

Sustainable Building Retrofitting and Energy Efficiency

Authors:

Nur IzieAdiana Abidin¹, Rozana Zakaria², Dodo Yakubu Aminu³

Email:

izieadiana@utm.my¹, rozana@utm.my², dyaaminu@yahoo.com³

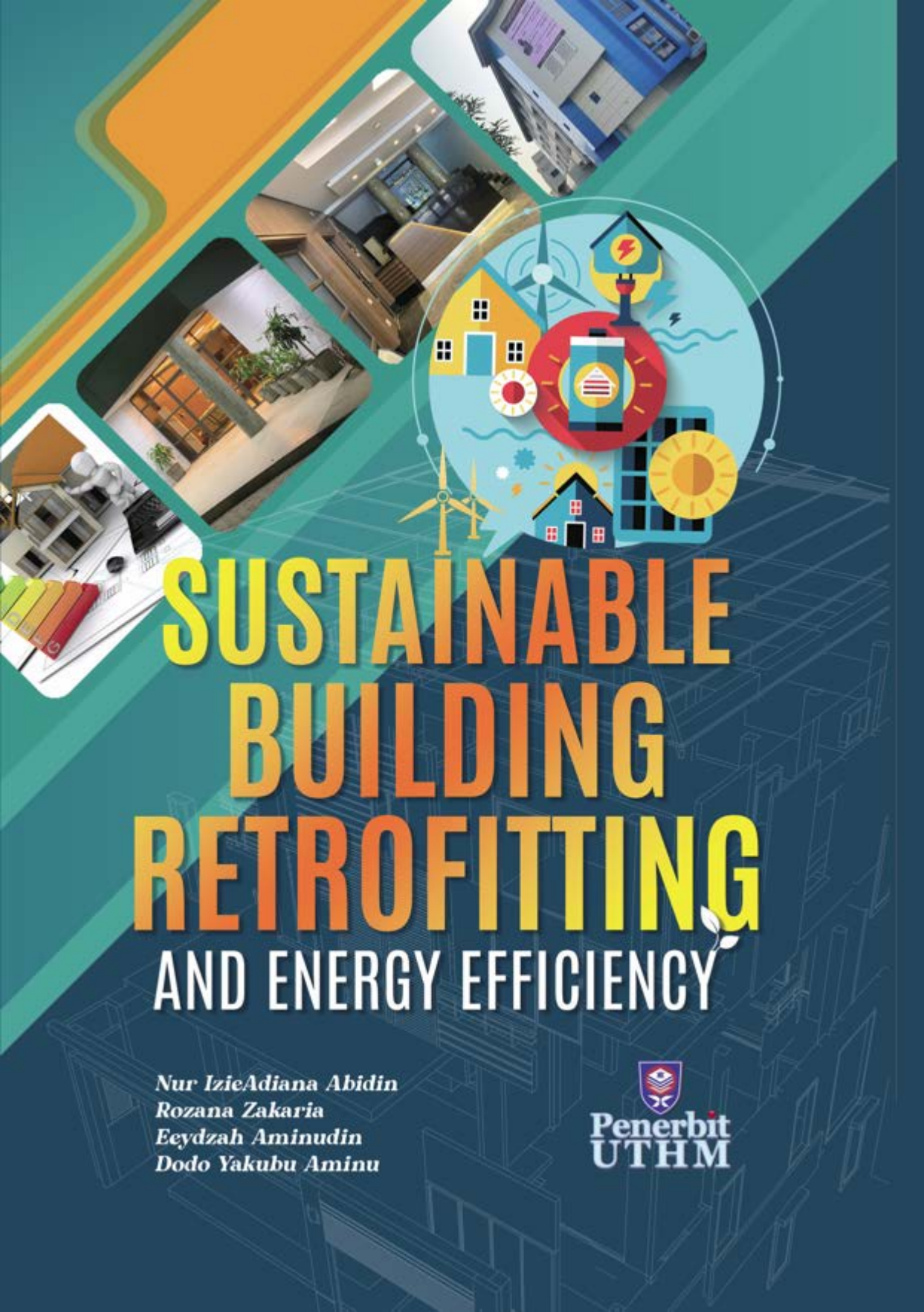
Abstract: This book introduces various topics related to energy efficiency and sustainable retrofitting. The topics cover researches and studies on the initiatives, strategies, reduction and improvements, application, effect and approach.

Chapter 1 discussed the steps of retrofitting initiatives that can be implemented to achieve building energy reduction. Retrofitting initiatives consist of three steps which are lean energy, green technology and clean energy. Chapter 2 focuses on giving an overview of green building assessment tools, the concept of retrofitting and retrofitting technologies. Chapter 3 discussed the building lighting energy simulation for retrofitting the Rest and Service Area (RSA) at Ayer Keroh Malaysia, which was conducted using the Revit BIM model.

Chapter 4 presents the prototyping of retrofitting strategies in the educational building to reuse a building type or building design. Chapter 5 reveals the strategies for mitigating the influence for modernism towards sustainable retrofitting of Hausa traditional palaces. Chapter 6 presenting the attitude towards energy consumption and strategies to encourage energy efficiency in a building.

The energy consumption and occupant's well-being based on the retrofitting implemented in the office building at National Primary Health Care Development Agency Abuja were highlighted in Chapter 7. Chapter 8 reveals cool paint application to the indoor temperature conducted at the student hostel room in UTM presidential college. Lastly, Chapter 9 highlighted the passive design approach of building envelope for individual residents in achieving energy-efficient building.

Keywords: Retrofitting, green building, prototyping, Hausa, attitude



SUSTAINABLE BUILDING RETROFITTING AND ENERGY EFFICIENCY

*Nur IzieAdiana Abidin
Rozana Zakaria
Eeydzah Aminudin
Dodo Yakubu Aminu*



**Penerbit
UTHM**



SUSTAINABLE BUILDING RETROFITTING AND ENERGY EFFICIENCY



SUSTAINABLE BUILDING RETROFITTING AND ENERGY EFFICIENCY

***Nur IzieAdiana Abidin
Rozana Zakaria
Eeydzah Aminudin
Dodo Yakubu Aminu***


**Penerbit
UTHM**
2021

© Penerbit UTHM
First Published 2021

Copyright reserved. Reproduction of any articles, illustrations and content of this book in any form be it electronic, mechanical photocopy, recording or any other form without any prior written permission from The Publisher's Office of Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor is prohibited. Any negotiations are subjected to calculations of royalty and honorarium.

Perpustakaan Negara Malaysia Cataloguing in Publication Data

Nur IzieAdiana Abidin, 1989-
SUSTAINABLE BUILDING RETROFITTING AND ENERGY EFFICIENCY /
Nur IzieAdiana Abidin, Rozana Zakaria, Eeydzah Aminudin, Dodo
Yakubu Aminu.
ISBN 978-967-2817-07-9
1. Sustainable buildings.
2. Buildings--Retrofitting.
3. Energy consumption.
4. Architecture and energy conservation.
5. Government publications--Malaysia.
I. Rozana Zakaria, 1970-. II. Eeydzah Aminudin, 1987-.
III. Dodo Yakubu Aminu, 1973-. IV. Title.
720.472

Published and printed by:
Penerbit UTHM
Universiti Tun Hussein Onn Malaysia
86400 Parit Raja,
Batu Pahat, Johor
Tel: 07-453 7051 / 7454
Fax: 07-453 6145

Website: <http://penerbit.uthm.edu.my>
E-mail: pt@uthm.edu.my
<http://e-bookstore.uthm.edu.my>

Penerbit UTHM is a member of
Majlis Penerbitan Ilmiah Malaysia
(MAPIM)

CONTENTS

PREFACE	vii
LIST OF CONTRIBUTORS	xi
CHAPTER 1 SUSTAINABLE RETROFITTING INITIATIVES OF EXISTING BUILDINGS TOWARDS ENERGY REDUCTION <i>Nur IzieAdiana Abidin, Rozana Zakaria, Safrin Rifaya Gulam Dasthagir, Nadirah Darus</i>	1
CHAPTER 2 GREEN BUILDING AND ENERGY RETROFITTING <i>Mohn Neady, Eeeydzah Aminudin, Rosli Mohamad Zin, Rozana Zakaria</i>	15
CHAPTER 3 BUILDING ENERGY SIMULATION FOR RETROFITTING <i>Mohn Neady, Eeeydzah Aminudin, Rosli Mohamad Zin, Rozana Zakaria</i>	25
CHAPTER 4 EMPLOYING RETROFITTING STRATEGIES IN EVALUATING PROTOTYPE DESIGN IN EDUCATIONAL BUILDINGS <i>Mariya Aminu Kabir, Ibrahim Abubakar Alkali, Haifa Youssef Hamdoun Muhammed, Gambo Abdullahi, Yakubu Aminu Dodo</i>	35
CHAPTER 5 STRATEGIES FOR MITIGATING THE INFLUENCE OF MODERNISM TOWARDS SUSTAINABLE RETROFITTING OF HAUSA TRADITIONAL PALACES <i>Bilkisu Tahir Mukhtar, Faizah Mohammed Bashir, Ogunbode Ezekiel Babatunde, Hannatu Abdullahi Idris, Hela Ahmad Gnaba, Yakubu Aminu Dodo</i>	47

CHAPTER 6	ATTITUDE TOWARDS ENERGY CONSUMPTION AND STRATEGIES TO ENCOURAGE ENERGY EFFICIENCY IN A BUILDING	63
	<i>Nurul Noraziemah binti Mohd Pauzi, Rozana Zakaria, Nur IzieAdiana Abidin, Safrin Rifaya Gulam Dasthagir, Nadirah Darus</i>	
CHAPTER 7	REDUCING ENERGY CONSUMPTION AND IMPROVING OCCUPANT WELL-BEING OF AN OFFICE BUILDING THROUGH RETROFITTING	79
	<i>Zulai Jarmai Baba-Girei, Ahmad Usman Naibi, Femi Akinbogun, Muhammad Mustapha Gambo, Yakubu Aminu Dodo</i>	
CHAPTER 8	EFFECT OF COOL PAINT APPLICATION TO THE INDOOR TEMPERATURE OF STUDENTS HOSTEL ROOM IN UTM RESIDENTIAL COLLEGE	93
	<i>Nur Adleen Fitriyana binti Azman, Rozana Zakaria, Nur IzieAdiana Abidin, Safrin Rifaya Gulam Dasthagir</i>	
CHAPTER 9	PASSIVE DESIGN APPROACH TOWARDS ENERGY-EFFICIENT BUILDING ENVELOPE FOR INDIVIDUAL RESIDENTIAL	105
	<i>Fatihah Ahmad Shah, Rozana Zakaria, Nur IzieAdiana Abidin, Safrin Rifaya Gulam Dasthagir</i>	
INDEX		123

PREFACE

This book introduces various topics related to energy efficiency and sustainable retrofitting. The topics cover researches and studies on the initiatives, strategies, reduction and improvements, applications, effect, and approach.

Chapter 1 discussed the steps of retrofitting initiatives that can implement to achieve building energy reduction. Retrofitting initiatives consist of three steps which are lean energy, green technology, and clean energy. Lean energy is also known as passive design, such as shading, glazing, green roof, green wall, daylighting. Green technology involves adopting technology such as occupancy sensors, automatic daylight harvesting systems, Variable Frequency Drives, energy-efficient lighting, and air-conditioning. Then, for the greatest effect of energy reduction and the demand for building energy, clean energy or renewable energy provides an opportunity for more significant energy reduction such as solar photovoltaic, wind power, and solar hot water. Chapter 2 focuses on giving an overview of green building assessment tools, the concept of retrofitting and retrofitting technologies. The retrofitting technologies categorized into three groups: supply-side management, demand-side management, and change of energy consumption pattern such as human factors.

Chapter 3 discussed the building lighting energy simulation for retrofitting the Rest and Service Area (RSA) at Ayer Keroh Malaysia, which conducted using the Revit BIM model. The simulations were performed to analyze the lighting performance and proposed retrofitting initiatives to reduce lighting consumption. Meanwhile, Chapter 4 presents the prototyping of retrofitting strategies in the educational building to reuse a building type or building design. This process needs to ensure compatibility of the design usage and functions.

Chapter 5 reveals the strategies for mitigating the influence of modernism towards sustainable retrofitting of Hausa traditional palaces. This is because traditional buildings are constructed from different materials and in different structural forms than modern buildings, and therefore, they perform differently. Thus there are some general qualities of traditional buildings that are worth defining compared to modern buildings, which require different understanding, skills, and material solutions.

Chapter 6 presenting the attitude towards energy consumption and strategies to encourage energy efficiency in a building. The attitude and strategies were obtained from a questionnaire survey conducted at the M50 office building, School of Civil Engineering Universiti Teknologi Malaysia. Consumers have shown a positive attitude towards energy savings by turning off the electrical appliances when they do not use them, utilizing natural sunlight to lighten the room, and setting up the air-conditioning temperature. Meanwhile, implementation of energy audit, information through seminars, and encouragement campaign ranked among the top 3 of other strategies to encourage energy efficiency.

The energy consumption and occupant's well-being based on the retrofitting implemented in the office building at National Primary Health Care Development Agency Abuja were highlighted in Chapter 7. This chapter aims to present the technical details of the building's current state and highlight the retrofitting projects since the building has consumed a lot of energy due to the light bulbs, heat gain from window units, continuous pumping of water, and poor indoor environmental quality. The case study grounded on 40% energy savings by providing adequate illuminance, ventilation, and thermal comfort for the occupants. Chapter 8 reveals cool paint application to the indoor temperature conducted at the student hostel room in UTM residential college. The study proved that the student's surrounding temperature in the residential college is lower after applying the cool paint. The paint also reflects more infrared light to reduce heat

absorption and decrease the level of energy consumption used to bring down the room's temperature. Lastly, Chapter 9 highlighted the passive design approach of building envelope for individual residents in achieving energy-efficient building. Selection of type, size, and location of glazing and windows at the building envelope and dominant wall areas for solar access is the most significant approach to site planning and orientation. A critical understanding of the energy efficiency problem is required in conjunction with the passive design approach of the building envelope. The related construction player should take a rule from the Overall Thermal Transfer Value (OTTV) as a tool for calculating the efficiency of the building envelope to achieve the minimum target value.

Nur IzieAdiana Abidin

Department of Structure and Materials

School of Civil Engineering

Faculty of Engineering

Universiti Teknologi Malaysia

2021

LIST OF CONTRIBUTORS

Eeydzah Aminudin
Fathihah Ahmad Shah
Monh Neardey
Nur Adleen Fitriyana Azman
Nur IzieAdiana Abidin
Rozana Zakaria
Rosli Mohamad Zin
Nadirah Darus
Safrin Rifaya Gulam Dasthagir
Universiti Teknologi Malaysia (UTM)

Ibrahim Abubakar Alkali
Bilkisu Tahir Mukhtar
Mariya Aminu Kabir
Bayero Universiti Kano, Nigeria

Haifa Youssef Hamdoun Muhammed
Faizah Mohammaed Bashir
Hela Ahmad Gnaba
University of Hail, Saudi Arabia

Hannatu Abdullahi Idris
Baze University Abuja, Nigeria

Gambo Abdullilahi
Federal Polytechnic Nasarawa, Nigeria

Yakubu Aminu Dodo
Istanbul Gelisim University, Turkey

Ogunbode Ezekiel Babatunde
Federal University of Technology, Minna, Nigeria

Nurul Noraziemah Mohd Pauzi
Curtin University, Sarawak

Zulai Jarmai Baba-Girei
Nigerian Building and Road Research Institute Abuja

Ahmad Usman Naibi

Femi Akinbogun

Icons Arkitektur -OCA, Abuja

Muhammad Mustapha Gambo

Policy, Research and Partnerships Unit, Shelter

Afrique, Nairobi, Kenya

CHAPTER 1

SUSTAINABLE RETROFITTING INITIATIVES OF EXISTING BUILDINGS TOWARDS ENERGY REDUCTION

*Nur IzieAdiana Abidin, Rozana Binti Zakaria, Safrin Rifaya
Gulam Dasthagir*

1.1 INTRODUCTION

Buildings play a crucial role in creating work and living spaces that contribute to national economic development, modernization, and urbanization achievement [1]. However, sustainability issues on buildings have become a global concern as they account for almost 40 percent of the total annual world energy consumption [2]. Besides, buildings are also becoming the most important sector for the end-use of energy consumption [3]. Therefore, most countries concentrate on the construction industry, with high expectations of reducing carbon dioxide (CO²) emissions [4]. Although the construction of new buildings is one of the sustainable development initiatives to meet the energy challenges, the idea of retrofitting the existing building is not being explored extensively [5]. Masrom et al. (2017) [6] had mentioned that the country is mainly concerned with the development of new sustainable buildings rather than retrofitting the existing buildings, which indicate by their low Green Building Index (GBI) rating [5].

However, retrofitting existing buildings has been recommended to achieve energy efficiency (EE) due to higher demand for energy, limited availability of fossil fuels, and the ecological impacts due to higher fuel usage. Hence, retrofitting a building is an opportunity to achieve energy savings and reduce carbon emissions. While most of the current buildings were not designed as energy-efficient

Therefore, the steps, theoretical and conceptual framework developed in the study help guide in the decision-making phase and during the selection of retrofitting initiative measures. Besides enhancing EE in the existing building, retrofitting also helps generate energy by using a renewable energy source. Furthermore, the conceptual framework provides more detail guidelines consisting of various criteria that can be considered to ensure the most efficient and satisfying results in retrofitting projects.

REFERENCES

- [1] Zhang, L., Wu, J., & Liu, H. (2018). Turning green into gold : A Review on the Economics of Green Buildings. *Journal of Cleaner Production*, 172, 2234-2245.
- [2] Yen, N.S , Abdul Shakur,E.S., and Wai, C.W. (2010) Energy Conservation Opportunities in Malaysian Universities. *Malaysian Journal of Real Estate*, 5(1), 26-35.
- [3] Johra, H., and Heiselberg, P. (2017). Influence of Internal Thermal Mass on The Indoor Thermal Dynamics and Integration of Phase Change Materials in Furniture for Building Energy Storage: A Review. *Renewable and Sustainable Energy Reviews*, 69, 19-32.
- [4] Abdullah Saleh, A. A., Mohammed, A. H., and Abdullah, M. N. (2015). Critical Success Factors for Successful Energy Management Implementation towards Sustainability in Malaysian Universities. *International Journal of Social, Behavioral, Educational, Economic and Management Engineering*, 9(3), 734-742.
- [5] Nazri, A. Q., & Baba, M. (2013). The Need for Retrofitting to Achieve Sustainability of Malaysian Buildings. *Jurnal Teknologi*.
- [6] Masrom, M. A. N., Rahim, M. H. I. A., Ann, S. C., Mohamed, S., & Goh, K. C. (2017). A preliminary Exploration of the Barriers of Sustainable Refurbishment for Commercial Building Projects in Malaysia. *Procedia Engineering*. 180, 1363-1371.

- [7] Abdelazim, A. I., Ibrahim, A. M., and Aboul-Zahab, E. M. (2016). Development of An Energy Efficiency Rating System for Existing Buildings Using Analytic Hierarchy Process - The Case of Egypt. *Renewable and Sustainable Energy Reviews*, 71, 414-425.
- [8] Kumar, P., Zainuddin, A. (2018). Energy Efficiency to Save Govt Nearly Rm47b by 2030. The *Malaysia Reserve*. Retrieved from <https://themalaysianreserve.com/2018/11/02/energy-efficiency-to-save-govt-nearly-rm47b-by-2030/>
- [9] Yang, J., Tham, K. W., Lee, S. E., Santamouris, M., Sekhar, C., and Cheong, D. K. W. (2016). Anthropogenic Heat Reduction Through Retrofitting Strategies of Campus Buildings. *Energy and Buildings*, 152, 813-822.
- [10] Lu, Y., Wang, S., Yan, C., and Huang, Z. (2017). Robust Optimal Design of Renewable Energy System in Nearly/Net Zero Energy Buildings Under Uncertainties. *Applied Energy*, 187, 62-71.
- [11] Sen, S., and Ganguly, S. (2015). Opportunities, Barriers and Issues with Renewable Energy Development - A Discussion. *Renewable and Sustainable Energy Reviews*, 69, 1170-1181.
- [12] Baker, J., Brandenburg, M., and Herbst, R. (2012). *United States Building Energy Efficiency Retrofits*. (1st ed). United States: Rockefeller Foundation.
- [13] Stafford, A., Gorse, C., and Shao, L. (2011). *The retrofit Challenge: Delivering Low Carbon Buildings*. United Kingdom: The Centre for Low Carbon Futures.
- [14] Wilkinson, S. (2012). Analysing Sustainable Retrofit Potential in Premium Office Buildings. *Structural Survey*, 30(5), 398-410.
- [15] Zakaria, R. B., Foo, K. S., Zin, R. M., Yang, J., Zolfagharian, S. (2012). Potential Retrofitting of Existing Campus Buildings to Green Buildings. *Applied Mechanics and Materials*. 178-181, 42-45.
- [16] Campbell, I., Doig, S., Gatlin, D., Malkin, A.E., Pogue, D.L., and Quartararo, R. (2009). *Building Retro*. Washington D.C: Urban Land.

- [17] Ma, S. L., Ding, Y., Shen, R. J., and Zhu, N. (2012). A Case Study of an Optimization Retrofit of the Heat Supply System in a Campus of Tianjin. *Applied Mechanics and Materials*, 170-173, 2670-2674.
- [18] Zhou, Z., Zhang, S., Wang, C., Zuo, J., He, Q., and Rameezdeen, R. (2016). Achieving Energy Efficient Buildings Via Retrofitting of Existing Buildings: A Case Study. *Journal of Cleaner Production*, 112, 3605-3615.
- [19] Eriksson, R., Nenonen, S., Junghans, A., Nielsen, S.B., Lindahl, G. (2015). Nordic Campus Retrofitting Concepts - Scalable Practices. *Procedia Economics and Finance*. 349-336.
- [20] Di Stefano, J. (2000). Energy Efficiency and The Environment: The Potential for Energy Efficient Lighting to Save Energy and Reduce Carbon Dioxide Emissions at Melbourne University, Australia. *Energy*, 25(9), 823-839.
- [21] Chung, M. H., and Rhee, E. K. (2014). Potential Opportunities for Energy Conservation in Existing Buildings on University Campus: A field survey in Korea. *Energy and Buildings*, 78, 176-182.
- [22] Kalkan, N., Bercin, K., Cangul, O., Morales, M. G., Saleem, M. M. K. M., Marji, I., Metaxa, A., and Tsigkogianni, E. (2011). A Renewable Energy Solution for Highfield Campus of University Of Southampton. *Renewable and Sustainable Energy Reviews*, 15(6), 2940-2959.
- [23] Chee Yu, J.L. (2014). *OTTV Calculation and Energy Simulation Technique for GreenRE Rating System*. Integrated Environmental Solutions.
- [24] Tymkow, P., Tassou, S., Kolokotroni, M., and Jounara, H. (2008). *Building Services Design for Energy Efficient Buildings*. 1st edition. USA: Routledge.
- [25] Syarifah Fairuz, S.F., Byrd, H. (2012). *Energy and Building Control Systems in the Tropics*. 1st edition. Pulau Pinang: Universiti Sains Malaysia.

- [26] Puvanasvaran, A.P., Miza Farhana,Y.Z., Zaid Ahmaed, A.H., Mukhiffun, M. (2012). Sustainability of Green technology in Malaysia Industry. International Conference on Design and Concurrent Engineering. 160-165.
- [27] Hassan, F. (2014). Application of Green Technology in Malaysia Construction: Have We Got It Right? *International Construction Week & Ecobuild SEA 2014*. Kuala Lumpur.
- [28] Danby, D., Menter, A., and Faludi, J. (2011). *Passive Design Strategies*. Retrieved From: <http://sustainabilityworkshop.autodesk.com/buildings/passive-design-strategies>
- [29] Vandepool (2009). *Integrated Performance Analysis for Sustainable Design, Building it Lean, Clean, Green*. United Kingdom: Integrated Environmental Solution.
- [30] Li, D. H. W., Yang, L., and Lam, J. C. (2013). Zero Energy Buildings and Sustainable Development Implications - A Review. *Energy*, 54, 1-10.
- [31] Zahedi, A. (2006). Solar Photovoltaic (PV) Energy; Latest Developments In The Building Integrated And Hybrid PV Systems. *Renewable Energy*, 31(5), 711-718.
- [32] Shaikh, P. H., Nor, N. bin M., Sahito, A. A., Nallagownden, P., Elamvazuthi, I., and Shaikh, M. (2017). Building Energy for Sustainable Development in Malaysia : A Review. *Renewable and Sustainable Energy Reviews*, 75, 1392-1403.
- [33] Ascione, F., Masi, R.F.D., Rossi, F. De, Ruggiero,S., and Vanoli,G.P. (2016). Optimization of Building Envelope Design for nZEBs in Mediterranean Climate: Performance Analysis of Residential Case Study. *Applied Energy*, 183, 938-957.
- [34] Chwieduk, D. A. (2017). Towards Modern Options of Energy Conservation in Buildings. *Renewable Energy*, 101, 1194-1202.

CHAPTER 2

GREEN BUILDING AND ENERGY RETROFITTING

*Monh Neardey, Eeydzah Aminudin, Rosli Mohamad Zin,
Rozana Zakaria*

2.1 INTRODUCTION

UN Climate Change (UNCC) has urged the need to reduce emissions due to increasing two-thirds of the global population by 2050. The expectation of a vulnerable large number of populations opens up improving the energy-saving mainly buildings and transportations sector. Green Building awareness has played a significant role in helping the cities leapfrog to a sustainable and green development pathway. Since 2015 the Green Building concept has been introduced to Malaysia to support the Sustainable Development Goal (SDG's) initiatives. One of the most important green buildings is achieving sustainable development in environmental protection and improving human life quality [1]. Based on the sources, the construction industry generates the most significant impact on the environment than other sectors. One of the mechanisms is green building designs and a standard to reduce energy consumption in building operation as energy efficiency in building [2]. Green building is one of the measures to mitigate significant impacts of the building stock on the environment, society, and economy [3]. One of the Green building explanations stated that green building had been used as a term identical to sustainable building and high-performance building. Furthermore, there are four pillars in encouraging green buildings, i.e., enhancing occupants' health conditions, minimizing impacts on the environment, local community, and the life cycle consideration during the planning and development process and the return on investment to developers [4][5].

building fabric and other advanced technologies such as air tightness, window shading, etc.

ACKNOWLEDGEMENTS

We would like to express a deep gratitude to AUN-SEED Net By JICA for financial support for this research study.

REFERENCES

- [1] Shafiei, M. W. M., Abadi, H. and Osman, W. N. (2017). The indicators of green buildings for Malaysian property development industry. *International Journal of Applied Engineering Research*, 12(10), 2182-2189.
- [2] Kwok, Statz, C. (2011). Carbon Emission Modeling for Green Buildings: A Comprehensive Study of Methodologies. 1(3), 9-17.
- [3] Zuo, J. and Zhao, Z. Y. (2014). Green building research-current status and future agenda: A review. *Renewable and Sustainable Energy Reviews*. 30, 271-281.
- [4] Robichaud, L. B. and Anantatmula, V. S. (2011). Greening project management practices for sustainable construction. *Journal of Management in Engineering*, 27(1), 48-57.
- [5] Jagarajan, R., Abdullah Mohd Asmoni, M. N., Mohammed, A. H., Jaafar, M. N., Lee Yim Mei, J. and Baba, M. (2017). Green retrofitting - A review of current status, implementations and challenges. *Renewable and Sustainable Energy Reviews*, 67, 1360-1368.
- [6] Yoon, S. W. and Lee, D. K. (2003) 'The development of the evaluation model of climate changes and air pollution for sustainability of cities in Korea. *Landscape and Urban Planning*, 63(3), 145-160.
- [7] Ali, H. H. and Al Nsairat, S. F. (2009). Developing a green building assessment tool for developing countries - Case of Jordan. *Building and Environment*. 44(5), 1053-1064.

- [8] Cole, J. R. (2003). Building Environmental Control. pp. 467-482.
- [9] Zuo, J. and Zhao, Z. Y. (2014). Green building research-current status and future agenda: A review. *Renewable and Sustainable Energy Reviews*. 30, 271-281.
- [10] MyCREST Book, Construction Industrial Development Board, 2016
- [11] Shafiei, M. W. M., Abadi, H. and Osman, W. N. (2017). The indicators of green buildings for Malaysian property development industry. *International Journal of Applied Engineering Research*, 12(10), 2182-2189.
- [12] Love P, Bullen PA (2009). Towards the sustainable adaptation of existing facilities. *Facilities*. 2: 357-67.
- [13] SanvidoVERiggsLS (1991). Managing retrofit projects. a final report submitted to the construction industry institute. Department of civil engineering university of Texas at Austin, Technical Report No. 25.
- [14] Latham D. (2000). Creative reuse of buildings. Dorset: Donhead Publishing.
- [15] Steemer K. (2003). Towards A. Research agenda for adapting to climate change. *Build Res Inf*, 31(3/4):291-301.
- [16] USGBC (2003). The costs and financial benefits of green buildings: a report to california's sustainable building task force, USGBC, San Francisco, CA. Available at: www.usgbc.org;
- [17] Ehsan, A., Manuel, A., Carlos, S., Lu, H. A. and Glicksman, L. (2014) 'Accepte cr t', *Energy & Buildings*. Elsevier B.V.
- [18] Ma, Z., Cooper, P., Daly, D. and Ledo, L. (2012). Existing building retrofits: Methodology and state-of-the-art. *Energy and Buildings*. 55, 889-902.
- [19] Zhou, Z., Zhang, S., Wang, C., Zuo, J., He, Q. and Rameezdeen, R. (2016). Achieving energy efficient buildings via retrofitting of existing buildings: A case study. *Journal of Cleaner Production*, 112, 3605-3615.

- [20] Jagarajan, R., Abdullah Mohd Asmoni, M. N., Mohammed, A. H., Jaafar, M. N., Lee Yim Mei, J. and Baba, M. (2017). Green retrofitting - A review of current status, implementations and challenges. *Renewable and Sustainable Energy Reviews*. 67, 1360-1368.
- [21] Tahir, M. Z., Nawawi, M. N. M. and Ibrahim, A. (2016). Low-cost and no-cost practice to achieve energy efficiency of government office buildings: A case study in federal territory of Malaysia. *AIP Conference Proceedings*, 1761.
- [22] Corish, P. and Agreement, L. (2010) Australian / New Zealand Standard.
- [23] Dubois, M. C. and Blomsterberg, Å. (2011). Energy saving potential and strategies for electric lighting in future north european, low energy office buildings: A literature review. *Energy and Buildings*. 43(10), 2572-2582.
- [24] Muthuvel, P., Daniel, S. A. and Yazhini, D. G. (2016). Retrofitting domestic appliances for PV powered DC Nano-grid and its impact on net zero energy homes in rural India', *Engineering Science and Technology, an International Journal*. Karabuk University, 19(4), 1836-1844.

CHAPTER 3

BUILDING ENERGY SIMULATION FOR RETROFITTING

*Monh Neardey, Eeydzah Aminudin, Rosli Mohamad Zin,
Rozana Zakaria*

3.1 INTRODUCTION

The awareness of Green building becomes more vital and crucial across the nation. The Green Building concept has been introduced to Malaysia for implementation of the sustainable development goal. In terms of environmental protection and improving human life quality, green building has an essential role in achieving sustainable development [1]. Based on the sources, the construction industry generates the greatest impact on the environment compared to other industries. One of the mechanisms is going to develop a standard to reduce energy consumption in building operation as energy efficiency in building and green building designs [2]. Green building is one of measures been put forward to mitigate significant impacts of the building stock on the environment, society and economy [3]. Green building has been used as a term identical to sustainable building and high-performance building defined as green building. Other study pointed out that there are four pillars of green buildings, i.e. enhancing occupants' health conditions, minimization of impacts on the environment, local community and the life cycle consideration during the planning and development process and the return on investment to developers [4][5].

To facilitate green building developments, there are various green building rating systems have been developed. There are various aspects of sustainability covering the structure of these green building assessment tools [3]. [6] In terms of cost and economic to performed the case study for ranking green building indicators, the result showed that among the total scores participants, energy efficiency contributes

REFERENCES

- [1] Shafiei, M. W. M., Abadi, H. and Osman, W. N. (2017). The indicators of green buildings for Malaysian property development industry. *International Journal of Applied Engineering Research*, 12(10), 2182-2189.
- [2] Kwok, Statz, C. (2011). Carbon Emission Modeling for Green Buildings: A Comprehensive Study of Methodologies. 1(3), 9-17.
- [3] Zuo, J. and Zhao, Z. Y. (2014). Green building research-current status and future agenda: A review', *Renewable and Sustainable Energy Reviews*. 30, 271-281.
- [4] Robichaud, L. B. and Anantatmula, V. S. (2011). Greening project management practices for sustainable construction. *Journal of Management in Engineering*, 27(1), 48-57.
- [5] Jagarajan, R., Abdullah Mohd Asmoni, M. N., Mohammed, A. H., Jaafar, M. N., Lee Yim Mei, J. and Baba, M. (2017). Green retrofitting - A review of current status, implementations and challenges. *Renewable and Sustainable Energy Reviews*. 67, 1360-1368.
- [6] Al-Mofleh, A., Taib, S., Mujeebu, M. A. and Salah, W. (2009). Analysis of sectoral energy conservation in Malaysia. *Energy*, 34(6), pp. 733-739.
- [7] Sartori, I., Napolitano, A. and Voss, K. (2012). Net zero energy buildings: A consistent definition framework. *Energy and Buildings*, 48, 220-232.
- [8] Ascione, F., Bianco, N., De Masi, R. F., Mauro, G. M. and Vanoli, G. P. (2017). Energy retrofit of educational buildings: Transient energy simulations, model calibration, and multi-objective optimization towards nearly zero-energy performance. *Energy and Buildings*. 144, 303-319.
- [9] Pinheiro, S., Wimmer, R., O'Donnell, J., Muhic, S., Bazjanac, V., Maile, T., Frisch, J. and van Treeck, C. (2018). MVD based information exchange between BIM and building energy performance simulation. *Automation in Construction*. 90, 91-103.

- [10] Aksamija, A. (2012). BIM-Based Building Performance Analysis: Evaluation and Simulation of Design Decisions. *2012 ACEEE Summer Study on Energy Efficiency in Buildings*. 1-12.
- [11] Han, T., Huang, Q., Zhang, A. and Zhang, Q. (2018). Simulation-based decision support tools in the early design stages of a green building-A review. *Sustainability* 10(10).
- [12] Hirsch, A. H. (2014). Sustainable Rest Areas Design and Operations. *Icsi 2014*, pp. 819-830.
- [13] De Wilde, P. (2018) *Building Performance Analysis, Building Performance Analysis*. Wiley-Blackwell.
- [14] Ivanova, I., Kiesel, K. and Mahdavi, A. (2015). BIM-generated data models for EnergyPlus: A comparison of gbXML and IFC formats. *Building Simulation Applications*, 407-414.
- [15] DesignBuilder (2018) 'DesignBuilder Revit - gbXML Tutorial'.
- [16] Bazjanac, V. and Kiviniemi, A. (2007). Reduction, simplification, translation and interpretation in the exchange of model data. *Proceedings of the 24th Conference on Bringing ITC Knowledge to Work*, 78, 163-168.

CHAPTER 4

EMPLOYING RETROFITTING STRATEGIES IN EVALUATING PROTOTYPE DESIGN IN EDUCATIONAL BUILDINGS

*Mariya Aminu Kabir, Ibrahim Abubakar Alkali, Haifa Youssef
Hamdoun Muhammed Gambo Abdullahi & Yakubu Aminu
Dodo*

4.1 INTRODUCTION

Prototype in architecture is a term used to define the reuse of a building type or building design. Prototypes have acquired certain prominence and visibility in recent times [1]. The idea of prototyping in architecture has been in existence for a while but until recently, it has been used primarily to test and refine elements of buildings, mainly during construction or the aesthetics. Currently, built prototypes are used to enhance environmental performance and reduce risks which translate into reducing cost.

Prototype designs have widely been adapted under residential buildings but recently, educational buildings have started adapting the trend also. It has been adapted mostly in primary and secondary schools because of their similarities. All stages of education from primary to secondary, use basic spaces, including classrooms, libraries, etc, making a design pattern that could be used to generate a prototype [2]. Although the functions may look the same, tertiary education requires more space to fulfill its function. These spaces may range between different fields being taught.

The prototype design is a common feature of buildings in Bayero University, Kano. It can be seen in many buildings in the university, for instance, the Centre for Renewable Energy and the Centre for Dry Land Agriculture, Faculty of

1. Prototype designs should be fully examined before adopting the design for a new building as the design's configuration may not be suitable for the uses/functions of the new building users.
2. Due to the peculiarities of each course/program undergone in universities, especially professional courses/programs where special requirements and equipments are needed, it is advised that these courses/programs are provided with facilities that are designed to suit the intended purpose of users.
3. The end users of the facilities, which are the students, should be included in the strategic planning for universities as relying on the BMAS alone, which was developed in this research is insufficient in achieving efficient learning facilities.
4. Policy makers should take into consideration the prospect for growth in the design of learning facilities as some new courses/programs tend to expand over time.

REFERENCES

- [1] Guggenheim, M. (2014). *From Prototyping to Allotyping: The invention of change of use and the crisis of building types*. 0350, 411-433.
- [2] Alaska Department of Education. (1998). *Use of Prototype Designs in Public School Construction Projects*.
- [3] Ma, Z., Cooper, P., Daly, D., & Ledo, L. (2012). Existing building retrofits : Methodology and state-of-the-art. *Energy & Buildings*, 55, 889-902.
- [4] Khairi, M., Jaapar, A., & Yahya, Z. (2017). The application, benefits and challenges of retrofitting the existing buildings. *Material Science and Engineering*, 271.
- [5] García, D., Soutullo, S., Suarez, M. J., & Blanco, E. (2019). Decision matrix methodology for retrofitting techniques of existing buildings. *Journal of Cleaner Production*, 240.

- [6] Bedi, K. (2013). Study on Various Methods and Techniques of Retrofitting. *International Journal of Engineering Research & Technology*, 2(9), 621-627. Retrieved from <https://www.ijert.org/research/study-on-methods-and-techniques-of-retrofitting-IJERTV2IS90071.pdf>
- [7] Asadi, E., Gameiro, M., Henggeler, C., & Dias, L. (2012). Multi-objective optimization for building retrofit strategies : A model and an application. *Energy & Buildings*, 44, 81-87.
- [8] Zakaria, R., Foo, K. ., Mohamad Zin, R., Yang, J., & Zolfagharian, S. (2012). Potential Retrofitting of Existing Campus Buildings to Green Buildings. *Applied Mechanics and Materials*, 181, 42-45.
- [9] Australian Learning and Teaching Council. (2010). *Retrofitting University Learning Spaces*. Retrieved from <http://learnline.cdu.edu.au/retrofittingunispace/>

CHAPTER 5

STRATEGIES FOR MITIGATING THE INFLUENCE OF MODERNISM TOWARDS SUSTAINABLE RETROFITTING OF HAUSA TRADITIONAL PALACES

Bilkisu Tahir Mukhtar, Faizah Mohammed Bashir, Ogunbode Ezekiel Babatunde, Hannatu Abdullahi Idris, Hela Ahmad Gnaba, and Yakubu Aminu Dodo

5.1 INTRODUCTION

According to Denyer [1] the myth of darkest Africa is persistent, and there are recast many people who hardly accept that traditional buildings of the continent merit more than passing consideration. Traditional architecture has gradually been sidelined and more attention is given to modernized facilities which is the new trend noticed in society today.

Before colonialism and its attendant modifiers, there had been a traditional practice of ornamentation in Makuba and external mural paintings for external walls in Hausa land, particularly concerning palace architecture. This decoration is mainly an urban phenomenon associated with wealth and sophistication, and it is primarily based on relief and abstract with some inanimate object [2]. A particular form of decoration known as graffito is used in Hausa land in which different color wall plasters are laid in layers, and the design is made by scratching away upper layers. Denyer [1] pointed out that this decoration may imbue some magical or religious significance.

Hausa architecture and settlement's essential lies in a hierarchy of spaces from the smallest village to the largest city, from the humble residences to the most complex

royal distinction. It is in this context that palace art and ornamentation can be appreciated.

Unfortunately, Hausa land palaces are becoming part of the calamities of modern influence to what is known as an upgrade. An extensive literature on these palaces' current situation reveals the injury the cause by modern trend. The research, however, draws attention to careful consideration on how to retrofit them. Otherwise, the sustainable approach deployed nowadays, when viewed from conservation and preservation will be no longer sustainable because it comprises future generations meeting their architectural heritage. The research, however, succeeded in exploring strategies and measures to approach retrofitting of Hausa traditional palaces.

REFERENCES

- [1] Denyer, S. (1978). African traditional architecture, London. Heinemann Publishers. Pp 164-165.
- [2] Hamma. S. (2016): Nigerian traditional and vernacular architecture, Bayero University, Kano.
- [3] Ochonu, M. (2010). Art, History, and Power in the Dutse Palace. *Critical Interventions*, 4(1), 27-44.
- [4] Bilyaminu M (2017). Modern Architecture in Nigeria and It's Trends in Historical Buildings (Failure of modernist in Conservation and Restoration of Historical Buildings.
- [5] Danjuma S. (2005). *Gishirin Zaman Duniya*. 5th Edition,
- [6] Chokor B. A. (2005). Changing urban housing form and organization in Nigeria: lessons for community planning, *Planning Perspectives*, vol.20, no.1, pp 69-96.
- [7] (schwerdtfeger 2006 in ochanu 2014).
- [8] Moughtin, J.C. (1985): Hausa Architecture. *Ethnographical Ltd*. London. Pp 1-123.
- [9] Nura, J. (2014). Chapter Twelve Traditional Hausa Architecture in The Royal Palace, City Walls. Saharan

Crossroads: Exploring Historical, Cultural, and Artistic Linkages between North and West Africa, 235.

- [10] Sustainable Traditional Buildings Alliance STBA (2017). Online, [https://en.m.wikipedia. Org](https://en.m.wikipedia.org)> Hausa [www. Ate liermasomi.com](http://www.Ate liermasomi.com)
- [11] Dodo, Y. A. (2017) Delivering Low Carbon Buildings Through Green Retrofit. Invited Guest Talk Universiti Teknologi Malaysia, Sustainable Construction Week Dewan Sultan Iskandar 28th November 2017 DOI: 10.13140/RG.2.2.22360.72969
- [12] EPPR 2015
- [13] Neil M. and Nigel G. (2015). Planning responsible retrofit of traditional buildings. Sustainable Traditional Buildings Alliance (STBA), UK. www.stbauk.org.
- [14] Godwin, M. H., & Kyratzis, A. (2011). 16 Peer Language Socialization. The handbook of language socialization, 365.
- [15] CPWD 2013. <https://helptheengineer.com/cpwd-publication>
- [16] Historic England (2019). Annual Report & Accounts.www.historicengland.org.uk/about/what-we-do/annual-reports-and-accounts

CHAPTER 6

ATTITUDE TOWARDS ENERGY CONSUMPTION AND STRATEGIES TO ENCOURAGE ENERGY EFFICIENCY IN A BUILDING

Nur IzieAdiana Abidin, Nurul Noraziemah Binti Mohd Pauzi, Rozana Binti Zakaria, Safrin Rifaya Gulam Dasthagir

6.1 INTRODUCTION

According to the prediction of the global construction industry, an average growth of 3.6 per cent of construction output expected to foreseen annually from 2018 to 2022 [1]. This increases the demand for energy significantly as well as the emission of carbons as the impact. With growing concerns about the environment, such as climate change, it is necessary to implement energy-saving strategies in every building [2]. Various factors affected how the energy used in homes, such as electricity costs, household and building characteristics, access to the energy supply, environment, types, and efficiencies of appliances used, energy sources, and energy policies [3].

However, [4] reports that about 80% of the building's economic growth value for energy efficiency remains undiscovered, mainly because of non-technical pitfalls. Based on an [5] report, energy-consuming devices' efficient operation will produce higher energy savings, sometimes 15 percent or more of the current energy bills. Therefore, its either actively or passively, households decide on when and how to use their electrical appliances as their primary energy system [6].

Besides, several measures for Energy Efficiency have been prepared to create a healthier living environment for present and future generations. These approaches include,

As a recommendation for future research, the study shall be conducted to a wider range of occupants to obtain more accurate results. This include, occupants from ordinary office building without professionals from academic background in order to study their awareness to promote energy efficiency in the building.

REFERENCES

- [1] Bagchi, Anirban. Global construction output to grow 3.6% per year until 2022 - report. Me Construction News. [Online] 17 October 2018. <http://meconstructionnews.com/31872/global-construction-output-to-grow-3-6-per-year-until-2022-report>.
- [2] Azizi, Z. M., Mokhtar Azizi, N. S., Abidin, N. Z., and Mannakkara, S. (2019). Making Sense of Energy-Saving Behaviour: A Theoretical Framework on Strategies for Behaviour Change Intervention. *Procedia Computer Science*, 158, 725-734.
- [3] Belaïd, F., and Journi, H. (2020). Behavioral attitudes towards energy saving: Empirical evidence from France. *Energy Policy*, 140 (March).
- [4] International Energy Agency, 2018. Market Report Series: Energy Efficiency 2018. Analysis And Outlooks To 2040. The International Energy Agency.
- [5] Eggink (2007)
- [6] Trotta, G. (2018). Factors affecting energy-saving behaviours and energy efficiency investments in British households, 114. 529-539.
- [7] Yoshida, Y., Shimoda, Y., & Ohashi, T. (2017). Strategies for a sustainable campus in Osaka University. *Energy and Buildings*. 147, 1-8.
- [8] Mills, B., & Schleich, J. (2012). Residential energy-efficient technology adoption, energy conservation, knowledge, and attitudes: An analysis of European countries. *Energy Policy*. 49, 616-628. H

- [9] Ren, G., Sunikka-Blank, M., & Zhang, X. (2020). Young urban households in Shanghai, China: Characteristics of energy use and attitudes. *Sustainable Cities and Society*. 102174.
- [10] Volland, B. (2017). The role of risk and trust attitudes in explaining residential energy demand: Evidence from the United Kingdom. *Ecological Economics*, 132, 14-30.
- [11] Stern, P. C. (2014). Individual and household interactions with energy systems: Toward integrated understanding. *Energy Research and Social Science*, 1, 41-48.
- [12] Birol, 2016. Energy Efficiency Market Report 2016. Retrieved from: <https://eef.se/wpcontent/uploads/2017/10/mediumtermenergyefficiency2016.pdf>.
- [13] Cox, A., Higgins,T., Gloster,R., Foley, B.(2012). The Impact Of Workplace Initiatives On Low Carbon Behaviours, . Institute for Employment Studies. The Scottish Government Social Research: London.
- [14] Hong,T., Lin H.W(2013). Occupant Behavior: Impact on Energy Use of Private Offices. Ernest Orlando Lawrence Berkeley National Laboratory: Berkeley, CA (US).
- [15] Azar, E. and Al Ansari, H. 2017. Framework to investigate energy conservation motivation and actions of building occupants: The case of a green campus in Abu Dhabi, UAE. *Applied energy*, 190, pp. 563-573.
- [16] Kollmuss, A., Agyeman,J. (2002). Mind the Gap: why do people act environmentally and what are the barriers to pro-environmental behaviour? 8(3). Carfax Publishing: United States.
- [17] Masoso,O.T., Grobler, L.J., The dark side of occupants' behaviour on building energy use, *Energy Build*. 42 (2) (2010) 173-177.

- [18] Carrico, A. R. and Riemer, M. 2011. Motivating energy conservation in the workplace: An evaluation of the use of group-level feedback and peer education., *Journal of environmental psychology*, 31(1), pp. 1-13.
- [19] Han, M. S., and Cudjoe, D. (2020). Determinants of energy-saving behavior of urban residents: Evidence from Myanmar. *Energy Policy*, 140(March). <https://doi.org/10.1016/j.enpol.2020.111405>
- [20] Giampietro, M., Mayumi, K., 2008. The Jevons Paradox: the evolution of complex adaptive systems and the challenge for scientific analysis. In:
- [21] Herring, H., 2007. The limits to energy efficiency: time to beat the rebound effect. In: Elliott, D. (Ed.), *Sustainable Energy. Opportunities and Limitations*. Palgrave MacMillan, Basingstoke, pp. 135-151.
- [22] Haas, R., Nakicenovic, N., Ajanovic, A., Faber, T., Kranzl, L., Muller, A., Resch, G., 2008. Towards sustainability of energy systems: a primer on how to apply the concept of energy services to identify necessary trends and policies. *Energy Policy* 36, 4012-4021.
- [23] Martiskainen, M., Watson, J., 2009. Energy and the citizen. In: Scrase, I., MacKerron, G. (Eds.), *Energy for the Future. A New Agenda*. Palgrave MacMillan, Basingstoke, pp. 166-182.
- [24] Ohler, Adrienne M., Billger, Sherrilyn M., 2014. Does environmental concern change the tragedy of the commons? Factors affecting energy saving behaviors and electricity usage. *Ecol. Econ.* 107, 1-12
- [25] Belaïd, F., and Joumni, H. (2020). Behavioral attitudes towards energy saving: Empirical evidence from France. *Energy Policy*, 140(March). <https://doi.org/10.1016/j.enpol.2020.111406>
- [26] Staddon, S. C., et al. 2016. Intervening to change behaviour and save energy in the workplace: A systematic review of available evidence. *Energy Research & Social Science*, 17, pp. 30-51

- [27] Xu, P., Shen, J., Zhang, X., Zhao, X., & Qian, Y. (2015). Case study of smart meter and inhome display for residential behavior change in Shanghai, China. *Energy Procedia*, 75, 2694-2699. <https://doi.org/10.1016/j.egypro.2015.07.679>.
- [28] Ma, G., Andrews-Speed, P., and Zhang, J. (2013). Chinese consumer attitudes towards energy saving: The case of household electrical appliances in Chongqing. *Energy Policy*, 56, 591-602. <https://doi.org/10.1016/j.enpol.2013.01.024>
- [29] Huat, N.B., Akasah, Z.B. (2011). An overview of Malaysia Green Technology Corporation Office Building: A showcase Energy-Efficient Building Project in Malaysia. *Journal of Sustainable Development*. 4(5), 212- 228.

CHAPTER 7

REDUCING ENERGY CONSUMPTION AND IMPROVING OCCUPANT WELL- BEING OF AN OFFICE BUILDING THROUGH RETROFITTING

Zulai Jarmai Baba-Girei¹, Ahmad Usman Naibi, Femi Akinbogun, Muhammad Mustapha Gambo, and Yakubu Aminu Dodo

7.1 INTRODUCTION

Energy consumption in the built environment has become a significant element in sustainable development discourses because of its adverse environmental effects and a projected and continued rise in energy demand [1,2]. Studies by Abu-ghozalah (2007); Boussora (1990), and Mahgoub (2004)[3,4,5] have shown that high energy consumption in buildings tends to be more conspicuous in large or corporate buildings, although energy demand in buildings influenced by a matrix of complex interrelations between several variables relating to the building itself, the climatic environment, and other socio-economic factors, it has established that the occupancy phase (overall building's use period) accounts for the highest amounts of energy consumed in a building life-span.

Humans spend 90% of their time indoors [6]. Various studies have posited that indoor environmental quality (IEQ) in the workplace is critical for occupants' health and productivity, it is evident that building performance is very crucial for a sustainable environment and occupant environmental comfort and well-being. This also has extensively pushed for the growth of various environmental designs and technologies in the quest for high building performance. Furthermore, the lack of understanding of how the building environment affects humans could negate performance and compromise occupant's environmental comfort and satisfaction.

adequate illumination, ventilation, and thermal comfort of the occupants.

The study has limited its focus to enhancing the building envelope, provision of energy-saving lighting and cooling systems, conservation of water, improved daylighting in the working environment, thermal comfort and improved well-being of occupants. The comparison presented above on before and after retrofit has indicated a huge 40% saving on energy consumption by retrofitting energy-saving light bulbs and air conditioners, provision of additional windows for enhanced daylight and ventilation, as well as improvement on the well-being of occupants by creating conducive conveniences, good illumination, and natural ventilation. There is the need to however monitor long term energy audit of the building which will give a more comprehensive performance of the building. This can act as a starting point for the Nigerian building professional to consider sustainable retrofitting as a strategy for retrofitting buildings.

REFERENCES

- [1] King, P., *Cracking the Zero Carbon Code*, in *Sustainable Business*. 2008. p. 20-21.
- [2] Roaf, S., F. Crichton, and F. Nicol. 2005. *Adapting Buildings and Cities for Climate Change*. Elsevier: Oxford
- [3] Abu-Ghazalah, S. (2007). Skyscrapers as an instrument for economic development: the case of Amman. *arq: Architectural Research Quarterly*, 11(01), 81-88.
- [4] Boussora, H. (1990). Regionalism: lessons from Algeria and the Middle East. *Mimar*, 36, 64-71.
- [5] Mahgoub, Y. (2004). Globalization and the built environment in Kuwait. *Habitat International*, 28(4), 505-519.
- [6] Bureau of Labor Statistics (BLS) (2011) American Time Use Survey—2011 Results; US Department of Labor, Bureau of Labor Statistics: Washington, DC, USA, 2011.

- [7] Fisk, W.J. (2002). How IEQ affects health, productivity. ASHRAE J. Am. Soc. Heat. Refrig. Air Cond. Eng. 2002, 44, 56-60.
- [8] Muhsin Kılıç, Ayşe F. Altun, in Exergetic, Energetic and Environmental Dimensions, 2018
- [9] Dodo, Y. A. (2017) Delivering Low Carbon Buildings Through Green Retrofit. Invited Guest Talk Universiti Teknologi Malaysia, Sustainable Construction Week Dewan Sultan Iskandar 28th November 2017 DOI: 10.13140/RG.2.2.22360.72969

CHAPTER 8

EFFECT OF COOL PAINT APPLICATION TO THE INDOOR TEMPERATURE OF STUDENT HOSTEL ROOM IN UTM RESIDENTIAL COLLEGE

*Nur Adleen Fitriyana Binti Azman, Rozana Binti Zakaria,
Nur Izie Adiana Abidin, Safrin Rifaya Gulam Dasthagir*

8.1 INTRODUCTION

Malaysia is an immensely developing country to offset its population growth and industrialization. Consequently, the natural landscape has been replaced with concrete jungle, which causes a rise in the earth's temperature due to development in urban areas. Moreover, the frequency and intensity of heat have been increasing gradually, and the value is expected to be more severe over time [1]. These have some alarming impacts both to human beings and the earth and its populace. The quantity of building construction has been increasing to adapt to the growing population, resulting in much heat production. At the same time, causing thermal discomfort for occupants in a building that eventually demands higher energy consumption [2]. Furthermore, the rising temperature has a huge impact of increasing the cooling demand hence the cost of giving comfort to the users both in business or private structures.

Today, buildings are designed in such a way as to provide thermal comfort to their occupants. The warmth island effect is a condition wherein the downtown areas' temperature is higher than surrounding rural zones [3]. Some factors causing this phenomenon of high density and sunlight retaining structures, utilization of heat absorbing materials, absence of green spaces and the creation of anthropogenic heat [4].

REFERENCES

- [1] Ikmalzatul Abdullah. (2013). Effects of Envelope Color and Heat Insulation on Building Thermal Performance.
- [2] Synnefa A, Santamouris M, Akbari H. (2007). Estimating the effect of using cool coatings on energy loads and thermal comfort in residential buildings in various climatic conditions. *Energy and Buildings*,39:1167-74.
- [3] Taha, H., Akbari, H., Rosenfel, A., Huang, J. (1988). Residential cooling loads and the urban heat island.
- [4] Bansal, N.K., Garg, S.N., Kothari, S. (1992). Effect of Exterior Surface Color on the Thermal Performance of Buildings. *Buildings and Environment* 27:31-37
- [5] Cheng, V., Ng, E. and Givoni, B. (2004). Effect of envelope color and thermal mass on indoor temperatures in hot humid climate. *Solar Energy* 78: 528-534.
- [6] Bretz, S., Akbari, H., and Rosenfeld, A. (1997). Practical Issues for Using Solar Reflective Materials to Mitigate Urban Heat Islands. *Atmosphere Environment* 32: 95-101.
- [7] MS1525:2007.Code of Practice on Energy Efficiency and Use of Renewable Energy for Non Residential Buildings.
- [8] AkzoNobel.(2014).AkzoNobel Report, from <http://report.akzonobel.com/2014/ar/case-studies/sustainable-business/paint-that-keeps-you-cool.html>
- [9] ASHRAE. 2010. *ANSI/ASHRAE Standard 55-2010*. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Green Building Index.

CHAPTER 9

PASSIVE DESIGN APPROACH TOWARDS ENERGY-EFFICIENT BUILDING ENVELOPE FOR INDIVIDUAL RESIDENTIAL

*Fathihah Ahmad Shah, Rozana Binti Zakaria, Nur Izie Adiana
Abidin, Safrin Rifaya Gulam Dasthagir*

9.1 INTRODUCTION

Energy issues are becoming a primary concern due to the depletion of non-renewable energy sources and increased carbon emissions. Growing population and rising standard of living among the residents have become the major factors leading to energy deficiency [1]. Besides, the imbalance of the carbon cycle due to electricity generation from burning fossil fuels eventually increases carbon emissions to the environment. Therefore, innovative approaches to chop down energy utilization and increasing renewable energy sources are fundamental to accomplish the energy efficiency goal. The Malaysian government expressed enthusiasm for the more prominent usage of green structures because of the current situations where energy consumption is in a huge demand [2]. Based on the above information, Malaysia has a solid requirement for, and incredible potential to apply, energy effective techniques in bringing down energy utilization in buildings by reducing energy usage for space cooling in buildings.

Building envelope systems are an essential aspect of private buildings. If energy efficiency is followed and manageable technologies are applied to the building envelope [3], more than 40% of energy consumption of the Malaysian buildings can be reduced. Various factors such as occupant comfort, productivity, energy use and running costs, strength, stability, durability, fire resistance, and aesthetic appeal of the building

REFERENCE

- [1] Yilmaz, Z., (2007). Evaluation of energy efficient design strategies for different climatic zones: comparison of thermal performance of buildings in temperate-humid and hot-dry climate. *Energy and Buildings*, 39 (3), 306-316.
- [2] Esa, M. R., Marhani, M. A., Yaman, R., Hassan, A. A., Rashid, N. H. N., and Adnan, H. (2011). "Obstacles in implementing green building projects in Malaysia." *Austral. J. Basic Appl. Sci.*, 5(12), 1806-1812.
- [3] Azni Zain, A., (2008). Integrating sustainable energy in buildings: a case study in Malaysia. FAU conference, The Association of Development Researchers in Denmark (FAU), Copenhagen, Denmark, 78-91.
- [4] Chew, Y. L. (2009). Construction technology for tall buildings, World Scientific, Singapore.
- [5] Chua, K. and Chou, S., 2010. Evaluating the performance of shading devices and glazing types to promote energy efficiency of residential buildings. *Building Simulation*, 3 (3), 181-194.
- [6] Anas Zafirof A.H & Al-Hafzan A.H. (2012). Kecekapan Tenaga Terhadap Sampul Bangunan Analisis Kajian OTTV Bangunan Canselor Universiti Sains Malaysia, *Journal Design + Built*, Volume 5, 2012.
- [7] Surabhi C. (2008). Energy efficiency and sustainability in buildings. AEI 2008: Building Integration Solutions Malaysia meteorological department.
- [8] Malaysia Energy Database and Information System (MEDiS) 2010, <http://medis.ptm.org.my/>
- [9] Saidur, R, Hasanuzzaman, M., Sattar, M. A., Masjuki, H. H, Irfan Anjum, M, and Mohiuddin, A. K. M. 2007 An analysis of energy use, energy intensity and emissions at the industrial sector of Malaysia, *International Journal of Mechanical and Materials Engineering*, 2, 84 - 92.

- [10] Daghigh, R., N. Adam, et al. (2009). "Ventilation Parameters and Thermal Comfort of Naturally and Mechanically Ventilated Offices." *Indoor and Built Environment* 18(2): 113-122.
- [11] Saidur, R, Rahim, N. A, Masjuki, H. H, Mekhilef, S, Ping, H. W. and Jamaluddin, M. F. 2009a End-use energy analysis in the Malaysian industrial sector *Energy*, 34. 153-158.
- [12] Howell, M. K. (2008). The building envelope breakdown *Construction Specifier* 58(4):70-78.

SUSTAINABLE BUILDING RETROFITTING AND ENERGY EFFICIENCY

This book introduces various topics related to energy efficiency and sustainable retrofitting. The topics cover researches and studies on the initiatives, strategies, reduction and improvements, application, effect and approach.

Chapter 1 discussed the steps of retrofitting initiatives that can be implement to achieve building energy reduction. Retrofitting initiatives consists of three steps which are lean energy, green technology and clean energy. **Chapter 2** focuses on giving an overview of green building assessment tools, the concept of retrofitting and retrofitting technologies. **Chapter 3** discussed the building lighting energy simulation for retrofitting the Rest and Service Area (RSA) at Ayer Keroh Malaysia, which conducted using the Revit BIM model.

Chapter 4 presents the prototyping of retrofitting strategies in the educational building to reuse a building type or building design. **Chapter 5** reveals the strategies for mitigating the influence for modernism towards sustainable retrofitting of Hausa traditional palaces. **Chapter 6** presenting the attitude towards energy consumption and strategies to encourage energy efficiency in a building.

The energy consumption and occupant's well-being based on the retrofitting implemented in the office building at National Primary Health Care Development Agency Abuja were highlighted in **Chapter 7**. **Chapter 8** reveals cool paint application to the indoor temperature conducted at the student hostel room in UTM presidential college. Lastly, **Chapter 9** highlighted the passive design approach of building envelope for individual residents in achieving energy-efficient building.



ISBN 978-967-2817-07-9



For more information,
please scan the code

