

**STRATEGIC DEVELOPMENT OF AN INFORMATION DASHBOARD
FOR ENHANCING CUTTING TOOLS PERFORMANCE
IN CYLINDER COMP K1X LINE**

By
Dzulfikar Arifuddin
22452005

MASTER'S DEGREE
in

MECHANICAL ENGINEERING – ENGINEERING MANAGEMENT
FACULTY OF ENGINEERING AND INFORMATION TECHNOLOGY



SWISS GERMAN UNIVERSITY
The Prominence Tower
Jalan Jalur Sutera Barat No. 15, Alam Sutera
Tangerang, Banten 15143 – Indonesia
Revision after the Thesis Defense on August 14, 2025

STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at any educational institution, except where due acknowledgement is made in the thesis.


Dzulfikar Arifuddin

Student
August 22, 2025

Date

Approved by:

Assoc. Prof. Dr. Ir. Gembong Baskoro M.Sc., IPU, ASEAN
Eng., ACPE, APEC Eng.

Thesis Advisor
August 23, 2025

Date


Assoc. Prof. Dr. rer. nat. Filiana Santoso

Thesis Co-Advisor
August 26, 2025

Date

Dr. Ir. Maulahikmah Galinium, S.Kom., M.Sc.

Dean Faculty Engineering and Information Technology

Date

ABSTRACT

STRATEGIC DEVELOPMENT OF AN INFORMATION DASHBOARD FOR ENHANCING CUTTING TOOLS PERFORMANCE IN CYLINDER COMP K1X LINE

By

Dzulfikar Arifuddin ST.

Assoc. Prof. Dr. Ir. Gembong Baskoro M.Sc., IPU, ASEAN Eng., ACPE, APEC Eng.,
Advisor

Assoc. Prof. Dr. rer. nat. Filiana Santoso, Co-Advisor

SWISS GERMAN UNIVERSITY

This thesis proposes a strategic development of an integrated information dashboard to enhance cutting tool efficiency in the Cylinder Comp K1X production line. Inefficiencies identified include the lack of real-time data access, inconsistent tool replacement cycles, and limited traceability across functions. Using the DMAIC methodology (Define, Measure, Analyze, Improve, Control), the research systematically analyzes current conditions and implements targeted improvements. The dashboard developed connects production, logistics, and tool management systems, enabling real-time monitoring, automated alerts, and historical usage analysis. Post-implementation evaluation demonstrates significant gains in performance indicators—improving tool usage accuracy, reducing unplanned downtime, and optimizing tool inventory control. Additionally, the system facilitates Industry 4.0 readiness by incorporating RFID, data analytics, and IoT connectivity, promoting smarter decision-making and predictive maintenance strategies. The result is a scalable digital solution that fosters operational efficiency, transparency, and sustainable process control through a data-driven approach.

Keywords: Cutting Tool Efficiency, Digital Dashboard, Industry 4.0, DMAIC, Real-Time Monitoring, Tool Management, Smart Manufacturing



DEDICATION

I dedicate this work to my parents and in-laws, my teachers, my brothers and sisters, my wife and two daughters, all my friends, and all humanity and all His creatures.



ACKNOWLEDGEMENTS

Praise be to Allah Subhanahu wa Ta'ala, for the abundance of His mercy, taufik, and guidance. Thanks to His permission and pleasure, I was able to complete this master's study journey to the final stage in the form of writing and completing a thesis. Alhamdulillahilladzi bini'matihi tatimmush shālihāt - All praise be to Allah, with His favor all goodness is perfect.

Prayers and greetings may always be poured out to our lord, the Prophet Muhammad SAW, the great example who brings treatises of knowledge, charity, and noble morals to all mankind. With all due respect and gratitude, I would like to express my deepest appreciation to, The Advisor of my thesis, Assoc. Prof. Dr. Ir. Gembong Baskoro M.Sc., IPU, ASEAN Eng., ACPE, APEC Eng., for his guidance, direction, and sincerity in guiding me with patience and thoroughness. My Co-Advisor, Assoc. Prof. Dr. rer. Nat. Filiana Santoso, who has provided a lot of constructive input, academic expertise, and enthusiasm during this research process.

I would also like to express my deep gratitude to my beloved family, for their unwavering love, prayers, and moral support throughout this study process. Thank you also to my comrades-in-arms, friends, and loved ones who have been a source of inspiration and strength when my spirit is wavering. Your support is one of the best gifts on this journey.

I would also like to express my deepest gratitude and appreciation to the management of the company where I work, as well as all the leaders and colleagues who have given me real support and the opportunity to pursue and complete my Master's education at the Swiss German University.

May all the kindness that has been given to me get a multiplied reward from Allah SWT. Finally, I dedicate this achievement as a small effort in spreading the benefits and values of the blessings of knowledge that can give meaning to many parties.

TABLE OF CONTENTS

	Page
STATEMENT BY THE AUTHOR	2
DEDICATION	5
ACKNOWLEDGEMENTS	6
TABLE OF CONTENTS.....	7
LIST OF FIGURES	10
LIST OF TABLES	12
CHAPTER 1 – INTRODUCTION.....	13
1.1. Background	13
1.2. Research Problem	16
1.3. Research Objective	16
1.4. Research Question	16
1.5. Hypothesis.....	17
1.6. Research Scope and Limitation	17
1.6.1. Research Scope.....	17
1.6.2. Research Limitation	18
1.7. Significance of Study	18
CHAPTER 2 – LITERATURE REVIEW	19
2.1. Introduction to Literature Review	19
2.2. The Machining Process and Role of Cutting Tools.....	19
2.3. The Complexity of Current Procedures and Cutting Tools Change Cycle.....	20
2.4. Importance of Troubleshooting in Cutting Tools Management.....	22
2.5. Cost Optimization in Cutting Tools Management.....	25
2.6. Information Dashboard Design: Challenges and Best Practices	27
2.7. Digitalization Implementation Strategy Based on Industry Readiness	27
2.8. Obstacles and Challenges in Digital Transformation	31
2.9. Previous Studies and Research Gaps	32
2.10. Research Conceptual Framework.....	32

CHAPTER 3 – RESEARCH METHODS	33
3.1. Research Framework	33
3.2. Analytical Method	33
3.3 Research Question Approach	35
3.4. Evaluation Method.....	36
3.5. Validation Method	36
CHAPTER 4 – RESULTS AND DISCUSSIONS	38
4.1. Research Environment	38
4.1.1. Enterprise Digital Transformation Initiatives.....	38
4.1.2. Machining Process Control Priority: Cutting Tools Focus	39
4.1.3. Position of Cylinder Comp K1X in Production System	41
4.2. Define Stage Results	45
4.2.1. Identify Digitalization Problems and Needs	45
4.2.2. Operational Processes and Tools Center Overview	50
4.2.3. Main Problems and Problem Resumes	56
4.3. Measure Stage Results: Initial Evaluation & Process Performance Assessment .	59
4.3.1. Cutting Tool Replacement Frequency (Conformity Standard – Actual) .	59
4.3.2. Cutting Tools Replacement and Machines–Tools Center Activities.....	62
4.3.3. Inventory Stock That Guarantees Cutting Tool Replacement Cycle.....	62
4.4. Analysis Stage Results: Root Cause and Digital Readiness Analysis	65
4.4.1. Root Analysis of Inefficiency Cutting Tools Problem	65
4.4.2. Cutting Tools Lead Time and Administrative Activities.....	73
4.4.3. Analysis of the Effectiveness of Buffer and Cycle Stock Cutting Tools.	74
4.4.4. Digitalization Readiness Assessment	76
4.4.5. Solution Priority Matrix & Roadmap for Increasing Maturity Level	79
4.4.6. RACI Matrix Implementation Roadmap Cutting Tools Management	81
4.4.7. Decision Matrix: Selection of RFID Concepts and Dashboards	83
4.5. Improve Stage: Effective Solution Development Design	86
4.5.1. Designed Improve Solutions	87
4.5.2. Implementation and Evaluation Plan	98
4.5.3. Conclusion of the Improve Stage	99
4.6. Control Stage: Keeping Improve Stable	99
4.6.1. Dashboard-Based Real-Time Monitoring System.....	99

4.6.2. Implementation of Early Warning and Digital Andon System	101
4.6.3. Process Statistical Control (SPC) and Historical Analysis	101
4.6.4. Data-Driven Process Audit and Feedback Loop	101
4.6.5. Standard Documentation and SOP Alignment	102
4.7. Impact Evaluation and Outcome Discussion.....	103
4.7.1. Impact Evaluation on Operational Performance	103
4.7.2. Discussion of Results and Relevance to Industry 4.0.....	111
4.7.3. Managerial and Strategic Implications	111
4.7.4. Reflection on Limitations and Further Recommendations	112
CHAPTER 5 – CONCLUSIONS AND RECOMMENDATIONS	113
5.1. Conclusions	113
5.2. Recommendations.....	115
5.3. Closing Remarks.....	116
GLOSSARY.....	117
REFERENCES.....	119
CURRICULUM VITAE.....	122

LIST OF FIGURES

Figures	Page
1.1. Engine Part and Percentage Cost Manufacturing Machining Part	13
1.2. Percentage composition of special & multi-purpose machines.....	14
1.3. Process and Material Part of Cylinder Comp.....	15
2.1. Cutting Tools Selection Framework & Material Trends	20
2.2. Existing Flow Procedure Tools Management	21
2.3. Existing Tools Change Cycle (Production Line – Tools Center).....	22
2.4. Cause and Effect diagram for low tool availability	24
2.5. Flowchart of the proposed cost optimization process.....	26
2.6. Influence of the levers on the targets	29
2.7. Industry 4.0 Readiness-Model for tool management	30
3.1. Research Framework for the Development of Information Dashboards.....	34
3.2. Cutting Tools Dashboard Development Research Roadmap	37
4.1. Company's Digital Transformation Initiative Cascade	39
4.2. 4 Key Aspect for Operational Excellence Machining Process.....	40
4.3. How Does a Four-Stroke Engine Work and Cylinder Comp Part.....	41
4.4. Lay Out Process Machining Cylinder Comp K1X (Blue Box : MPM).....	42
4.5. Value Stream Map (VSM) Process Machining Cylinder Comp K1X.....	44
4.6. Flow of Cutting Tools Changing Cycle	51
4.7. Flow of Cutting Tools transaction and documents.	52
4.8. Process Flow and Replacement Time of Cutting Tools in Machines	53
4.9. Tools Shop and Tools Grinding Man Power Work Load	54
4.10. List Cutting Tools Process Cylinder Comp K1X Multi Purpose Machine.....	55
4.11. Cutting Tool Replacement Breakdown and Overuse Pareto Analysis	59
4.12. Situation Analysis (SA) Counter Measure Dril Dia. 6,6 (IN-5DS309)	61
4.13. Top 3 of Cutting tools with the highest damage Frequency.....	65
4.14. 3 types of L/O cutting tools with the highest damage rate.....	66

4.15. RCA - fishbone diagram Top 3 of Cutting tools	68
4.16. FTA Inefficiency of cutting tools replacement.....	70
4.17. Potential Time Reduction in Flow of Cutting Tools Changing Cycle.....	73
4.18. Decision Matrix Analysis of Concept Digitization Information Dashboard.....	85
4.19. Network – Topology and Data – Infrastructure & connecting.....	88
4.20. RFID & Barcode System for Individual Identification.....	89
4.21. Master Plan Digital Transformation Cutting Tools Management System.....	91
4.22. Cutting Tool Management System Concept and Its Application.....	92
4.23. Key Feature of Dashboard Cutting Tools Management System	94
4.24. Various operational training modules that contain SOPs & other instructions..	96
4.25. Dashboard display – visual indicators of abnormal (red) & normal (green) ...	100
4.26. Cutting Tools Replacement & Conformity Improvement Before–After.....	104
4.27. Before and after Flow of Cutting Tools Changing Cycle	106



LIST OF TABLES

Table	Page
1.1. Material, Machine & Process in In-Plant Part Manufacturing Matrix	14
3.1. Suitability of DMAIC Stages with Research Activities	35
4.1. SIPOC – Cutting Tools Management System	45
4.2. Questionnaire results recapitulation – service and information update	46
4.3. Interview recap – Digital transformation management cutting tools.	49
4.4. Initial Actual Data Frequency of Cutting Tools replacement	55
4.5. Categories of Abnormal Replacement of 3 Cutting Tools	56
4.6. Findings and conclusions from the VOC, VOB and VOP	58
4.7. Big 4 conformity deviations exceeding 100%	60
4.8. List Quantity & Percentage Cutting Tools Process, Safety Stock Cycle	63
4.9. Initial Process Performance Metrics of Cutting Tools Management	64
4.10. FMEA – Risk in Cutting Tools Management	72
4.11. Implications for the effectiveness of the stock system	75
4.12. Industry 4.0 Readiness-Model for cutting tools management	78
4.13. Solution Priority Matrix	80
4.14. RACI Matrix for Roadmap Cutting Tool Management Implementation	82
4.15. The success indicators of the Improve Implementation	98
4.16. Big 3 conformity deviations exceeding 100% (Before – After)	104
4.17. Replacement activities before & after the implementation	107
4.18. List Cutting Tools Comparison Before and After	109
4.19. Comparison of Indicator Performance Before and After	110