POTENTIAL OF WINDOW DESIGN TO ENHANCE NATURAL SMOKE VENTILATION PERFORMANCE IN THE MALAYSIAN PUBLIC HOSPITAL BUILDINGS

BY

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ABSTRACT

This thesis investigates the possibilities of improving natural smoke ventilation performance in public hospital buildings in Malaysia. In the hospital buildings, windows are the most common form of natural ventilation mechanism for thermal comfort and smoke ventilation. Natural smoke ventilation mechanism is to remove smoke, hot gases, and other effects of combustion in the case of a fire. Statistics on cases shows that numbers of catastrophic fire incidents in hospital buildings and other buildings reveal that smoke is the leading cause of deaths in the event of fires. Therefore, this research is conducted to investigate the possibility of windows design as means for natural smoke ventilation in public hospital buildings. In specific, the objective of this research is to investigate the effects of windows configuration in responding to the different wind directions on natural smoke ventilation performance. This research involves two stages. Firstly, the inventory exercise of three (3) selected public hospital buildings. This is to identify the wards and the windows design and, secondly, computer simulation using CFD software, FDS Version 6.3, to evaluate the existing windows configuration on natural smoke ventilation performance, and to evaluate the potential of the proposed windows configuration in enhancing the natural smoke ventilation performance. The analysis of fire and smoke behavior is conducted in 4-bed wards. The result shows that the existing windows configuration in the 4-bed wards is ineffective in safeguarding the life safety of patients as the Available Safe Egress Time (ASET) is below the Required Safe Egress Time (RSET) of 191 seconds. However, by increasing the size of the windows from 19 % to 22.73 %, the ASET for visibility and temperature increased by 113.7% and 76.47%, respectively. It is observed that the two models (M4 and M6) which are the vertical windows configuration with inlet louvers near the floor are able to serve as means for natural smoke ventilation strategy in public hospital buildings in Malaysia at 90^{o} (parallel) wind direction. Thus, the findings of this research provide a guideline for fire and rescue departments, local authorities, healthcare providers, design professionals, and contractors in understanding, designing, constructing, and enforcing natural smoke ventilation design by means of windows design in the wards of public hospital buildings.

خلاصة البحث

تتحقق الرسالة من الفرص في تحسين أداء تهوئة الدخان الطبيعي في المستشفيات العامة في ماليزيا حيث تكون النوافذ هي الشكل الأكثر شيوعا لآلية التهوئة الطبيعية للراحة الحرارية والتهوئة الدخانية. تهدف آلية تهوئة الدخان الطبيعية إلى إزالة الدخان والغازات الساخنة وغيرها من آثار الاحتراق في حالة الحريق. تدل احصائيات الحالات على عدد من حوادث النيران المأسوية في مباني المستشفيات وغيرها يفيد بأن الدخان هو العامل السائد لسبب الوفاة في حوادث النيران. ولذلك يتم إجراء هذه الدراسة للتحقق من احتمال تصميم النوافذ كآلية لتهوئة الدخان الطبيعية في المستشفيات العامة فيكون هدف البحث هو لدراسة آثار تركيب النوافذ في الرد على اتجاهات الرياح المختلفة التي تؤثر على أداء الدخان الطبيعي. تتم الدراسة في مرحلتين أولهما جرد الأصول المادية لثلاث من المستشفيات العامة من أجل معرفة تصميم عنابرها ونوافذها وثانيهما إجراء المحاكاة الحاسوبية باستخدام تطبيق ديناميكا الموائع الحسابية نسخة ديناميكا الحريق الحسابية ٦.٣ من أجل تقويم تركيب النوافذ الحالية وآثاره على أداء التهوئة الطبيعية للدخان وكذلك للتحقق من إمكانية اقتراح تركيب بديل للنوافذ في تطوير أداء التهوئة الطبيعية للدخان. تم تحليل النيران وسلوك الدخان في عنابر ذات أربعة أسرة. تدل النتائج على آن التصميم الحالي للنوافذ في العنابر ذات أربعة أسرة غير فعال في حماية سلامة المرضي لأن الوقت المتاح للخروج كان متدنيا من الوقت الآمن للخروج وهو ١٩١ ثانية. ولكن من خلال زيادة حجم النوافذ من ١٩ ٪ إلى ٢٢.٧٣٪ يزداد فرصة الخروج ووضوح الرؤية إلى ب١١٣.٧٪ و٧٦.٤٧. ويلاحظ آن النموذجين إيم ٤ و٦ وهما التركيب العمودي مع النوافذ الداخلية بالقرب من الأرضية يمكن آن يكون وسيلة لاستراتيجية التهوئة الطبيعية للدخان في مباني المستشفيات العامة في ماليزيا ل٩٠ درجة من اتجاه الرياح الموازي. وبهذا تزود نتائج هذه الدراسة مبدأ توجيهيا لأقسام الدفاع المدني والسلطات المحلية ومزودات الخدمات الصحية ومحترفي التصميم والمقاولين في الفهم والتصميم والإنشاء ولتطبيق لتصميم تهوئة الدخان بواسطة تصميم النوافذ في عنابر المستشفيات العامة.

APPROVAL PAGE

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DECLARATION

I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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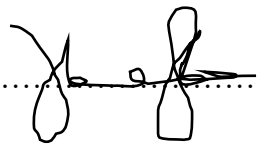
Signature  …… Date: 02-04-2021

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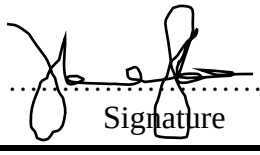

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Table of Contents

Abstract ii
Abstract in Arabic iii
Approval Page iv
Declaration v
Copyright vi
Acknowledgement vii
List of Tables xiii
List of Figures xix
List of Abbreviations xxvi
List of Symbols xxix
List of Statutes xxxii
List of Appendices xxxiii

CHAPTER ONE : INTRODUCTION 1
1.1 Introduction 1
1.2 Background of the Study 1
1.3 Statement of the Problem 4
1.4 Research Questions 5
1.5 Research Aim and Objectives 6
1.5.1 Aim 6
1.5.2 Objectives 6
1.6 Research Hypothesis 7
1.7 Literature Overview 8
1.7.1 Fire Safety Issue in Malaysia and Worldwide 8
1.7.2 Fires in Hospital Buildings 8
1.8 Significance of Research 10
1.9 Research Scope 11
1.10 Research Methodology 11
1.11 Research Framework 13
1.12 Outline of the Thesis 14
1.12.1 Chapter 1: Introduction 14
1.12.2 Chapter 2: Background Study of Natural Smoke Ventilation, Wind Climate and Public Hospital Building 14
1.12.3 Chapter 3: Natural Smoke Ventilation Design in Buildings: Regulations and Requirements 15
1.12.4 Chapter 4: Research Methodology 15
1.12.5 Chapter 5: Building Inventory 15
1.12.6 Chapter 6: CFD Simulation 15
1.12.7 Chapter 7: Results and Discussion 16
1.12.8 Chapter 8: Conclusion and Recommendation 16
1.13 Summary 16

CHAPTER TWO : BACKGROUND STUDY OF NATURAL SMOKE VENTILATION, WIND CLIMATE AND PUBLIC HOSPITAL BUILDING…….....17
2.1 Introduction 17
2.2 Natural Smoke Ventilation 17
2.2.1 Definition of Ventilation.....17
2.2.2 Definition of Smoke.....18
2.2.3 Definition of Natural Smoke Ventilation.....18
2.2.4 Functions of Natural Smoke Ventilation 18
2.2.5 Smoke Ventilation for Life Safety.....19
2.2.6 Driving Forces of Natural Smoke Ventilation 27
2.3 Fire Science 33
2.3.1 Elements of Fire.....33
2.3.2 Fire Development in Buildings.....33
2.3.3 Fire Growth Rate.....35
2.3.4 Heat Release Rate (HRR) 36
2.4 Wind Around High-Rise Building.....37
2.5 Factors Affecting Wind 38
2.6 Review of the Related Research in Public Hospital Buildings 40
2.7 Review of the Related Research on Factors that Affect Natural Smoke Ventilation Performance.....41
2.7.1 Building Form and Configuration.....41
2.7.2 Internal Layout.....42
2.7.3 Building Details 43
2.7.4 Special Architectural Features 48
2.8 Research Gap and Point of Departure 49
2.10 Public Hospital Buildings in Malaysia 55
2.10.1 Definitions of Hospital Building.....55
2.10.2 Public Hospital Buildings 55
2.10.3 Characteristics of Public Hospital Buildings 56
2.10.4 Public Healthcare System 57
2.10.5 Physical Development of Public Hospital Building 58
2.10.6 Ward Development in the Public Hospital Building 60
2.10.7 Project Brief.....62
2.11 Fire Outbreaks in Malaysia.....64
2.11.1 Fires in Hospital Buildings 66
2.12 Summary.....67

CHAPTER THREE : NATURAL SMOKE VENTILATION DESIGN IN BUILDINGS : REGULATIONS AND REQUIREMENTS.....69
3.1 Introduction 69
3.2 Regulatory Requirement of Natural Smoke Ventilation in Buildings....69
3.2.1 Fire Safety Design Practices in Malaysia 69
3.3 Requirements of Natural Smoke Ventilation in Malaysia.....71
3.3.1 Uniform Building by Laws (UBBL,1984).....72
3.3.2 Malaysian Standard (MS 1780) 76
3.4 Comparison of Natural Smoke Ventilation Design Specifications Amongst Countries.....78
3.5 Research Methodology Overview in Fire Safety Study 80

3.5.1 Fire Risk Analysis 80
3.6 Methods of Estimating Natural Smoke Ventilation Performance 80
3.6.1 Experiment Full-Scale Test 81
3.6.2 Small-Scale Modelling 81
3.6.3 Basic Hand Calculations 82
3.6.4 Computer Simulation 83
3.7 Selection of CFD Software 86
3.8 Grid System 88
3.9 Studies Using FDS 89
3.10 FDS Verification and Validation 89
3.11 Summary 90

CHAPTER FOUR : RESEARCH METHODOLOGY 91
4.1 Introduction 91
4.2 Research Methodology Overview 91
4.3 Research Outline and Process 93
4.4. Research Steps 94
4.5 Case Study 95
4.5.1 Criteria for Selection of Case Study Buildings 95
4.5.2 Referral Hospital (Tertiary Hospitals) 98
4.6 Building Inventory 99
4.6.1 Objectives 99
4.7 Computer Simulation and Analysis of Design Parameter 100
4.7.1 Objectives of the Computer Simulation 101
4.7.2 Overview of FDS Applications 101
4.7.3 Model Building 103
4.7.4 Simulation Condition 103
4.7.5 Building Analysis 104
4.8 Wind Condition in Selangor, Malaysia 104
4.9 Summary 106

CHAPTER FIVE : BUILDING INVENTORY 107
5.1 Introduction 107
5.2 Building Inventory 107
5.3 Public Hospital Buildings in Selangor, Malaysia 108
5.3.1 Selayang Hospital 108
5.3.2 Serdang Hospital 121
5.3.3 Ampang Hospital 131
5.4 Analysis of Wards Design and Windows Design for Natural Smoke Ventilation Strategy 140
5.4.1 Analysis of Number of 4-Bed Ward 140
5.4.2 Analysis of Building Orientation 141
5.4.3 Analysis of Ward Geometry and Shape 142
5.4.4 Analysis of Design of Opening 143
5.5 Evaluation of the Existing Conditions of Fire Safety and Hazards in Hospital Wards 147
5.5.1 Fire Load 147
5.5.2 Compartment of Ward 148
5.5.3 Window Design 150

5.5.4 Fire Protection System 151
5.5.5 Safety VS Security 152
5.6 Development of Simplified Model of 4-Bed Ward 153
5.6.1 Compliance of Simplified Model of 4-Bed Ward to UBBL 1984 156
5.7 Finding of the Building Inventory 157
5.8 Summary 157

CHAPTER SIX : CFD SIMULATION 159
6.1 Introduction 159
6.2 Fire Dynamic Simulation 159
6.2.1 Simulation Procedures 159
6.2.2 Simulation Condition 165
6.2.3 Design Basis and Assumptions 178
6.3 FDS Model Setup 179
6.3.1 FDS Validation and Verification 180
6.3.2 Establishment of Test Models 181
6.4 FDS Validation and Model Verification 186
6.4.1 Grid Sensitivity Study 188
6.4.2 Comparison of the Simulation and Measurements 191
6.4.3 Results of Opening's Enlargement on Natural Smoke Ventilation Performance in the Room 193
6.5 Verification of 4-Bed Ward Model 194
6.5.1 Description of Simplified Model of 4-Bed Ward 195
6.5.2. Size of Grid 195
6.5.3 Results of Grid Sensitivity Study 197
6.5.4 Comparison with Alpert's Correlations 197
6.6 The Characteristics of Outside Wind Flow Around Public Hospital Building 199
6.7 Summary 203

CHAPTER SEVEN : RESULTS AND DISCUSSION 205
7.1 Introduction 205
7.2 Estimation of Available Safe Egress Time (aset) 205
7.3 Results of Fire Simulation Analysis 206
7.3.1 Selayang Hospital (H-1) 207
7.3.2 Serdang Hospital (H-2) 212
7.3.3 Ampang Hospital (H-3) 217
7.4 Finding and Conclusion on Performance of the Existing Windows Design as Natural Smoke Ventilation at the Existing 4-Bed Wards 222
7.5 Natural Smoke Ventilation Performance in Base Case Model and Test Models 225
7.5.1 Base Case Model 225
7.5.2 Model 1 (M1) 230
7.5.3 Model 2 (M2) 235
7.5.4 Model 3 (M3) 240
7.5.5 Model 4 (M4) 246
7.5.6 Model 5 (M5) 251
7.5.7 Model 6 (M6) 256

7.6 The Effects of Different Sizes and Configurations of Windows on Visibility 262
7.6.1 ASET for Visibility at 0˚ Wind Angle 262
7.6.2 ASET for Visibility at 45˚ Wind Angle 265
7.6.3 ASET for Visibility at 90˚ Wind Angle 268
7.6.4 Summary of the Effects of Different Sizes and Configurations of Window on ASET for Visibility 271
7.7 The Effects of Different Sizes and Configurations of Windows on Temperature 272
7.7.1 ASET for Temperature at 0˚ Wind Angle 272
7.7.2 ASET for Temperature at 45˚ Wind Angle 275
7.7.3 ASET for Temperature at 90˚ Wind Angle 278
7.7.4 Summary of the Effects of Different Sizes and Configurations of Window on ASET for Temperature 281
7.8 Findings and Conclusions of Natural Smoke Ventilation Performance for Modified Window Sizes and Configurations 282
7.9 Summary 287

CHAPTER EIGHT : CONCLUSION AND RECOMMENDATION 288
8.1 Introduction 288
8.2 Thesis Summary 288
8.3 Thesis Conclusion 289
8.3.1 The Performance of the Existing Windows Design as Natural Smoke Ventilation at the Existing 4-Bed Wards 290
8.3.2 Evaluation of the Proposed Windows Design in Enhancing the Natural Smoke Ventilation Performance at the Existing 4-Bed Wards 292
8.3.3 The Possibility of Windows Design as Means for Natural Smoke Ventilation Strategy in Public Hospital Buildings in Malaysia 296
8.4 Thesis Conclusion 296
8.5 Recommendations for Future Research 297

REFERENCES 299

APPENDICES 308

LIST OF TABLES

Table 1.1	The Relationship Between Research Questions, Research Objectives, and Research Methodologies	7
Table 2.1	Tenability Criteria	22
Table 2.2	Tenability Criteria Caused by Smoke Obscuration	23
Table 2.3	Tenability Limits for Visibility and Temperature	23
Table 2.4	Tenability Limits for Smoke Toxicity	24
Table 2.5	Tenability Criteria Used for the Study	25
Table 2.6	Typical Pressure Values for Driving Forces	32
Table 2.7	Classification of Fire Growth Rate	36
Table 2.8	Heat Release Rate Per-Unit Area (HRRPUA) for Different Occupancies	37
Table 2.9	Relation Between Ground Wind Speed and Type of Terrain	39
Table 2.10	Mass Flow of Smoke (kg/s) in 10 Minutes of Analysis with Different Wind Angles	44
Table 2.11	Summary of Previous Studies on Natural Smoke Ventilation in Buildings	51
Table 2.12	Statistics on Fire Breakouts, Malaysia, 2010- 2018	65
Table 2.13	Statistics on Fire Causes, Malaysia, 2013- 2018	65
Table 2.14	Number of Fire Breakouts by Type of Building, Malaysia, 2010-2018	67
Table 3.1	Comparison of Natural Smoke Ventilation Design Requirement and Specification of Four (4) Countries	79
Table 4.1	Brief Background of the Selected Public Hospital Buildings as Case Studies	98

Table 4.2	Mean Surface Wind Speed (m/s) of 5 Stations in Selangor (2009-2018)	105
Table 4.3	Average Wind Direction of 5 Stations in Selangor	105
Table 5.1	Analysis the Numbers of 4-Bed Wards	141
Table 5.2	Analysis the Building Orientation of 4-Bed Wards	142
Table 5.3	Analysis the Space Planning of 4-Bed Wards	143
Table 5.4	Analysis of Specifications of Window	146
Table 5.5	Simplified Model of 4-Bed Ward	154
Table 5.6	Compliance of Simplified Model of 4-Bed Ward to UBBL 1984	156
Table 6.1	Relation Between Ground Wind Speed and Type of Terrain	170
Table 6.2	Annual Mean Air Temperature at 5 Meteorological Stations in Selangor	172
Table 6.3	Summary of Simulation Condition of Grid Sensitivity	174
Table 6.4	Summary of the Simulation Conditions Adopted	178
Table 6.5	The Size of the Windows and Louvres for the Investigation of Natural Smoke Ventilation in 4-Bed Wards of Public Hospital Buildings	183
Table 6.6	The Summary of Simulation Condition for the Numerical Tests	185
Table 6.7	Summary of Simulation Condition of Grid Sensitivity	189
Table 6.8	The Comparison of Mean Temperature Distribution at the Central Line Doorway of Two Models (WOB and WOC) Between FDS Simulations and Experiment Data	192
Table 6.9	Summary of Grid Sizes	196
Table 7.1	Contour of Visibility Distributions in H-1 at 0˚,45˚ and 90˚ Wind Angles	207
Table 7.2	ASET for visibility in H-1 at 0˚,45˚ and 90˚ Wind Angles	208

Table 7.3	Contour of Temperature Distributions in H-1 at 0˚,45˚ and 90˚ Wind	210
Table 7.4	ASET for Temperature in H-1 at 0˚,45˚ and 90˚ Wind Angles	211
Table 7.5	Contour of Visibility Distributions in H-2 at 0˚,45˚ and 90˚ Wind Angles	213
Table 7.6	ASET for Visibility in H-2 at 0˚,45˚ and 90˚ Wind Angles	214
Table 7.7	Contour of Temperature Distributions in H-2 at 0˚,45˚ and 90˚ Wind Angles	215
Table 7.8	ASET for Temperature in H-2 at 0˚,45˚ and 90˚ Wind Angles	216
Table 7.9	Contour of visibility distributions in H-3 at 0˚,45˚ and 90˚ Wind Angles	218
Table 7.10	ASET for visibility in H-3 at 0˚,45˚ and 90˚ Wind Angles	219
Table 7.11	Contour of Temperature Distributions in H-3 at 0˚,45˚ and 90˚ Wind Angles	220
Table 7.12	ASET for Temperature in H-3 at 0˚,45˚ and 90˚ Wind Angles	221
Table 7.13	Comparison of RSET versus ASET for an evacuation in 4 bed-wards. A cross mark indicates that the ASET is lower than the RSET	224
Table 7.14	Contours of Visibility Distribution in Base Case Model at 0˚,45˚ and 90˚ Wind Angles	226
Table 7.15	ASET for Visibility in Base Case Model of 4 Bed-Ward at 0˚,45˚ and 90˚ Wind Angles	227
Table 7.16	Contour of Temperature Distributions in Base Case Model of 4-bed ward at 0˚,45˚ and 90˚ Wind Angles	228
Table 7.17	ASET for Temperature in Base Case Model of 4 Bed-Ward at 0˚,45˚ and 90˚ Wind Angles	229
Table 7.18	Contours of Visibility Distributions in M1 at 0˚,45˚ and 90˚ Wind Angles	231

Table 7.19	ASET for Visibility in M1 at 0˚,45˚ and 90˚ Wind Angles	232
Table 7.20	Contour of Temperature Distributions in M1 at 0˚,45˚ and 90˚ Wind Angles	233
Table 7.21	ASET for Temperature in M1 at 0˚,45˚ and 90˚ Wind Angles	234
Table 7.22	Contours of Visibility Distribution in M2 at 0˚,45˚ and 90˚ Wind Angles	236
Table 7.23	ASET for Visibility in M2 at 0˚,45˚ and 90˚ Wind Angles	227
Table 7.24	Contour of Temperature Distributions in M2 at 0˚,45˚ and 90˚ Wind Angles	238
Table 7.25	ASET for temperature in M2 at 0˚,45˚ and 90˚ Wind Angles	239
Table 7.26	Contours of Visibility Distribution in M3 at 0˚,45˚ and 90˚ Wind Angles	241
Table 7.27	ASET for visibility in M3 at 0˚,45˚ and 90˚ Wind Angles	242
Table 7.28	Contour of Temperature Distributions in M3 at 0˚,45˚ and 90˚ Wind Angles	244
Table 7.29	ASET for Temperature in M3 at 0˚,45˚ and 90˚ Wind Angles	245
Table 7.30	Contours of Visibility Distribution in M4 at 0˚,45˚ and 90˚ wind angles	247
Table 7.31	ASET for Visibility in M4 at 0˚,45˚ and 90˚ Wind angles	248
Table 7.32	Contour of Temperature Distributions in M4 at 0˚,45˚ and 90˚ Wind Angles	249
Table 7.33	ASET for Temperature in M4 at 0˚,45˚ and 90˚ Wind Angles	250
Table 7.34	Contours of Visibility Distribution in M5 at 0˚,45˚ and 90˚ Wind Angles	252

Table 7.35	ASET for Visibility in M5 at 0˚,45˚ and 90˚ Wind Angles	253
Table 7.36	Contour of Temperature Distributions in M5 at 0˚,45˚ and 90˚ Wind Angles	255
Table 7.37	ASET for Temperature in M5 at 0˚,45˚ and 90˚ Wind Angles	256
Table 7.38	Contours of Visibility Distribution in M6 at 0˚,45˚ and 90˚ Wind Angles	257
Table 7.39	ASET for Visibility in M6 at 0˚,45˚ and 90˚ Wind Angles	258
Table 7.40	Contour of Temperature Distributions in M6 at 0˚,45˚ and 90˚ Wind Angles	260
Table 7.41	ASET for Temperature in M6 at 0˚,45˚ and 90˚ Wind Angles	261
Table 7.42	Contours of Visibility Distributions for Each Model at 0˚ Wind Angle	263
Table 7.43	ASET for Visibility in Each Model of 4 Bed-Ward at 0˚ wind angle	264
Table 7.44	Contours of Visibility Distribution for Each Model at 45˚ Wind Angle	266
Table 7.45	ASET for Visibility in Each Model of 4 Bed-ward at 45˚ Wind Angle	267
Table 7.46	Contours of Visibility Distributions for Each Model at 90˚ Wind Angle	269
Table 7.47	ASET for Visibility in Each Model of 4 Bed-Ward at 90˚ Wind Angle	270
Table 7.48	Contours of Temperature Distribution for Each Model at 0˚ Wind Angle	273
Table 7.49	ASET for Temperature in Each Model of 4 Bed-Ward at 0˚ Wind Angle	274
Table 7.50	Contours of Temperature Distribution for Each Model at 45˚ Wind Angle	276

Table 7.51	ASET for Temperature in Each Model of 4 Bed-Ward at 45˚ Wind Angle	277
Table 7.52	Contours of Temperature Distribution for Each Model at 90˚ Wind Angle	279
Table 7.53	ASET for Temperature in Each Model of 4 Bed-Ward at 90˚ Wind Angle	280
Table 7.54	Summary of Natural Smoke Ventilation Performance for Each Model of Modified Window Size	285
Table 8.1	The Relationship Between Research Questions, Research Objectives, and Research Methodologies	289
Table 8.2	The Comparison of ASET and RSET for the existing Windows Design	291
Table 8.3	The Comparison of ASET and RSET for the Proposed Windows Design	295

LIST OF FIGURES

Figure 1.1	Summary of Research Framework	13
Figure 2.1	Schematic Illustration of Smoke Ventilation Functions	19
Figure 2.2	Timeline of ASET and RSET	20
Figure 2.3	Effect of Fire in Building	21
Figure 2.4	(a) Smoke Buoyancy (b) Pressure Profile During a Fire	28
Figure 2.5	Pressure Profile Caused by Stack Effect	30
Figure 2.6	(a) Stack Effect (b) Reverse Stack Effect	30
Figure 2.7	Pressures Developed by Wind Effect	31
Figure 2.8	The Triangle of Fire Concept Model	33
Figure 2.9	Standard Fire Curve in Built Environment	33
Figure 2.10	The Impacts of Natural Wind on Buildings	38
Figure 2.11	Atrium Configurations	42
Figure 2.12	Different Sizes of Compartments	43
Figure 2.13	Ventilation Parameters for the Different Scenario	45
Figure 2.14	Windward and Leeward Direction	47
Figure 2.15	Elevation Sketch Shows a Single-Sided Ventilation with Two Openings Gives a Higher Mass Flow Rate Than One Opening	47
Figure 2.16	Venturi Shape Roof	48
Figure 2.17	Malaysian Healthcare Referral System	57
Figure 2.18	(a) Pavilion Hospital Design (b) High-Rise Hospital Design	59
Figure 3.1	The Zone Model of Fire Simulation	84

Figure 3.2	Finite Volume Method of Field Model	85
Figure 3.3	The differences between Zone Model and Field Model (CFD)	87
Figure 4.1	Research Outline and Process	94
Figure 4.2	Method for Case Studies Selection	95
Figure 4.3	(a) Selayang Hospital (b) Serdang Hospital (c) Ampang Hospital	97
Figure 4.4	Fieldwork Process	100
Figure 4.5	The FDS and Smoke View Framework	102
Figure 4.6	Wind directions in Peninsular of Malaysia	104
Figure 5.1	Selayang Hospital: (a) Location (b) Site View	108
Figure 5.2	Selayang Hospital: Satellite View	110
Figure 5.3	Selayang Hospital: Shape and Orientation	112
Figure 5.4	Selayang Hospital: Typical Floor Plan from Level 4 to 10 (b) Floor plan at Level 11	113
Figure 5.5	Selayang Hospital: Floor plan at Level 11	114
Figure 5.6	Selayang Hospital: (a) 4 Bed-Wards at Level 4 to 8, (b) and (c) Layout of 4-Bed Wards	116
Figure 5.7	Selayang Hospital: (a) and (b) Window Design	118
Figure 5.8	Selayang Hospital: (a) Dimension (b) Layout of 4-bed Ward	119
Figure 5.9	Selayang Hospital: Specifications of Window Design	119
Figure 5.10	Serdang Hospital: (a) Location (b) Site View	121
Figure 5.11	Serdang Hospital: (a) Satellite View (b) Site Location	122
Figure 5.12	Serdang Hospital: Shape and Orientation	124
Figure 5.13	Serdang Hospital: Floor Plan of Ward Compartment	126
Figure 5.14	Serdang Hospital: Layout of 4-bed Wards	127

Figure 5.15	Serdang Hospital: Window Design	128
Figure 5.16	Serdang Hospital (a) Dimension (b) Layout of 4-Bed Ward	129
Figure 5.17	Serdang Hospital: Specifications of Window Design	129
Figure 5.18	Ampang Hospital: (a) Location (b) Site View	131
Figure 5.19	Ampang Hospital: (a) Satellite View (b) Site Location	132
Figure 5.20	Ampang Hospital: Shape and Orientation	134
Figure 5.21	Ampang Hospital: Floor Plan of Ward Compartments	136
Figure 5.22	Ampang Hospital: (a) and (b) Window Design	137
Figure 5.23	Ampang Hospital: Dimension and layout of 4-Bed Ward	138
Figure 5.24	Ampang Hospital: Specifications of Window Design	139
Figure 5.25	Common Wind Directions in Selangor, Malaysia	141
Figure 5.26	(a) and (b) Fire Loads in Hospital Ward	147
Figure 5.27	(a) Door in Open Position (b) Patient Bed Along Escape Route (b) (c) Additional Patient Bed (c) Patient Bed in Visitor Lounge	149
Figure 5.28	The Damages of Door in 4-Bed Ward	150
Figure 5.29	Window Curtain in the Wards	151
Figure 5.30	(a) and (b) Sprinkler System, (c) and (d) Call Bell Button	152
Figure 5.31	The Windows Are Not Fully Opened	153
Figure 5.32	Simplified Model of 4-Bed Ward a) Geometry and Floor Plan b) Window Design	155
Figure 6.1	The Position of Monitor Point in 4-Bed Wards (a) H-1 (b) H-2 (c) H-3 and (d) Simplified Model	161
Figure 6.2	(a) Black Line Indicates the Transition Zone from Visibility of 2.0 m or Higher to a Lower Value (Top View) (b) Black Line Indicates the Transition Zone	

	from a Temperature of 60˚C or Lower to a Higher Value (Top View)	162
Figure 6.3	(a) Overall Simulation Modelling Setting-Up for 4-Bed Ward (b) Location of a 4-Bed Ward in a Hospital Building	164
Figure 6.4	Summary of the Steps for the Simulation Study	165
Figure 6.5	Location of Bed Fire in 4-Bed Wards	166
Figure 6.6	The Proposed Wind Direction 0˚,45˚ and 90˚ to the Building Block	167
Figure 6.7	(a), (b) and (c) Wind Blows Towards Hospital Building Block at 0˚,45˚ and 90˚ Wind Direction	169
Figure 6.8	Results of the Grid Sensitivity Study for Four Different Grid Sizes	174
Figure 6.9	(a) and (b) Arrangement of Meshing in 4-Bed Ward	176
Figure 6.10	(a) and (b) Arrangement of Meshing for Outdoor Airflow of Overall building	177
Figure 6.11	Stages of FDS Modeling	179
Figure 6.12	FDS Model set up: (a) Full-Scale model (b) Simplified model of 4-bed ward	181
Figure 6.13	Test Models of Six (6) Different Window Designs	182
Figure 6.14	(a) Dimension of the compartment (b) Floor plan of the compartment (c) Dimension of door openings (d) Dimension of window openings	187
Figure 6.15	Fire Simulation Model for DO-B (a) Geometrical Sketch (b) Plan View	189
Figure 6.16	Vertical Maximum Temperature Profile Through the Doorway Center for Different Grid Sizes for DO-B	190
Figure 6.17	Maximum Vertical Temperature Profile Through the Doorway Center for Full Window (WOC)	191
Figure 6.18	Maximum Vertical Temperature Profile Through the Doorway Center for 2/3 Window (WOB)	192

Figure 6.19	Results of Opening's Enlargement on Natural Smoke Ventilation	194
Figure 6.20	The Base Case Model of 4-Bed Ward (a) Sketch View (b) Plan View	195
Figures 6.21	The Comparison of the Predicted Temperatures Underneath the Ceiling for Different Cell Sizes	197
Figure 6.22	Results of Temperature Distributions Underneath the Ceiling	198
Figure 6.23	(a), (b), (c), (d), (e) and (f) Velocity Contour of Outside Wind Flow at 0˚, 45˚ and 90˚ Wind Directions	201
Figure 7.1	(a) Top View of Visibility Distribution (b) Side View (c) Top View of Temperature Distribution (d) Side View	206
Figure 7.2	Time-Visibility Curves at Mid-Point of the Exit Door in H-1 at 0˚,45˚ and 90˚ Wind Angles	208
Figure 7.3	Time-Temperature Curves at Mid-Point of the Exit Door in H-1 at 0˚,45˚ and 90˚ Wind Angles	211
Figure 7.4	Time-Visibility Curves at Mid-Point of the Exit Door in H- 2 at 0˚,45˚ and 90˚ Wind Angles	213
Figure 7.5	Time-Temperature Curves at Mid-Point of the Exit Door in H-2 at 0˚,45˚ and 90˚ Wind Angles	216
Figure 7.6	Time-visibility curves at mid-point of the exit door in 4-bed ward of H-3 at 0˚,45˚ and 90˚	218
Figure 7.7	Time-Temperature Curves at Mid-Point of the Exit Door in H-3 at 0˚,45˚ and 90˚ Wind Angles	220
Figure 7.8	Simulation Setting of H-1: ASET in 4-bed Ward at 0˚,45˚ and 90˚	222
Figure 7.9	Simulation Setting of H-2: ASET in 4-bed Ward at 0˚,45˚ and 90˚	222
Figure 7.10	Simulation Setting of H-3: ASET in 4-bed ward at 0˚,45˚ and 90˚	223
Figure 7.11	Time-Visibility Curve of Fire Simulations in Base Case Model at 0˚,45˚ and 90˚ Wind Angles	226

Figure 7.12	Time-Temperature Curves at Mid-Point of the Exit Door for Base Case Model at 0˚,45˚ and 90˚ Wind Angles	229
Figure 7.13	Time-Visibility Curves in M1 at 0˚,45˚ and 90˚ Wind Angles	231
Figure 7.14	Time-Temperature Curves at Mid-Point of the Exit Door for M1 at 0˚,45˚ and 90˚ Wind Angles	234
Figure 7.15	Time-Visibility Curves in M2 at 0˚,45˚ and 90˚ Wind Angles	236
Figure 7.16	Time-Temperature Curves at Mid-Point of the Exit Door for M2 at 0˚,45˚ and 90˚ Wind Angles	239
Figure 7.17	Time-visibility curves in M3 at 0˚,45˚ and 90˚ Wind Angles	242
Figure 7.18	Time-Temperature Curves at Mid-Point of the Exit Door for M3 at 0˚,45˚ and 90˚ Wind Angles	245
Figure 7.19	Time-Visibility Curves in M4 at 0˚,45˚ and 90˚ Wind Angles	248
Figure 7.20	Time-Temperature Curves in M4 at Mid-Point of the Exit Door at 0˚,45˚ and 90˚ Wind Angles	250
Figure 7.21	Time-Visibility Curves in M5 at 0˚,45˚ and 90˚ Wind Angles	253
Figure 7.22	Time-Temperature Curves at Mid-Point of the Exit Door for M5 at 0˚,45˚ and 90˚ Wind Angles	255
Figure 7.23	Time-Visibility Curves in M6 at 0˚,45˚ and 90˚ Wind Angles	258
Figure 7.24	Time-Temperature Curves for M6 at 0˚,45˚ and 90˚ Wind Angles	260
Figure 7.25	Time-Visibility Curves at Mid-Point of the Exit Door at 0˚ Wind Angle	264
Figure 7.26	Time-Visibility Curves at Mid-point of the Exit Door at 45˚ Wind Angle	267
Figure 7.27	Time-Visibility Curves at Mid-Point of the Exit Door at 90˚ Wind Angle	270