

# ASSESSING CEMENT BLOCKS IN THE CONTEXT OF SUSTAINABLE CONSTRUCTION

Disna Suraji Weerasekera

(108529T)



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

Degree of Master of Science in Project Management

Department of Building Economics

University of Moratuwa

Sri Lanka

September 2015

# ASSESSING CEMENT BLOCKS IN THE CONTEXT OF SUSTAINABLE CONSTRUCTION

Disna Suraji Weerasekera

(108529T)



University of Moratuwa, Sri Lanka.

Electronic Theses & Dissertations

Dissertation submitted in partial fulfillment of the requirements for the  
degree Master of Science in Project Management

[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

Department of Building Economics

University of Moratuwa  
Sri Lanka

September 2015

## DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or institute of higher learning, and to the best of my knowledge and belief, it does not contain any material previously published or written by another person, except where acknowledgement is made in the next.

Also, I hereby grant to the University of Moratuwa the non-exclusive right to reproduce and distribute my dissertation, in whole or in part, in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature:.....

Date:.....

D. Suraji Weerasekera  
(108529T )



University of Moratuwa, Sri Lanka.

The above candidate has carried out research for the Masters dissertation under my supervision.

Electronic Theses & Dissertations

[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

Signature of the Supervisor: ..... Date: .....

Mr. Ravihansa Chandrathilaka,  
Senior lecturer,  
University of Moratuwa.

## DEDICATION

 *I dedicate this dissertation to my dearest Parents, Husband and Little Daughter.....*  
University of Moratuwa, Sri Lanka  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

## ACKNOWLEDGEMENT

A dissertation study of this nature requires the cooperation and collaboration of a many people. Although it is difficult to mention every individual who assisted me, it is my duty to extend my gratitude to all of them for their cooperation and assistance.

First and foremost, I am indebted to my supervisor, Mr. Ravihansa Chandrathilaka, for the interest, encouragement, gentle guidance and support offered throughout this study. I extend my sincere thanks to Dr.(Mrs.) Nirodha Fernando for her interest, encouragement and guidance towards this work as reaserch coordinator. I extend my sincere thanks to former reaserch coordinator Dr.(Mrs.)Yasangika Sandanayake for her guidance, encouragement and helpful cooperation significantly contributing towards the successful completion of this dissertation.

It is my foremost duty to pay my gratitude to the Head, Department of Building Economics, Mr. Indunil Senevirathne, for the endorsement he gave me during the academic years of the university, as well as during the research period. I would like to express my sincere thanks to the facilitator Miss. Lakshmi Siriwardena, for her support given to me to complete my dissertation successfully. I extended my gratitude to the Department of Building Economics, University of Moratuwa, and all the academic and non-academic staff of the Department of Building Economics for their valuable services.

Next, I express my heartfelt gratitude to the National Water Supply & Drainage Board, my current employer, and my wholehearted thanks to Quantity Surveyor of the Planning & Design Division, Ms. B. H. C. Jeevanthi, for her support and encouragement throughout this study. Special thanks also go to the engineers and architects who assisted in this study, for their contribution and support towards it.

Finally, I express my heartfelt thanks to my family and my batch mates who have given me their unstinted support for the successful presenting of this dissertation.

## ABSTRACT

The task of assessing cement blocks represents an important strategy in the sustainable design and construction of a building. A principal challenge is the identification of assessment criteria based on the concepts and principles of sustainability, and the process of prioritizing and aggregating relevant criteria into an assessment framework. Therefore, the purpose of this study is to fill these gaps by describing the development stages of key assessment criteria used within an assessment tool under development for sustainable CB in the building industry.

After conducting a thorough and systematic literature review, a total of 24 sustainability assessment criteria based on the triple bottom line and the needs of building stakeholders were identified. A survey of engineers and architects was conducted to capture their perceptions on the importance of the criteria. Survey questionnaires were randomly mailed and handed over to 231 engineers and 110 architects. Ninety eight (98) effective responses were received, after removing the invalid ones. The response rate was 28.7 per cent. Factor analysis was utilized to group the criteria into assessment factors for modelling sustainability of CB.

Ranking analysis revealed that all criteria were highlighted at “high” or “high-medium” levels in selecting cement block building material. A total of 12 criteria was highlighted at the “high” importance level, with aesthetics, embodied energy and initial acquisition cost to make the top three criteria of importance. After the literature review, questionnaire survey and expertise opinion, the top criterion is the embodied energy. The second high criterion is the aesthetics and the third top criterion is the initial acquisition cost of CB. Factor analysis shows that these SACs can be aggregated into six factors, namely; “environmental impacts”, “resource efficiency”, “waste minimization”, “life cycle cost”, “social benefit”, and “performance capability”. Since these criteria were derived from the survey through expert opinion, consideration of these six criteria in sustainable block making processes and products will ensure sustainability of building projects.

According to the six criteria in the cement block material selection, the environmental issues are not strongly considered, despite the need of reducing the environmental impact of building activities. Hence the result is an example of evidence pointing to the trend that environmental aspects are no longer the least important factors for cement block material selection in building projects.

The current study contributes to the building industry and sustainability research in at least two aspects. First, it widens the understanding of the degree of importance of sustainable CB making processes and products. It also provides building stakeholders a new way to select CB, thereby facilitating the sustainability of building projects.

## TABLE OF CONTENTS

Declaration.....	i
Dedication.....	ii
Acknowledgement.....	iii
Abstract.....	iv
Table of Contents.....	<b>Error! Bookmark not defined.</b>
List of Figures.....	<b>Error! Bookmark not defined.</b>
List of Tables.....	viii
List of Abbreviations.....	x
CHAPTER 1 - INTRODUCTION TO THE RESEARCH.....	1
1.1 Background.....	1
1.2 Research problem statement.....	5
1.3 The Aims and Objectives.....	5
1.3.1 Aims.....	5
1.3.2 Objectives.....	5
1.4 Research methodology.....	6
1.5 Scope and Limitations.....	6
1.5.1 Scope.....	6
1.5.2 Limitations.....	6
1.6 Main findings.....	6
1.7 Chapter breakdown.....	9
1.8 Summary.....	9
CHAPTER 2 - LITERATURE REVIEW.....	10
2.1 Introduction.....	10
2.2 Sustainability.....	11
2.2.1 Green building concept.....	12
2.2.2 Social Sustainability.....	13
2.2.3 Environmental sustainability.....	13
2.2.4 Economical sustainability.....	14
2.3 Sustainability assessment tools commonly used in the construction industry.....	15
2.3.1 BREEAM.....	15

2.3.2	CASBEE .....	16
2.3.3	LEED .....	16
2.3.4	GB TOOL .....	17
2.3.5	DGNB .....	18
2.4	Development of Sustainable Assessment Criteria (SAC) effective in building materials selection .....	20
2.4.1	Review of criteria related studies .....	20
2.4.2	Criteria developed .....	23
2.4.3	Sustainability Assessment Criteria (SAC) effective in cement block selection .....	25
2.4.4	Sustainability Assessment Criteria .....	26
2.5	A comparative analysis of cement blocks with other walling materials through literature review .....	30
2.6	Summary .....	34
<b>CHAPTER 3 - RESEARCH METHODOLOGY .....</b>		<b>36</b>
3.1	Introduction .....	36
3.2	Research methodology .....	36
3.2.1	Research approach .....	36
3.2.2	Research techniques .....	37
3.2.3	Data collection techniques .....	37
3.3	Research process .....	38
3.3.1	Initial impetus .....	38
3.4	Questionnaire development .....	38
3.5	Data collection and sample .....	39
3.6	Method of data analysis .....	40
3.7	Summary .....	42
<b>CHAPTER 04 - DATA ANALYSIS AND DISCUSSION.....</b>		<b>43</b>
4.1	Introduction .....	43
4.2	Data analysis .....	43
4.2.1	Sample characteristics .....	43
4.2.2	Criteria importance rating .....	45



4.2.3	Expertise opinion of the SAC .....	48
4.3	Factor analysis .....	48
4.3.1	Factor1: Life-cycle cost .....	50
4.3.2	Factor2: Performance capability. ....	51
4.3.3	Factor 3: Resource efficiency.....	54
4.3.4	Factor 4: Environmental impact. ....	56
4.3.5	Factor 5: Waste minimization. ....	56
4.3.6	Factor 6: Social benefit .....	57
4.4	Discussion .....	59
4.5	Summary .....	61
CHAPTER 5 - CONCLUSIONS AND RECOMMENDATIONS .....		62
5.1	Introduction.....	62
5.2	Conclusion .....	62
5.3	Recommendations for further research.....	64
REFERENCES .....		66
APPENDIX A: QUESTIONNAIRE.....		75



University of Moratuwa, Sri Lanka.  
 Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

## LIST OF FIGURES

Figure 1.1 Life cycle cost of the cement blocks .....	03
Figure 1.2 Research framework and methodology .....	08
Figure 2.1 : Sustainability equations .....	14
Figure 2.2 BREEAM weighting.....	15
Figure 3.1 Five important levels transformed from RI values .....	41
Figure 4.1 Model for Sustainability Assessment Criteria (SAC).....	63



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

## List of Tables

Table 2.1 Summary of different sources defining the effective material aspects for materials selection process.....	20
Table 2.2 Sustainability Assessment Criteria (SAC).....	28
Table 4.1 Summary of respondents' demographic data (engineers and architects)...	44
Table 4.2 Rank for sustainability criteria for cement block material selection .....	46
Table 4.3 Factor loadings for social-economic criteria after Varimax rotation.....	52
Table 4.4 Factor loadings for environmental criteria after Varimax rotation.....	53
Table 4.5 Factor loadings for technical criteria after Varimax rotation.....	55
Table 4.6 Rank of sustainability criteria for building material selection – importance level “High” (Top twelve criterias).....	60
Table 4.7 Rank of sustainability criteria for building material selection – importance level “High- Medium”.....	60



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

## List of Abbreviations

ASTM	- American Society for Testing and Materials
BEE	- Building Environmental Efficiency
BREAM	- Building Research Establishment Environmental Assessment -- Method
CB	- Cement Blocks
CASBEE	- Comprehensive Assessment System for Building Environment Efficiency
CEB	- Compressed Earth Blocks
GB	- Green Building
LCCA	- Life Cycle Costing Analysis
LEED	- Leadership in Energy and Environment Design
RI	- Relative Indices
SAC	- Sustainability Assessment Criteria
SEDA	- Scottish Ecological Design Association
UK	- United Kingdom
VOC	- Volatile Organic Compounds
WCED	- World Commission on Environment and Development



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)