BUILDING MATERIAL SELECTION FRAMEWORK FOR TROPICAL CLIMATIC CONDITIONS: AN ECO-DESIGN BASED APPROACH

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Degree of Master of Science

Department of Civil Engineering

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DECLARATION

I declare that this is my own work and this thesis 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 the acknowledgement is made in the text.

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ABSTRACT

All over the world, sustainability has been given immense attention, thus novel state-of-the-art materials and building systems are emerging as alternatives. With those different alternatives, comparison and the selection of a better-performing material or a building system using diverse perspectives such as economic, ecological, social, and cultural are important to ensure the adaptation of the proposed research findings to the particular community. Even though many researchers introduced multiple material selection frameworks using economic and ecological parameters, a holistic approach including Social and Cultural adaptability of those selections has been overlooked in previous studies.

This study proposed an eco-design-based material selection approach that considers the individual and wholistic perspective of diverse themes including economic, ecological, social, and cultural. Several sub-themes are identified under each theme and are verified through expert surveys. The pairwise comparison of themes and sub-themes and analysis using the Analytical Hierarchy Process (AHP) leads to proposing weights for each theme and sub-theme and developing an eco-design-based material selection framework in ranking and choosing better-performing building materials. Accordingly, saving energy, reducing the overexploitation of natural resources, reducing energy emissions, and reducing construction, as well as operational cost, are the parameters that create a greater impact on the selection of sustainable material with the aid of eco-design.

Furthermore, the developed framework is validated by comparing an emerging walling material Cement Stabilized Earth Blocks (CSEB) with conventional materials such as Burnt Clay Bricks (BCB) and Cement Sand Blocks (CSB). Technique for Order Preference by Similarities to Ideal Solution (TOPSIS) had been carried out to compare and rank the respective walling materials under different scenarios. Accordingly, CSEB is concluded to be the best alternative when analyzed in the eco-design concept. Furthermore, individual analysis of ecological and economic themes shows that CSEB is the best material over the long run while BCB is said to be performing well socially and culturally.

The proposed framework could be highly beneficial for industry practitioners such as contractors, building developers, planners, and policymakers in choosing community-preferred, affordable, and environmental-friendly construction materials. Moreover, this piece of research could be improved with the inclusion of fuzzy numbers which enables consideration of uncertainty.

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LIST OF ABBREVIATIONS

SDG – Sustainable Development Goals

AP – Accredited Professionals

GBCSL – Green Building Council of Sri Lanka

IGBC – Indian Green Building Council

BREEAM - Building Research Establishment Environmental Assessment Method

LEED - Leadership in Energy and Environmental Design

RI – Relative Index

MCDM – Multi-Criteria Decision Making

AHP – Analytical Hierarchy Process

TOPSIS - Technique for Order Preference by Similarities to Ideal Solution

BCB – Burnt Clay Bricks

CSB – Cement Sand Blocks

CSEB - Cement Stabilized Earth Blocks