

TABLE OF CONTENTS

APPROVAL SHEET	iii
VALIDATION SHEET.....	v
DECLARATION OF ACADEMIC INTEGRITY.....	vi
ACKNOWLEDGEMENTS	vii
TABLE OF CONTENTS	viii
LIST OF TABLES	xi
GLOSSARY	xiv
<i>INTISARI</i>	xvi
<i>ABSTRACT</i>	xvii
BAB I INTRODUCTION	1
I.1 Background.....	1
I.2 Research Question	4
I.3 Aim and Objectives.....	5
I.4 Research Scope	5
I.5 Research Contribution	6
BAB II LITERATURE REVIEW	8
II.1 Previous Study	8
II.1.1 Japan.....	8
II.1.2 South Korea.....	9
II.1.3 United Kingdom.....	10
II.1.4 NPV and BCR method.....	10
II.1.5 FMEA Method	11
II.2 Research Originality	12
BAB III THEORETICAL FRAMEWORK	14
III.1 Level Crossing Safety	14
III.2 Current Condition of Level Crossings in Indonesia.....	15
III.3 Early Warning System	19
III.4 Classification of Bollard Technologies.....	20
III.5 Classification of Road-Blockers	21
BAB IV METHODOLOGY	23
IV.1 Location.....	23



IV.2	Research Procedure	23
IV.3	Secondary Data Collection.....	25
IV.4	Analysis Method	26
IV.4.1	System Design and Visual Simulation.....	26
IV.4.2	Technical Evaluation.....	28
IV.4.3	Cost Estimation and Economic Feasibility	33
IV.4.4	Preliminary Risk Analysis (FMEA).....	35
BAB V ANALYSIS DATA		37
V.1	Accident Data Analysis.....	37
V.1.1	National Accident Trends (2017-2024)	37
V.1.2	Accident Distribution by Type of Users (2017-2024)	44
V.1.3	Locations (2017-2024)	46
V.2	Proposed System Design.....	47
V.2.1	Functional Design Layout	47
V.3	Technical Evaluation.....	52
V.3.1	Conventional Barrier-Gates Components	52
V.3.2	Rising Barriers-Based Warning Systems	53
V.3.3	Ergonomics Considerations for Road Users	54
V.3.4	System Components Overview	57
V.4	Economic Feasibility Analysis of Proposed Design	62
V.4.1	Economic Losses and Annual Savings Due to Railway Crossing Accidents .	62
V.4.2	NPV and BCR.....	64
V.4.3	Sensitivity Analysis.....	68
V.5	Risk Evaluation.....	69
V.5.1	Risk Analysis and Key-Functional Design	74
BAB VI CONCLUSIONS		76
VI.1	Findings.....	76
VI.2	Recommendations	77
REFERENCES.....		79
<i>APPENDIX 1-CapEx & opex</i>		<i>83</i>
<i>APPENDIX 2 – COST ESTIMATION</i>		<i>84</i>
<i>APPENDIX 3a – BASIC CALCULATION OF VALUE STATISTICAL OF LIFE.....</i>		<i>90</i>
<i>APPENDIX 3b – DISCOUNT RATE</i>		<i>92</i>
<i>APPENDIX 4 – ESTIMATED AVERAGE DAILY TRAFFIC DATA - ADT.....</i>		<i>110</i>



Initial Feasibility Analysis of Barrier-Gates and Rising Barriers-Based Warning Systems for Safer Level Crossings in Indonesia

Dia Cahaya Putri, Prof. Dr. Techn. Ir. Danang Parikesit, M.Sc., IPU, APEC.Eng. ; Ir. Mukhammad Rizka Fahmi Amroza

Universitas Gadjah Mada, 2026 | Diunduh dari <http://etd.repository.ugm.ac.id/>

UNIVERSITAS
GADJAH MADA

<i>APPENDIX 5 (CANVA)</i>	111
<i>APPENDIX 6 (AUTOCAD)</i>	112
<i>APPENDIX 7 (SKETCHUP)</i>	114
<i>APPENDIX 8 (BERTEMAN CAMPAIGN)</i>	115
<i>APPENDIX 9 JUSTIFICATION OF FMEA SCORING</i>	117