CONTENTS

Dedication	I
Acknowledgement	II
Abstract	III
Arabic Abstract	V
Contents	**VI**
List of Figures	XI
List of Tables	XIV
Chapter One Introduction	1
1.1 Problem definition	1
1.2 Objectives	1
1.3 Hypotheses	1
1.4 Theses methodology	2
1.5 Theses overview	2
1.6 Related work	3
Chapter Two Failures and dependability attributes	5
2.1 The dependability of networks	6
2.2 The threats	7
2.3 The means	8
2.4 Failure rate	8
2.5 Overall data	12
2.6 Failure severity	13
2.7 Failure ratio	14
2.8 Life cycle process	15
2.9 The exponential law of failure	21
2.10 The Weibull distribution	22
2.11 Down time and repair time	23
2.12 Hazard and risk	25
2.13 Quantifying failure	26

2.14 Dependability planning of networks 27
2.15 Models used for dependability 28
2.16 The cost of dependability 30
Chapter Three Failure analysis and human factors 31
3.1 Fault Tree Analysis (FTA) 32
3.2 Failure Mode and Effect Analysis (FMEA) 37
3.3 Root Cause Failure Analysis (RCFA) 42
3.5 Fault analysis 47
3.6 Operating procedures 47
3.7 Training/safety culture 48
3.8 Environmental control 48
3.9 Human factors 50

Chapter Four Data collection and analysis 55
4.1 General hints in dependability data collection 56
4.2 Reasons for dependability data collection 57
4.3 Information and difficulties 58
4.4 Spread sheets 59
4.5 Free text 61
4.6 SUST network field data 63
4.7 PSTN data 74
4.8 FTA for SUST network sites 87
4.9 Summary table 89

Chapter Five Network reliability modeling and measurement 90
5.1 Reliability modeling 91
5.2 Redundancy 92
5.3 Reliability measurement 96
5.4 Microelectronic basic data reliability 98
5.5 Software reliability 102
5.6 Reliability modeling concepts 103
5.7 Using Annual Failure Rate (AFR) 110

5.8 The SUST network reliability measurement 110
5.9 Engineering campus reliability 114
5.10 Human development college reliability 115
5.11 X-Ray college reliability 115
5.12 Agricultural studies campus reliability 115
5.13 Animal production campus reliability 116
5.14 Forestry studies campus reliability 116
5.14 General approach for reliability modeling of PSTN 117
5.15 Estimating PSTN reliability from customer data 120
5.16 The overall reliability of PSTN of the country 121
5.17 Overall SUST network average reliability 121
5.18 Reliability growth modeling 122

Chapter Six Network availability 123
6.1 Understanding availability 124
6.2 Availability modeling 124
6.3 Effect of system operation on item availability 126
6.4 Network availability 128
6.5 Availability using downtime 129
6.6 SUST network availability calculation 130
6.7 Engineering campus availability 133
6.8 Human development site availability 133
6.9 Agricultural studies site availability 134
6.10 Animal production site availability 134
6.11 Forestry studies site availability 134
6.12 PSTN availability 135
6.13 The SUST network average availability 139
6.14 The network availability assumed nines 139
6.15 Effect of the two phases on SUST network availability 140

Chapter Seven Network maintainability 142
7.1 Maintainability subsets 144
7.2 Maintenance task 147
7.3 Maintenance task classification 148
7.4 Maintainability function 152
7.5 Cost of maintenance tasks 155
7.6 Maintenance levels 157
7.7 Selecting the suitable maintenance level for networks 159
7.8 COTS systems 160
7.9 Network maintenance policy 160
7.10 Inspection based maintenance policy 163
7.11 Opportunity based maintenance policy 166
7.12 The suitable policy for networks 166

Chapter Eight Dependability of wireless networks 168
8.1 Introduction 169
8.2 Wireless building block 169
8.3 WLAN reliability 170
8.4 WLAN availability 171
8.5 Mobile network dependability 172

Chapter Nine Results 179
9.1 Importance of network dependability 180
9.2 General guidance 180
9.3 Relationship between reliability, availability, and maintainability 181
9.4 Impact of redundancy 182
9.5 Decision making 189
9.6 Availability classes and management 190
9.7 SUST network results 191
8.8 Benefits of low MTTR 193
9.9 Network Critical Physical Infrastructure (NCPI) 194
9.10 Optimum design level determination 196

9.11 Conclusion 197
9.12 Recommendations 200
References 202

Appendices 204
Appendix 1 Acronym 1/14
Appendix 2 PSTN sources of failures 5/14
Appendix 3 Many items in series destroy system reliability 6/14
Appendix 4 Effect of λ on exponential pdf 7/14
Appendix 5 Effect of γ on exponential reliability function 8/14
Appendix 6 MTBM and MDT relationship for fixed availability 9/14
Appendix 7 EITT Failure Report Form 10/14
Appendix 8 Probability rules, Binomial and Bayes theorems 11/14
Appendix 9 Human errors rates 14/14