jurnal Rekayasa dan Teknologi*.