

A NON-LINEAR OPTIMIZATION MODEL FOR COST-EFFECTIVE AND SPACE-EFFICIENT ARCHITECTURAL LAYOUT DESIGN: A CASE STUDY OF A SINGLE-STORY RESIDENTIAL BUILDING

H.M.H.M.G.T.M. Herath* and W.B. Daundasekera

*Department of Mathematics, Faculty of Science, University of Peradeniya, Peradeniya,
Sri Lanka*

**thisarah98@gmail.com*

Reducing construction costs while optimizing usable space according to client's preferences is essential for achieving economical and functional building designs. Architectural layout design optimization (ALDO) addresses this challenge by refining building layouts to achieve an optimal balance between cost efficiency, functionality, and spatial usability while satisfying predefined constraints. This research focuses on optimizing a building layout by developing a Non-linear Optimization model. The objectives are to minimize total construction cost and maximize the usable area while adhering to dimensional constraints, such as width, length, and total area. The case study focuses on a residential building located in the Central Province, Sri Lanka. Construction costs are calculated using the Building Schedule of Rates (BSR) Central Province–2024, while dimensional constraints for rooms are based on the Planning and Development Regulations issued by the Minister of Urban Development and Housing (MUDH). Data and background information for the study were gathered through BSR, MUDH, literature review, and consultation with a building architect. The case study is conducted on a rectangular land with dimensions $18 \times 9 \text{ m}^2$ ($60 \times 30 \text{ feet}^2$). The formulated model is solved using Excel Solver and compared with the manual design; the optimized results demonstrate high flexibility, allowing adjustments to better meet client preferences while effectively addressing the objectives. Results were exhibited using 3D graphs in OriginPro, highlighting the impact of design weights on cost and usable area, and offering insights to support informed decisions by clients and stakeholders. The study assumes fixed material and labor rates based on BSR–2024, a uniform wall height of 3 meters, and a single-story residential layout with rectangular-shaped rooms. The limitations of the study are, excluding structural elements, aesthetic considerations, and multi-story design aspects. This study highlights the effectiveness of ALDO and suggests future work on multi-story layouts, structural and aesthetic integration, and the inclusion of additional design preferences.

Keywords: Architectural layout design optimization, Building layout, Constraints, Excel Solver, Non-linear optimization