Development of a Sustainability Assessment Framework for Malaysian Office Buildings Using a Mixed-Methods Approach

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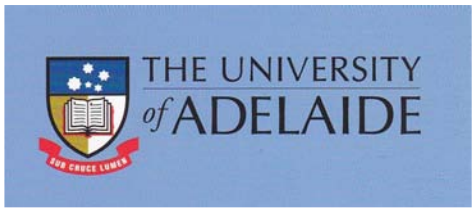
Thesis submitted in fulfillment of the requirements for the degree of
Doctor of Philosophy



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Abstract

An extensive number of studies have been conducted around the world to develop building performance assessment systems (BPASs) to measure the sustainability of building designs and the built environment in general. However, it has been revealed that most existing BPASs are single-dimensional in their structure; hence, inadequate in addressing many of the non-environmental priorities of emerging/developing countries. Malaysia is one of these countries in need of a context-specific system, especially when the necessary balance between socio-economic and ecological systems – to avoid further environmental damage – has not yet been reached. Therefore, the aim of this research is to develop an appropriate assessment framework that enables sustainability to be addressed and incorporated in office building development, relevant to emerging/developing countries, particularly the Malaysian context.

Since sustainability and the framework must be context specific, this study adopted a mixed-methods approach, particularly using the exploratory sequential design i.e. a qualitative followed by a quantitative phase. The goal of the qualitative phase was to identify the most essential assessment criteria. This entailed a synthesis of results from research conducted in three stages: 1) wide-ranging literature review; 2) in-depth, semi-structured, open-ended interviews; and 3) focus groups discussion. The literature review findings from the first stage were synthesized to reveal the relevant assessment criteria and to formulate the requirements for developing the assessment framework. These criteria were further refined in the second and third stages conducted with experts from various backgrounds of the Malaysian construction industry. The criteria identified from, and refined in, the qualitative phase were then brought into the quantitative phase for the purpose of assigning their weighting levels. This phase involved a cross-sectional questionnaire survey in which more than 200 local building stakeholders participated.

Synthesizing the above research, and the presentation of the tentative assessment framework to local experts for validation, this thesis finally proposes the Validated Comprehensive Malaysian Office Building Sustainability Assessment (MOBSA) Framework, composed of the followings attributes: 1) 88 Criteria, grouped under 17 Sub-Issues, which in turn are grouped under 3 sustainability Issues; 2) performance benchmarks for each

criterion applicable to all phases of building assessment, derived based on theory and expert opinions; and 3) scoring system. The framework was applied to a case study building to identify criteria with missing input data. A comparison of the building's overall results with those of an existing environmental-focused BPAS indicates that the building achieved a very high overall score in terms of its environmental design performance but scored lower when assessed based on the whole concept or three dimensions of sustainability.

The MOBSA framework will potentially encourage a continuous learning process, enhancing stakeholders' understanding of their roles and responsibilities in supporting sustainability throughout the life cycle of their projects; and, hence, stimulating needed changes in the Malaysian construction industry. This research also contributes to the development of a new model or approach, particularly appropriate for emerging/developing countries, through which a country-specific building sustainability assessment framework may be established that takes relevant priorities into account. In doing so, emerging/developing countries will ultimately have an appropriate basis to create sustainable construction industries, alongside efforts in developed countries to achieve global changes necessary for the future.

Signed Statement

I, Zalina Shari certify that this work contains no material that has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Zalina Shari

Date: 25 October 2011

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List of Acronyms and Abbreviations

A21 SCDC	Agenda 21 for Sustainable Construction in Developing Countries
A21SC	Agenda 21 on Sustainable Construction
ACEM	Association of Consulting Engineers Malaysia
ACE	Air Change Effectiveness
ACH	Air Change per Hour
AFFL	Above finished-floor level
APEC	Asia-Pacific Economic Cooperation
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, USA
BCA	Building and Construction Authority Singapore
BEI	Building Energy Intensity
BMS	Building Management System
BPAS	Building Performance Assessment System
BRE	Building Research Establishment, UK
BREEAM	Building Research Establishment Environmental Assessment Method, UK
C&C	Construction and Commissioning
CASBEE	Comprehensive Assessment System for Building Environmental Efficiency for Japan
CCTV	Closed-circuit television
CDM	Clean Development Mechanism
CGBC	China Green Building Council
CIB	International Council for Research and Innovation in Building and Construction
CIDB	Construction Industry Development Board of Malaysia
CIMP	Construction Industry Master Plan for Malaysia
CoP	Conference of Parties
CPD	Continuous Professional Development
CSD	Commission on Sustainable Development
DF	Daylight Factor
DOSH	Department of Occupational Safety and Health, Malaysia
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
EQA	Environmental Quality Act
ESCP	Erosion and Sedimentation Control Plan
FM	Facility Management
FSC	Forest Stewardship Council
GBC	Green Building Challenge
GBCA	Green Building Council of Australia
GBCI	Green Building Council of Indonesia
GBES	Green Building Evaluation Standard, China
GBI	Green Building Index, Malaysia
GFA	Gross Floor Area
GPM	Gallon per Minute
GSB	GreenBuildingIndex Sdn. Bhd., Malaysia

HK-BEAM	Hong Kong Building Environmental Assessment Method
HVAC	Heating, Ventilation and Air-Conditioning
IAEA	International Atomic Energy Agency
IBS	Industrialized Building System
ICLEI	International Council for Local Environmental Initiatives
IDP	Integrated Design Process
IEA	International Energy Agency
IEM	Institute of Engineers Malaysia
IEO-IMF	Independent Evaluation Office of the International Monetary Fund
IEQ	Indoor Environmental Quality
IGBC	India Green Building Council
IIED	International Institute for Environment and Development
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
IUCN	International Union for the Conservation of Nature
JPI	Johannesburg Plan of Implementation
KLCP	Kuala Lumpur City Plan
LA21	Local Agenda 21
LAM	Lembaga Arkitek Malaysia (Malaysian Board of Architects)
LCA	Life Cycle Analysis/Assessment
LCC	Life Cycle Costing
LCE	Low Carbon Economy
LEED	Leadership in Energy and Environmental Design
M&E	Mechanical and Electrical
MASMA	Stormwater Management Manual for Malaysia
MDGs	Millennium Development Goals
MIP	Malaysian Institute of Planners
MOBSA	Malaysian Office Building Sustainability Assessment
MTCC	Malaysia Timber Certification Council
NAHRIM	National Hydraulic Research Institute of Malaysia
NLA	Net Lettable Area
NPP	National Physical Plan, Malaysia
NUP	National Urbanization Policy, Malaysia
O&M	Operation and Maintenance
ODS	Ozone-depleting substances
OHSAS	Occupational Health and Safety Standard
OSHMS	Occupational Safety and Health Management System
OTTV	Overall Thermal Transfer Value
PAM	Pertubuhan Akitek Malaysia (Malaysian Institute of Architects)
PMV	Predicted Mean Vote
POE	Post-Occupancy Evaluation
REHDA	Real Estate and Housing Developers' Association Malaysia
RTTV	Roof Thermal Transfer Value

SBS	Sick Building Syndrome
SBTool	Sustainable Building Tool
SDI	Sustainable Development Indicator
SEDA	Sustainable Energy Development Authority
TBL	Triple Bottom Line
UBBL	Uniform Building Bylaw
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USGBC	US Green Building Council
VOC	Volatile Organic Compound
WCED	World Commission on Environment and Development
WCS	World Conservation Strategy
WSSD	World Summit on Sustainable Development