



ENVIRONMENTAL IMPACTS OF KUALA LUMPUR
INTERNATIONAL AIRPORT 2 (KLIA2) DURING ITS
CONSTRUCTION STAGE

BY

SYAZWANI BINTI SAHRIR

A thesis submitted in fulfilment of the requirement for the
degree of Master of Science (Built Environment)

Kulliyyah of Architecture and Environmental Design
International Islamic University Malaysia

DECEMBER 2014

ABSTRACT

Transportation is an essential sector of the economy, contributing more than 5 percent to the annual Gross Domestic product of the nation. However, the growth in transportation sector creates environmental issue such as air pollution. The thesis assessed the environmental impacts of airport infrastructure upgrading and the construction of Kuala Lumpur International Airport 2 (KLIA2), the second budget airline airport to support the current international airport in Malaysia. This development of new airport has created significant adverse effects ranging from physical effects to the environment, land use compatibility, to a direct impact on the health of the surrounding communities. The study tested and examined environmental impacts namely particulate matter (PM) and noise level caused by the airport development during construction stage. Some of the crucial environmental concerns in airport development are health levels, community severance, noise levels, local air quality and sustainability, as well as the loss of habitat and wildlife in the area. In addition, companionable and synchronized land uses are crucial to the discussion of the airport, regional transportation linkages and regional planning. It is clear that the changing role of airport development will involve new airport construction, in terms of its function as a transportation hub, as well as a retail and commercial area. Various airborne particulate matter samplers (Cyclone Sampler and & 7 Hole Sampler) and sound level meter (SLM) used to record both noise and particulate matter levels. The research identified five sampling locations within the study area and also the airport's surrounding areas. The sampling locations were selected based on the intensity of the development within the sites and the severity of land use changes. Variables such as construction area size, development intensity, particulate matters and sound levels have been examined against the infrastructure upgrading of the airport over time and space. These variables of particulate matter and noise have been found to be significant outcomes of airport development. Instead, this thesis concluded that increased intensity of construction activities and land use changes had direct relationships with noise and particulate matter levels. It is hoped that the findings of the study would assist in providing better insight into the intangible costs incurred and benefits derived from an airport construction on land use changes. Most importantly, new airport planning and consultation measures are needed to mitigate risks from airport developments in seeking a common platform of fairness, certainty and transparency so that the opportunity to recognize broader planning consequences and governance questions of airports in their spatial settings is not lost.

ملخص البحث

النقل هو قطاع أساسي في الاقتصاد، ويساهم بما يزيد عن 5 في المئة من الناتج المحلي الإجمالي السنوي للدولة. بينما، النمو في قطاع النقل يخلق قضايا بيئية مثل تلوث الهواء. هذه الأطروحة تقيم الآثار البيئية لتطوير البنية التحتية للمطار كوالالمبور وتشييد المطار الدولي الثاني (KLIA2)، وميزانية الطيران للمطار الميزانية لدعم المطار الدولي الحالي في ماليزيا. وهذا التطوير للمطار الجديد اوجد آثار سلبية كبيرة تتراوح بين الآثار المادية للبيئة، وملائمة استخدام الأراضي، إلى تأثير مباشر على صحة المجتمعات المحيطة بها. هذه الدراسة اختبرت وتفحصت الآثار البيئية وهي الجسيمات (PM) ومستوى الضوضاء الناجمة عن تطوير المطار أثناء مرحلة البناء. بعض المخاوف البيئية الحاسمة في تطوير المطارات هي مستويات الصحة، انفصال المجتمع، ومستويات الضوضاء، ونوعية الهواء المحلي والاستدامة، فضلا عن فقدان المساكن والحياة الفطرية في المنطقة. بالإضافة إلى ذلك، استعمالات الأراضي ضرورية ملائمة ومتزامنة لمناقشة المطار من حيث روابط النقل الإقليمية والتخطيط الإقليمي. فمن الواضح أن الدور المتغير لتطوير المطار سوف يشمل بناء المطار الجديد، من حيث وظيفته كمركز النقل، فضلا عن مناطق التجزئة والتجارية. مختلف الجسيمات المحمولة جوا تم اختبارها (عينات سايكلون و عينات هول 7) وقياس مستوى الصوت (إس إل إم) استخدمت لتسجيل الضوضاء ومستويات الجسيمات. حدد البحث خمسة مواقع أخذ العينات داخل منطقة الدراسة وكذلك أيضاً المناطق المحيطة بالمطار. تم اختيار مواقع أخذ العينات على أساس كثافة التنمية داخل المواقع و قسوة التغيرات في استخدام الأراضي. وقد تم فحص المتغيرات مثل حجم مساحة البناء، وكثافة التنمية، وكذلك فحص الجسيمات ومستويات الصوت تجاه تطوير البنية التحتية للمطار عبر الزمان والمكان. تم العثور على هذه المتغيرات من الجسيمات والضوضاء لتكون نتائج هامة من تطوير المطارات. بدلا من ذلك، خلصت هذه الأطروحة أن الكثافة المتزايدة من أنشطة البناء والتغيرات في استخدام الأراضي لها علاقة مباشرة مع الضوضاء ومستويات الجسيمات. ومن المؤمل أن نتائج الدراسة ستساعد في توفير فهم أفضل للتكاليف المتكبدة غير الملموسة والفوائد نتيجة بناء المطار على التغيرات في استخدام الأراضي. الأهم من ذلك، هناك حاجة إلى تدابير واستشارات عند أي تخطيط جديد للمطار لتخفيف المخاطر الناجمة عن تطوير المطار للبحث عن أرضية مشتركة من الإنصاف و الثقة والشفافية، بحيث لا تضيع الفرصة للاعتراف بعواقب التخطيط الأوسع نطاقا واسئلة إدارة المطارات في الإعدادات المكانية الخاصة بهم.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science (Built Environment)

.....
Syahriah Bachok
Supervisor

.....
Mariana Mohamed Osman
Co-Supervisor

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science (Built Environment)

.....
M Zainora Asmawi
Internal Examiner

.....
Jamilah Mohammad
External Examiner

This thesis was submitted to the Department of Urban and Regional Planning and is accepted as a fulfilment of the requirement for the degree of Master of Science (Built Environment)

.....
Mariana Mohamed Osman
Head, Department of Urban and
Regional Planning

This thesis was submitted to the Kulliyyah of Architecture and Environmental Design and is accepted as a fulfilment of the requirement for the degree of Master of Science (Built Environment)

.....
Khairuddin Abdul Rashid
Dean, Kulliyyah of Architecture
and Environmental Design

DECLARATION

I hereby declare that this thesis is the result of my own investigation, 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.

Syazwani Sahrir

Signature.....

Date

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

**DECLARATION OF COPYRIGHT AND AFFIRMATION
OF FAIR USE OF UNPUBLISHED RESEARCH**

Copyright ©2014 by International Islamic University Malaysia. All rights reserved.

**ENVIRONMENTAL IMPACTS OF KUALA LUMPUR INTERNATIONAL
AIRPORT 2 (KLIA2) DURING ITS CONSTRUCTION STAGE**

No part of this unpublished research may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior written permission of the copyright holder except as provided below.

1. Any material contained in or derived from this unpublished research may be used by others in their writing with due acknowledgement.
2. IIUM or its library will have the right to make and transmit copies (print or electronic) for institutional and academic purposes.
3. The IIUM library will have the right to make, store in a retrieval system and supply copies of this unpublished research if requested by other universities and research libraries.

Affirmed by Syazwani Sahrir

.....
Signature

.....
Date

ACKNOWLEDGEMENTS

Alhamdulillah. I would like to thank ALLAH Almighty for His guidance, blessings, and protection throughout my agenda to complete this thesis. First and foremost, my deepest thanks to my supervisor, Dr. Syahriah Bachok, who have provided me with guidance, and supporting me during the process of carrying out this research. The supervision and support that she gave truly help the progression and smoothness of the research. I would also like to thank Dr. Mariana Mohamed Osman as the co-supervisor, for her constant encouragement, and invaluable suggestions made this research successful.

My sincere thanks go to lecturers and staffs for their assistance in guiding me and letting me borrow all the equipment needed in order to complete this research. My sincere thankfulness also goes to the staff of Malaysia Airports Holding Berhad (MAHB) and others for all the valuables information and knowledge.

This thesis would not have been possible without the love of family. I am grateful to my parents, (Encik Sahrir and Puan Rusiah) and siblings (Shaffiq, Syahmin, and Zuhdi), for their marvelous support during the course of my studies, which has contributed to this great success of mine.

I would like to thank best friend of mine, all my colleagues in MSBE (Adiba, Aqila, Tuminah, Alyani, Farah, Raihan, Aida, Shazwani, Aulia, Azza, Azizi, Aisyah, Ainaa, Isya), the lecturers and staffs of KAED that had given valuable information, suggestions and guidance in the compilation and preparation this thesis. Last but not least, thanks to all of my friends and the entire community of the Kulliyyah, those have been contributed by supporting my work and help me during the thesis progress till it is fully completed.

Lastly, I thank those people who I have not mentioned here for assisting me through this study. I am thankful for their aspiring guidance, invaluable constructive criticism and friendly advice during the study. Thank you all for the support, kindness, and caring.

TABLE OF CONTENTS

Abstract	ii
Abstract in Arabic	iii
Approval page	iv
Declaration	v
Copyright Page.....	vi
Acknowledgements.....	vii
List of Tables	xi
List of Figures	xiv
List of Abbreviations	xvii
CHAPTER 1: INTRODUCTION.....	1
1.1 Research Background	1
1.2 Problem Statement.....	2
1.3 Research Questions.....	6
1.4 Research Hypothesis.....	6
1.5 Aim and Objectives	7
1.6 Research Significance.....	8
1.7 Research Scope and Limitaion	10
1.8 Research Structure	13
1.8.1 First Stage: Introduction and Theoretical Studies.....	14
1.8.1 Second Stage: Data collection.....	14
1.8.1 Third Stage: Analysis of Data.....	15
1.8.1 Fourth Stage: Recommendations and Conclusions.....	15
1.9 Conclusion	17
CHAPTER 2: LITERATURE REVIEW.....	18
2.1 Introduction.....	18
2.2 Definition of Terms	19
2.2.1 Environment.....	19
2.2.2 Pollution	19
2.2.3 Land Use Planning.....	20
2.2.4 Land Use Change	21
2.2.5 Airport Planning.....	21
2.3 Noise Pollution	22
2.3.1 Impacts of Airport Noise.....	26
2.3.2 Impacts of Airport Construction and Construction.....	28
2.4 Air Pollution	35
2.4.1 Types of Air Pollutant.....	37
2.4.2 Airborne Particulate Matter (PM).....	40
2.4.3 Impacts of Airport Construction of Particulate Matter	44
2.4.4 Air Monitoring in Malaysia	47
2.5 Interrelations Between Air And Noise Pollutants And Construction of an Airport.....	53

2.6 Environmental Deliberation in Planning System of Malaysia	56
2.6.1 Environmental Deliberation in Planning System of Malaysia	57
2.6.2 Tools for Environmental Planning	59
2.6.2.1 Environmental Impact Assessment (EIA)	59
2.6.2.2 Environmental Management Plan (EMP)	61
2.6.3 Environmental Consideration in Planning System of Malaysia	61
2.7 Land Use Planning	63
2.8 Airport Planning	64
2.9 Airport Infrastructure Upgrading	66
2.9.1 Air Transportation Growth in Malaysia: Kuala Lumpur International Airport 2 (KLIA 2)	67
2.9.2 KLIA2 in the context of Sepang Local Plan 2015	71
2.9.2.1 Environmental Quality and Protection	77
2.10 Case Study of Airport Infrastructure Upgrading Impacts	81
2.11 Findings	82
2.12 Summary and Indication of Variables	84
2.13 Conclusion	85
CHAPTER 3: STUDY METHODOLOGY	86
3.1 Introduction	86
3.2 Research Development Framework	86
3.3 Research Design Process	88
3.4 Methods of Data Collection	91
3.4.1 Problem Identification and Limitation	92
3.4.2 Literature Review and Previous Study	92
3.4.3 Primary Data	95
3.4.3.1 Site Observation	95
3.4.3.2 Field Survey	98
3.4.4 Measurement and Scale of Variables	106
3.4.5 Secondary Data	107
3.5 Methods of Data Analysis	108
3.5.1 Correlation	109
3.5.2 Cross-Tabulation	109
3.5.3 Analysis of variance (ANOVA)	110
3.5.4 Multivariate Analysis of variance (MANOVA)	110
3.6 Conclusion	112
CHAPTER 4: ANALYSIS AND FINDINGS	113
4.1 Introduction	113
4.2 Statistical Assessment	113
4.3 On site observation	114
4.4 Noise Level Measuring	119
4.4.1 Results and Discussion	120
4.4.2 Noise level Measurement on construction noise threshold criteria	128
4.4.3 Noise level Measurement on noise level according to land uses ...	131
4.5 Airborne Particulate Sampling	135

4.5.1 Airborne Particulate Mass Concentration Analysis	136
4.5.2 Total Mass Concentration and Land Use Changes	144
4.6 Interrelation between Noise and PM	147
4.7 Summary of Statistical Analysis	149
4.8 Conclusion	150
CHAPTER 5: RECOMMENDATION AND CONCLUSION	151
5.1 Introduction.....	151
5.2 Revisiting Objectives.....	152
5.3 Justifications of Research Outcome.....	152
5.4 Summary of the Research.....	154
5.5 Recommendations.....	155
5.5.1 Reducing Air Pollution	158
5.5.2 Reducing Noise Pollution	159
5.6 Potential areas for Future Research	161
5.7 Conclusion	162
REFERENCES.....	165
LIST OF PROCEEDINGS AND PUBLICATIONS	178
APPENDIX I: NOISE LEVEL MEASUREMENT CHECKLIST	180
APPENDIX II: NOISE LEVEL MEASUREMENT DATA.....	182
APPENDIX III: PARTICULATE MATTER SAMPLING CHECKLIST.....	186
APPENDIX IV: PARTICULATE MATTER ANALYSIS.....	187
APPENDIX V: KL INTERNATIONAL AIRPORT LAYOUT.....	188
APPENDIX VI: KEY FEATURES OF KLIA2	190
APPENDIX VII: LETTER TO MAHB.....	191

LIST OF TABLES

<u>Table No.</u>		<u>Page No.</u>
1.1	Hypotheses for Statistical Analyses	7
1.2	The relationship between objectives and the structure of the study	13
2.1	Table of Environmental Noise and Permissible Steady Level Noise Exposure	23
2.2	Permissible Sound Level (L _{aeq})	26
2.3	Permissible Sound Level (L _{aeq})	32
2.4	Airport Comparison Chart	33
2.5	National Ambient Air Quality Standards [NAAQS]	36
2.6	Ambient Air pollutants	38
2.7	PM ₁₀ and PM _{2.5} Characteristics	42
2.8	Sources and management of particulates	46
2.9	Malaysian Ambient Quality	50
2.10	Air Pollutant Index	50
2.11	Impacts of Airport Construction	55
2.12	Four hierarchies of plans at different levels- Elements of Environment	58
2.13	Fundamentals Development Plans related to KLIA2	62
2.14	Gross Domestic Product by Kind of Economic Activity at Current Prices, 2006- 2010, Malaysia RM (Million)	68
2.15	Air Traffic Statistics by year (2008-2011)	69
2.16	Major Upgrades in Specifications for KLIA2	71
2.17	Key Features of KLIA2	71

2.18	Risk Zone KLIA (including KLIA2)	74
2.19	Risk Zone KLIA (including KLIA2) 2005-2020	75
2.20	Phases of KLIA 2	80
2.21	Key impacts typically caused by each of these activities	83
3.1	General Inquiries in Determining Data Collection Methods	90
3.2	Sampling Method on Noise Level based on previous study	93
3.3	Sampling Method on Particulate Sampling based on previous study	94
3.4	Measuring Point of the Noise level survey	101
3.5	Checklist for Noise Level Measurement	102
3.6	Sampling points for Airborne Particulate Sampling	106
3.7	Interpreting Values of Lamda	109
3.8	Measure of Association and Measure of Effect Size	111
3.9	Method and Expected output of survey	111
4.1	Major Upgrades in Specifications	116
4.2	Measuring Point of the Noise level	120
4.3	Overall Noise Levels at Construction Sites Surveyed (Site Office KUB Outdoor)	121
4.4	Overall Noise Levels at Construction Sites Surveyed (Main access to KLIA 2 site)	122
4.5	Overall Noise Levels at Construction Sites Surveyed data (Site Office outdoor)	123
4.6	Overall Noise Levels at Adjacent Area (Pekan Sepang)	125
4.7	Overall Noise Levels at Adjacent Area (Client Office Outdoor, KLIA)	126
4.8	Table of Summary for all Sampling Location	127

4.9	Hypothesis for Statistical Analyses	128
4.10	ANOVA Descriptive for Mean Differences of Construction Noise	129
4.11	ANOVA Outputs	129
4.12	Hypothesis for Statistical Analyses	131
4.13	ANOVA Descriptive for Mean Differences of Construction Noise	132
4.14	ANOVA Outputs	132
4.15	ANOVA Outputs (Post Hoc Tests)	132
4.16	Sampling Points Area chosen in Executing Air Sampling Method	136
4.17	Total Mass Concentration for each Sampling Points in KLIA2	138
4.18	Hypothesis for Statistical Analyses	144
4.19	MANOVA Descriptive Statistics for Mean Differences of Construction Noise	145
4.20	MANOVA Outputs	145
4.21	Pearson Correlation	147
4.22	Indication of Correlation Strength	147
4.23	Correlation Outputs	147
4.24	Hypotheses for Statistical Analyses	149

LIST OF FIGURES

<u>Figure No.</u>		<u>Page No.</u>
1.1	Research Structure	16
2.1	The Particles radius size rating	41
2.2	Location of Continuous Air Quality Monitoring Stations, Peninsular Malaysia	49
2.3	Location of Continuous Air Quality Monitoring Stations, East Malaysia	49
2.4	Malaysia Annual Average Concentration of Particulate Matter (PM ₁₀), 1999 - 2012	51
2.5	Malaysia: Number of Unhealthy Days, Klang Valley, 2001 - 2012	52
2.6	Integrated Resource Planning and Management System	57
2.7	GDP of services and average annual growth for 2011-2015	68
2.8	Construction of permanent second terminal to replace current LCCT	70
2.9	Local Plan Area	72
2.10	Development Blocks	73
2.11	Land Use Map, 2010	76
2.12	Recommendation on Earth Bund for the prevention of noise	77
2.13	Land Use Map (DB 6-KLIA)	79
2.14	Construction underway at the site (KLIA2) in the year 2012	80
3.1	Research Framework	87
3.2	The Research Process	88

3.3	Steps in Conducting Field Survey	89
3.4	Macro level: Location Plan of KLIA2	96
3.5	Micro level: Layout of KLIA2	97
3.6	Construction underway at the site (KLIA2) in year 2012	97
3.7	Location of Noise Level station	99
3.8	Noise Level Surveys Measuring	100
3.9	During Airborne Particulate Matter (PM) sampling	103
3.10	Location of Airborne Particulate Station	104
3.11	The 7 Hole Head Sampler and Cyclone Sampler	105
3.12	Relationship between Independent and Dependent Variable	107
4.1	The locality setting of KLIA2	115
4.2	Comparison – MTB, LCCT & KLIA2	116
4.3	Construction of permanent second terminal to replace current LCCT	117
4.4	Land use changes for KLIA2 area from year 2003 until 2014	117
4.5	Construction underway at the site (KLIA2) in year 2012	119
4.6	Fifteen-minute Fluctuation of Noise Level (Site Office KUB outdoor)	121
4.7	Fifteen-minute Fluctuation of Noise Level (Main access to KLIA 2 site)	123
4.8	Fifteen-minute Fluctuation of Noise Level (Site Office outdoor)	124
4.9	Fifteen-minute Fluctuation of Noise Level (Pekan Sepang)	125
4.10	Fifteen-minute Fluctuation of Noise Level (Client Office outdoor: KLIA)	126

4.11	Location of Noise Level Sampling and Mean dBA for every station	134
4.12	Airborne Particulates Sampling Result (Site Office KUB indoor and outdoor)	139
4.13	Airborne Particulates Sampling Result (Main Access to KLIA 2 and Guard office Indoor)	140
4.14	Airborne Particulates Sampling Result (Main Access to KLIA 2 and Guard office Indoor)	140
4.15	Airborne Particulates Sampling Result (Pekan Sepang Indoor and Outdoor)	141
4.16	Airborne Particulates Sampling Result (Pekan Sepang Indoor and Outdoor)	142
5.1	Flow of Revisiting Objectives	152
5.2	Hearing protective devices	160

LIST OF ABBREVIATIONS

ACI	Airport Council International
AEA	Advanced Engineering Acoustics
AEF	Aviation Environment Federation
AG	Australian Government
API	Air Pollutant Index
APU	Aircraft Auxiliary Power Units
BLM	Bureau of Land Management
BLRC	Bradley Landfill & Recycling Center
BWI	Baltimore/ Washington International Airport
CEC	Commission Of The European Communities
CO	Carbon Monoxide
dBA	Decibels with “A Weighting”
DEFRA	Department for Environment, Food and Rural Affairs
DEQ	Department of Environmental Quality Oklahoma
DOE	Department of Environment
DOENSW	Department of Environment and Conservation
DOT	Department of Transport
EIA	Environmental Impact Assessment
ELF	European Lung Foundation
EPA	Environmental Pollution Agency
FAA	Federal Aviation Administration
FAO	Food and Agriculture Organization

GSA	Government of South Australia
HAP _s	Hazardous Air Pollutants
HCDOES	Hamilton County Department of Environmental Services
ICAO	International Civil Aviation Organization
IPCC	Intergovernmental Panel on Climate Change
JFK	John F. Kennedy Airport
KLIA	Kuala Lumpur International Airport
KLIA 2	Kuala Lumpur International Airport 2
LAX	Los Angeles International Airport
MAAQG	Malaysian Ambient Air Quality Guidelines
MAHB	Malaysia Airports Holdings Berhad
MANOVA	Multivariate analysis of variance
NAAQS	National Ambient Air Quality Standards
NACAA	National Association of Clean Air Agencies
NAMP	National Airport Master Plan
OSHA	Occupational Safety and Health Administration
PM	Particulate Matter
QGOV	Queensland Government
SEA	Strategic Environmental Assessment
SHLs	Significant Harm Levels
SLM	Sound Level Meter
SPSS	Statistical Package For Social Sciences
TAS	Tenancy Agreement Service
TRB	Transportation Research Board

TSP	Total Suspended Particulates
VOCs	Volatile Organic Compounds
WBG	World Bank Group
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 RESEARCH BACKGROUND

This research assesses the environmental impacts of the new International Airport Hub during its construction stage. The approach implemented to collect data for this research was by conducting a case study. The case study chosen is Kuala Lumpur International Airport 2 (KLIA2) construction area, which is at about 95 percent completion in terms of its physical structure in the year 2013 (Sidhu, 2013). During the research period, KLIA2 has significantly expanded and upgraded to meet increasing demands (Malaysia Airports Holdings Berhad [MAHB], 2012). The concerns were the relationship between the construction of new airport and how this growth contributes to environmental impacts. It is therefore anticipated that the findings will ultimately assist in future planning for construction of new airport.

Strong demand for aviation is a link to the demand to increase the competitiveness of a region (Burghouwt, 2007). Airport construction reflects a variety of environmental and social implications due to land use changes and land takes (Lambin and Geist, 2006; Aviation Environment Federation [AEF], 2008; Aspinall, 2008). Land use changes can result in soil degradation as a result of deforestation and urbanization (Chhabra et al., 2006). This is a typical phenomenon in developing countries with resulted changes in green areas and the urban form. Moreover, airport development during its construction period and operation phases can be detrimental to the environment (Upham et al., 2003; Luther 2007; Schrenk et al., 2009).

Aircraft operations contribute an enormous amount of emissions; however, airport infrastructure upgrading and construction also produce pollution (Schrenk et al., 2009). Serious environmental concerns resulting from airport operations and construction include noise, air quality, climate change, biodiversity, as well as community severity (Upham et al., 2003; Luther, 2007; Airport Council International [ACI], 2008; Schrenk et al., 2009).

This study provides an assessment to understand and indicate the impacts of the new International Airport Hub during construction stage to the environment in the attempt to recommend strategic airport planning and mitigation measures for future planning.

1.2 PROBLEM STATEMENT

Airport construction and infrastructure upgrading may produce numerous environmental effects, as a result of airborne particulate produced by aircraft, heavy equipment emissions, and noise pollution (Schiff, 2009). In order for the aviation system to continue spurring economic growth, innovative action and a sustainable approach that addresses mobility and environmental concerns must be achieved (Waitz et al., 2004; Walker and Baker, 2010). The continuing construction of new air transport nurtures serious concerns on the long-term sustainability of the industry; even currently, massive discussions are revealing that air transport is less contaminating than ground vehicles (Popescu et al., 2011).

Aviation affects the environment through many ways including land use change, air quality, and noise pollution (Thomas et al., 2001; Upham, et al., 2003; Campbell, 2010). Airport strategic planning is a challenging task due to the strains

between economic growth and environmental impacts (Kwakkel, 2008; Walker and Baker, 2010).

As the economy and demand of air transportation are growing, environmental effects are similarly predicted to grow and will become one of the fundamental constraints on air transportation growth (Upham et al., 2003; Waitz et al., 2004). Inevitably, the surrounding area must be planned with the consideration of the advent of an airport city as an airport can no longer be considered in isolation (Walker and Baker, 2010). Hence, airport planning anticipates a wide range of possible forthcoming, giving the responsible authority to modify their plans so that they can accommodate the variation of prospects that may occur in the future (Neufville and Odoni, 2003). Briefly, constructions of new airport are complex, costly, and controversial (Cohen and Coughlin, 2003; Kwakkel, 2008).

Aviation, as well as airport facility operations and maintenance of aviation and construction, produces various operations that impact the surroundings (Luther, 2007; Transportation Research Board [TRB], 2008; AEF, 2008). Nowadays, the management of noise pollution of inhabited neighbourhoods has become a significant issue for many airports (Bell, 2001; Bréchet and Picard, 2010). It is estimated that 120 million people worldwide have developed hearing problems due to noise pollution (Hamoda, 2008). Noise-induced hearing loss is predominantly severe in the construction industry since the construction industry is considered the backbone of development (Hamoda, 2008). Although many industries involve noise exposures, construction workers are at high risk as they are exposed to noise ranging from 80 to 120 dBA (Seixas, 2004; Hamoda, 2008). Moreover, airport noise can explicitly cause sleep disturbance, hearing problems, physiological stress reactions and distress, and interference with speech and communication (Bell, 2001; Fast, 2004).

Airport activities may yield various pollutants, comprising numerous hazardous air pollutants (HAPS), volatile organic compounds (VOCs), carbon monoxide (CO) and particulate matter (PM) (Luther, 2007; Ratliff et al., 2009; Timko et al., 2010; Popescu et al., 2011; Woody et al., 2011). Considering projected development and environmental concerns, the aircrafts contribute to impacts on air quality from environmental aspects and public health perspective (Woody et al., 2011). Construction of the airport and development projects may lead to particles and discharges from asphalt placement (Kenney, 2006).

Research by Popescu et al. (2011) shows an association between fine particles (size, concentration) and health effects such as premature mortality, cardiopulmonary morbidity and increased respiratory illness. Construction sites may become the source of serious environmental nuisance and pollution if not properly managed (Yu-Leuk, 1997). The construction activities may affect not only the workers on site but even surrounding occupants and the general public (Yu-Leuk, 1997).

Land takes for airport-related development and construction of an airport may increase a drip-feed of growth in a range which accumulates to a transformation from a rural to a further urban extent (AEF, 2008). The goals concerning airport development should be within the reputable framework of an area's comprehensive plan as aviation is a region's transportation system (Federal Aviation Administration [FAA], 2002). An essential component to effective land use planning around airports is communication (Li et al., 2007). Local land use planning is a method of determining the appropriate use of properties around airports in structuring an integral part of the land use policy and regulatory tools used by airports and local land use planners (FAA, 2002). Innovative airport development and deliberation measures

need to lower the risks from airport growth and noise in seeking a common platform of fairness, certainty and transparency.

Guiding compatible land use has been difficult as most airports' boundaries had pre-existing development (FAA, 1998; Li et al., 2007). The capacity of an airport to expand its border can be restrained by market price and value of the land, as well as wildlife threatened (Upham et al., 2003). Based on research by Cidell (2004), the relationship between the planning process and public participation proved to be a vital part of the connection between air transportation, globalization and land use. Thus, land use development and planning is intended to secure flexibility and cohesion in the enclosing and accomplishment of national policy with respect to use and development of land.

As KLIA2 is being constructed alongside the existing Kuala Lumpur International Airport (KLIA), preliminary observation indicated some problems surfacing due to the construction works. The construction site for the new terminal is located next to the existing KLIA runway. As a result, environmental impact is inevitable since the gap between the rate of development and the degree of infrastructure upgrading appears. In addition, awareness of airport construction impact is still lacking in Malaysia as no one knows the impact of this mega development due to the hushed nature of its initial planning. This scenario suggests that serious consideration must be taken on how crucial it is to manage airport construction wisely and also to balance both economic development and the environment.