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IMPROVING QUALITY IN ATM CARD PRODUCTION AT PT. DEF USING SIX SIGMA METHODOLOGY

Muhammad Farrel Apta Fedora¹

Master of Business Administration Program, Institut Teknologi Bandung

Correspondence E-mail: muhammad_fedora@sbm-itb.ac.id

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Abstract

The ATM card production process at PT DEF has encountered recurring quality defects, including misaligned printing, uneven cutting, and scratched surfaces, leading to increased costs, operational inefficiencies, and reduced customer satisfaction. These issues have significantly impacted production reliability and raised concerns about the company's ability to meet industry standards. Given the critical importance of quality in banking products, PT DEF must address these challenges to maintain its reputation, operational efficiency, and customer trust. This research employs the Six Sigma DMAIC framework to identify, analyze, and address the root causes of defects. Data collection methods include Failure Mode and Effects Analysis (FMEA), control charts, and fishbone diagrams, supported by interviews and observations. The study prioritizes corrective actions based on Risk Priority Numbers (RPN) and implements improvements such as equipment upgrades, enhanced training programs, and stricter material quality control. A robust control phase ensures sustainability through monitoring, audits, and real-time reporting. The findings reveal a reduction in defect rates and significant improvements in process efficiency following the implementation of corrective measures. The DPMO decreased from 5,108.38 in June 2022 to 1,881.40 in March 2024, with corresponding improvements in Final Yield and Sigma Values. These results demonstrate the effectiveness of a structured quality management approach in addressing production challenges and underline the importance of sustained efforts to achieve near-perfect production standards in the banking industry.

Keywords : Six Sigma, Fishbone Analysis, FMEA

1. INTRODUCTION

PT. DEF is a prominent player in Indonesia's banking industry, established in 1956 and now part of the Mitsubishi UFJ Financial Group (MUFG) since 2017. With a strategic focus on supporting micro, small, and medium enterprises (MSMEs), PT. DEF plays a significant role in financial inclusion across Indonesia, leveraging its extensive network of branches and digital products. Its partnerships with Adira Finance, Zurich Insurance, and Home Credit Indonesia highlight its diverse financial services. However, despite its strong position, PT. DEF faces critical operational challenges in its ATM card production. In 2023, PT. DEF encountered persistent quality defects in its ATM card production process, data defect will be summarize into this table below

Year	Credit Card Production	Debit Card Production	Total Production
2022	113,313	423,669	536,982
2023	120,444	505,218	625,662
2024 (ongoing)	170,685	352,399	523,084

Source: Internal Data PT. DEF (2024)

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These defects caused inefficiencies in production workflows, leading to wasted materials, rework, and delays in meeting targets. The operational impact extended to increased costs and disruptions, requiring a systematic approach to identify and address root causes. The recurring nature of these issues highlights gaps in quality control amidst growing production demands.

The defective ATM cards significantly affected customer satisfaction, resulting in a surge of replacement requests and complaints. This strained customer service operations, diverting resources from other essential functions and reducing the department's overall efficiency. The dissatisfaction among customers further risked damaging the bank's reputation and loyalty, as clients increasingly considered switching to competitors offering better product reliability.

Despite an increase in total production from 2022 to 2023, defect rates rose, emphasizing the challenge of maintaining quality amid higher output. By 2024, total production decreased, but defect numbers also showed a notable reduction, likely due to enhanced quality control measures. However, the recurring defects continue to impact operational performance and customer trust, necessitating focused corrective strategies to address these issues effectively.

Moving forward, PT. DEF must prioritize addressing its most critical quality defects to improve operational efficiency and customer satisfaction. Implementing targeted solutions, supported by robust quality control systems, will be essential for sustaining its position in Indonesia's competitive banking sector while restoring customer confidence and loyalty.

2. IMPLEMENTATION METHOD

The research addressing quality defects in ATM card production at PT. DEF adopts a structured flow beginning with problem identification to clearly define issues related to production defects. This is followed by a literature review to gather relevant theories and research. The study employs a descriptive quantitative approach in a case study format, guiding the subsequent data collection process. Methods such as interviews, observations, and the use of Failure Mode and Effects Analysis (FMEA) forms are utilized to gather insights into the production process. Once data is collected, the analysis phase uses the Six Sigma DMAIC methodology, involving steps like defining critical quality elements, measuring defects through tools like control charts and calculating Defects Per Million Opportunities (DPMO), and analyzing root causes with fishbone diagrams and FMEA.

Following the analysis, the improvement phase focuses on creating and implementing plans based on the findings, ensuring enhancements in the production process. The control phase ensures the sustainability of these improvements through continuous monitoring and necessary adjustments. The research concludes with the synthesis of findings into actionable recommendations to minimize production defects and enhance the efficiency of ATM card production. This systematic approach ensures a comprehensive understanding of the problem and effective solutions, as outlined in the accompanying figure.

3. RESULTS AND DISCUSSION**3.1 Define Phase****3.1.1 ATM Card Production Process in PT DEF**

The ATM card production process at PT DEF involves several critical steps to ensure the cards meet quality and functionality standards. According to an interview conducted using the FGD method, the process begins with Material Preparation, where PVC sheets for the card's front and back, along with magnetic strips, are readied for subsequent stages. In the Printing stage, base colors are applied to the PVC sheets, followed by design elements like logos and security features such as UV imprints for authenticity. The next stage is Lamination, combining the front layer, back layer, and magnetic strip into a single sheet, which is then pressed to enhance durability.

After lamination, the sheets proceed to the Cutting phase, where they are trimmed to standard size, and holes are created for chip placement. Chips are then inserted into the designated holes during



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this stage. The final step, Finishing and Packaging, involves adding holograms and signature strips for security and personalization before the cards are packaged for distribution. This detailed process ensures the production of high-quality ATM cards that meet security and operational standards. The production flow is visually summarized in the accompanying control chart, which highlights each step and its contribution to the overall process.

3.1.2 Critical to Quality (CTQ)

Critical to Quality (CTQ) aspects in ATM card production focus on three main defects identified during interviews with operational staff. These are essential for ensuring product quality, functionality, and customer satisfaction:

1. Scratched Card Surfaces

Scratched surfaces diminish the card's visual appeal and may interfere with its functionality in card readers. This defect often arises from improper handling or inadequate protection during production and transportation. Addressing this issue requires stringent quality control measures to prevent damage.

2. Unevenly Cut Edges

This defect results from inaccuracies in the cutting process, leading to misaligned edges that can cause operational failures in card readers. Ensuring precise cutting and regular calibration of machinery is crucial to eliminating this issue.

3. Misaligned Printing

Improper alignment of printed elements, including logos and security features, affects the card's professional appearance and compliance with industry standards. This defect highlights the need for strict attention to detail in the printing phase to maintain consistency and accuracy.

These CTQ elements are prioritized as they directly influence the final product's quality, usability, and customer trust, underscoring the need for robust quality control measures at every production stage.

3.2 Measure Phase

3.2.1 Control Chart

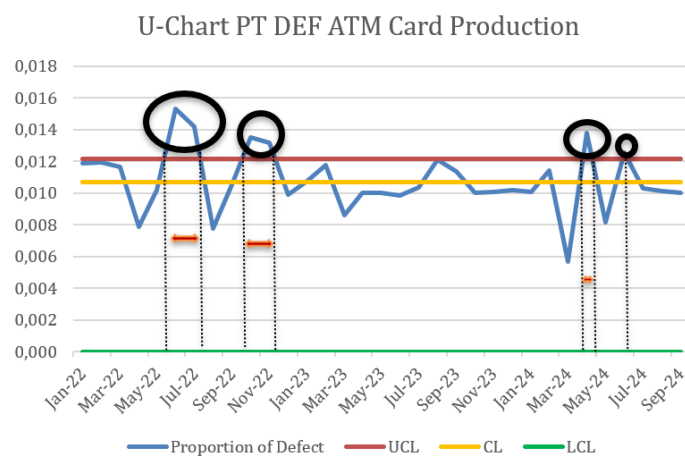


Figure 3.1

The figure shows that defect rates in PT DEF's ATM card production occasionally exceeded the Upper Control Limit (UCL), signaling irregularities beyond acceptable thresholds. Notable instances include June 2022 (0.015), July 2022 (0.014), and June 2024 (0.013), indicating abnormal variations that suggest unresolved root causes. These deviations may stem from machine malfunctions, inconsistent material quality, operational errors, or external disruptions. To address these issues, PT DEF must conduct a comprehensive fishbone analysis to systematically identify

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and resolve underlying factors across equipment, materials, methods, personnel, and environment, ensuring long-term process stability.

3.2.2 DPMO Calculation

Table 3.1 DPMO Calculation

Date	Total Production	Total Defects	CTQ	DPMO	Final Yield	Sigma Value
Jan-22	44.917	534	3	3.962,86	99,60%	4,155
Feb-22	36.082	431	3	3.981,67	99,60%	4,154
Mar-22	56.027	652	3	3.879,08	99,61%	4,162
Apr-22	49.086	387	3	2.628,04	99,74%	4,291
May-22	44.763	456	3	3.395,66	99,66%	4,207
Jun-22	44.241	678	3	5.108,38	99,49%	4,068
Jul-22	27.026	384	3	4.736,18	99,53%	4,095
Aug-22	34.143	265	3	2.587,16	99,74%	4,296
Sep-22	37.309	393	3	3.511,22	99,65%	4,196
Oct-22	40.396	546	3	4.505,40	99,55%	4,112
Nov-22	62.507	824	3	4.394,17	99,56%	4,120
Dec-22	60.485	599	3	3.301,09	99,67%	4,216
Jan-23	58.051	625	3	3.588,80	99,64%	4,188
Feb-23	47.956	563	3	3.913,31	99,61%	4,159
Mar-23	54.862	471	3	2.861,73	99,71%	4,263
Apr-23	37.940	379	3	3.329,82	99,67%	4,213
May-23	50.847	510	3	3.343,36	99,67%	4,212
Jun-23	68.284	673	3	3.285,30	99,67%	4,218
Jul-23	56.805	588	3	3.450,40	99,65%	4,202
Aug-23	50.084	605	3	4.026,57	99,60%	4,150
Sep-23	52.580	598	3	3.791,05	99,62%	4,170
Oct-23	57.260	572	3	3.329,84	99,67%	4,213
Nov-23	52.523	528	3	3.350,91	99,66%	4,211
Dec-23	38.470	392	3	3.396,59	99,66%	4,207
Jan-24	68.211	687	3	3.357,23	99,66%	4,211
Feb-24	68.396	782	3	3.811,14	99,62%	4,168
Mar-24	55.278	312	3	1.881,40	99,81%	4,397
Apr-24	42.291	584	3	4.603,03	99,54%	4,104
May-24	56.101	456	3	2.709,40	99,73%	4,281
Jun-24	69.731	874	3	4.177,96	99,58%	4,137
Jul-24	59.399	610	3	3.423,18	99,66%	4,204
Aug-24	48.693	492	3	3.368,04	99,66%	4,210
Sep-24	54.984	550	3	3.334,30	99,67%	4,213



Based on Table 3.1, PT DEF's production quality, measured by Defects Per Million Opportunities (DPMO), highlights significant variations. The lowest DPMO of 1,881.40 in March 2024 reflects strong process control nearing 6σ , while the highest DPMO of 5,108.38 in June 2022 indicates deviations at 4σ , with higher Costs of Poor Quality (CoPQ). Final Yield and Sigma Values further illustrate this trend, with the highest yield (99.81%) and Sigma Value (4.397) in March 2024, contrasting with lower metrics in June 2022. Currently operating at 4σ to 4.2σ , PT DEF falls short of the ideal 5σ level for banking standards, where DPMO would drop to 230 and CoPQ significantly decrease. Achieving 5σ requires robust quality management to enhance reliability and efficiency.

3.3 Analyze

3.3.1 Fishbone Analysis

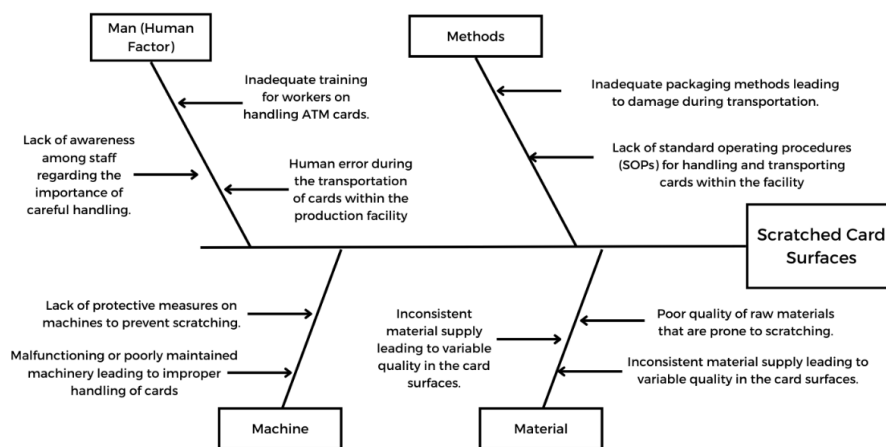


Figure 3.2 Fishbone Scratched Card Surfaces Analysis

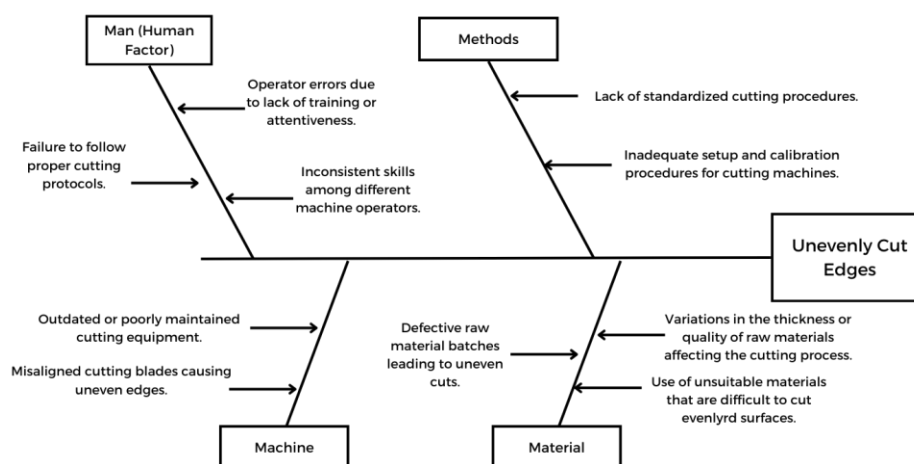


Figure 3.3 Fishbone Unevenly Cut Edges Analysis

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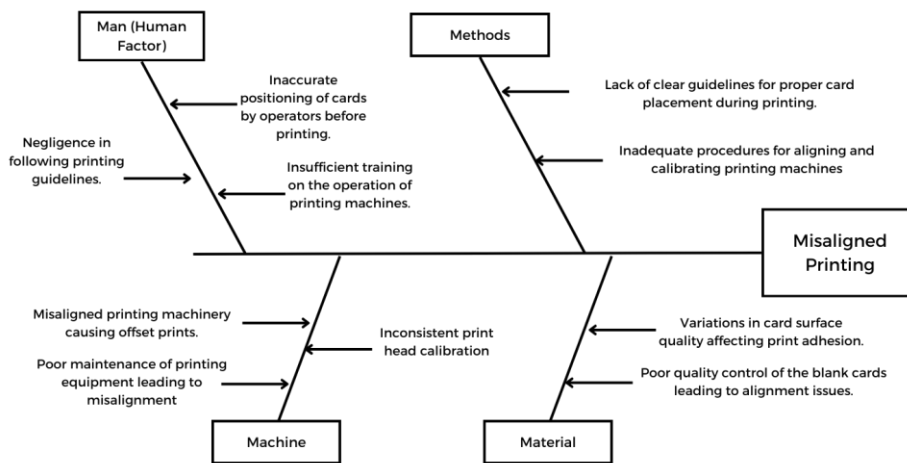


Figure 3.4 Fishbone Misaligned Printing Analysis

3.3.2 FMEA

FMEA provides an in-depth analysis of defects in ATM card production by categorizing root causes and evaluating their associated Severity (SEV), Occurrence (OCC), and Detection (DET) scores, which combine to form the Risk Priority Number (RPN). Higher RPN values denote critical risks demanding immediate action, while lower values indicate lesser urgency. Misaligned printing machinery causing offset prints holds the highest RPN of 408.00, making it the most pressing issue in the production process. This defect necessitates immediate corrective actions, such as regular machine calibration and maintenance. Similarly, poor maintenance of printing equipment (398.67) and outdated cutting tools (393.52) also rank high in criticality, emphasizing the importance of scheduled maintenance and equipment upgrades to maintain production consistency.

Other significant risks include insufficient training on operating printing machines (357.00), human error during card transportation (354.37), and misaligned cutting blades causing uneven edges (352.00). These highlight the role of human factors and machine operation in production defects, underscoring the need for comprehensive training programs and strict adherence to operational protocols. Moderately high RPN values, such as inadequate packaging during transportation (309.63) and negligence in following printing guidelines (327.41), suggest critical yet less urgent issues that still affect production quality and customer satisfaction. Addressing these factors requires enhanced process controls and consistent guideline enforcement.

Lower RPN values, such as poor-quality raw materials prone to scratching (222.22) and lack of standardized cutting procedures (160.44), indicate risks with lower severity but potential for improvement. Although less frequent, these issues can be mitigated by improving supplier quality control and implementing consistent cutting standards. Addressing both high- and low-priority risks is essential for enhancing production efficiency and maintaining customer trust. The sorted FMEA table prioritizes solutions based on RPN values, ensuring critical root causes are addressed systematically.

3.4 Improve Phase

The Improve Phase focuses on implementing solutions to address defects in ATM card production at PT DEF, guided by prioritized Risk Priority Numbers (RPN). Actions for the most critical defects, such as Misaligned Printing Machinery Causing Offset Prints (RPN: 408.00) and Poor Maintenance of Printing Equipment (RPN: 398.67), include regular machine calibration,



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automated alignment tools, and routine maintenance schedules, executed by the Maintenance Team from January to March 2025. Similarly, addressing Outdated Cutting Equipment (RPN: 393.52) and Malfunctioning Machinery (RPN: 376.52) involves replacing outdated machines and preventive maintenance schedules, carried out by the Engineering and Maintenance Teams from March to May 2025. These actions aim to improve production reliability and mitigate disruptions effectively.

Additional actions target Insufficient Training on Printing Machines (RPN: 357.00) and Human Error During Card Transportation (RPN: 354.37) through structured hands-on training, skill assessments, and automated transportation systems led by the Training and Logistics Teams from March to May 2025. Medium-priority defects, such as Inadequate Calibration Procedures (RPN: 332.44) and Negligence in Following Printing Guidelines (RPN: 327.41), focus on creating standardized calibration protocols and enforcing adherence to guidelines, implemented by Calibration Experts and Quality Assurance Teams from July to October 2025. Finally, lower-priority defects like Poor Quality Control of Blank Cards (RPN: 238.52) and Defective Raw Material Batches (RPN: 255.56) are addressed with stricter QC protocols and supplier quality audits, led by the Procurement Team from March to May 2026. This structured approach ensures simultaneous and sequential actions to optimize resources and achieve long-term quality improvements.

3.5 Control Phase

The Control Phase establishes monitoring and evaluation mechanisms to ensure the sustainability of improvements and prevent defect recurrence. Each action has a designated Person in Charge (PIC) responsible for overseeing implementation, progress tracking, and compliance. For example, the Maintenance Team Leader oversees machinery-related tasks, while the Training Manager focuses on operator skill development. A monitoring framework includes progress meetings, checklists, and KPIs like reduced defect rates and improved operator efficiency. Regular reporting tools, such as dashboards, ensure transparency and real-time updates.

Periodic audits and feedback loops are integral to this phase. Quarterly calibration checks, semi-annual operator performance assessments, and annual SOP compliance reviews help maintain adherence to improvements. Feedback from stakeholders ensures the plan remains dynamic and responsive to challenges. PICs submit periodic progress reports to senior management, highlighting completed tasks and proposing adjustments where needed. This systematic approach fosters accountability, continuous improvement, and a robust production process at PT DEF.

4. CONCLUSION

The defects in ATM card production at PT. DEF Indonesia are caused by multiple factors categorized into human error, process inefficiencies, machine-related issues, and material quality inconsistencies. The primary contributing factors include inadequate training for operators, negligence in following Standard Operating Procedures (SOPs), malfunctioning or outdated machinery, improper machine calibration, and the use of substandard raw materials. These issues collectively lead to critical defects such as scratched card surfaces, unevenly cut edges, and misaligned printing, each significantly impacting production quality and operational efficiency.

Among these defects, machine-related causes have the most significant impact on the production process. Poorly maintained or outdated equipment leads to high defect rates, with issues like misaligned printing machinery and malfunctioning cutting equipment identified as the most critical through high Risk Priority Numbers (RPN). For example, the misalignment of printing machinery scored an RPN of 408, highlighting its severe impact on product quality and operational performance. These machine-related failures directly affect precision, reliability, and the overall defect rates, emphasizing the need for immediate interventions.

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To address production challenges, PT. DEF should implement a structured improvement plan based on the Six Sigma DMAIC framework. Key recommendations include regular calibration and maintenance of machinery, upgrading outdated equipment, comprehensive operator training to adhere to SOPs, and stricter material quality control during procurement. Prioritizing solutions by Risk Priority Number (RPN) ensures focus on critical defect causes for maximum impact. A robust control phase with periodic audits, continuous monitoring, and real-time reporting will sustain improvements, while clear accountability for Maintenance, Quality Assurance, and Training teams enhances implementation effectiveness. These measures will significantly reduce defect rates, boost operational efficiency, and improve customer satisfaction, positioning PT. DEF to consistently deliver high-quality ATM cards that meet industry standards and customer expectations.

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