

OPTIMIZATION OF CYKLOP INK USAGE IN THE UHT BOX CODING PROCESS USING THE DMAIC APPROACH: A CASE STUDY AT PT INDOLAKTO FACTORY CICURUG 3

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ABSTRACT

The use of factory supplies is one of the areas that requires control to improve production cost efficiency. This case study examines the optimization of Cyklop ink usage in the UHT box coding process at PT Indolakto Factory Cicurug 3 using the Define–Measure–Analyze–Improve–Control (DMAIC) approach. The initial condition showed an average usage ratio of 17.689 ctn/cartridge during January–December 2024. Pareto analysis identified Cyklop ink as one of the major contributors to factory supplies costs. Stratification by production line showed relatively consistent ratios for Lines A, B, and C, at 17.663, 17.665, and 17.737 ctn/cartridge, respectively. Observations of production output across several periods also indicated that changes in production volume were not accompanied by meaningful changes in the usage ratio. Root cause analysis using the 5 Whys identified three primary causes: the printer could not detect the actual amount of ink remaining in the cartridge, the LED alarm indicator was too small, and no detection system was available to identify instances in which the production code was not printed. Improvements were subsequently implemented through the reuse of residual ink by modifying the cartridge, installation of an external visual alarm, and addition of a camera-based detection system. The average ratio during January–June 2025 increased to 28.719 ctn/cartridge, representing a 62.36% improvement over the baseline and exceeding the target of 22.969 ctn/cartridge. During the monitoring period from July–September 2025, the average ratio reached 29.901 ctn/cartridge. Financial validation recorded actual cost savings of IDR 392,672,035 per year, with an investment of IDR 1,084,080 and an ROI of 1,812%. These results demonstrate that DMAIC can systematically integrate baseline condition analysis, root cause verification, technical improvement actions, and performance control.

Keywords: DMAIC; Cyklop ink; box coding; factory supplies; continuous improvement; cost efficiency; UHT

1. INTRODUCTION

PT Indolakto Factory Cicurug 3 operates UHT and beverage production facilities. In its production activities, factory supplies represent a cost category that requires control because inefficient consumption increases operating costs without providing proportional added value. Under the 2024 business objectives/KRAs, reducing factory supplies consumption was identified as one of the improvement priorities in the UHT area.

The FY 2024 factory supplies cost mapping showed that Cyklop ink was among the major contributors. The cost of Cyklop ink was approximately IDR 733 million, ranking fourth in the Top 10

Factory Supplies Pareto for UHT C3. This position made Cyklop ink sufficiently material to be selected as an improvement target. In addition to cost considerations, the team identified that ink usage lacked adequate control and standardization.

Figure 1 illustrates the position of Cyklop ink within the factory supplies cost structure. Cumulatively, the ten items shown represent the overall contribution of the mapped costs. For the team, the Pareto result provided a starting point for selecting a problem with substantial impact while still offering opportunities for improvement.

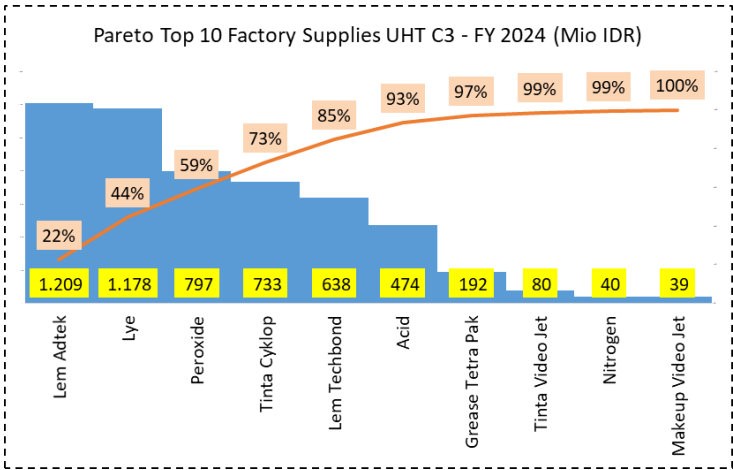


Figure 1. Pareto of Top 10 Factory Supplies – UHT C3, FY 2024

The FY 2024 usage condition was subsequently examined in greater detail. The recorded monthly ratios were 16.452; 20.887; 22.391; 15.146; 15.177; 15.713; 14.320; 17.031; 18.804; 17.112; 22.969; and 20.995 ctn/cartridge, with an average of 17.689 ctn/cartridge. The range indicates that usage performance was not yet stable. The best observed performance, or highest usage ratio, of 22.969 ctn/cartridge was used as the internal benchmark for establishing the improvement target.

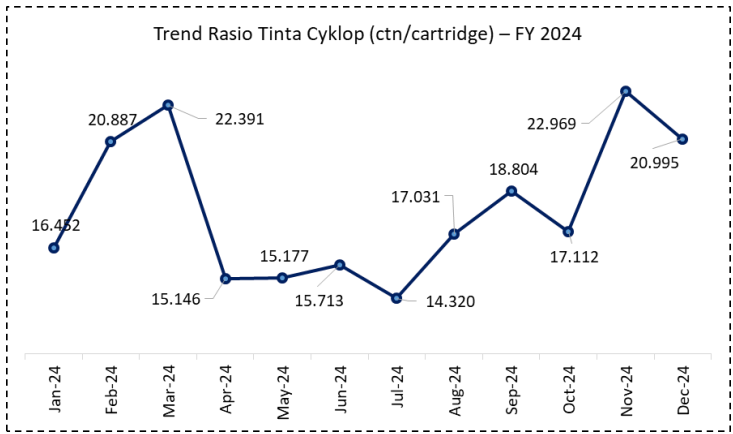


Figure 2. Trend of Cyklop Ink Usage Ratio, FY 2024

To determine whether the problem was limited to a particular production line, the data were also stratified by line. The results showed ratios of 17.663 ctn/cartridge for Line A, 17.665 for Line B, and 17.737 for Line C. The difference was not significant, amounting to only 0.074 ctn/cartridge between

the highest and lowest values. This consistency indicates that the problem was more systemic in nature rather than a characteristic specific to a single production line.

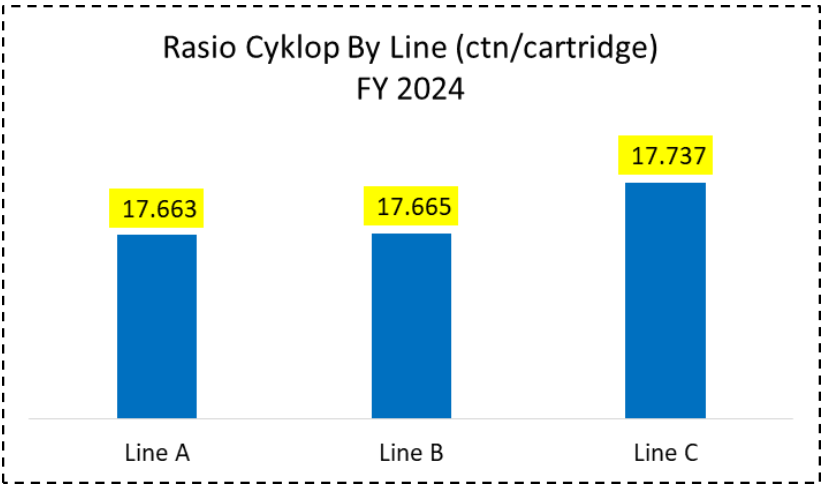


Figure 3. Cyklop Ink Usage Ratio by Production Line

Production output observations provided an additional perspective. Across the four periods presented, output increased from 2,989,392 to 3,118,073 tons, while the Cyklop ratio remained very close to 17.689–17.688 ctn/cartridge. Although the data are insufficient to establish a statistical relationship between output and the ratio, they indicate that an increase in production volume did not automatically result in improved ink-use efficiency. Therefore, the cartridge usage and control mechanisms required further investigation.

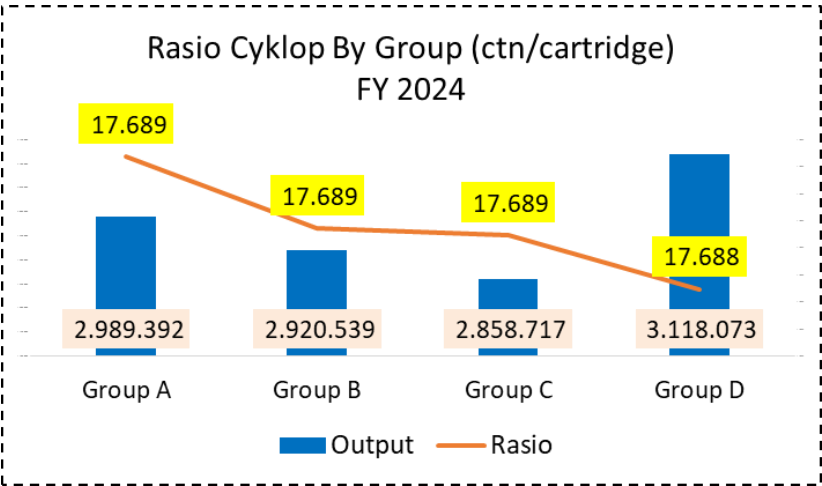


Figure 4. Production Output and Cyklop Ink Usage Ratio

2. METHODOLOGY

This study employed the DMAIC approach, consisting of Define, Measure, Analyze, Improve, and Control. This approach was selected because the problem extended beyond consumption measurement and required root cause investigation, solution selection, and control after implementation of the improvements.

During the Define phase, the team established the Cyklop ink usage ratio in the box coding process as the primary focus. During the Measure phase, historical data from January–December 2024 were used as the baseline, and the data were stratified by production line and production period. Data were collected for Lines A, B, and C through records of ink consumption on the coding box machines.

The Analyze phase was conducted using process mapping, data stratification, cause-and-effect analysis, and the 5 Whys. These methods were used to distinguish symptoms from controllable causes. During the Improve phase, alternative solutions were selected using SCAMPER and a priority matrix, after which the risks of the selected solutions were evaluated using FMEA. The Control phase was implemented through WI/OPL standardization, communication and training, trend monitoring, and routine control.

The target was established by increasing the baseline average of 17.689 ctn/cartridge to 22.969 ctn/cartridge. Accordingly, the improvement target was 29.85%, with the achievement period set for January–June 2025.

3. RESULTS AND DISCUSSION

3.1 Root Cause Verification

The 5 Whys analysis led the team to identify three root causes. First, the printer could not detect the actual amount of ink remaining in the cartridge (RC1), resulting in suboptimal utilization of residual ink. Second, the LED alarm indicator was too small (RC2), making the alarm condition difficult for operators to observe. Third, no detection system was available to identify cases in which the production code was not printed (RC3), meaning that the condition still depended on operator observation.

These three causes were important because they were interconnected with cartridge usage behavior. When residual ink could not be utilized, cartridges could be replaced before their entire contents were consumed. When the alarm was difficult to observe, the response to an ink-out condition could be delayed. Meanwhile, the absence of post-print detection meant that code-printing failures were not immediately identified by the system. These findings formed the basis for designing improvements that did not rely solely on operator discipline but also addressed the system itself.

3.2 Improvement Design and Implementation

The first solution focused on reusing residual ink. The team conducted trials to manually refill the remaining ink and modified the cartridge so that it could accept additional ink. The trial stages included refilling, reinstalling the cartridge, testing ink flow, and checking the print output. This implementation provided a practical method for reducing residual ink in the cartridge, although ergonomic aspects and the refilling method still required further refinement during the initial stage.

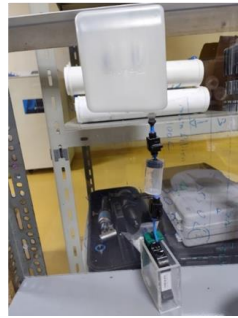


Figure 5. Trial of Cyklop Residual Ink Refill

The second solution involved the addition of an external visual alarm. The system was designed using relay wiring and a lamp/buzzer connected to the machine's alarm signal. The external indicator made the alarm condition easier to observe from the operator's working area. In addition to the wiring design, the team conducted trials and installed the system directly on the coding box unit to verify that the lamp was activated according to the alarm condition.

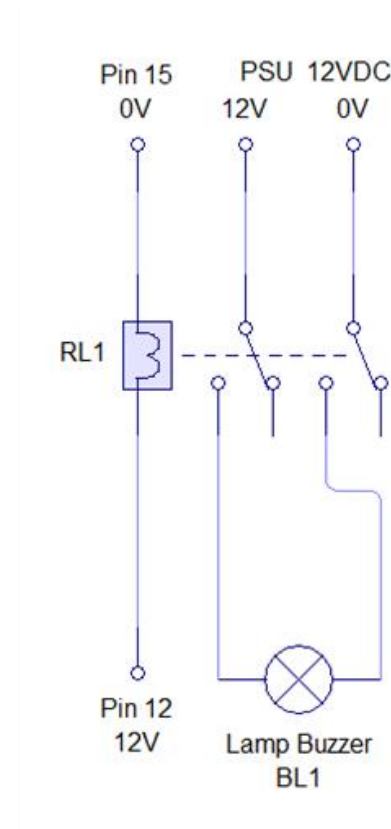
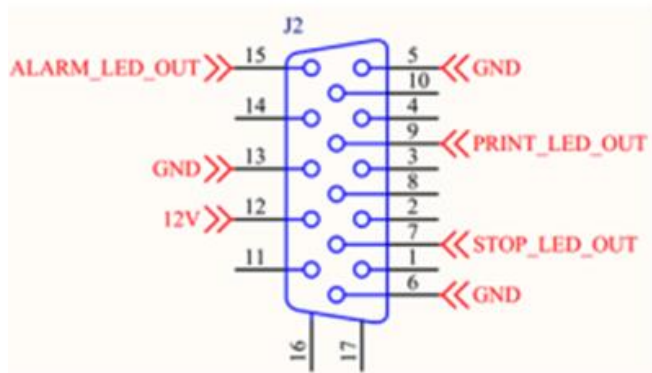


Figure 6. External Visual Alarm Wiring Design



Figure 7. Implementation of the External Visual Alarm on the Coding Box Machine

The third solution involved adding a detection system after the printing process. The team developed and tested a camera-based detection device to read production-code characters on the carton box. During testing, the camera was able to detect the text characters of the production code. When the code was not detected, Stopper 1 and Stopper 2 were activated, thereby stopping the production flow. The system also involved sensor repositioning and application updates to support the detection function.



Figure 8. Initial Testing of the Code Detection System

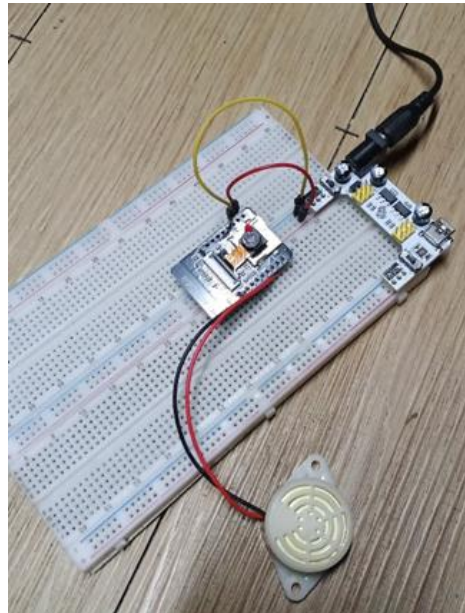


Figure 9. Prototype of the Detection System Circuit

FMEA analysis of the selected solutions resulted in RPN values of 175 for RC1, 216 for RC2, and 210 for RC3. All three were classified as medium risk. The control plans included adding a vacuum system during ink refilling and implementing WI/OPL for RC1; designing the wiring and checking

connections for RC2; and synchronizing the detector system with the conveyor and conducting periodic validation for RC3.

3.3 Improvement Effectiveness

The project results showed a clear change after the improvement actions were implemented. The average usage ratio during January–June 2025 reached 28.719 ctn/cartridge. Compared with the baseline of 17.689 ctn/cartridge, this represented a 62.36% improvement and exceeded the target of 22.969 ctn/cartridge. In other words, the initial improvement target of 29.85% was not only achieved but substantially exceeded.

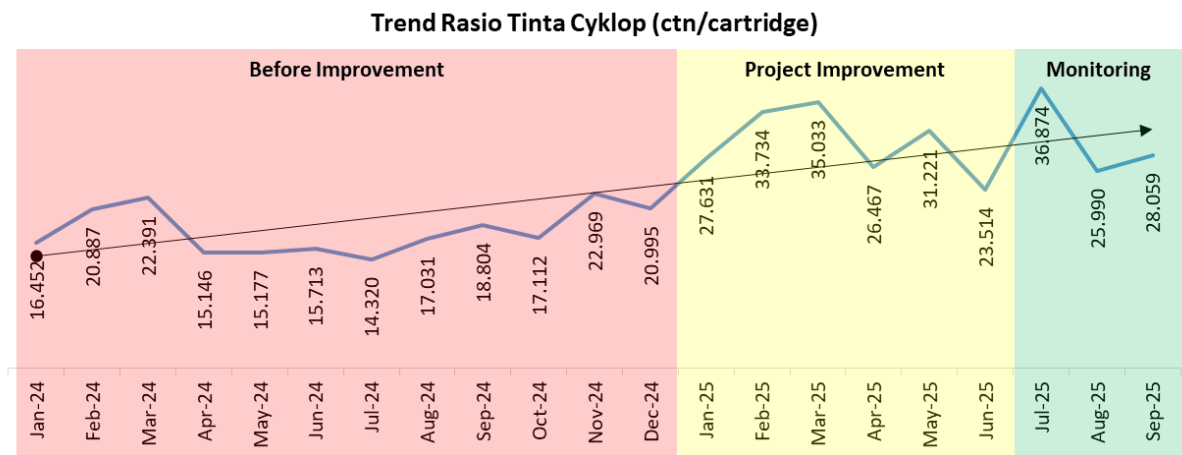


Figure 10. Cyklop Ratio Trend Before Improvement, During the Project, and During Monitoring

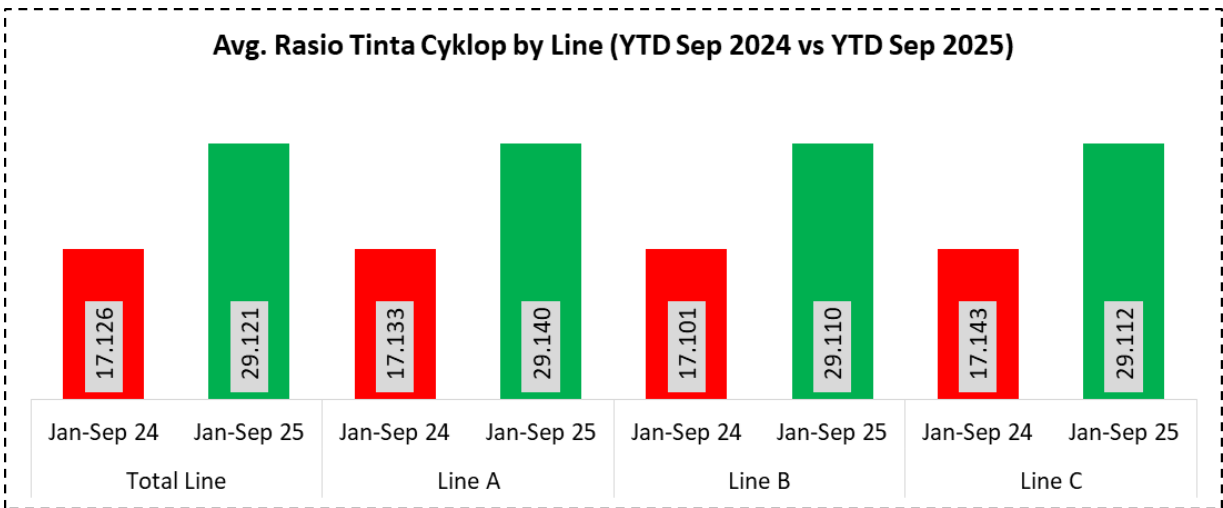


Figure 11. Comparison of YTD September 2024 and 2025 Ratios

The performance did not immediately return to the initial condition after the project improvement period. During monitoring from July–September 2025, the average ratio was 29.901 ctn/cartridge. The monitoring trend shows that the post-improvement values remained well above all FY 2024 baseline values. This provides an indication that the implemented changes could be sustained during the subsequent observation period.

The YTD September comparison further supports this finding. The total-line ratio increased from 17.126 ctn/cartridge in YTD September 2024 to 29.121 ctn/cartridge in YTD September 2025. For Line A, the ratio increased from 17.133 to 29.140; for Line B, from 17.101 to 29.110; and for Line C, from 17.143 to 29.112 ctn/cartridge. The relatively consistent increase across all three lines indicates that the improvement was not limited to a single production area.

3.4 Financial and Non-Financial Impacts

Under the baseline condition, annual cartridge requirements were estimated at 672 units, with an average cost of IDR 1,091,071 per cartridge. The total annual cost reached IDR 733,200,000. With the target ratio of 22.969 ctn/cartridge, cartridge requirements were projected to decrease to 471 units, reducing the total cost to IDR 514,308,238. This calculation resulted in an initial potential benefit of IDR 218,891,762 per year.

Following project implementation and validation, total cost savings were recorded at IDR 392,888,851, with an investment of IDR 1,084,080. The actual cost savings after accounting for the investment amounted to IDR 392,672,035 per year. The project recorded an ROI of 1,812%, a payback period of 0.001 years, and a cost-benefit ratio of 362.

From a quality perspective, customer complaints related to box coding remained at zero cases. Employee satisfaction increased from 2.9 to 4.2 on a Likert scale. From an environmental perspective, average Cyklop cartridge B3 waste decreased from 6.2 kg/month before the improvement to 2.0 kg/month after the improvement, below the target of 4.3 kg/month. Thus, the benefits of the project were reflected not only in cost reduction but also in process control and waste reduction.

4. CONCLUSION

The application of DMAIC to the UHT box coding process successfully improved Cyklop ink usage efficiency. The usage ratio increased from the baseline of 17.689 ctn/cartridge to 28.719 ctn/cartridge during January–June 2025, representing a 62.36% improvement. This value exceeded the target of 22.969 ctn/cartridge. The monitoring result of 29.901 ctn/cartridge during July–September 2025 indicates that the improved performance was sustained.

The initial analysis showed that the problem occurred relatively consistently across Lines A, B, and C; therefore, the improvement was directed toward system-related factors. The three root causes were addressed through residual ink reuse, an external visual alarm, and a camera-based production-code detection system. This approach reduced reliance on manual actions alone and strengthened process control.

Financially, the project generated actual cost savings of IDR 392,672,035 per year, with an investment of IDR 1,084,080 and an ROI of 1,812%. From a non-financial perspective, there were no customer complaints related to box coding, employee satisfaction increased, and B3 cartridge waste decreased. The results were controlled through WI/OPL, communication and training, and trend monitoring. Future development may focus on automating the refill process and further developing the digital camera checker.

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