

**SIMULATION MODELLING TO IMPROVE THE PRODUCTION
CAPACITY OF THE PLASTIC INJECTION LINE AT PT XYZ USING
PLANT SIMULATION SOFTWARE: A CASE STUDY**

By

Doni Hermawan
2-2452-008

MASTER'S DEGREE
in

MASTER OF MECHANICAL ENGINEERING DEPARTMENT
FACULTY OF ENGINEERING AND INFORMATION TECHNOLOGY

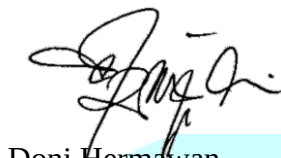


SWISS GERMAN UNIVERSITY
The Prominence Tower
Jalan Jalur Sutera Barat No. 15, Alam Sutera
Tangerang, Banten 15143 - Indonesia

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.



Doni Hermawan

14 August 2025

Student

Date

Approved by:

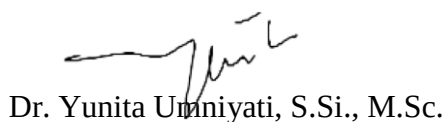


Dr. Ir. Maulahikmah Galinium, S.Kom., M.Sc.

23 August 2025

Thesis Advisor

Date



Dr. Yunita Umniyati, S.Si., M.Sc.

25 August 2025

Thesis Co-Advisor

Date



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

23 August 2025

Dean

Date

Doni Hermawan

ABSTRACT

SIMULATION MODELLING TO IMPROVE THE PRODUCTION CAPACITY OF THE PLASTIC INJECTION LINE AT PT XYZ USING PLANT SIMULATION SOFTWARE: A CASE STUDY

By:

Doni Hermawan

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

Dr. Yunita Umniyati, S.Si., M.Sc., Co-Advisor

SWISS GERMAN UNIVERSITY

PT XYZ faces production capacity limitations of 2,250 part-sets per day of plastic parts, with an additional 400 part-sets demand that drives 40.5% overtime costs. This study develops a simulation model to improve the K-XX injection line. Using the DMAIC (Define, Measure, Analyze, Improve, Control) framework. By combining real data collection, FGD (Focus Group Discussion), OEE (Overall Equipment Effectiveness), Six Big Losses Analysis and simulation using Tecnomatix Plant Simulation, aiming to address inefficiencies in cycle time and machine downtime and quality issue. The modelling output indicates an 8.89 % increase in capacity, from 2,250 to 2,450 part-sets per day. The OEE improves from 78.0 % to 85.3 %, surpassing company targets and approaching world-class standards. Cost analysis reveals a 43.5 % reduction in annual overtime for the K-XX injection line, showing improved capacity utilisation, balanced scheduling, and more efficient labour control. Forecast accuracy remains high, with MAPE (Mean Absolute Percentage Error) 1.69 %. These findings demonstrate that simulation modelling supports informed decision-making in sustainable production planning and control.

Keywords: Production Capacity, Plastic Injection, Simulation Modelling, Tecnomatix Plant Simulation



DEDICATION

I dedicate this work to my family, my friends from college, my colleagues at work,
and to the fields of education and industry in Indonesia and around the world.



ACKNOWLEDGEMENTS

First and foremost, I sincerely thank Allah SWT for the blessings and ease granted throughout the completion of this work.

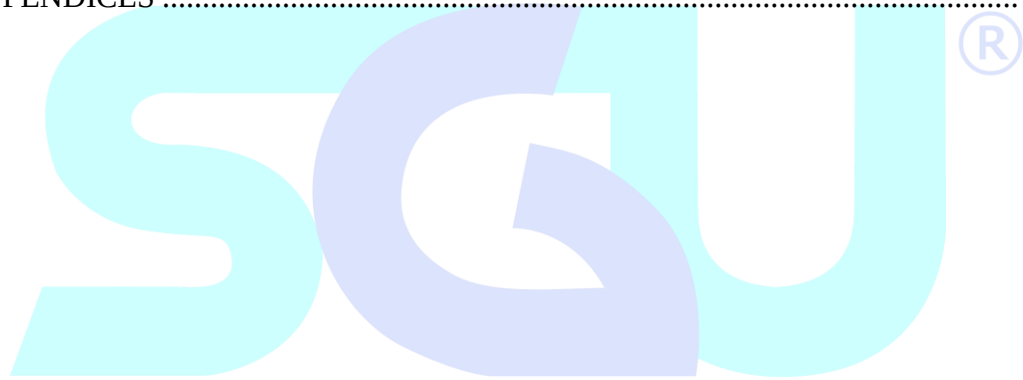
I am also deeply grateful to all members of my thesis committee for their continuous support, patience, and encouragement. Their thoughtful and constructive guidance has been invaluable. I found my learning activities throughout the Curriculum and Learning program stimulating and thoughtful, providing me with the tools to explore past and present ideas and issues. My sincere appreciation goes to Dr. Ir. Maulahikmah Galinium, S.Kom., M.Sc., my main thesis advisor, for his valuable direction throughout the research process. I also extend my gratitude to Dr. Yunita Umniyati, S.Si., M.Sc, as my co-advisor, for her consistent support during the completion of this thesis. I would like to acknowledge Dr. Ir. Gembong Baskoro, M.Sc., and Dr. Eng. Aditya T. Pratama, S.Si., M.T. for their helpful input during my Thesis Proposal defense. Additionally, I am thankful to Mr. Dena Hendriana, B.Sc., S.M., Sc.D., who believed in our capability not only to finish this academic journey but to do so with outstanding results.

The learning experience through the Curriculum and Learning program has been enriching and inspiring, equipping me with critical tools to examine past and present concepts and challenges.

TABLE OF CONTENTS

	Page
STATEMENT BY THE AUTHOR.....	2
ABSTRACT.....	3
DEDICATION.....	5
ACKNOWLEDGEMENTS.....	6
TABLE OF CONTENTS.....	7
LIST OF FIGURES	9
LIST OF TABLES.....	11
CHAPTER 1 – INTRODUCTION	13
1.1. Background.....	13
1.2. Research Problem	18
1.3. Research Objective	18
1.4. Research Question	18
1.5. Hypothesis.....	19
1.6. Research Scope and Limitation.....	19
1.7. Significance of Study.....	20
1.8. Thesis Structure	20
CHAPTER 2 - LITERATURE REVIEW.....	22
2.1 Theoretical Perspective	22
2.2 Simulation.....	37
2.3. Previous Studies.....	45
CHAPTER 3 – RESEARCH METHODS	49
3.1. Research Framework	49
3.2 Define Phase	51
3.3 Measure Phase	56
3.4 Analyze Phase.....	60
3.5 Improve Phase.....	66
3.6 Control Phase	69
CHAPTER 4 – RESULTS AND DISCUSSIONS.....	72
4.1 Overview	72

4.2 Define Phase Result	73
4.3 Measure Phase Result	79
4.4 Analyze Phase Result.....	103
4.5 Improve Phase Result	113
4.6 Control Phase Result.....	120
4.7 Key Performance Indicators Result	134
CHAPTER 5 – CONCLUSIONS AND RECCOMENDATIONS.....	138
5.1. Conclusions.....	138
5.2. Future Works	139
5.3. Recommendations.....	139
GLOSSARY	140
REFERENCES	141
CURRICULUM VITAE	145
APPENDICES	147



LIST OF FIGURES

Figures.....	Page
Figure 1. 1 General production process (PT XYZ, 2002).....	13
Figure 1. 2 Product sample of plastic injection at PT XYZ.....	14
Figure 1. 3 Trend demand for K-XX model	15
Figure 1. 4 The K-XX model of plastic injection capacity.....	16
Figure 1. 5 OEE achievement of Plastic Injection K-XX model 2024.....	17
Figure 2. 1 Injection molding flow chart (a) and a simplified model of an injection modelling machine (b) (Zhao <i>et al.</i> , 2022)	22
Figure 2. 2 Factors that affect OEEF (Nursanti and Susanto, 2014)	33
Figure 2. 3 Network visualization of DES application in last five years.....	39
Figure 2. 4 Plant Simulation first step (Bangsowmi, 2020).....	42
Figure 2. 5 Percentage of time distribution of the balanced production line (Islam, Sarker and Parvez, 2019)	44
Figure 3. 1 Research framework.....	50
Figure 3. 2 FGD-1 flow	52
Figure 3. 3 CTQ formulation method	54
Figure 3. 4 Comprehensive SIPOC diagram.....	55
Figure 3. 5 FGD-2 flow	58
Figure 3. 6 Flow actual process mapping	60
Figure 3. 7 Interview process.....	61
Figure 3. 8 RCA diagram (Ishikawa, 1960).....	64
Figure 3. 9 Example of simulation analysis using resource statistics.....	65
Figure 3. 10 FGD-4 flow	68
Figure 3. 11 Flow FGD-5.....	71
Figure 4. 1 SIPOC diagram of plastic injection process	77
Figure 4. 2 High level SIPOC mapping of plastic injection process	78
Figure 4. 3 Initial simulation model design using Tecnomatic Plant Simulation.....	97
Figure 4. 4 Radar chart of FGD-3 result	104
Figure 4. 5 Value weight factors relationship	106
Figure 4. 6 Ishikawa diagram of Six Big Losses	107

Figure 4. 7 Average downtime duration	109
Figure 4. 8 Average downtime per machine	110
Figure 4. 9 Average MTTR per machine	111
Figure 4. 10 Resources statistics anaylisis	112
Figure 4. 11 Alternative improvement - model simulation 1.....	115
Figure 4. 12 Alternative improvement - model simulation 2.....	116
Figure 4. 13 Alternative improvement - model simulation 3.....	117
Figure 4. 14 Final model simulation to implement.....	120
Figure 4. 15 Update improvement - optimizing cycle time result	122
Figure 4. 16 Update improvement - down time reduction.....	124
Figure 4. 17 Sample activity to reduce rejection rate	125
Figure 4. 18 Update improvement - rejection rate reduction.....	125
Figure 4. 19 Actual machine capacity (after improvement)	127
Figure 4. 20 Actual production output capacity (after improvement)	128
Figure 4. 21 Line capability to meet demand.....	129
Figure 4. 22 Draft new SOP for the simulation model used.....	133
Figure 4. 23 Updated OEE achievement.....	134
Figure 4. 24 Manpower cost	135
Figure 4. 25 Overtime efficiency	136
Figure 4. 26 Potential cost saving from overtime	137

LIST OF TABLES

Table	Page
Table 2. 1 Requirement data to calculate injection time.....	24
Table 2. 2 Data requirement for cooling time calculation	25
Table 2. 3 Data requirement for take-out part time.....	27
Table 2. 4 Six big losses (Patel and Deshpande, 2016)	34
Table 2. 5 DES application in the research.....	41
Table 2. 6 Research comparison	46
Table 3. 1 Uncorrelated data	57
Table 3. 2 Correlation Coefficient (Schober and Boer, 2018)	62
Table 3. 3 World class OEE in industry (Nakajima, 1988)	63
Table 3. 4 A scale of judgment of forecast accuracy (Lewis, 1982).....	70
Table 4. 1 Initial discussion result of FGD-1	73
Table 4. 2 Thematic issue of discussion result FGD-1	74
Table 4. 3 Interrelationship matrix of FGD-1 result	75
Table 4. 4 Critical to Quality determination	76
Table 4. 5 Technical data of injection machine	79
Table 4. 6 Plastic material data sheet	80
Table 4. 7 Data of plastic part product.....	81
Table 4. 8 Operation time in plastic injection process	82
Table 4. 9 Maintenance data setting.....	83
Table 4. 11 Cost of plastic parts model K-XX.....	84
Table 4. 12 Actual data collection	85
Table 4. 13 Injection rate calculation.....	86
Table 4. 14 Injection time calculation.....	86
Table 4. 15 Thermal diffusivity of each plastic part	87
Table 4. 16 Cooling time calculation	88
Table 4. 17 Molding time calculation	89
Table 4. 18 Ejection time calculation	89
Table 4. 19 Takeout part time calculation.....	90
Table 4. 20 Cycle time calculation.....	91

Table 4. 21 Effective working time calculation	92
Table 4. 22 Setting capacity per machine by design.....	93
Table 4. 23 Setting capacity per product by design	93
Table 4. 24 Initial performance target setting	94
Table 4. 25 Actual production capability	95
Table 4. 26 Actual production performance	96
Table 4. 27 Actual capacity using simulation model	98
Table 4. 28 Initial data validation	99
Table 4. 29 Cross functional clarification of opinion	100
Table 4. 30 Potential problem validation	101
Table 4. 31 Simulation vs actual gap matrix.....	102
Table 4. 32 Actual process mapping of machine	103
Table 4. 33 Relationship of factors with the production capacity	104
Table 4. 34 OEE component correlation.....	105
Table 4. 35 Correlation of the matrix of influential factors	108
Table 4. 36 Alternative solution identification result	113
Table 4. 37 Improvement alternative activities.....	114
Table 4. 39 Final agreement table.....	119
Table 4. 40 Sample activities to reduce cooling time	121
Table 4. 41 Sample activities to reduce mold set-up time	123
Table 4. 42 Daily production setting.....	126
Table 4. 44 Final Review Validation of Simulation Model & SOP Agreement.....	132