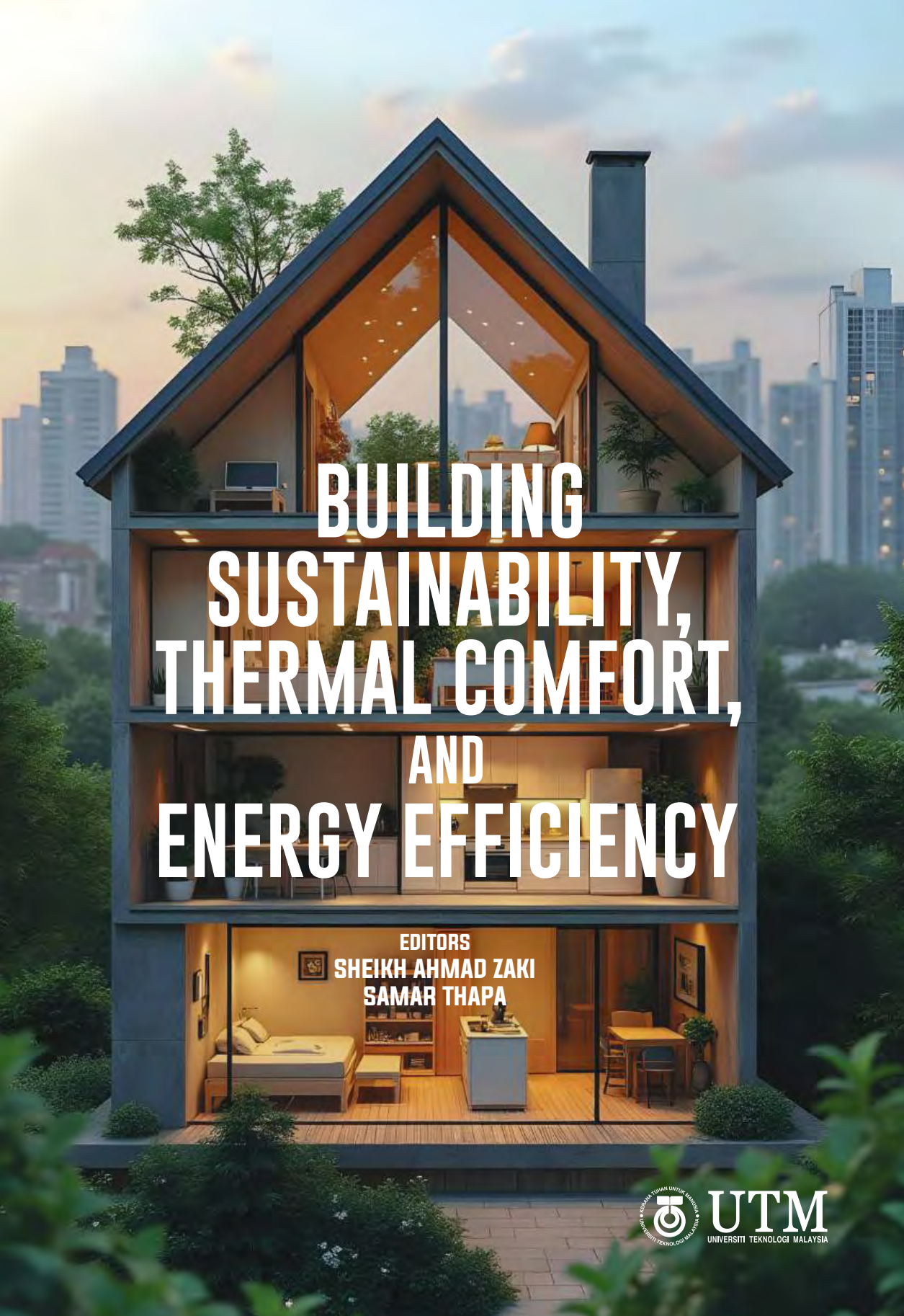




BUILDING SUSTAINABILITY, THERMAL COMFORT, AND ENERGY EFFICIENCY

**EDITORS
SHEIKH AHMAD ZAKI
SAMAR THAPA**



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

BUILDING SUSTAINABILITY, THERMAL COMFORT, AND ENERGY EFFICIENCY

In an era of climate change and rapid urbanisation, Building Sustainability, Thermal Comfort, and Energy Efficiency explores the critical intersection of energy consumption, thermal comfort, and sustainable design. This comprehensive volume brings together cutting-edge research from diverse geographic contexts, including Malaysia, Japan, Turkey, Nigeria, and Australia.

Each chapter provides profound insights and practical strategies for creating energy-efficient, comfortable living and working environments. From understanding how socioeconomic factors influence energy use in Malaysian homes to advocating for renewable energy solutions in the tropics, this book offers a holistic view of sustainable architecture and urban planning.

Ideal for architects, urban planners, policymakers, and researchers, this book emphasises the need for integrative and inclusive approaches to building design. By leveraging technological innovations and fostering community engagement paves the way for a future where sustainability and comfort coexist harmoniously, creating liveable and thriving communities for all.



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

Penerbit
UTM Press



**BUILDING
SUSTAINABILITY,
THERMAL COMFORT,
AND
ENERGY EFFICIENCY**

BUILDING SUSTAINABILITY, THERMAL COMFORT, AND ENERGY EFFICIENCY

**EDITORS
SHEIKH AHMAD ZAKI
SAMAR THAPA**



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

Penerbit
UTM Press

www.penerbit.utm.my

2024

First Edition 2024

© **SHEIKH AHMAD ZAKI SHAIKH SALIM & SAMAR THAPA** 2024

Hak cipta terpelihara. Tiada dibenarkan mengeluarkan mana-mana bahagian artikel, ilustrasi, dan isi kandungan buku ini dalam apa jua bentuk dan cara apa jua sama ada dengan cara elektronik, fotokopi, mekanikal, atau cara lain sebelum mendapat izin bertulis daripada Timbalan Naib Canselor (Penyelidikan & Inovasi), Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor Darul Ta'zim, Malaysia. Perundingan tertakluk kepada perkiraan royalti atau honorarium.

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical including photocopying, recording, or any information storage and retrieval system, without permission in writing from Deputy Vice-Chancellor (Research & Innovation), Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor Darul Ta'zim, Malaysia. Negotiation is subject to royalty or honorarium estimation.

Editor: **SHEIKH AHMAD ZAKI SHAIKH SALIM & SAMAR THAPA**

Editor Penyelaras/*Acquisition Editor*: **MAZLAN SAID**

Pereka Kulit /*Cover Designer*: **NUR'ATIQA ARSHAD**

Diatur huruf oleh /*Typeset by*:

SHEIKH AHMAD ZAKI SHAIKH SALIM & SAMAR THAPA

Malaysia-Japan International Institute of Technology

UNIVERSITI TEKNOLOGI MALAYSIA

81310 UTM Johor Bahru,

Johor Darul Ta'zim, MALAYSIA

Diterbitkan di Malaysia oleh/

Published in Malaysia by:

PENERBIT UTM PRESS

UNIVERSITI TEKNOLOGI MALAYSIA

81310 UTM Johor Bahru,

Johor Darul Ta'zim, MALAYSIA

(Ahli Majlis Penerbitan Ilmiah Malaysia (MAPIM) dan
Persatuan Penerbit Buku Malaysia (MABOPA)

no. keahlian 9101)

Dicetak di Malaysia oleh/

Printed in Malaysia by:

JASAMAX ENTERPRISE

No.16, Jalan Kebudayaan 2,

Taman Universiti,

81310 Skudai,

Johor Darul Ta'zim,

MALAYSIA



Cataloguing-in-Publication Data

Perpustakaan Negara Malaysia

A catalogue record for this book is available from the

National Library of Malaysia

ISBN 978-983-52-2117-0

CONTENTS

<i>Contributors</i>	<i>vii</i>
<i>Preface</i>	<i>ix</i>
CHAPTER 1 BALANCING COMFORT AND SUSTAINABILITY IN BUILDINGS	1
<i>Sheikh Ahmad Zaki and Samar Thapa</i>	
CHAPTER 2 ELECTRICITY AND INDOOR ENVIRONMENT IN MALAYSIAN HOUSES	13
<i>Naja Aqilah, Hom Bahadur Rijal, and Fitri Yakub</i>	
CHAPTER 3 THERMAL COMFORT ZONE IN JAPANESE OFFICE BUILDINGS	31
<i>Supriya Khadka, Hom Bahadur Rijal, and Sheikh Ahmad Zaki</i>	
CHAPTER 4 SMART TECHNOLOGIES FOR ISTANBUL'S URBAN LIVABILITY	51
<i>Ohuwagbemiga Paul Agboola and Farah Liana Mohd Redzuan</i>	

CHAPTER 5	THERMAL COMFORT AND CLEAN ENERGY IN NIGERIAN HOMES	75
	<i>Offor Justus Nwafor and Farah Liana Mohd Redzuan</i>	
CHAPTER 6	COOLING BEHAVIOUR IN AUSTRALIAN TROPICAL CLIMATE	87
	<i>Siti Aisyah Damiaty, Veronica Soebarto, Terence Williamson, and Dong Chen</i>	
INDEX		117

CONTRIBUTORS

Dong Chen *Commonwealth Scientific and Industrial Research Organisation, Australia*

Farah Liana Mohd Redzuan *Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia*

Fitri Yakub *Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia*

Hom Bahadur Rijal *Faculty of Environmental Studies, Tokyo City University, Japan*

Naja Aqilah *Faculty of Environmental Studies, Tokyo City University, Japan*

Offor Justus Nwafor *Faculty of Environmental Sciences Enugu State, University of Science and Technology, Nigeria*

Oluwagbemiga Paul Agboola *Faculty of Engineering and Architecture, Istanbul Gelisim Universitesi, Turkey*

Samar Thapa *Land Reforms and Refugee Relief Rehabilitation Department, WB, India*

Sheikh Ahmad Zaki *Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia*

Siti Aisyah Damiati *School of Architecture and Civil Engineering, University of Adelaide, Australia*

Supriya Khadka *Faculty of Environmental Studies, Tokyo City University, Japan*

Terence Williamson *School of Architecture and Civil Engineering, University of Adelaide, Australia*

Veronica Soebarto *School of Architecture and Civil Engineering, University of Adelaide, Australia*

PREFACE

In an era where the impacts of climate change are becoming increasingly evident, the need to create sustainable and comfortable built environments has never been more urgent. *Building Sustainability, Thermal Comfort and Energy Efficiency* emerge as a timely and essential contribution to architecture, urban planning, and environmental science. This book brings together a collection of research studies that delve into the intricate relationship between energy consumption and thermal comfort – moreover, sustainable design, offering profound and practical insights.

The genesis of this book lies in the recognition that achieving sustainability in the built environment is a multifaceted challenge. It requires an integrative approach considering diverse geographic, climatic, and socioeconomic contexts. The studies presented here span a wide range of locations, from the tropical climates of Malaysia and Australia to the temperate regions of Japan, each providing unique perspectives on how different environments influence energy use and occupant comfort.

The first chapter, *Balancing Comfort and Sustainability in Buildings*, which is an editorial, sets the stage for the subsequent chapters, highlighting the significance of the research and contributions it makes to advance our understanding of sustainable and comfortable built environments. It underscores the urgency and relevance of the book's themes, inviting readers to engage with the studies and apply the insights to their contexts and practices.

As the world grapples with the dual challenges of climate change and urbanisation, the insights and strategies outlined in this book are indispensable for architects, urban planners, policymakers, and

researchers. By embracing innovative design principles, leveraging intelligent technologies, and fostering community engagement, one can create energy-efficient built environments and enhance the comfort and well-being of the occupants.

Building Sustainability, Thermal Comfort and Energy Efficiency is a testament to the power of interdisciplinary research and collaboration. It advocates for a vision of sustainable comfort that prioritises adaptability, resilience, and inclusivity, ensuring that our built environments are equipped to meet the needs of present and future generations. Through the collective efforts of the contributors and the broader community, we can move towards a future where sustainability and comfort coexist harmoniously, creating liveable and thriving communities for all.

Sheikh Ahmad Zaki

Universiti Teknologi Malaysia, Malaysia

Samar Thapa

Land Reforms and Refugee Relief Rehabilitation Department, India

2024

INDEX

- air velocity, 91
- American Society of Heating,
Refrigerating and Air-
Conditioning Engineers. *See*
ASHRAE
- ASHRAE, 31–33, 36, 64, 87
- carbon emissions, 79
- climatic variables, 75
- cooling, 2, 7, 14, 21, 32, 54, 56,
62, 81, 87–88, 91, 93, 95–
97, 100–02, 106–07, 109–
10, 112–14
- dry bulb temperature, 91–92
- dwellings, 3, 14–15, 17–18, 21,
23, 27, 88, 89–91, 95–96,
106–08, 110
- electricity, 2–3, 7, 9, 13–15,
17–21, 24–25, 27, 32, 77–
78, 81–82
- environment, 6, 9–10, 25, 31–
32, 38, 51–54, 62, 78, 88,
91–93, 107
- external temperature, 101
- fluctuations in energy demand,
14
- geothermal, 6–7, 82
- GHG, 7, 32, 75–81
- globe temperature, 36–37, 40–
41, 91–93
- greenhouse gas. *See* GHG
- internet of things. *See* IoT
- IoT, 52, 54–55, 62–64
- NatHERS, 7, 87–88, 91, 102,
106, 109–10, 113–14
- National Oceanic and
Atmospheric Administration.
See NOAA
- Nationwide House Energy
Rating Scheme. *See*
NatHERS
- NOAA, 79–80
- OECD, 77, 81
- office buildings, 1–2, 4, 9, 32–
33, 36–38, 40

Organisation for Economic Co-
operation and Development.
See OECD

peak demand, 3, 14, 20–21, 27

PMV, 31

PPD, 31

predicted mean vote. *See* PMV

predicted percentage

dissatisfied. *See* PPD

relative humidity, 4, 16, 91–92

relative importance index. *See*

RII

renewable sources, 2, 82

residential energy simulation,

27

RII, 58, 62, 64

SD, 23, 40

smart buildings, 51–52, 55–56

smart living, 2, 5–6, 9, 53–54,
63

standard deviation. *See* SD

sustainability, 1–2, 4–6, 9–10,
51–52, 55–56, 59, 63, 77

TCZ, 33, 36–37

thermal comfort, 2–3, 7–8, 10,
25, 31, 33, 36, 52, 54, 56,
58–60, 62, 64–65, 67–68,
76–77, 82, 100, 107

thermal comfort zone. *See* TCZ

thermal sensation votes. *See*

TSV

thermostat, 87, 102, 107, 113–
14

TSV, 36, 38, 40

urban settings, 5