Ain Shams University
Faculty of Engineering
Department of Structural Engineering

Developing A Decision Support System (DSS) to Select Optimal Structural System Using Value Engineering (VE) Analysis for Multi-Story Buildings

A THESIS
Submitted in Partial Fulfillment for the Requirements of the Degree of

DOCTOR OF PHILOSOPHY IN CIVIL ENGINEERING (STRUCTURAL)

Submitted by

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Master of Science in Civil Engineering
(Structural Engineering)
Faculty of Engineering, Ain Shams University, 2015

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Cairo, 2020

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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Doctor of Philosophy in Civil Engineering (Structural Engineering).

The work included in this thesis was carried out by the author in the Department of Structural Engineering, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis has been submitted for a degree or qualification at any other university or institution.

Name: Hosam Mostafa Mahmoud Eid Hegazy

Signature: *Hosam Elhegazy*

Date: **25 / 6 / 2020**

DEDICATION

Especially dedicated

To

Our Holy God

Who guide and never leave me in making this research

My Parents (Father and Mother)

Who will remain a great source of inspiration, support and always encourage me to believe in myself. Without them, i will not be able to succeed in my work

My Dear Brothers and Sisters

For giving me strength to overcome pressure while doing this thesis

To all of you who believed that i can finish the study despite of all the struggles, depression, and stress i experienced in the making of this thesis, I dedicate this work

Hosam Elhegazy

June 2020

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ABSTRACT

Different structural systems have been used for the construction of many multi-story buildings during the last number of decades. Because a large part of the government and private sector funding and time is spent on building projects in particular , it is important to plan how resources in the building industry can be used effectively. The design phase is the very first phase of a building project; preceding all other building activities, construction costs, the project schedule and the construction method have a profound impact. The choice of the best design alternative can save a lot. The optimal design should include the best balance between cost, performance and reliability and is determined by performing a value-engineering (VE) analysis.

Nowadays, VE considered a tool of construction management that can help companies to optimize time, cost and quality, to serve the client's needs. During the VE process, the designs are carefully evaluated to identify which will accomplish or even improve the basic function required and reduce the overall cost of the project without sacrificing quality or performance. Superstructure systems for multi-story buildings are the main topics to be covered in this thesis. The application of value techniques with respect to the construction industry will be utilized.

A parametric study was carried out including 54 multi-story building models (R.C and steel structure). Each model has its grid spacing, number of stories and structural system (gravity and lateral). The study covered grid spacing from 6.0 to 12.0m and the number of stories from a 5 to 50 stories. An ANNs model was proposed to produce extremely reliable construction cost estimates for eleven different datasets for the floor system of a multi-story buildings.

In this thesis, a simple computer model is designed and developed for recommending the optimal structural system for the construction of a multi-story building during the preliminary design stage. The VE team to achieve the VE goals mentioned above and help designers and decision makers in the contemporary structural engineering can use this model. In this research, integrates DSS into the QFD framework. This proposed approach enables designers to select the optimum structural system for multi-story buildings according to the KPIs towards customer satisfaction and conduct analytical investigations to facilitate decision-making in structural system for multi-story buildings. The conclusions presented in this research are based on the comprehensive body of work that supported by the review of scientific literature, quantitative analysis of selecting the optimal structural system using VE analysis for a multi-story building, qualitative analysis of expert opinions and these have been discussed in detail with case studies. The research outlines the essential information that architects and structural engineers need to choose the optimal structural system for multi-story buildings.

Keywords: *Value Engineering; Cost Estimation; Preliminary Design; Structural System; Decision-making; Multi-Story Buildings; Decision Support System; Analytical Model; Structural Optimization; Finite Element Model; MathWorks® MATLAB® Software; Knowledge-based system; Building materials and designs; Construction Management; Artificial Neural Networks; IBM® SPSS® Statistics 25; ETABS®; House of Quality; Quality Function Deployment; Key Factors; Questionnaire Survey; Relative Importance Index.*

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