

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
ABSTRACT (ENGLISH)	iv
ABSTRACT (THAI)	vi
LIST OF TABLES	xiii
LIST OF FIGURES	xv
ABBREVIATIONS	xvii
CHAPTER 1 INTRODUCTION	1
1.1 Chapter Overview	1
1.2 Research Problems	1
1.3 Power Distribution System	3
1.4 Challenges and Asset Management Practices of NEA	7
1.5 Research Justification	9
1.6 Research Theme	10
1.6.1 Research Methodology and Proposed Framework	10
1.6.2 Research Questions	11
1.6.3 Research Objectives	12
1.6.4 Research Outcomes	12
1.6.5 Novelties	13
1.7 Related Publications	13
1.8 Thesis Overview	14
CHAPTER 2 ASSET MANAGEMENT AND LIFE CYCLE ASSESSMENT	15
2.1 Chapter Overview	15
2.2 Asset Management	15
2.2.1 Definition and Terminology	15

TABLE OF CONTENTS (CONTINUED)

	Page
2.2.2 Asset Management Framework	17
2.2.3 Publicly Available Specification: PAS 55-1	19
2.2.4 Asset Management Process in Power Utility	22
2.2.5 Challenges in Asset Management	22
2.3 Life Cycle Assessment	24
2.3.1 Life Cycle Assessment Methodology	24
2.3.2 Life Cycle Phases of Power Transformer	26
2.3.3 Life Cycle Costing	28
2.3.4 Life Cycle Management	29
2.4 Health Indices of Power Transformer	31
2.5 Power Transformer Loading	33
2.6 Power Transformer Asset Management	35
2.7 Proposed Life Cycle Assessment Framework	39
2.8 Chapter Summary	39
 CHAPTER 3 DECISION MODEL FOR LIFE CYCLE ASSESSMENT OF POWER TRANSFORMER	 41
3.1 Chapter Overview	41
3.2 Introduction	41
3.3 Review of Existing Life Cycle Assessment Models	42
3.4 Load Profile	45
3.5 Proposed Model	46
3.5.1 Proposed Conceptual Life Cycle Assessment Framework	47
3.5.2 Working Mechanism	48
3.5.3 Suitability and Limitations of the Proposed Model	50
3.6 Robustness	50
3.7 Implementation	51
3.8 Chapter Summary	51

TABLE OF CONTENTS (CONTINUED)

	Page
CHAPTER 4 FINANCIAL AND KNOWLEDGE BASED MODELS	52
4.1 Chapter Overview	52
4.2 Financial Model	52
4.2.1 Review of Existing Financial Measures in Decision Making	53
4.2.2 Economic Value Added	54
4.2.3 Financial Terminology	55
4.3 Knowledge Based Model	58
4.3.1 Knowledge and Knowledge Engineering	59
4.3.1.1 Knowledge Based Engineering (KBE) Lifecycle	60
4.3.1.2 Knowledge Engineering Methodologies	60
4.3.2 Selection of Suitable KE Methodologies	62
4.3.3 Hidden Knowledge	62
4.3.4 Construction of the Knowledge Based Model	65
4.3.4.1 The Context Level	66
4.3.4.2 The Concept Level	66
4.3.4.3 The Artifact Level	67
4.3.4.4 Implementation	68
4.4 Case Study	68
4.4.1 Parameters	69
4.4.2 Results and Discussion	70
4.4.2.1 Financial Model	70
4.4.2.2 Knowledge Based Model	72
4.4.2.2.1 Construction	72
4.4.2.2.2 Utilization	78
4.5 Chapter Summary	81

TABLE OF CONTENTS (CONTINUED)

	Page
CHAPTER 5 OPTIMIZATION TECHNIQUE OF POWER TRANSFORMER	82
5.1 Chapter Overview	82
5.2 Introduction	82
5.3 Decision Algorithm	82
5.3.1 Single Power Transformer on Network	83
5.3.1.1 Flowchart	84
5.3.1.2 Description	84
5.3.2 Generalization	85
5.3.2.1 Flowchart	86
5.3.2.2 Description	89
5.4 Case Studies	94
5.4.1 Case I: Single Power Transformer	95
5.4.1.1 Results and Analysis	96
5.4.2 Case II: Three Network Power Transformers	97
5.4.2.1 Results and Analysis	100
5.4.3 Case III: Three Power Transformers With Two Power Transformers for Future Requirements	102
5.4.3.1 Results and Analysis	103
5.4.4 Case IV: Network and Future Requirement Power Transformers With One Stock Power Transformer	106
5.4.4.1 Results and Analysis	107
5.5 Simulation Software	109
5.5.1 Development of Simulation Software	109
5.6 Discussions	119

TABLE OF CONTENTS (CONTINUED)

	Page
CHAPTER 6 CONCLUSION AND FUTURE WORK	121
6.1 Conclusion	121
6.1.1 Knowledge Management Context	121
6.1.2 Financial Model Context	122
6.1.3 Decision Making Context	122
6.1.4 Asset Planning Context	122
6.2 Future Work	123
REFERENCES	125
APPENDICES	137
Appendix A Questionnaire	138
Appendix B Knowledge Representation of PT	141
Appendix C Simulation Software	161
CURRICULUM VITAE	167

LIST OF TABLES

Table	Page
1.1 Different Voltage Levels of NEA	6
2.1 Health Index of Power Transformer	33
4.1 CommonKADS Model Suite	66
4.2 Key Ontology Template	67
4.3 Support Tacit Knowledge	68
4.4 Designed Load Demand of One MVA Power Transformer	69
4.5 BV, MC and Depreciation of Power Transformer	70
4.6 Identifying Knowledge Oriented Problems and Opportunities	72
4.7 Description of Organizational Aspects Affecting by KMS	73
4.8 Description of Tasks and Knowledge Components	74
4.9 Hidden Knowledge Cost	79
5.1 Data of Existing Power Transformer	95
5.2 Data of New PT	96
5.3 Load Profile of Pt1mr	96
5.4 LOE _R and Mortgage Cost of Pt1mr	97
5.5 Net Profit of New PT	97
5.6 Decision Table during LV of Pt1mr	97
5.7 Data of the Network Power Transformer Pt2mr	98
5.8 Data of the Existing Power Transformer Pt3mr	98
5.9 Data of New Power Transformers	99
5.10 Load Profile of Pt2mr	99
5.11 Load Profile of Pt3mr	99
5.12 Status of PT for the replacement of Pt1mr	100
5.13 Comparison between Pt _{new1} and Pt2mr for the replacement of Pt1mr	100
5.14 Status of all Possible PT for the replacement of Pt2mr	101

LIST OF TABLES (CONTINUED)

Table	Page
5.15 Comparison between Pt_new2 and Pt3mr for the replacement of Pt2mr	101
5.16 Status of New PT for the replacement of Pt3mr	102
5.17 Optimal Decisions on Network Power Transformers in Case II	102
5.18 Data for future requirement of power transformers	103
5.19 Comparison of location for the relocation of Pt2mr	104
5.20 Comparison of location for the relocation of Pt3mr	104
5.21 Status of Pt1mr for the relocation in Pt1newkl	105
5.22 Optimal Decisions on Network Power Transformers in Case III	105
5.23 Data of Stock Power Transformer	106
5.24 Status of Pt1st for the replacement of Pt1mr	107
5.25 Status of Pt2mr for the replacement of Pt1mr	107
5.26 Status of Pt2mr for the relocation of Pt2newgv	108
5.27 Optimal Decisions on Network Power Transformers in Case IV	108
5.28 Use Case Description	110

LIST OF FIGURES

Figure	Page
1.1 Transformer Application in Typical Electrical Supply	4
1.2 Distribution Network of Power Utility	5
1.3 Distribution System Showing Components	5
1.4 Asset Investment Planning Process of NEA	8
1.5 Proposed Decision Framework for the Power Transformer Asset Management	11
2.1 Asset Management Process	18
2.2 Asset Management Framework	19
2.3 Scope and Business Context of Physical Asset Management	20
2.4 Asset Management System Elements	20
2.5 Bathtub Curve of an Asset	27
2.6 Life Cycle Phases of Power Transformer	28
2.7 Power Transformer Life Extension and Management	37
2.8 Proposed Life Cycle Assessment Framework for Power Transformer	39
3.1 Decision Model for Power Transformer	44
3.2 Lifetime Management of Power Transformer	45
3.3 Proposed Decision Model of Power Transformer Life Cycle Assessment	48
4.1 The CommonKADS Model Suite	61
4.2 Gross Revenue and EVA of Power Transformer	71
4.3 Payback Period of Power Transformer	71
4.4 Task Knowledge Diagram	75
4.5 Inference Knowledge Diagram	76
4.6 Domain Knowledge Diagram	76
4.7 Key Ontology Diagram	77
4.8 Support Tacit Knowledge Diagram	77

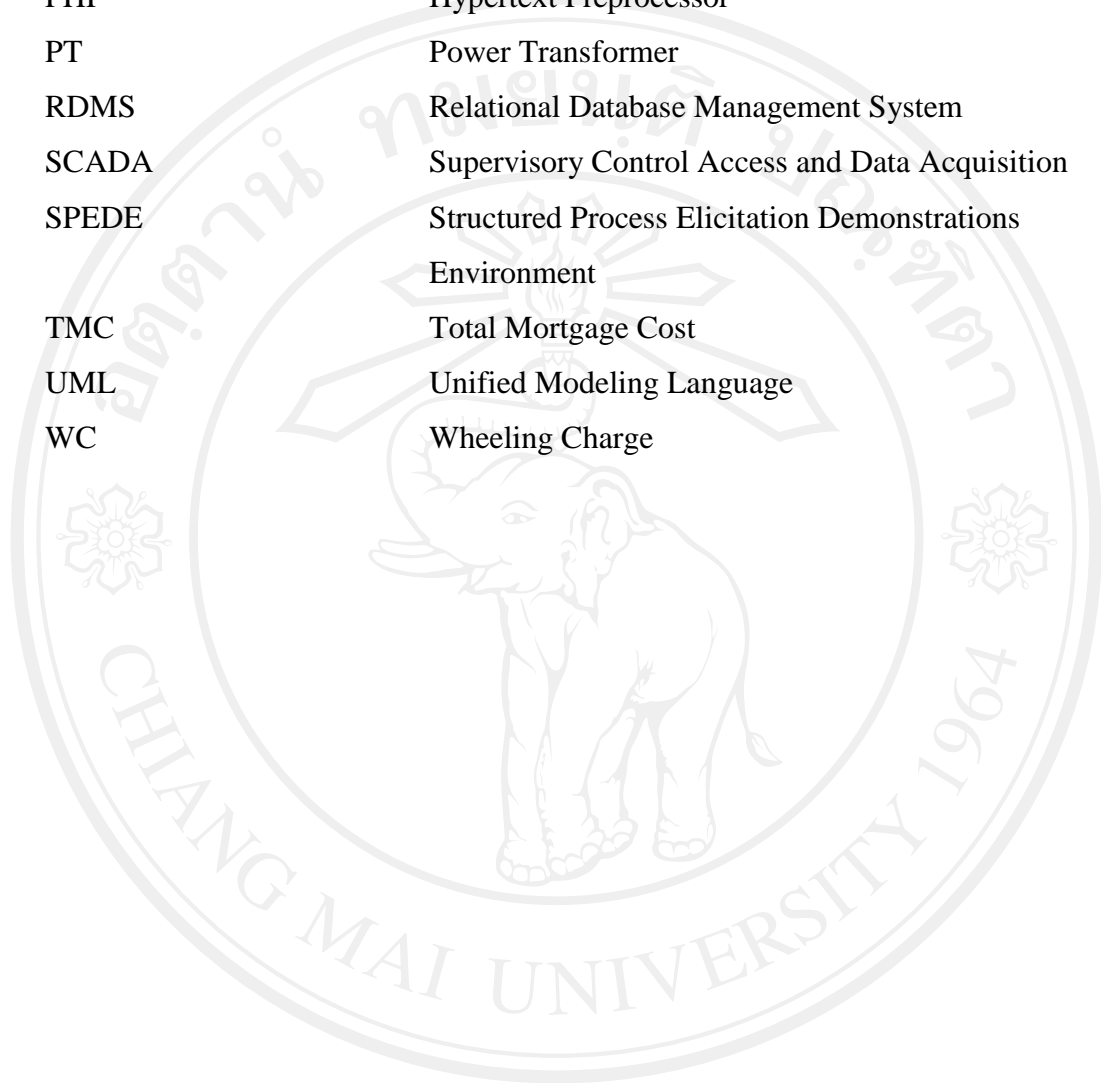
LIST OF FIGURES (CONTINUED)

Figure	Page
4.9 Implementation in Microsoft Share Point	78
4.10 Utilization of Hidden Knowledge over its Life Cycle in case of Relocation	80
5.1 Decision Algorithm for Assessing Single Power Transformer	84
5.2 Affect on PT with the Proposed Decision Algorithm after LV	86
5.3 Decision Algorithm for Assessing PTs on Network	88
5.4 Line Diagram of Single Power Transformer	95
5.5 Line Diagram of the Three Power Transformers	98
5.6 Line Diagram of Both Network and Future Requirement PTs	103
5.7 Line Diagram of Both Network and Future Requirement PTs with the Inclusion of Stock PT	106
5.8 Use Case Diagram for PT Life Cycle Assessment System	109
5.9 Sequence Diagram of PT Life Cycle Assessment System	111
5.10 Class Diagram of PT Life Cycle Assessment System	112
5.11 Entity-Relationship Diagram	113
5.12 Proposed Software Architecture	114
5.13 Database of Power Transformer	117
5.14 Decision on Pt1mr in Case I	117
5.15 Decision on Pt2mr in Case II	118
5.16 Decision on Pt3mr and Pt2newgv in Case III	118
5.17 Decision on Pt1mr and Pt2newgv in Case IV	119

ABBREVIATIONS

AC	Acquisition Cost
ALD	Actual Load Demand
AM	Asset Management
BSI	British Standards Institution
BV	Book Value
CommonKADS	Common Knowledge Acquisition and Design System
DLD	Designed Load Demand
EVA	Economic Value Added
FDL	Financial Designed Life
GR	Gross Revenue
HI	Health Index
HTTP	Hyper Text Transfer Protocol
IAM	Institute of Asset Management
KBE	Knowledge Base Engineering
KE	Knowledge Engineering
KMS	Knowledge Management System
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
LCM	Life Cycle Management
LV	Load Violation
MC	Mortgage Cost
MOKA	Methods and Tools Oriented Knowledge Acquisition
MVC	Model-View-Controller
NEA	Nepal Electricity Authority
NEA	Nepal Electricity Authority
NPV	Net Present Value
OC	Operation and Maintenance Cost
OM	Organization Models

PAS	Publicly Available Specification
PF	Power Factor
PHP	Hypertext Preprocessor
PT	Power Transformer
RDMS	Relational Database Management System
SCADA	Supervisory Control Access and Data Acquisition
SPEDE	Structured Process Elicitation Demonstrations Environment
TMC	Total Mortgage Cost
UML	Unified Modeling Language
WC	Wheeling Charge



ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright© by Chiang Mai University
All rights reserved