



**UNDERGRADUATE THESIS**

**DESIGN AND DEVELOPMENT OF AN  
INVENTORY RENTAL SYSTEM USING THE  
RAPID APPLICATION DEVELOPMENT METHOD  
AND OPTICAL CHARACTER RECOGNITION-  
BASED STUDENT IDENTITY CARD VALIDATION**

**MUHAMMAD FAIZUL ULUM**  
NPM 22081010132

**THESIS ADVISORS**

Retno Mumpuni, S.Kom, M.Sc  
Afina Lina Nurlaili, S.Kom, M.Kom

**MINISTRY OF HIGHER EDUCATION, SCIENCE, AND TECHNOLOGY  
UNIVERSITAS PEMBANGUNAN NASIONAL VETERAN JAWA TIMUR  
FACULTY OF COMPUTER SCIENCE  
INFORMATICS STUDY PROGRAM  
SURABAYA  
2026**

# APPROVAL SHEET

## DESIGN AND DEVELOPMENT OF AN INVENTORY RENTAL SYSTEM USING THE RAPID APPLICATION DEVELOPMENT METHOD AND OPTICAL CHARACTER RECOGNITION-BASED STUDENT IDENTITY CARD VALIDATION

By:  
MUHAMMAD FAIZUL ULUM  
NPM. 22081010132


Has been defended before, and accepted by, the Board of Assessors of the Thesis Examination of the Informatics Study Program, Faculty of Computer Science, Universitas Pembangunan Nasional Veteran Jawa Timur, on May 12, 2026:

Approved,


Retno Mumpuni, S.Kom, M.Sc  
NIP. 198707162025212045

  
..... (Advisor I)


Afina Lina Nurlaili, S.Kom, M.Kom  
NIP. 1993121 3202203 2 010

  
..... (Advisor II)

Dr. Ir. Kartini, S.kom, MT  
NIP. 19611110 199103 2 001

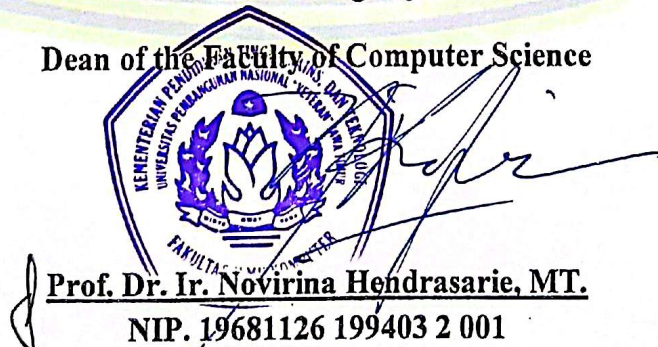

  
..... (Head Assessor)

Budi Mukhamad Mulvo S.Kom, M.T.  
NIP. 19891118 202406 1 003

  
..... (Assessor I)

Acknowledge by,

Dean of the Faculty of Computer Science

  
  
Prof. Dr. Ir. Novirina Hendrasarie, MT.  
NIP. 19681126 199403 2 001

## APPROVAL SHEET

### DESIGN AND DEVELOPMENT OF AN INVENTORY RENTAL SYSTEM USING THE RAPID APPLICATION DEVELOPMENT METHOD AND OPTICAL CHARACTER RECOGNITION-BASED STUDENT IDENTITY CARD VALIDATION

By:  
MUHAMMAAD FAIZUL ULUM  
NPM. 22081010132

Approved to proceed to the Thesis Examination

Approved by,

Coordinator of Informatics Study Program  
Faculty of Computer Science



Dr. Intan Yuniar Purbasari, S.Kom. MSc.  
NIP. 19800602 202521 2 029

## STATEMENT OF ORIGINALITY

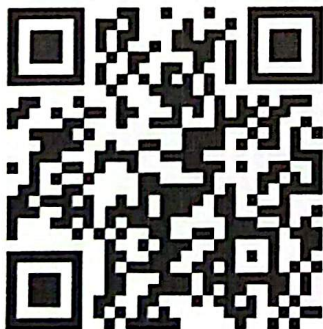
I am the undersigned:

Student Name : Muhammad Faizul Ulum  
NPM : 22081010132  
Degree Program : Bachelor (S1)  
Study Program : Informatics  
Faculty : Faculty of Computer Science

Hereby declares that this undergraduate thesis contains no part of any other scientific work that has been submitted to obtain an academic degree at any higher education institution. Furthermore, it does not contain any work or opinions previously written or published by others, except for those which are explicitly cited in this thesis and listed completely in references.

And I declare that this scientific document is free from elements of plagiarism. If in the future indications of plagiarism are found in this Thesis, I am willing to accept sanctions in accordance with the applicable laws and regulations.

Thus, I made this statement without any coercion from anyone and to be used as it should.



Surabaya, May 22, 2026  
Declarant,



MUHAMMAD FAIZUL ULUM  
NPM. 22081010132

## ABSTRACT

Student Name / NPM : Muhammad Faizul Ulum / 22081010132  
Thesis Title : Design and Development of an Inventory Rental System Using The Rapid Application Development Method and Optical Character Recognition-Based Student Identity Card Validation  
Advisor : 1. Retno Mumpuni, S.Kom, M.Sc  
2. Afina Lina Nurlaili, S.Kom, M.Kom

Inventory management at the Islamic Spiritual Activity Unit (UKKI) of UPN "Veteran" Jawa Timur is currently operated manually using spreadsheets. This method is susceptible to data entry errors, hinders real-time stock monitoring, and has security vulnerabilities in validating borrowers' identities, which increases the risk of asset misuse. This study aims to design and develop a web-based Inventory Rental Management Information System to overcome these problems. The system was developed using the Rapid Application Development (RAD) method, which proved effective in accommodating business flow changes iteratively. To ensure transaction security, the system integrates Optical Character Recognition (OCR) technology using the Tesseract engine to automatically extract and validate the Student Identity Card (KTM). To overcome the decrease in OCR accuracy due to noise and poor physical lighting conditions, the system applies post-processing algorithms based on Regular Expressions (Regex), Levenshtein Distance, and Bayesian Probability to intelligently correct reading errors (typos) by matching them with the internal database. The functional testing (Black Box) results prove that all features, including QR Code validation and transaction tracking, function properly. Algorithm performance testing shows an average character accuracy (Levenshtein Accuracy) of 95.51%. Decision accuracy evaluation using the Confusion Matrix yielded an accuracy rate of 83.33% with a 0% False Positive rate, proving the system is highly rigorous and secure in rejecting document manipulation. The implementation of this system has successfully realized an efficient, transparent, and accountable inventory management.

**Keywords:** Information System, Inventory, Rapid Application Development, Optical Character Recognition, Levenshtein Distance.

## ACKNOWLEDGEMENTS

Praise and gratitude be to Allah SWT for all His grace, guidance, and blessings bestowed upon the author, so that the thesis entitled “**Design and Development of an Inventory Rental System Using The Rapid Application Development Method and Optical Character Recognition-Based Student Identity Card Validation**” could be successfully completed.

In the preparation of this thesis, the author realizes that the smoothness and success achieved are inseparable from the guidance, advice, and support of various parties, whether moral, spiritual, or material. Therefore, on this occasion, the author would like to express the deepest gratitude to:

1. Prof. Dr. Ir. Novirina Hendrasarie, MT, as the Dean of the Faculty of Computer Science, Universitas Pembangunan Nasional "Veteran" Jawa Timur.
2. Dr. Intan Yuniar Purbasari, S.Kom., M.Sc., as the Coordinator of the Informatics Study Program, Faculty of Computer Science, Universitas Pembangunan Nasional "Veteran" Jawa Timur.
3. Retno Mumpuni, S.Kom., M.Sc., as the Primary Advisor, who has patiently spared her time to provide guidance, advice, knowledge, and motivation to the author from the beginning to the completion of this thesis.
4. Afina Lina Nurlaili, S.Kom., M.Kom., as the Secondary Advisor, who consistently provided invaluable direction, evaluation, and technical input during the system design and report writing processes.
5. Dr. Ir. Kartini, S.Kom., M.T., as the First Examiner, who has taken the time to examine and provide invaluable criticism, suggestions, and input for the refinement of this thesis.
6. Budi Mukhamad Mulyo, S.Kom., M.T., as the Second Examiner, who has also provided highly constructive direction, evaluation, and revision notes for this research.
7. All Lecturers of the Informatics Study Program, Universitas Pembangunan Nasional "Veteran" Jawa Timur, who have equipped the author with various scientific knowledge during the academic years.

8. The beloved Parents and family, who never tire of offering prayers, affection, and full support, both morally and materially, in every step of the author's life journey.
9. All Members of the Unit Kegiatan Kerohanian Islam (UKKI) UPN "Veteran" Jawa Timur, who were willing to be the case study subject, and provided permission, time, and highly cooperative collaboration during the system testing process.
10. Fellow Informatics students at UPN "Veteran" Jawa Timur, who have been companions in exchanging ideas, discussing, and mutually encouraging one another from the college years through the completion of this final project.

The author realizes that there are still many shortcomings in the preparation of this thesis. Therefore, constructive criticism and suggestions from all parties are highly expected for the perfection of this thesis writing. Finally, with all the author's limitations, it is hoped that this thesis report can provide benefits and inspiration for all parties in general, and for the author in particular.

Surabaya, May 22<sup>nd</sup> 2026

MUHAMMAD FAIZUL ULUM  
NPM. 22081010132

## **TABLE OF CONTENTS**

<b>COVER PAGE</b> .....	<b>i</b>
<b>APPROVAL SHEET</b> .....	<b>ii</b>
<b>APPROVAL SHEET</b> .....	<b>v</b>
<b>STATEMENT OF ORIGINALITY</b> .....	<b>vii</b>
<b>ABSTRACT</b> .....	<b>ix</b>
<b>ACKNOWLEDGEMENTS</b> .....	<b>xi</b>
<b>TABLE OF CONTENTS</b> .....	<b>xiii</b>
<b>LIST OF FIGURES</b> .....	<b>xvii</b>
<b>LIST OF TABLES</b> .....	<b>xxiii</b>
<b>CHAPTER I INTRODUCTION</b> .....	<b>1</b>
1.1    Background .....	1
1.2    Problem Formulation .....	3
1.3    Problem Scoping .....	4
1.4    Research Objectives.....	5
1.5    Research Benefits .....	5
<b>CHAPTER II LITERATURE REVIEW</b> .....	<b>7</b>
2.1    Previous Research.....	7
2.2    Theoretical Foundation .....	14
2.2.1    Inventory Management Information System .....	14
2.2.2    Website .....	15
2.2.3    Rapid Application Development (RAD) Method.....	16
2.2.4    Optical Character Recognition (OCR) .....	18
2.2.5    Tesseract OCR.....	19
2.2.6    Image Pre-processing Techniques .....	20
2.2.7    String Matching and Regular Expression Algorithms .....	23
2.2.8    Bayes' Theorem (Bayesian Probability) .....	26
2.2.9    Quick Response Code (QR) Code .....	28
2.2.10    Flowchart .....	29
2.2.11    UML (Unified Modeling Language).....	30
2.2.12    Use Case Diagram .....	31

2.2.13	Activity Diagram .....	32
2.2.14	Sequence Diagram .....	34
2.2.15	Entity Relational Diagram (ERD).....	35
2.2.16	Wireframe .....	35
2.2.17	Software Testing.....	36
2.2.18	OCR Performance Evaluation Metrics .....	36
<b>CHAPTER III METHODOLOGY .....</b>		<b>39</b>
3.1	Problem Identification.....	40
3.2	Literature Study .....	40
3.3	System Analysis and Design .....	41
3.3.1	Hardware Specifications .....	41
3.3.2	Software Specifications.....	41
3.3.3	System Requirements Analysis .....	43
3.3.4	System Design.....	45
3.3.4.1	System Flowchart .....	46
3.3.4.2	Use Case Diagram .....	52
3.3.4.3	Activity Diagram .....	64
3.3.4.4	Sequence Diagram.....	78
3.3.4.5	Optical Character Recognition (OCR) Module Design .....	86
3.3.4.6	Entity Relationship Diagram (ERD) .....	98
3.3.4.7	Wireframe .....	100
3.3.4.8	Interface Design (Mockup).....	111
3.3.4.9	Iterative Development Process Using the RAD Method .....	129
3.3.4.10	System Design Finalization.....	147
3.4	System Testing Scenarios.....	149
3.4.1	Functional Testing (Black Box Testing) .....	149
3.4.2	OCR Module and Validation Performance Testing.....	154
3.4.2.1	Character Accuracy Testing .....	154
3.4.2.2	Decision Accuracy Testing.....	155
3.4.2.3	Research Implementation Schedule .....	156
<b>CHAPTER IV RESULTS AND DISCUSSION .....</b>		<b>159</b>

4.1	System Implementation Using the Rapid Application Development Method.....	159
4.1.1	Implementation Environment .....	159
4.1.2	Construction Phase .....	160
4.1.3.1	Database and Backend Construction (API Development) .....	161
4.1.3.2	User Interface Construction (Frontend Development) .....	161
4.1.3.3	System Module and Third-Party Service Integration .....	161
4.2	User Interface Implementation Results .....	162
4.2.1	Visitor Interface.....	162
4.2.1.1	Main Page (Landing Page).....	162
4.2.1.2	Item Catalog Page.....	164
4.2.1.3	Guide Page.....	166
4.2.1.4	About Page.....	168
4.2.1.5	Contact Page .....	170
4.2.1.6	Item Detail Page .....	173
4.2.1.7	Rental Form Page .....	174
4.2.1.8	Payment Integration Page (Payment Gateway).....	177
4.2.1.9	Email Notification Interface .....	179
4.2.2	Managerial Interface (Admin & Member).....	179
4.2.2.1	Login Page .....	180
4.2.2.2	Main Dashboard Page .....	181
4.2.2.3	Inventory Data Management Page .....	182
4.2.2.4	Transaction Management Page.....	186
4.2.2.5	Member Account Management Page .....	188
4.2.2.6	Reports Page .....	190
4.2.2.7	QR Code Verification Page .....	192
4.3	Implementation of OCR-Based KTM Validation .....	193
4.3.1	Image Pre-Processing Implementation.....	194
4.3.1.1	Card Detection and Cropping (Smart Cropping) .....	195
4.3.1.2	Image Enhancement.....	196
4.3.2	Text Extraction and Cleansing (Regex).....	198
4.3.2.1	Data Cleansing (Text Cleansing) .....	198

4.3.2.2	Pattern-Based Extraction (Pattern Matching) .....	199
4.3.3	Validation Using String Matching and Levenshtein Distance .....	200
4.3.3.1	Institutional Identity Validation (Header Validation).....	201
4.3.3.2	Cross-Validation Using Levenshtein Distance .....	201
4.3.4	Probabilistic Correction Using Bayes' Theorem .....	203
4.3.5	Tiered Search (Fuzzy Focused Search) .....	205
4.4	System Testing .....	206
4.4.1	Functional Testing (Black Box Testing) .....	207
4.4.1.1	Authentication Module Testing .....	207
4.4.1.2	Pengujian Modul Manajemen Inventaris (Admin) .....	207
4.4.1.3	Member Management Module Testing (Admin) .....	208
4.4.1.4	Transaction Management Module Testing (Admin) .....	209
4.4.1.5	Reports & Analytics Module Testing.....	210
4.4.1.6	Booking & KTM Validation Module Testing.....	210
4.4.1.7	Payment (Midtrans) & Email Notification Module Testing.....	211
4.4.1.8	QR Code Scanner Module Testing .....	212
4.4.2	OCR Module and Validation Performance Testing.....	212
4.4.2.1	Character Accuracy Testing (Levenshtein Accuracy) .....	213
4.4.2.2	Decision Accuracy Testing.....	219
4.5	Discussion .....	220
4.5.1	Discussion on RAD Method Performance.....	220
4.5.2	Discussion on OCR Accuracy Level.....	221
<b>CHAPTER V CONCLUSIONS AND RECOMMENDATIONS .....</b>		<b>225</b>
5.1	Conclusions .....	225
5.2	Recommendations .....	226
<b>REFERENCES.....</b>		<b>227</b>
<b>APPENDICES .....</b>		<b>233</b>

## LIST OF FIGURES

Figure 2. 1 RAD Method Workflow .....	17
Figure 2. 2 Perspective results marked with points.....	21
Figure 2. 3 Original RGB image and Grayscale conversion.....	22
Figure 2. 4 Result of applying noise removal on an image .....	23
Figure 3. 1 Methodology Flowchart .....	39
Figure 3. 2 Inventory Rental Process Flowchart.....	47
Figure 3. 3 Item Retrieval Process Flowchart .....	49
Figure 3. 4 Item Return Process Flowchart .....	51
Figure 3. 5 System Use Case Diagram .....	54
Figure 3. 6 Activity Diagram for Login .....	64
Figure 3. 7 Activity Diagram for Adding Inventory Data .....	65
Figure 3. 8 Activity Diagram for Viewing Inventory Data .....	66
Figure 3. 9 Activity Diagram for Updating Inventory Data .....	67
Figure 3. 10 Activity Diagram for Deleting Inventory Data.....	67
Figure 3. 11 Activity Diagram for Managing Item Availability .....	68
Figure 3. 12 Activity Diagram for Adding Member Account .....	69
Figure 3. 13 Activity Diagram for Viewing Member Accounts .....	70
Figure 3. 14 Activity Diagram for Updating Member Account.....	71
Figure 3. 15 Activity Diagram for Deleting a Member Account .....	72
Figure 3. 16 Activity Diagram for Managing Reports .....	73
Figure 3. 17 Activity Diagram for Viewing the Dashboard .....	74
Figure 3. 18 Activity Diagram for Verifying the Retrieval QR Code .....	74
Figure 3. 19 Activity Diagram for Verifying the Return QR Code.....	75
Figure 3. 20 Activity Diagram for Viewing the Inventory Catalog .....	76
Figure 3. 21 Activity Diagram for the Booking/Rental Process .....	77
Figure 3. 22 Sequence Diagram for Login .....	78
Figure 3. 23 Sequence Diagram for Managing Inventory Data .....	79
Figure 3. 24 Sequence Diagram for Managing Reports .....	80
Figure 3. 25 Sequence Diagram for Managing Member Accounts .....	81
Figure 3. 26 Sequence Diagram for the Booking Process .....	83

Figure 3. 27 Sequence Diagram for the Payment Process .....	84
Figure 3. 28 Sequence Diagram for Retrieval QR Code Verification .....	85
Figure 3. 29 Sequence Diagram Verifikasi QR Code Pengembalian Barang .....	85
Figure 3. 30 OCR Process Flow Diagram.....	86
Figure 3. 31 Post-Processing and Data Validation Flow .....	89
Figure 3. 32 System ERD .....	98
Figure 3. 33 Landing Page Wireframe .....	101
Figure 3. 34 Inventory Catalog Page Wireframe .....	101
Figure 3. 35 Item Detail Page Wireframe .....	102
Figure 3. 36 Rental Form Page Wireframe .....	103
Figure 3. 37 Payment Page Wireframe .....	104
Figure 3. 38 Login Wireframe.....	105
Figure 3. 39 Main Dashboard Page Wireframe .....	106
Figure 3. 40 Inventory Management Page Wireframe .....	106
Figure 3. 41 Add, Detail, and Edit Inventory Form Wireframe .....	107
Figure 3. 42 Member Account Management Page Wireframe .....	108
Figure 3. 43 Add, Detail, and Edit Member Account Modal.....	108
Figure 3. 44 Reports and Analytics Page Wireframe .....	109
Figure 3. 45 QR Code Verification Page Wireframe .....	110
Figure 3. 46 Item Retrieval Confirmation Modal Wireframe .....	111
Figure 3. 47 Landing Page Mockup.....	112
Figure 3. 48 Landing Page Mockup - Mobile.....	113
Figure 3. 49 Inventory Catalog Page Mockup.....	113
Figure 3. 50 Inventory Catalog Page - Mobile .....	114
Figure 3. 51 Item Detail Page Mockup.....	115
Figure 3. 52 Item Detail Page – Mobile .....	116
Figure 3. 53 Rental Form and Identity Validation Page Mockup .....	117
Figure 3. 54 Rental Form and Identity Validation Page Mockup - Mobile .....	117
Figure 3. 55 Payment Page Mockup.....	118
Figure 3. 56 Payment Page Mockup - Mobile .....	118
Figure 3. 57 Login Mockup .....	119
Figure 3. 58 Login Mockup - Mobile .....	119

Figure 3. 59 Main Dashboard Page Mockup.....	120
Figure 3. 60 Main Dashboard Page Mockup - Mobile.....	120
Figure 3. 61 Inventory Management Page Mockup.....	121
Figure 3. 62 Inventory Management Page Mockup - Mobile.....	121
Figure 3. 63 Add, Detail, and Edit Inventory Form Mockup.....	122
Figure 3. 64 Add, Detail, and Edit Inventory Form Mockup - Mobile.....	123
Figure 3. 65 Member Account Management Page Mockup.....	124
Figure 3. 66 Member Account Management Page – Mobile.....	124
Figure 3. 67 Add and Edit Member Form Mockup.....	125
Figure 3. 68 Add and Edit Member Form Mockup - Mobile.....	125
Figure 3. 69 Reports and Analytics Page Mockup.....	126
Figure 3. 70 Reports and Analytics Page Mockup - Mobile.....	126
Figure 3. 71 QR Code Verification Page Mockup.....	127
Figure 3. 72 QR Code Verification Page Mockup - Mobile.....	127
Figure 3. 73 QR Data Confirmation Modal Mockup.....	128
Figure 3. 74 QR Data Confirmation Modal Mockup- Mobile.....	128
Figure 3. 75 Mockup of the Sidebar Menu before the change.....	130
Figure 3. 76 Mockup of the Sidebar Menu after the change.....	130
Figure 3. 77 Guide Page Mockup.....	131
Figure 3. 78 About Us Page Mockup.....	132
Figure 3. 79 Contact Us Page Mockup.....	133
Figure 3. 80 Contact Us Form & Map Section Mockup.....	134
Figure 3. 81 Reset Password Activity Diagram.....	135
Figure 3. 82 Reset Password Sequence Diagram.....	135
Figure 3. 83 User Schema Before Modification.....	136
Figure 3. 84 User Schema After Modification.....	136
Figure 3. 85 Member Page Mockup Before.....	137
Figure 3. 86 Member Page Mockup After.....	137
Figure 3. 87 Reset Password Modal Mockup.....	137
Figure 3. 88 Viewing Details & Transaction Tracking Activity Diagram.....	139
Figure 3. 89 Viewing Details & Transaction Tracking Sequence Diagram.....	139
Figure 3. 90 Adding Relations to the User Table.....	140

Figure 3. 91 Transaction Schema Relation.....	140
Figure 3. 92 Transaction Management Page Mockup.....	140
Figure 3. 93 Transaction Detail and Validator Tracking Modal Mockup.....	141
Figure 3. 94 Item Detail (Initial date selector design).....	142
Figure 3. 95 Item Detail (New date selector design).....	143
Figure 3. 96 Date Block Modal.....	144
Figure 3. 97 Add Manual Transaction Activity Diagram.....	145
Figure 3. 98 Add Manual Transaction Sequence Diagram.....	146
Figure 3. 99 Add Manual Transaction Modal Mockup.....	147
Figure 3. 100 Final Use Case Diagram.....	148
Figure 3. 101 Research Implementation Schedule.....	156
Figure 4. 1 Main Page on Mobile Device.....	163
Figure 4. 2 Main Page on Desktop Device.....	164
Figure 4. 3 Catalog Page on Mobile Device.....	165
Figure 4. 4 Catalog Page on Desktop Device.....	166
Figure 4. 5 Guide Page on Mobile Device.....	167
Figure 4. 6 Guide Page on Desktop Device.....	168
Figure 4. 7 About Us Page on Mobile Device.....	169
Figure 4. 8 About Us Page on Desktop Device.....	170
Figure 4. 9 Contact Page on Mobile Device.....	171
Figure 4. 10 Contact Page on Desktop Device.....	172
Figure 4. 11 Item Detail Page on Mobile Device.....	173
Figure 4. 12 Item Detail Page on Desktop Device.....	174
Figure 4. 13 Rental Form Page on Mobile Device.....	175
Figure 4. 14 Rental Form Page on Desktop Device.....	176
Figure 4. 15 Interface Display When KTM is Invalid.....	176
Figure 4. 16 Midtrans Pop-up Display on Mobile Device.....	177
Figure 4. 17 Midtrans Pop-up Display on Desktop Device.....	178
Figure 4. 18 Successful Payment Display.....	178
Figure 4. 19 Failed Payment Display.....	178
Figure 4. 20 Email Notification Display.....	179
Figure 4. 21 Login Page on Mobile Device.....	180

Figure 4. 22 Login Page on Desktop Device.....	181
Figure 4. 23 Main Dashboard Page for Admin Role.....	181
Figure 4. 24 Main Dashboard Page for Member Role .....	182
Figure 4. 25 Inventory Data Management Interface .....	182
Figure 4. 26 Add Inventory Data Modal Interface.....	183
Figure 4. 27 Successful Addition of Inventory Data Interface .....	183
Figure 4. 28 Edit and View Inventory Data Modal Interface .....	183
Figure 4. 29 Inventory Data Interface After Update .....	184
Figure 4. 30 Delete Inventory Data Interface .....	184
Figure 4. 31 Successful Deletion of Inventory Data Interface.....	184
Figure 4. 32 Rental Date Block Modal Interface .....	185
Figure 4. 33 Blocked Rental Date List Modal Interface.....	185
Figure 4. 34 Transaction Page Interface .....	186
Figure 4. 35 Transaction Detail Interface in Modal View .....	186
Figure 4. 36 Manual Transaction Input Form Interface .....	187
Figure 4. 37 Successful Manual Transaction Input Interface .....	187
Figure 4. 38 Member Account Management Page Interface .....	188
Figure 4. 39 Add and Edit Member Account Modal Interface .....	188
Figure 4. 40 Successful Addition of Member Data Interface .....	189
Figure 4. 41 Successful Update of Member Data Interface.....	189
Figure 4. 42 Delete Member Account Interface .....	189
Figure 4. 43 Reset Password Modal Interface .....	190
Figure 4. 44 Pop-up Interface After Password Reset.....	190
Figure 4. 45 Reports & Analytics Page Interface .....	191
Figure 4. 46 Report Result Document Interface in PDF Format.....	191
Figure 4. 47 QR Code Scanner Interface .....	192
Figure 4. 48 Retrieval/Return Confirmation Modal Interface .....	193
Figure 4. 49 Failed QR Code Verification Interface .....	193
Figure 4. 50 Visualization of the KTM Image Pre-processing Workflow .....	194

## LIST OF TABLES

Table 2. 1 Comparison of Previous Research.....	11
Table 2. 2 Use Case Diagram Components.....	32
Table 2. 3 Activity Diagram Components.....	33
Table 2. 4 Sequence Diagram .....	34
Table 3. 1 Hardware Specifications .....	41
Table 3. 2 Software Specifications .....	42
Table 3. 3 Use Case Login.....	54
Table 3. 4 Use Case Manage Inventory Data .....	55
Table 3. 5 Use Case Manage Item Availability .....	56
Table 3. 6 Use Case Manage Member Data.....	57
Table 3. 7 Use Case Manage Reports .....	58
Table 3. 8 Use Case View Dashboard.....	59
Table 3. 9 Use Case Verify Retrieval QR Code .....	60
Table 3. 10 Use Case Verifikasi QR Code Pengembalian.....	61
Table 3. 11 Use Case View Inventory Catalog.....	62
Table 3. 12 Use Case Execute Automated Rental Process .....	63
Table 3. 13 Authentication Module Testing Scenarios .....	150
Table 3. 14 Inventory Management Module Testing Scenarios (Admin).....	150
Table 3. 15 Skenario Pengujian Modul Manajemen Pengurus (Admin) .....	151
Table 3. 16 Transaction Management Module Testing Scenarios (Admin) .....	151
Table 3. 17 Reports & Analytics Module Testing Scenarios.....	152
Table 3. 18 Booking & KTM Validation Module Testing Scenarios.....	152
Table 3. 19 Payment & Notification Module Testing Scenarios .....	153
Table 3. 20 QR Code Module Testing Scenarios.....	154
Table 4. 1 Authentication Module Testing Results.....	207
Table 4. 2 Hasil Pengujian Modul Manajemen Inventaris .....	208
Table 4. 3 Member Management Module Testing Results .....	208
Table 4. 4 Transaction Management Module Testing Results.....	209
Table 4. 5 Reports & Analytics Module Testing Results .....	210
Table 4. 6 Booking & KTM Validation Module Testing Results .....	211

Table 4. 7 Payment (Midtrans) & Email Notification Module Testing Results ..	212
Table 4. 8 QR Code Scanner Module Testing Results .....	212
Table 4. 9 Character Accuracy Testing Results .....	213
Table 4. 10 Recapitulation of Average Character Accuracy per Attribute .....	219
Table 4. 11 Confusion Matrix of KTM Validation Results .....	219