HEALTH RISK EFFECT OF INDOOR AIR QUALITY INDEX AT ADAPTIVE REUSED MUSEUM IN MALAYSIA

SYAHRUN NEIZAM BIN MOHD DZULKIFLI

A thesis submitted in
fulfilment of the requirement for the award of the
Doctor of Philosophy

Faculty of Civil and Environmental Engineering
Universiti Tun Hussein Onn Malaysia

JANUARY 2019

DEDICATION

Specially dedicated to my parents, Mohd Dzulkifli bin A. Jalil and Shaikhah binti Ahmad, to my brothers, Syarizul Amri bin Mohd Dzulkifli and Syafiee Syukrie bin Mohd Dzulkifli and to my sister, Dzunnur Zaily binti Mohd Dzulkifli.
My supervisor, Associate Professor Ts. Dr. Abd Halid bin Abdullah, my co-supervisors, Associate Professor Dr. Abdul Mutalib bin Leman and Dr Lee Yee Yong and to all my friends.
Thank you for your endless support to me.

ACKNOWLEDGEMENTS

In the name of Allah, most gracious, most merciful. Alhamdulillah, all praise to Allah, the most beneficent and most merciful, who has given me the strength and grace to conduct this study.

I would like to take this opportunity to put on record my heartfelt thanks and deep appreciation to my supervisor Associate Professor Ts. Dr. Abd Halid bin Abdullah for his patience, enduring optimism, guidance, invaluable advice and assistance in this study. Special appreciation also goes to my co-supervisors, Associate Professor Dr. Abdul Mutalib bin Leman and Dr. Lee Yee Yong for their continuity of supervision. All advices and help their giving to me, academically or non-academically, are really helpful and will never be forgotten.

Special thanks to Ministry of Higher Education Malaysia (MOHE) for providing scholarship to me by the channel of MyBrain15-MyPhD. The cooperation given by the management of the museums is highly appreciated.

Sincere gratitude extend to Dr. Hazrul bin Abdul Hamid who had provided assistance and knowledge on statistical analysis in my research study. Thanks to Mrs. Raha binti Sulaiman, Dr. Azian binti Hariri, Dr. Azeanita binti Suratkon and Dr. Tong Yean Ghing for invaluable advice and sharing their knowledge for me to complete my research study. The technicians, Mr. Osman bin Abdul Rahman and Mr. Mohd Azizi bin Mohd Afandi should also be recognized for their support and help.

Last but not least, deepest appreciation to my parents, Mohd Dzulkifli bin A. Jalil and Shaikhah binti Ahmad, and my siblings, Syarizul Amri bin Mohd Dzulkifli, Dzunnur Zaily binti Mohd Dzulkifli and Syafiee Syukrie bin Mohd Dzulkifli for their support and give me a lot of encouragement, guidance and motivation. My sincere appreciation also extends to my friends, Dr. Paran anak Gani, Dr. Umi Kalthsom binti Parjo and Mohd Mahathir Suhaimi bin Shamsuri.

ABSTRACT

To this date, there are still limited studies conducted on the risk assessment of the indoor air quality (IAQ) which affect towards the people in the public building, especially in the museum. As one of the environmental risk assessment tool, the environmental quality index was utilised to determine whether the current location provides a healthy environment or not. Therefore the purpose of this study is to develop an index, called IAQ Index (InAQI), as a health risk assessment tool for the people, especially for visitors, for a short term period at the adaptive reused museum in Malaysia. In this study, the mixed-mode method was used to fulfil the objectives of the study by using a qualitative method and quantitative method. For qualitative method, there is only one data collection technique involve in this study which is a walkthrough inspection (observation method), while for quantitative method, there are two types of data collection techniques which are subjective measurement (questionnaire survey) and physical measurement (indoor environment variables measurements). The physical measurement was conducted on the adaptive reused museum and at the same time the subjective measurement were distributed to the visitors. The results of the study indicated that the IAQ condition for gaseous pollutant of NO_2, SO_2 and CO_2 and particulate matter of $PM_{2.5}$, exceeded the acceptable Threshold Limit Value. Subsequently, to develop a representative human health index based on the indoor environment, the InAQI regression equation was established, using statistical approach, by integrating the factor of IAQ variables and Sick Building Syndrome (SBS) perception. Apart from that, the InAQI regression equation was verified through the execution of the actual case study by comparing the observed and predicted outputs. These verifications have shown that the InAQI may be suitably applied at all adaptive reused museums, especially in Malaysia, to rank the health risk effect towards visitors that associates well with the IAQ and SBS symptom.

ABSTRAK

Sehingga kini, masih terdapat kajian yang terhad dilakukan terhadap penilaian risiko kualiti udara dalaman (IAQ) yang memberi kesan kepada orang ramai di bangunan awam, terutama di muzium. Sebagai salah satu alat penilaian risiko alam sekitar, indeks kualiti alam sekitar digunakan untuk menentukan sama ada lokasi semasa menyediakan persekitaran yang sihat atau tidak. Oleh itu, tujuan kajian ini adalah untuk membangunkan indeks, dikenali sebagai Indeks IAQ (InAQI), sebagai alat penilaian risiko kesihatan untuk manusia, terutamanya untuk pelawat, untuk tempoh yang singkat di bangunan muzium yang telah disuai guna semula di Malaysia. Dalam kajian ini, kaedah gabungan telah digunakan untuk memenuhi objektif kajian dengan menggunakan kaedah kualitatif dan kaedah kuantitatif. Untuk kaedah kualitatif, terdapat hanya satu teknik pengumpulan data yang digunakan iaitu pemeriksaan (kaedah pemerhatian), manakala untuk kaedah kuantitatif, terdapat dua jenis teknik pengumpulan data yang digunakan iaitu pengukuran subjektif (kajian soal selidik) dan pengukuran fizikal (pengukuran persekitaran dalaman). Pengukuran fizikal telah dijalankan di bangunan muzium yang telah digunakan semula dan pada masa yang sama pengukuran subjektif telah diedarkan kepada pelawat. Keputusan kajian menunjukkan bahawa keadaan IAQ untuk bahan pencemar gas NO_2, SO_2 dan CO_2 dan zarah $PM_{2.5}$, melebihi Nilai Had Ambang yang dapat diterima. Selepas itu, untuk membangunkan indeks kesihatan manusia berdasarkan persekitaran dalaman, persamaan regresi InAQI ditubuhkan, menggunakan kaedah statistik, dengan mengintegrasikan faktor pembolehubah IAQ dan persepsi Sindrom Bangunan Sakit (SBS). Selain itu, persamaan regresi InAQI disahkan melalui pelaksanaan kajian kes sebenar dengan membandingkan output yang diperhatikan dan dijangka. Pengesahan ini telah menunjukkan bahawa InAQI mungkin sesuai digunakan di semua bangunan muzium yang telah digunakan semula, terutama di Malaysia, untuk menilai kesan risiko kesihatan terhadap pelawat yang berkaitan dengan IAQ dan gejala SBS.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

α	-	Cronbach's Alpha
p	-	Significant value
m^2	-	unit of area (square meter)
m^3	-	unit of volume (cubic meter)
µm	-	unit in the metric system equal to one millionth (10^{-6}) of a meter.
cm/s	-	measurement unit of speed or velocity (centimeter per second)
$\mu g/m^3$	-	measurement unit of density (microgram per cubic meter)
ppm	-	measurement unit of mass (parts per million)
ach	-	the air change rate (hr^{-1}).
df	-	Degree of freedom
n	-	Total of survey respondent
N	-	Number of item
$\bar{c}$	-	Average covariance between item-pairs.
$\bar{v}$	-	Average variance.
W+	-	the Wilcoxon of positive rank statistic
W-	-	the Wilcoxon of negative rank statistic
%	-	Percent
am	-	ante meridiem (before midday or before noon)
pm	-	post meridiem (after midday or after noon)
RM	-	Ringgit Malaysia (Currency)
USD	-	United State Dollar (Currency)
r-value (field study)	-	Spearman's Rank Order correlation coefficient value

r-value (pilot study)	-	the PPMC critical value of correlation coefficient
r_{xy}-value (pilot study)	-	the correlation coefficient value
I/O	-	the indoor/outdoor pollutant ratio
S	-	the surface area (m^2).
S/V	-	surface area to volume ratio
V	-	the interior volume (m^3).
V_{deep}	-	the deposition velocity of pollutant (m hr^{-1}).
CO	-	Carbon Monoxide
CO_2	-	Carbon Dioxide
ETS	-	Environmental Tobacco Smoke
HCHO	-	Formaldehyde
NO_2	-	Nitrogen Dioxide
O_3	-	Ozone
PM	-	Particulate Matter
PM_{10}	-	Particles with a size of 10 micrometer
$PM_{2.5}$	-	Particles with a size or smaller than 2.5 micrometer
$PM_{0.1}$	-	Particles with a size or smaller than 0.1 micrometer
SO_2	-	Sulfur Dioxide
VOC/TVOC	-	Volatile Organic Compounds / Total Volatile Organic Compounds
Act 514	-	Occupational Safety and Health Act
ANOVA	-	Analysis of Variance
ASHRAE	-	American Society of Heating, Refrigerating and Air-conditioning Engineers
ATS-DLD-78	-	American Thoracic Society and the Division of Lung Diseases
BRI	-	Building Related Illness
CAI-Asia	-	Clean Air Initiative for Asia
COP/COP-IAQ	-	Code of Practice / Code of Practice on Indoor Air Quality
CSR	-	Crowd Safety and Risk

DOSH	-	Department of Safety and Health
EPA	-	Environment Protection Agency
HIRARC	-	Hazard Identification, Risks Assessment and Risk Control
HVAC	-	Heating, Ventilating and Air Conditioning
IAPI	-	Indoor Air Pollution Index
IAQ	-	Indoor Air Quality
IBM SPSS v21	-	IBM Statistical Package for the Social Science version 21
ICOP-DOSH	-	Questionnaire for Building Occupant
ICOP/ICOP-IAQ	-	Industry Code of Practice / Industry Code of Practice on Indoor Air Quality
IEI	-	Indoor Environmental Index
IEQ	-	Indoor Environmental Quality
InAQI	-	Indoor Air Quality Index
IPSI	-	Indoor Pollutant Standard Index
IU ATLD	-	International Union against Tuberculosis and Lung Diseases
KTM	-	Keretapi Tanah Melayu Berhad
MM-040	-	Indoor Climate Questionnaire
MVAC	-	Mechanical Ventilating and Air Conditioning
NIOSH	-	National Institutes of Occupational Safety and Health
Null hypothesis	-	Significant value larger than 0.05 ($\rho > 0.05$)
OHD	-	Occupational Health Doctor
USECHH	-	the Use and Standard of Exposure Chemical Hazardous to Health
OSH	-	Occupational Safety and Health
OSHA	-	Occupational Safety and Health Administration
PERZIM	-	Perbadanan Muzium Melaka (Melaka Museums Corporation)
PLUM	-	Polytomous Universal Model
PNC	-	particle number concentration
PPMC	-	Pearson Product Moment Correlations

QEESI	-	Quick Environmental Exposure and Sensitivity Inventory
SBS	-	Sick Building Syndrome
SEA	-	South East Asia (Region)
SPM	-	Suspended Particulate Matter
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
USA/US	-	United States of America / United States
TBS	-	Tight Building Syndrome
TLV	-	Threshold Limit Value
TSP	-	Total Suspended Particle
WHO	-	World Health Organization

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

The problem related to the Indoor Air Quality (IAQ) has rapidly become a major health concern since people are spending almost 90% of their time indoors (Abraham & Li, 2014; Asmi et al., 2012; Kamaruzzaman & Razak, 2011; Mohddin & Aminuddin, 2014; Utami & Nasri, 2018). Thus, due to the improper air circulation turnover within and outside the buildings, people might be exposed to hazardous and harmful concentrations of pollutants (Cincinelli & Martellini, 2017; Frontczak et al., 2012). In general, the aged and ill people especially the youngsters who spend a long time inside the buildings have a tendency of exposing to the indoor hazardous pollution. These indoor environments include homes, restaurants, warehouses, factories, offices, stores, public buildings and vehicles. Hence, in these environments, people are exposed to the pollutants emanating from a wide array of sources that lead to the indoor environmental issues which could affect their health. The people encounter the same concern while they are in the working environment. In event that the indoor environment is poor or perceived to be below acceptability, it could produce a low productivity among workers. Thus, it is significant to encourage the public to pay more attention and make an effort by creating and sustaining a healthy environment, especially when they encounter the indoor environmental issues which could affect their health. In general, several factors that affect the working performance and human health in an indoor environment, are IAQ, ergonomics, noise, daylight, thermal comfort, and ventilation effectiveness (Kamaruzzaman et al., 2010).

REFERENCES

Abboud, N. A. (2017). *Echoing Sustainability in MENA: Sickness of Buildings – Causes, Risks and Solutions*. Retrieved from https://www.ecomena.org/sickness-buildings/

Abdul-Wahab, S. A. (2011). *Sick Building Syndrome: In Public Building and Workplace*. Springer.

Abdul-Wahab, S. A., Salem, N., & Ali, S. (2015). Evaluation of Indoor Air Quality in a Museum (Bait Al Zubair) and Residential Homes. *Indoor and Built Environment*, *24*(2), 244–255.

Abdullah, I. H. T., Manan, M. M. A., Manan, E. A., & Abdullah, M. R. T. (2016). Heritage Tourism Satisfaction Toward Malacca Museums in Malaysia. *Journal of Applied Environmental and Biological Sciences*, *6*, 63–68.

Abraham, S., & Li, X. (2014). A Cost-effective Wireless Sensor Network System for Indoor Air Quality Monitoring Applications. *Procedia Computer Science*, *34*, 165–171.

Ahamed, R. (2012). *Indicators in Practice: Environmental Quality Indicators of Malaysia*. Retrieved from http://epi2012.yale.edu/indicators-in-practice/environmental-quality-indicators-malaysia

Air and Water Incorporated (2017). *Air Pollution: Understanding the Problem and Ways to Help Solve It*. Retrieved from https://www.air-n-water.com/air-pollution.htm

Ali, A. S., Chua, S. J. L., & Lim, M. E.-L. (2015). The Effect of Physical Environment Comfort on Employees' Performance in Office Buildings: A Case Study of Three Public Universities in Malaysia. *Structural Survey*, *33*(4/5), 294–308.

Ambu, S., Chu, W., Mak, J., Wong, S., Chan, L., & Wong, S. (2008). Environmental Health And Building Related Illnesses, *Internationanl e-Journal of Science, Medicine and Education, 2*(Suppl 1), 11–18.

American Academic of Pediatrics (2018). *Ages and Stages*. Retrieved on March 16, 2018, from https://www.healthychildren.org/English/ages-stages/Pages/default.aspx

Andersson, K., Fagerlund, I., Bodin, L. & Ydreborg, B. (1988). Questionnaire as an Instrument When Evaluating Indoor Climate. *Healthy Building, 3*, pp. 139–145.

Andersson, K., Bakke, J. V, Bjorseth, O., Bornehag, C. G., Clausen, G., Hongslo, J. K., Kjellman, M., Kjaergaard, S., Levy, F., Molhave, L., Skerfving, S. & Sundell, J. (1997). TVOC and Health in Non-industrial Indoor Environments Report from a Nordic Scientific Consensus Meeting at Liingholmen in. *Indoor Environment*, *7*(2), 78–91.

Andersson, K., Fagerlund, I., Stridh, G., & Aslaksen, W. (1998). *MM 040 Questionnaire: Work Environment Manual*.

ASHRAE Standard Committee. (2013). *Ventilation and Acceptable Indoor Air Quality*. Atlanta: ANSI/ASHRAE Standard 62.1-2013.

ASHRAE Technical Committee. (2015). *Heating, Ventilating and Air-Conditioning Applications*. Atlanta: ASHRAE Handbook Inch-Pound Edition (Inch-Pound).

Asmi, A., Putra, J. C. P., & Rahman, I. A. (2012a). A Study of Indoor Air Quality in University Laboratory Buildings. *International Journal of Engineering Science and Technology*, *4*(9), 4187–4195.

Asmi, A., Putra, J. C. P., & Rahman, I. A. (2013). Simulation of Room Airflow Using Comsol Multiphysics Software. *Applied Mechanics and Materials*, *465–466*, 571–577.

Asmi, A., Putra, J. C. P., & Rahman, I. B. A. (2012b). A Study of Indoor Air Quality of Public Toilet in University's Building. In *2012 IEEE Colloquium on Humanities, Science and Engineering (CHUSER)*, Kota Kinabalu, Sabah (pp. 403–408).

Attfield, M.D. (1986). Respiratory Questionnaires. *NIOSH Publication* 86-102, pp. 171–179.

Australian Bureau of Statistics (2018). *Museums Fact Sheet 2010: How Many Museums Are There?*. Retrieved from http://www.abs.gov.au/

Badri, A., Nadeau, S., & Gbodossou, A. (2011). Proposal of a Risk-Factor-Based Analytical Approach for Integrating Occupational Health and Safety into Project Risk Evaluation. *Accident Analysis and Prevention*, *48*, 223–234.

Balocco, C., & Grazzini, G. (2007). Plant Refurbishment in Historical Buildings Turned into Museum. *Energy and Buildings*, *39*(6), 693–701.

Baltimore County Public Schools (2017). *The Role of Statistics in Research*. Retrieved from https://www.bcps.org/offices/lis/researchcourse/statistics_role.html

Barnett, A. G. (2012). Modern Museums: A Visitor - Centered Approach to Doing Business. *Journal of Museum Studies*, *6*(1), 1–14.

Bernama (2017). Melaka Tourists Arrivals Jump 12.7% for January to April. *The Sundaily*. Retrieved from http://www.thesundaily.my/news/2017/06/07/malacca-tourist-arrivals-jump-127-jan-april

Blacksmith Institute (2008). The Top Ten of the Toxic Twenty. *The World's Worst Pollution Problems Report*. Blacksmith Institute and Green Cross International.

Blades, N., Oreszczyn, T., Bordass, B., & Cassar, M. (2000). *Guidelines on pollution control in heritage buildings*.

Bluyssen, P. M. (2009). Towards an Integrative Approach of Improving Indoor Air Quality. *Building and Environment*, *44*(9), 1980–1989.

Brasche, S., Bullinger, M., Gebhardt, H. J. & Bischof, W. (2001). Why Do Women Suffer From Sick Building Syndrome More Often Than Men? Subjective Higher Sensitivity versus Objective Causes. *Indoor Air, 11* (4), 217-222..

Breiman, L., & Friedman, J. H. (1982). Estimating Optimal Transformation for Multiple Regression and Correlation. *Journal of the American Statistical Association*, (May 2013), 80. Retrieved from http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA123908

Brook, R. D., Rajagopalan, S., Pope III, C. A., Brook, J. R., Bhatnagar, A., Diez-Roux, A. V., Holguin, F., Hong, Y., Luepker, R. V., Mittleman, M. A., Peters, A., Siscovick, D., Smith, S. C., Whitsel, L. & Kaufman, J. D. (2010). Particulate Matter Air Pollution and Cardiovascular Disease: An Update to the Scientific Statement from the American Heart Association. *Circulation*, *121*(21), 2331–2378.

Burney, P.G., Laitinen, L.A., Perdrizet, S., Huckauf, H., Tattersfield, A.E., Chinn, S., Poisson, N., Heeren, A., Britton & Jones, T. (1989). Validity and Repeatability of the IUATLD (1984) Bronchial Symptoms Questionnaire: An International Comparison. *European Respiratory Journal, 2*(10), pp. 940–945.

CAI-Asia. (2006). Malaysia. *Country Synthesis Report on Urban Air Quality Management*. Philippines: Asian Development Bank.

CAI-Asia. (2010a). 13: Nitrogen dioxide (NO 2) Standards in Asia. *CAI-Asia Factsheet*, (13). Philippines: Asian Development Bank. pp. 1–6.

CAI-Asia. (2010b). 3: Particulate Matter (PM) Status and Trends in Asia. *CAI-Asia Factsheet*, (3). Philippines: Asian Development Bank. pp. 1–3.

CAI-Asia. (2010c). 4: Sulfur dioxide (SO2) Standards in Asia. *CAI-Asia Factsheet*, (4). Philippines: Asian Development Bank. pp. 1–5.

Cai, W., Wang, D., Wen, X., & Yu, X. (2010). Indoor Air Quality Assessment in an Art Gallery with an HVAC System. In *2010 4th International Conference on Bioinformatics and Biomedical Engineering* (pp. 1–4).

Calderón-Garcidueñas, L., Solt, A. C., Henríquez-Roldán, C., Torres-Jardón, R., Nuse, B., Herritt, L., Villarreal-Calderon, R., Osnaya, N., Stone, I., Garcia, R., Brooks, D. M., Gonzalez-Maciel, A., Reynoso-Robles, R., Delgado-Chavez, R. & Reed, W. (2008). Long-term Air Pollution Exposure is Associated with Neuroinflammation, an Altered Innate Immune Response, Disruption of the Blood-Brain Barrier, Ultrafine Particulate Deposition, and Accumulation of Amyloid β-42 and α-Synuclein in Children and Young Adult. *Toxicologic Pathology, 36*(2), 289–310.

Camuffo, D., Grieken, R. V., Busse, H.-J., Sturaro, G., Valentino, A., Bernardi, A., Blades, N., Shooter, D., Gysels, K., Deutsch, F., Wieser, M., Kim, O. & Ulrych, U. (2001). Environmental Monitoring in Four European Museums. *Atmospheric Environment*, *35*(1), 127–140.

Card, J. W., Zeldin, D. C., Bonner, J. C., & Nestmann, E. R. (2008). Pulmonary Applications and Toxicity of Engineered Nanoparticles. *American Journal Physiol Lung Cellular and Molecular Physiology*, *295*(3), L400–L411.

Carey, S., Davidson, L., & Sahli, M. (2012). Capital City Museums and Tourism Flows: an Empirical Study of theMuseum of New Zealand Te Papa Tongarewa. *International Journal of Tourism Research*, *113*, 101–113.

Cassar, M. (1994). *Environmental Management: Guidelines for Museums and Galleries* (Heritage: Care-Preservation-Management), Routledge.

Cecchi, L., D'Amato, G., & Annesi-Maesano, I. (2018). External Exposome and Allergic Respiratory and Skin Diseases. *Journal of Allergy and Clinical Immunology*, *141*(3), 846–857.

Cheng, Z. O. (2017). *Air Pollution in Malaysia*. Retrieved from https://tunza.eco-generation.org/ambassadorReportView.jsp?viewID=43521

Chianese, E., Riccio, A., Duro, I., Trifuoggi, M., Iovino, P., Capasso, S., & Barone, G. (2012). Measurements for Indoor Air Quality Assessment at the Capodimonte Museum in Naples (Italy). *International Journal Environmental Resources*, *6*(2), 509–518.

Choo, E. U., & Wedley, W. C. (2008). Comparing Fundamentals of Additive and Multiplicative Aggregation in Ratio Scale Multi-Criteria Decision Making. *The Open Operational Research Journal*, *2*(1), 1–7.

Cincinelli, A., & Martellini, T. (2017). Indoor Air Quality and Health. *International Journal of Environmental Research and Public Health*, *14*(11).

Cincinelli, A., Martellini, T., Amore, A., Dei, L., Marrazza, G., Carretti, E., Belosi, F., Ravegnani, F. & Leva, P. (2016). Measurement of Volatile Organic Compounds (VOCs) in Libraries and Archives in Florence (Italy). *Science of the Total Environment*, *572*, 333–339.

Citrinot, L. (2012). *UNESCO Gives a New Breed of Life to Tourism in Melaka*. Retrieved from http://www.traveldailynews.asia/news/article/49888/unesco-gives-a-new-breed

Cohen et al. (2001). *Required Sample Size*. Retrieved from https://rosma212.wordpress.com/2011/12/17/penentuan-saiz-sampel/

Connelly, L. M. (2008). Pilot Studies. *Medsurg Nursing*, *17*(6), 411-2.

Conrad, E. A. (1996). Balancing Environmental Needs of the Building, the Collection and the User. In Abstracts of Papers Presented at the *Twenty-Fourth Annual Meeting*, Norfolk, Virginia, June 10-16, 1996, by the American Institute for Conservation. American Institute For Conservation, Washington D.C., pp. 15-18.

Conrad, E. A. (1999). The Realistic Preservation Environment. *14th Annual Preservation Conference*, March 25, 1999, at the National Archives Building 700 Pennsylvania Avenue, NW Washington, DC.

Costanzo, S., Cusumano, A., Giaconia, C., & Mazzacane, S. (2007). Ventilation Problems in Heritage Buildings. In *International Conference on Energy & Environment (EE'07),* Portoroz, Slovenia, May 15-17, 2007 (pp. 279–284).

Crimmins, A., Balbus, J., Gamble, J. L., Beard, C. B., Bell, J. E., Dodgen, D., Eisen, R. J., Fann, N., Hawkins, M. D., Herring, S. C., Jantarasami, L., Mills, D. M., Saha, S., Sarofim, M. C., Trtanj, J. & Ziska, L. (2016). The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. *Global Change Research Program*. U.S.

Dadzie, J., Ding, G., & Runeson, G. (2017). Relationship between Sustainable Technology and Building Age: Evidence from Australia. *Procedia Engineering*, *180*, 1131–1138.

Datta, A., Suresh, R., Gupta, A., Singh, D., & Kulshrestha, P. (2017). Indoor Air Quality of Non-Residential Urban Buildings in Delhi, India. *International Journal of Sustainable Built Environment*, *6*(2), 412–420.

De Franzo, S. E. (2012). *Why Use Demographic Questions in Surveys?*. Retrieved on March 16, 2018, from https://www.snapsurveys.com/blog/demographics-questions-surveys/

De Gruyter, S. (2014). *Museums of the World*. De Gruyter, 21th Edition.

Demirel, G., Özden, Ö., Döğeroğlu, T., & Gaga, E. O. (2014). Personal Exposure of Primary School Children to BTEX, NO2 and Ozone in Eskişehir, Turkey: Relationship with Indoor/Outdoor Concentrations and Risk Assessment. *Science of the Total Environment*, *473–474*(2), 537–548.

Deng, G., Li, Z., Wang, Z., Gao, J., Xu, Z., Li, J., & Wang, Z. (2015). Indoor/Outdoor Relationship of PM2.5 Concentration in Typical Buildings with and without Air Cleaning in Beijing. *Indoor and Built Environment*, *26*(1), 60–68.

Department of Occupational Safety and Health. (2008). *Guidelines for Hazard Identification, Risk Assessment and Risk Control (HIRARC)*. Malaysia: JKKP DP 127/789/4-47.

Department of Occupational Safety and Health. (2010). *Industry Code of Practice on Indoor Air Quality*. Malaysia: JKKP DP(S) 127/379/4-39.

Department of Occupational Safety and Health, Malaysia (2017). *Occupational Health Doctor*. Retrieved on January 30, 2017, from http://www.dosh.gov.my/index.php/en/occupational-health-doctor

Di Pietro, L., Mugion, R. G., Renzi, M. F., & Toni, M. (2014). An Audience-Centric Approach for Museums Sustainability. *Sustainability (Switzerland)*, *6*(9), 5745–5762.

Dictionary for Kids (2013). *Age: Physical Ddescription*. Retrieved on March 16, 2018, from https://kidspicturedictionary.com/english-through-pictures/people-english-through-pictures/age-physical-description/

Dirks, K. N., Scarfe, J., Talbot, N. P., Marshall, R., & Salmond, J. A. (2017). A Statistical Analysis of the Relationship between Brown Haze and Surface Air Pollution Levels on Respiratory Hospital Admissions in Auckland, New Zealand. *Climate*, *5*(4), 86.

El-Gohary, M., Marouf, M., & Metwally, M. (2016). Monitoing Air Pollutants and Dust in Luxor Museum of the Ancient Art. *Egyptian Journal of Archaeological and Restoration Studies*, *6*(1), 39–48.

Engineering Toolbox. (2005). *Air Change Rates in Typical Rooms and Buildings*. Retrieved from https://www.engineeringtoolbox.com/air-change-rate-room-d_867.html

eNotes Homework Help (2018). *What are the Types of Approaches in Research? Explain*. Retrieved on 18 Disember 2018 from https://www.enotes.com

Environmental Technology (2013). *Occupational Safety and Health: Workers and Industrial Safety Monitoring for Sustainable Work Environment Development*. Retrieved from https://www.envirotech-online.com/

Enviropedia (2018). *Air Quality: Rural Air Quality*. Retrieved from http://www.enviropedia.org.uk/index.php

Erdmann, C., Steiner, K., & Apte, M. (2002). Indoor Carbon Dioxide Concentrations and Sick Building Syndrome Symptoms in the Base Study Revisited: Analyses of the 100 Building Dataset. In *Indoor Air* (pp. 443–448).

European Environment Agency (2016). *Chapter 5: Environment, Health and Quality of Life*. Retrieved on 19 December 2018 from https://www.eea.europa.eu

European Environment Agency (2018). *Suspended Particulate Matter*. Retrieved on May 24, 2018, from https://www.eea.europa.eu/publications/2-9167-057-X/page021.html

European Group on Museum Statistics (2018). *Statistics: Number of Museums According to Type of Collection*. Retrieved from http://www.egmus.eu/

Ferris, B. (1978). Recommended Respiratory Disease Questionnaires for use with Adults and Children in Epidemiological Research. *Epidemiology Standardization Project II.* American Review of Respiratory Disease, pp. 7–52.

Fisk, W. J. (2015). Review of Some Effects of Climate Change on Indoor Environmental Quality and Health and Associated No-Regrets Mitigation Measures. *Building and Environment, 86*, 70–80.

Friend, M. A. & Khon, J. P. (2007). *Fundamental of Occupational Safety and Health*. Fourth Edition. Government Institute. The Scarecrow Press, Maryland, United States of America. pp 1-7.

Frontczak, M., Andersen, R. V., & Wargocki, P. (2012). Questionnaire Survey on Factors Influencing Comfort with Indoor Environmental Quality in Danish Housing. *Building and Environment, 50*, 56–64.

Gaüzère, C., Moletta-Denat, M., Blanquart, H., Ferreira, S., Moularat, S., Godon, J.-J., & Robine, E. (2014). Stability of Airborne Microbes in the Louvre Museum Over Time. *Indoor Air*, *24*(1), 29–40.

George, D., & Mallery, P. (2003). *SPSS for Windows Step by Step: A Simple Guide and Reference (11.0 Update)*. Fourth Edition. Boston: Allyn & Bacon.

Georgii, H. W. (1969). The Effects of Air Pollution on Urban Climates. *Bulletin of the World Health Organization*, *40*(4), 624–635.

Ghaffarianhoseini, A., AlWaer, H., Omrany, H., Ghaffarianhoseini, A., Alalouch, C., Clements-Croome, D., & Tookey, J. (2018). Sick Building Syndrome: Are We Doing Enough? *Architectural Science Review*, *61*(3), 99–121.

Gliem, J. a, & Gliem, R. R. (2003). Calculating, Interpreting and Reporting Cronbach's Alpha Reliability Coefficient for Likert-Type Scales. In *Midwest Research to Practice Conference in Adult, Continuing, and Community Education* (pp. 82–88).

Godish, T. (1995). Sick Buildings: Definition, Diagnosis and Mitigation, Lewis, Ann Arbor.

Godish, T. (2001). *Indoor Environmental Quality*. CRC Press Book.

Godoi, R. H. M., Carneiro, B. H. B., Paralovo, S. L., Campos, V. P., Tavares, T. M., Evangelista, H., … Godoi, A. F. L. (2013). Indoor Air Quality of a Museum in a Subtropical Climate: The Oscar Niemeyer Museum in Curitiba, Brazil. *Science of the Total Environment*, *452–453*, 314–320.

Gomzi, M., & Bobić, J. (2009). Sick Building Syndrome: Do We Live and Work in Unhealthy Environment? *Periodicum Biologorum*, *111*(1), 79–84.

Goyal, R., & Kumar, P. (2013). Indoor-Outdoor Concentrations of Particulate Matter in Nine Microenvironments of a Mix-Use Commercial Building in Megacity Delhi. *Air Quality, Atmosphere and Health*, *6*(4), 747–757.

Graedel, T. E. (1992). Corrosion Mechanisms for Silver Exposed to the Atmosphere. *Journal of the Electrochemical Society 139* (7): 1963-1970.

Grzywacz, C. M. (2006). *Monitoring for Gaseous Pollutants in Museum Environments: Tools for Conservation*. The Getty Conservation Institute.

Gysels, K., Delalieux, F., Deutsch, F., Van Grieken, R., Camuffo, D., Bernardi, A., Sturaro, G., Busse, H-J & Wieser, M. (2004). Indoor Environment and Conservation in the Royal Museum Of Fine Arts, Antwerp, Belgium. *Journal of Cultural Heritage*, *5*(2), 221–230.

Hamid, S. A., Hamid, S. S. A., & Ali, F. M. (2012). *Domestic Tourists' Satisfaction Towards Museums In Melaka*. Research Reports: Research Management Institute (RMI), Alor Gajah, Melaka. (Unpublished).

Hanapi, N., & Din, S. A. M. (2012). A Study on the Airborne Particulates Matter in Selected Museums of Peninsular Malaysia. In *ASEAN Conference on Environment-Behaviour Studies, Bangkok, Thailand, 16-18 July 2012* (Vol. 50, pp. 602–613).

Hariri, A. (2015). *The Development of Welding Fumes Health Risk Assessment Tool for Automotive Component Related Industries*. Universiti Tun Hussein Onn Malaysia: Ph.D Thesis.

Harris, T. (2007). Chapter 1: Why you need to use statistics in your research (pp. 1–10). McGraw Hill.

Heale, R., & Twycross, A. (2015). Validity and Reliability in Quantitative Studies. *Evidenced Based Nursing*, *18*(3), 66–67.

HealthWay Malaysia (2017). *Sick Building Syndrome in Malaysian Buildings*. Retrieved from https://www.healthway.com.my/single-post/2017/09/08/Sick-Building-Syndrome-in-Malaysian-Buildings

Hertzog, M. A. (2008). Considerations in Determining Sample Size for Pilot Studies. *Research in Nursing & Health*, *31*, 180–191.

Hill, R. (1998). What Sample Size is " Enough " in Internet Survey Research ? *Interpersonal Computing and Technology: An Electronic Journal for the 21st Century*, *6*(3), 1–10.

Hou, D., He, J., Lü, C., Ren, L., Fan, Q., Wang, J., & Xie, Z. (2013). Distribution Characteristics and Potential Ecological Risk Assessment of Heavy Metals (Cu, Pb, Zn, Cd) in Water and Sediments from Lake Dalinouer, China. *Ecotoxicology and Environmental Safety*, *93*, 135–144.

Hu, T., Jia, W., Cao, J., Huang, R., Li, H., Liu, S., Ma, T. & Zhu, Y. (2015). Indoor Air Quality at Five Site Museums of Yangtze River Civilization. *Atmospheric Environment*, *123*, 449–454.

Hussin F., Ali J. & Zamzuri Noor M. S. (2014). *Kaedah Penyelidikan & Analisis Data SPSS*. Sintok: Penerbit Universiti Utara Malaysia.

IBM Knowledge Center (2018). *Ordinal Regression*. Retrieved from https://www.ibm.com/support/knowledgecenter/en/SSLVMB_sub/statistics_mainhelp_ddita/spss/advanced/idh_plum.html

Ilyas, S. Z., Khattak, A. I., Nasir, S. M., Qurashi, T., & Durrani, R. (2010). Air Pollution Assessment in Urban Areas and ts Impact on Human Health in the City of Quetta, Pakistan. *Clean Technologies and Environmental Policy*, *12*(3), 291–299.

Indoor Air Quality UK (2018). *IAQ UK Resources: Particulate Matter*. Retrieved on January 2018 from http://www.iaquk.org.uk/ResourcesParticulate.html

Institute for Digital Research and Education UCLA (2007). *What Does Cronbach's Alpha Mean?*. Retrieved, from https://stats.idre.ucla.edu/spss/faq/what-does-cronbachs-alpha-mean/

Institute for Health Metrics and Evaluation (2018). *Country Profile: Malaysia*. Retrieved from http://www.healthdata.org/malaysia

Institute of Museum and Library Services (2018). *Government Doubles Official Estimates: There are 35,000 Active Museums in the US*. Retrieved from https://www.imls.gov/

International Council of Museum (2018a). *The World Museum Community: Museum Meaning*. Retrieved from http://icom.museum/

International Council of Museum (2018b). *International Committee for Achitecture and Museum Techniques: Adaptive Reuse*. Retrieved on 12 Disember 2018 from http://network.icom.museum

Isa, S. S., Ali, A., Mohd Yusof, W. Z., & Isa, S. S. (2012). The Adaptation of Creativity in Museum Sector: A Case Study of Malacca Maritime Museum, Malaysia. In *Symposium on Business, Engineering and Industrial Applications* (pp. 781–786).

Ismail, N., Masron, T., & Ahmad, A. (2014). Cultural Heritage Tourism in Malaysia: Issues and Challenges. *SHS Web of Conferences*, *9*, 1–8.

Ismail, S. H., Deros, B. M., & Leman, A. M. (2010). Indoor Air Quality Issues for Non-Industrial Workplace. *International Journal of Research and Reviews in Applied Sciences*, *5*, 235–244.

Israeli, E., & Pardo, A. (2011). The Sick Building Syndrome as a part of the Autoimmune (Auto-Inflammatory) Syndrome Induced by Adjuvants. *Modern Rheumatology*, *21*(3), 235–239.

Issac, S. & Michael, W. B. (1995). *Handbook in Research and Evaluation*. San Diego, CA: Educational and Industrial Testing Services.

Jabatan Muzium Malaysia. (2016). *Laporan Tahunan 2016*. Kuala Lumpur: Jabatan Muzium Malaysia.

Jacobs, L., Nawrot, T. S., De Geus, B., Meeusen, R., Degraeuwe, B., Bernard, A., Sughis, M., Nemery, B. & Panis, L. I. (2010). Subclinical Responses in Healthy Cyclists Briefly Exposed to Traffic-Related Air Pollution: An Intervention Study. *Environmental Health*, *9*(1), 1–8.

Jafari, M. J., Khajevandi, A. A., Mousavi, N. S. A., Yekaninejad, M. S., Pourhoseingholi, M. A., Omidi, L. & Kalantary, S. (2015). Association of Sick Building Syndrome with Indoor Air Parameters. *Tanaffos, 14* (1), 55-62.

Jenkins, T. (2018). *Financial Times: Public Art Collection in an Age of Austerity and Superwealth*. Retrieved from https://www.ft.com/content/3fc09f1c-162b-11e8-9c33-02f893d608c2

Jiang, Y., Nan, Z., & Yang, S. (2013). Risk Assessment of Water Quality using Monte Carlo Simulation and Artificial Neural Network Method. *Journal of Environmental Management, 122*, 130–136.

Johanson, G. A., & Brooks, G. P. (2010). Initial Scale Development: Sample Size for Pilot Studies. *Educational and Psychological Measurement*, *70*(3), 394–400.

Judeikis, H.S. and Stewart T.B. (1976). Laboratory Measurement of Sulphur Dioxide Deposition Velocities on Selected Building Materials and Soils. *Atmospheric Environment*, *10*, 769-776.

Julious, S. A. (2005). Sample Size of 12 per Group Rule of Thumb for a Pilot Study. *Pharmaceutical Statistics*, *4*(4), 287–291.

Kabacoff, R. I. (2013). *R in Action: Data Analysis and Graphics with R*. Second Edition. Manning Publications. Retrieved from papers2://publication/uuid/7664B587-C1BA-4979-B596-974A9BF696E5

Kamaruzzaman, S. N., & Razak, R. A. (2011). Measuring Indoor Air Quality Peformance in Malaysian Government Kindergarten. *Journal of Building Performance*, *2*(1), 70–79.

Kamaruzzaman, S. N., Zawawi, E. M. A., Pitt, M., & Don, Z. M. (2010). Occupant Feedback on Indoor Environmental Quality in Refurbished Historic Buildings. *International Journal of Physical Sciences*, *5*(3), 192–199.

Khor, M. (2016). Act on Air Pollution, the Silent Killer. *The Star Online*. Retrieved from https://www.thestar.com.my/opinion/columnists/global-trends/2016/10/24/act-on-air-pollution-the-silent-killer-curb-the-problem-for-it-kills-eight-million-people-yearly-wor/

Khusainova, R. M., Shilova, Z. V., & Curteva, O. V. (2016). Selection of Appropriate Statistical Methods for Research Results Processing. *Mathematics Education*, *11*(1), 303–315.

Kodama, Y., Arashidani, K., Tokui, N., Kawamoto, T., Matsuno, K., Kunugita, N., & Minakawa, N. (2002). Environmental NO2 Concentration and Exposure in Daily Life along Main Roads in Tokyo. *Environmental Research*, *89*(3), 236–244.

Kohler, N., & Hassler, U. (2002). The Building Stock as a Research Object. *Building Research and Information*, *30*(4), 226–236.

Krupińska, B., Van Grieken, R., & De Wael, K. (2013). Air Quality Monitoring in a Museum for Preventive Conservation: Results of a Three-Year Study in the Plantin-Moretus Museum in Antwerp, Belgium. *Microchemical Journal*, *110*, 350–360.

La Gennusa, M., Rizzo, G., Rodono, G., Scaccianoce, G., & Pietrafesa, M. (2009). People Comfort and Artwork Saving in Museums: Comparing Indoor Requisites. *International Journal of Sustainable Design*, *1*(2), 199–222.

Lagoudi, A., Loizidou, M., Santamouris, M., & Asimakopoulos, D. (1996). Symptoms Experienced, Environmental Factors and Energy Consumption in Office Buildings. *Energy and Buildings*, *24*(3), 237–243.

Lahtinen, M., Sundman-Digert, C., & Reijula, K. (2004). Psychosocial Work Environment and Indoor Air Problems: A Questionnaire as a Means of Problem Diagnosis. *Occupational and Environmental Medicine*, *61*(2), 143–149.

Lani, J. (2017). *Statistics Solutions: Table of Critical Values Pearson Correlation*. Retrieved from http://www.statisticssolutions.com/table-of-critical-values-pearson-correlation/

Lani, J. (2018). *Statistics Solutions*. Retrieved on January 17, 2018, from http://www.statisticssolutions.com/ordinal-regression-2/

Lee, Y. Y. (2016). *Impact of Thermal Behaviour on Outdoor Human Thermal Comfort in Tropical Climate*. Universiti Teknologi Malaysia: Ph.D Thesis.

Leman, A. M., Yusof, M. Z. M., Omar, A. R., & Jung, W. (2010). Environmental Quality Index (EQI) for Industrial Ventilation and Occupational Safety and Health Evaluation in Manufacturing Plant. *Asian Journal on Quality*, *11*(3), 210–222.

Leung, D. Y. C. (2015). Outdoor-Indoor Air Pollution in Urban Environment: Challenges and Opportunity. *Frontiers in Environmental Science*, *2*(January), 1–7.

Lewis, G. D. (2018). *Encyclopedia Britannica: Types of Museum*. Retrieved from https://www.britannica.com/

Li, L., Li, H., Zhang, X., Wang, L., Xu, L., Wang, X., Yu, Y., Zhang, Y. & Cao, G. (2014). Pollution Characteristics and Health Risk Assessment of Benzene Homologues in Ambient Air in the Northeastern Urban Area of Beijing, China. *Journal of Environmental Sciences (China)*, *26*(1), 214–223.

Liao, C.-M., Huang, S.-J., & Yu, H. (2004). Size-Dependent Particulate Matter Indoor/Outdoor Relationships for a Wind-Induced Naturally Ventilated Airspace. *Building and Environment*, *39*(4), 411–420.

Lippman, M. (2002). E*ncyclopedia of Public Health: Total Suspended Particles*. Retrieved on May 24, 2018, from https://www.encyclopedia.com/education/encyclopedias-almanacs-transcripts-and-maps/total-suspended-particles-tsp

López-Aparicio, S., & Grašienė, R. (2013). Screening Indoor Air Quality Evaluation in the Lithuanian Theatre, Music and Cinema Museum. *Journal of Environmental Engineering and Landscape Management*, *21*(1), 52–58.

Lord, B. & Lord, G. D. (2001). *The Manual of Museum Exhibitions*. Altamira Press.

Lund, A. & Lund, M. (2015). *Laerd Statistics*. Retrieved on July 17, 2017, from https://statistics.laerd.com/

Machin, D., Campbell, M. J., & Walters, S. J. (2007). *Medical Statistics: A Textbook for the Health Sciences*. Fourth Edition.

Mahorm, S. (2018). More Tourists Visit Melaka. *The Star Online*. Retrieved from https://www.thestar.com.my/metro/metro-news/2018/02/01/more-tourists-visit-melaka-number-of-visitors-the-highest-seen-by-state-in-years/

Martin, D., Khan, A. A., Puustinen, K., Seale, J., Carr, L. & Sindall, K. (2014). *ReStore: National Centre for Research Methods*. Retrieved on July 17, 2017, from http://www.restore.ac.uk/

McDonald, J.A., Burnett, N., Coronado, V.G. & Johnson, R.L. (2003). *Questionnaire Design: Reproductive Health Epidemiology Series Module 4*. Georgia: Centers for Disease Control and Prevention U.S.A.

Melikov, A. K., & Kaczmarczyk, J. (2012). Air Movement and Perceived Air Quality. *Building and Environment*, *47*(1), 400–409.

Mendell, M. J. (2003). Commentary: Indices for IEQ and Building-Related Symptoms. *Indoor Air*, *13*, 364–368.

Mey, L. P., & Mohamed, B. (2010). Measuring Service Quality, Visitor Satisfaction and Behavioral Intentions: Pilot Study at a Museum in Malaysia. *Journal of Global Business and Economics*, *1*(1), 226–240.

Miller, C. & Prihoda, T. (1999). The Environmental Exposure and Sensitivity Inventory (EESI): A Standardized Approach for Measuring Chemical Intolerances for Research and Clinical Applications. *Toxicological Industrial Health, 15*(3-4), pp. 370–385.

Milner, J., Armstrong, B., Davies, M., Ridley, I., Chalabi, Z., Shrubsole, C., Vardoulakis, S. & Wilkinson, P. (2017). An Exposure-Mortality Relationship for Residential Indoor PM2.5 Exposure from Outdoor Sources. *Climate*, *5*(3), 66.

Ministry of Natural Resources and Environment (2012). *Malaysia Environmental Performance Index*. Retrieved from http://www.epi.utm.my/v4/

Mohd Darif, I. L. (2008). Rencana Utama: Kurang Sambutan Belia. *Kosmo Online*. Retrieved on 26 May 2008 from http://www.kosmo.com.my/kosmo/content.asp?y=2008&dt=0526&pub=Kosmo&sec=Rencana_Utama&pg=ru_01.htm

Mohddin, S. A., & Aminuddin, N. M. (2014). The Exposure Assesment of Airborne Particulates Matter Towards Building Occupants: A Case Study at KL Sentral, Kuala Lumpur, Malaysia. In *8th International Symposium of the Digital Earth* (Vol. 18, pp. 1–6).

Molhave, L. (2003). Commentary: Biomarkers and Other Substitute Measures in Indoor Air Sciences. *Indoor Air*, *13*, 369–370.

Moschandreas, D. J., & Sofuoglu, S. C. (2003). Commentary: What Indices of Indoor Air Pollution Can and Can't Do. *Indoor Air*, *13*, 375–376.

Moschandreas, D. J., & Sofuoglu, S. C. (2004). The Indoor Environmental Index and Its Relationship with Symptoms of Office Building Occupants. *Journal of the Air & Waste Management Association*, *54*(11), 1440–1451.

Muhamad-Darus, F., Zain-Ahmed, A., & Latif, M. T. (2011). Preliminary Assessment of Indoor Air Quality in Terrace Houses. *Health and the Environment Journal*, *2*(2), 8–14.

National Heritage Board (2016). *Stories: Museums in Singapore*. Retrieved from https://roots.sg/

National Institute for Occupational Safety and Health. (2007). *NIOSH Pocket Guide to Chemical Hazards*. Pittsburgh: DHHS (NIOSH) No. 2005-149.

Nazaroff W.W. and Cass G.R. (1986). Mathematical Modelling of Chemically Reactive Pollutants in Indoor Air. *Environmental Science and Technology*, *20* (9), 924-934.

Nazeer, S., Hashmi, M. Z., & Malik, R. N. (2014). Heavy Metals Distribution, Risk Assessment and Water Quality Characterization by Water Quality Index of the River Soan, Pakistan. *Ecological Indicators*, *43*, 262–270.

Nishikido, N., Yuasa, A., Motoki, C., Tanaka, M., Arai, S., Matsuda, K., Ikeda, T., Iijima, M., Hirata, M., Hojoh, M., Tsutaki, M., Ito, A., Maeda, K., Miyoshi, Y., Mitsuhashi, H., Fukuda, E. & Kawakami, Y. (2006). Development of Multi-Dimensional Action Checklist for Promoting New Approaches in Participatory Occupational Safety and Health in Small and Medium-Sized Enterprises. *Industrial Health*, *44*, 35–41.

Noraini, N. M. R. (2015). *Comparative Study of Indoor Air Contaminants in Different Stages of New Building Occupancy: Work Environment Assessment*. Universiti Tun Hussein Onn Malaysia: Master's Thesis.

Norhidayah, A., Chia-Kuang, L., Azhar, M. K., & Nurulwahida, S. (2013). Indoor Air Quality and Sick Building Syndrome in Three Selected Buildings. *Procedia Engineering*, *53*(2010), 93–98.

Occupational Safety & Health Administration (2009). OSHA/EPA Occupational Chemical Database NIOSH Pocket Guide to Chemical Hazards: Wood Dust, Hard Wood.

Occupational Safety and Health Association USA (2012). *OSHA: Occupational Chemical Database*. Retrieved on June 2012 from https://www.osha.gov/chemicaldata/

Ooi, P. L., Goh, K. T., Phoon, M. H., Foo, S. C., & Yap, H. M. (1998). Epidemiology of Sick Building Syndrome and Its Associated Risk Factors in Singapore. *Occupational and Environmental Medicinenvironmental Medicine*, *55*(3), 188–193.

Ostermeyer, Y., Nägeli, C., Heeren, N., & Wallbaum, H. (2017). Building Inventory and Refurbishment Scenario Database Development for Switzerland. *Journal of Industrial Ecology*, 1–14.

Ott, W.R. (1978). *Environmental Indices Theory and Practice*. Michigan: Ann Arbor Science Publisher Inc.

Pallant, J. (2003). *SPSS Survival Manual: A Step by Step Guide to Data Analysis using SPSS for Windows (Versions 10 and 11)*. Philadelphia: Open University Press.

Pavlogeorgatos, G. (2003). Environmental Parameters in Museums. *Building and Environment*, *38*(12), 1457–1462.

Payrissat M. and Beilke S. (1975). Laboratory Measurements of the Uptake of Sulphur Dioxide by Different European Soils. *Atmospheric Environment, 9*, 211-217.

Pedersen, M., Giorgis-Allemand, L., Bernard, C., Aguilera, I., Andersen, A. M. N., Ballester, F., … Slama, R. (2013). Ambient Air Pollution and Low Birthweight: A European Cohort Study (ESCAPE). *The Lancet Respiratory Medicine*, *1*(9), 695–704.

Perbadanan Muzium Melaka. (2014). *Warna-Warna Sejarah & Warisan Di Muzium Melaka*. Melaka: Perbadanan Muzium Melaka.

Perbadanan Muzium Melaka (2016). *Statistik Pelawat Muzium*. Retrieved on January 30, 2016, from http://www.perzim.gov.my/ms/perzim/statistik-pelawat-muzium/

Phelan, C., & Wren, J. (2007). Exploring Reliability in Academic Assessment. *Open Journal of Forestry, 6*(5).

PlatinumPrep (2015). *Arithmetic Mean (Average): GMAT Math Study Guide*. Retrieved on January 30, 2017, from http://www.platinumgmat.com/gmat_study_guide/statistics_mean

Pollution Control Federation (2017). *Air Pollution*. Retrieved from http://www.pcfindian.in/air-pollution.html

Priftis, K. N., Anthracopoulos, M. B., Paliatsos, A. G., Tzavelas, G., Nikolaou-Papanagiotou, A., Douridas, P., … Mantzouranis, E. (2007). Different Effects of Urban and Rural Environments in the Respiratory Status of Greek Schoolchildren. *Respiratory Medicine*, *101*(1), 98–106.

Putra, J. C. P. (2015). *Effects of Indoor Air Quality on the Occupant's Health and Productivity in an Office Building*. Universiti Tun Hussein Onn Malaysia: Master's Thesis.

Ramli, Z. (2017). Heritage Tourism in Malaysia: Potential & Challenges. *The Social Sciences*, *12*(3), 431–440.

Rani, P. (2015). The Impact of Adaptive Reusing Heritage Building as Assessed by the Indoor Air Quality Case study:UNESCO World Heritage Site Penang. *Procedia - Social and Behavioral Sciences*, *179*, 297–307.

Redlich C. A., Sparer J., Cullen M. R. (1997). *Sick Building Syndrome*. The Lancet 349:1013–1016.

Rubin, J. (2017). *Theme Index and Museum Index: The Global Attractions Attendance Report*. Themed Entertainment Association.

Ryhl-Svendsen, M. (2016). Indoor Air Pollution in Museums: Prediction Models and Control Strategies. *Studies in Conservation*, *51*(1), 27–41.

Sabersky R.H., Sinema D.A. and Shair F.H. (1973). Concentrations, Decay Rates, and Removal of Ozone and Their Relation to Establishing Clean Indoor Air. *Environmental Science and Technology, 7* (4), 347-353.

Sadiq, R., Haji, S. A., Cool, G., & Rodriguez, M. J. (2010). Using Penalty Functions to Evaluate Aggregation Models for Environmental Indices. *Journal of Environmental Management*, *91*, 706–716.

Salmond, J., Sabel, C. E., & Vardoulakis, S. (2018). Towards the Integrated Study of Urban Climate, Air Pollution and Public Health. *Climate*, *6*(14), 12–15.

Saraga, D., Pateraki, S., Papadopoulos, a., Vasilakos, C., & Maggos, T. (2011). Studying the Indoor Air Quality in Three Non-Residential Environments of Different Use: A Museum, a Printery Industry and an Office. *Building and Environment*, *46*(11), 2333–2341.

Schieweck, A., Lohrengel, B., Siwinski, N., Genning, C., & Salthammer, T. (2005). Organic and Inorganic Pollutants in Storage Rooms of the Lower Saxony State Museum Hanover, Germany. *Atmospheric Environment*, *39*(33), 6098–6108.

Sekhar, S. C., Tham, K. W., & Cheong, K. W. (2003a). Commentary: Response to Comments from Mark Mendell, Lars Molhave and Peder Wolkoff. *Indoor Air*, *13*(2003), 373–374.

Sekhar, S. C., Tham, K. W., & Cheong, K. W. (2003b). Indoor Air Quality and Energy Performance of Air-Conditioned Office Buildings in Singapore. *Indoor Air*, *13*, 315–331.

Shi, M. H., & Tao, A. R. (2000). Investigation on the Comfort Evaluation Index CPD of Indoor Environments. *International Journal on Architectural Science*, *1*(3), 123–125.

Shuang, G. W., Kamaruzzaman, S. N., & Zulkifli, N. (2014). Occupant's Perception on Indoor Performance of Historical Museum: A Case Study of National Museum and Perak Museum, Malaysia. In *2nd International Conference on Research in Science, Engineering and Technology (ICRSET'2014)* March 21-22, 2014 Dubai (UAE) (pp. 170–175).

Siegle, D. (2015). *Critical Values of the Pearson Product-Moment Correlations Coefficient*. Retrieved from https://researchbasics.education.uconn.edu/r_critical_value_table/

Silverman, G. S., & Silverman, M. K. (2000). Perceptions of Environmental Problems by Malaysian Professionals. *Environmental Practice*, *2*(4), 299–310.

Simonson, C. J., Salonvaara, M., & Ojanen, T. (2002). The Effect of Structures on Indoor Humidity - Possibility to Improve Comfort and Perceived Air Quality. *Indoor Air*, *12*(4), 243–251.

Singer, B. C., Delp, W. W., Black, D. R., & Walker, I. S. (2017). Measured performance of filtration and ventilation systems for fine and ultrafine particles and ozone in an unoccupied modern California house. *Indoor Air*, *27*(4), 780–790.

Siraj, K. (2017). *Environmental Impact of Rural-Urban Linkages*. Retrieved from https://www.dailypioneer.com/columnists/oped/environmental-impact-of-rural-urban-linkages.html

Smallwood, J. J. (2004). The Influence of Engineering Designers on Health and Safety During Construction. *Journal of the South African Institution of Civil Engineering*, *46*(1), 2–8.

Smith, J. A. (1999). *Risk Assessment for Object Conservation*. Butterworth-Heinemann.

Smith, K. (2007). *Rural Air Pollution Often Overlooked*. Retrieved from http://ehs.sph.berkeley.edu/newsbefore2014/2015/1/26/rural-air-pollution-often-overlooked

Smith, K. R., Bruce, N., Balakrishnan, K., Adair-rohani, H., Balmes, J., Pope, D., & Rehfuess, E. (2014). Millions Dead : How Do We Know and What Does It Mean ? Methods Used in the Comparative Risk Assessment of Household Air Pollution. *The Annual Review of Public Health*, *35*, 185–206.

Sofuoglu, S. C., & Moschandreas, D. J. (2003). The Link Between Symptoms of Office Building Occupants and In-Office Air Pollution: The Indoor Air Pollution Index. *Indoor Air*, *13*, 332–343.

Spacey, J. (2016). *5 Types of Adaptive Reuse*. Retrieved on 12 Disember 2018 from https://simplicable.com

Specialized Property Evaluation Control Services (2016). *What is a Building Condition Assessment*? Retrieved from https://www.specs.ca/blog/what-is-building-condition-assessment

Spedding D.J. and Rowlands R.P. (1970). Sorption of Sulphur Dioxide by Indoor Surfaces - I. Wallpapers. *Journal of Applied Chemistry, 20*, 143-146.

Spellman, F. R. (2008). *The Science of Air: Concepts and Applications*. Second Edition. CRC Press.

Spengler, J. D., Samet, J. M. & McCartht, J. F. (2000). *Indoor Air Quality Handbook*. New York: McGraw-Hill.

Standardisation Department. (2009). *Code of Practice for Indoor Air Quality for Air-Conditioned Buildings* (Vol. 2009). Singapore: SS 554:2009.

Statista (2018). *Art and Culture: Number of Museums in China from 2006 to 2016*. Retrieved from https://www.statista.com/

Stephanie (2017). *Pearson Product-Moment Correlation (PPMC) Coefficient Table of Critical Values*. Retrieved from http://www.statisticshowto.com/tables/ppmc-critical-values/

Stephens, B., & Siegel, J. A. (2012). Penetration of Ambient Submicron Particles into Single-Family Residences and Associations with Building Characteristics. *Indoor Air*, *22*(6), 501–513.

Sterry, P. (2004). An Insight into the Dynamics of Family Group Visitors to Cultural Tourism Destinations: Initiating the Research Agenda. *Proceedings of the New Zealand Tourism and Hospitality Research Conference 2004*, Wellington, pp 398-406.

Still, G. K. (2013). *Crowd Safety and Risk Analysis*. Retrieved from http://www.gkstill.com/Support/crowd-density/CrowdDensity-1.html

Sulaiman, R., Kamaruzzaman, S. N., Rao, S. P., & Pitt, M. (2011). The Environmental Performance of Air Conditioning Systems in Heritage Buildings in Tropical Climates. *Journal of Surveying, Construction & Property*, *2*(1), 93–106.

Sulaiman, R., Kamaruzzaman, S. N., Salleh, N., & Mahbob, N. S. (2011b). Can We Achieve A Balanced Indoor Environmental Quality (IEQ) In Malaysian Historical Museum Building? In *2nd International Conference on Environmental Science and Technology 2011*, Singapore (Vol. 6, pp. 402–406).

Sulaiman, R., Schellen, H. L., & Hensen, J. L. M. (2010). Pilot Study on Indoor Climate Investigation and Computer Simulation in Historical Museum Building: Amerongen Castle, the Netherlands. *Journal of Design and Built Environment, 7,* 75-94.

Syazwan Aizat, I., Juliana, J., Norhafizalina, O., Azman, Z. A., & Kamaruzaman, J. (2009). Indoor Air Quality and Sick Building Syndrome in Malaysian Buildings. *Global Journal of Health Science*, *1*(2), 126–135.

Syazwan Aizat, I., Rafee, B. M., Hafizan, J., Azman, A. Z. F., Nizar, A. M., Izwyn, Z., … Kamarul, F. T. (2012). Analysis of Indoor Air Pollutants Checklist using Environmetric Technique for Health Risk Assessment of Sick Building Complaint in Nonindustrial Workplace. *Drug, Healthcare and Patient Safety*, *4*, 107–126.

Syazwan Aizat, I., Rafee, B. M., Hafizan, J., Azman, A. Z. F., Nizar, A. M., Izwyn, Z., … Othman, J. (2012). Development of an Indoor Air Quality Checklist for Risk Assessment of Indoor Air Pollutants by Semiquantitative Score in Nonindustrial Workplaces. *Risk Management and Healthcare Policy*, *5*(2012), 17–23.

Taha, A. (2009). *Museums in Malaysia: Challenges and Development*. (eds Noi, L. H. & Eng, T. E.). ASEAN Museum Directors' Symposium, ASEAN Civilizations Museum, Singapore, 19 – 20 August 2009

Tharazi, M. I. (2011a). *Museum and Monument: A Study on the Architectural Features of Heritage Building for Museum (With Reference to Preventive Conservation)*. Universiti Teknologi MARA: Master's Thesis.

Tharazi, M. I. (2011b). The Use of Passive Design of Heritage Buildings as an Alternative Indoor Climate Control for Museum. In *Unpublished*. Retrieved from http://umkeprints.umk.edu.my/297/

The Chartered Institution of Building Services Engineers. (2002). *Guide to Building Services for Historic Building: Sustainable Service for Traditional Buildings*. The Chartered Institution of Building Engineers.

The Chartered Institution of Building Services Engineers. (2005). *CIBSE Guide B: Heating, Ventilating, Air Conditioning and Refrigeration*. The Chartered Institution of Building Services Engineers.

The Chartered Institution of Building Services Engineers. (2006). *CIBSE Guide A: Environmental Design*. The Chartered Institution of Building Services Engineers.

Thriveni, T., Ramakrishna, C. H., Nam, S. Y., & Whan, A. J. (2017). Monitoring of PM2.5 in Coal Ash Samples & Heavy Metals Stabilization by Carbonation Method. In *World of Coal Ash Conference* (pp. 1–15).

Trinh, T. T., & Ryan, C. (2013). Museums, exhibits and visitor satisfaction: a study of the Cham Museum, Danang, Vietnam. *Journal of Tourism and Cultural Change*, *11*(4), 239–263.

Turiel, I., Hollowell, C. D., Miksch, R. R., Rudy, J. V., Young, R. A., & Coye, M. J. (1983). The Effects of Reduced Ventilation on Indoor Air Quality in an Office Building. *Atmospheric Environment*, *17*(1), 51–64.

Underhill, L. J., Bose, S., Williams, D. L., Romero, K. M., Malpartida, G., Breysse, P. N., Klasen, E. M., Combe, J. M., Checkley, W. & Hansel, N. N. (2015). Association of Roadway Proximity with Indoor Air Pollution in a Peri-Urban Community in Lima, Peru. *International Journal of Environmental Research and Public Health*, *12*(10), 13466–13481.

US Environmental Protection Agency. (1991). *Building Air Quality: Guideline For Building Owner and Facility Manager*.

Utami, D. L., & Nasri, S. M. (2018). The Evidence of Sick Building Syndrome (SBS) among Oil Gas Refinery Officers. *KnE Life Sciences*, *4*(5), 566–574.

Utusan Online (2015). *Jumlah Pelancong ke Melaka Meningkat 5.03 Peratus*. Retrieved on March 20, 2015, from http://www.utusan.com.my/gaya-hidup/pelancongan/jumlah-pelancong-ke-melaka-meningkat-5-03-peratus-1.69196

van Belle, G. (2008). *Statistical Rules of Thumb*. Second Edition.

van Teijlingen, E., & Hundley, V. (2002). The Importance of Pilot Studies. *Nursing Standard*, *16*(40), 33–36.

Walsh, M., Black, A., Morgan, A. and Crenshaw, G. H. (1977). Sorption of SO2 by Typical Indoor Surfaces Including Wool Carpets, Wallpaper and Paints. *Atmospheric Environment 11*, 1107-1111.

Wang, J., Li, B., Yang, Q., Wang, H., Norback, D. & Sundell, J. (2013). Sick Building Syndrome among Parents of Preschool Children in Relation to Home Environment in Chongging, China. *Chinese Science Bulletin, 58* (34), 4267-4276.

Wardoyo, A. Y. P., Juswono, U. P., & Noor, J. A. E. (2018). Varied Dose Exposures to Ultrafine Particles in the Motorcycle Smoke Cause Kidney Cell Damages in Male Mice. *Toxicology Reports*, *5*(July 2017), 383–389.

Weschler C.J., Shields H.C. and Naik D.V. (1989). Indoor ozone exposures. *Journal of the Air Pollution Control Association, 39*, 1562-1568.

Wetenhall, J. (2017). M*useum: Why Not To Run Your Museum "More Like A Business"*. Retrieved from http://www.bluetoad.com/publication/?i=403463&article_id=2770065&view=articleBrowser&ver=html5#{%22issue_id%22:403463,%22view%22:%22articleBrowser%22,%22article_id%22:%222770065%22}

Whitehead, A. L., Julious, S. A., Cooper, C. L., & Campbell, M. J. (2015). Estimating the Sample Size for a Pilot Randomised Trial to Minimise the Overall Trial Sample Size for the External Pilot and Main Trial for a Continuous Outcome Variable. *Statistical Methods in Medical Research*, *25*(3), 1057–1073.

Wolkoff, P. (2003). Commentary: Are We Ready for Indoor Air Pollution Indices? *Indoor Air*, *13*, 371–372.

World Health Organization. (1982). *Indoor Air Pollutants: Exposure and Health Effects*. Copenhagen: World Health Organization.

World Health Organization. (2005a). *Air Quality Guidelines: Gloal Update 2005*. Copenhagen: World Health Organization.

World Health Organization. (2005b). *WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide: Summary of Risk Assessment*. Copenhagen: World Health Organization.

World Health Organization (2006). *Almost a Quarter of All Disease Caused by Environmental Exposure*. Retrieved from http://www.who.int/mediacentre/news/releases/2006/pr32/en/

World Health Organization (2010). *WHO Guideline for Indoor Air Quality: Selected Pollutant*. Copenhagen: World Health Organization.

Yau, Y. H., Chew, B. T., & Saifullah, A. Z. A. (2011). A Field Study on Thermal Comfort of Occupants and Acceptable Neutral Temperature at the National Museum in Malaysia. *Indoor and Built Environment*, *22*(2), 433–444.

Yoon, Y. H., & Brimblecombe, P. (2000). Clothing as a Source of Fibres within Museums. *Journal of Cultural Heritage*, *1*(4), 445–454.

Zorpas, A. A., & Skouroupatis, A. (2016). Indoor Air Quality Evaluation of Two Museums in a Subtropical Climate Conditions. *Sustainable Cities and Society*, *20*, 52–60.