VALUE ENGINEERING APPLICATION IN RESTORATION AND REHABILITATION OF HERITAGE BUILDINGS

By

Essam Mesbah Abou-Elfetouh

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
STRUCTURAL ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of

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Title of Thesis: **Value Engineering Application in Restoration and Rehabilitation of Heritage Buildings**

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Summary:

Heritage Buildings perform a pivotal and very important role in the history of the nation, culture and express the wealth of it. In order to expand life and increase the strength of heritage buildings, conservation is a very important process for future generations to keep knowledge about how humans lived in the past ages. Conservation of heritage buildings keep values of the countries cultural, Moreover, conservation enables heritage buildings to be given a second life and a profitable investment. Conservation of Heritage Building projects is considered the complex process that is associated with many factors that affect the decision of selecting restoration technique. A structured questionnaire was distributed among the experts in the field of Heritage Building conservation projects in order to determine the factors affecting the decision of restoration technique. A statistical analysis was carried out on the collected questionnaire to reach the importance and weights of each factor. In Heritage Building conservation projects, Value engineering (VE) is considered a fertile area for the implementation of multi-criteria decision making (MCDM) due to the existence of different alternative combinations that are studied by the decision maker to reach a satisfactory restoration technique. The research presents the development of Heritage Building Restoration Model (HBRM) that uses MCDM technique which assists Heritage Building owners to decide on the best restoration technique in order to conserve and adapt the reuse of their Heritage Buildings. The model implements Simo's procedure to determine the importance and weights of the factors that influence the decision of restoration and rehabilitation of Heritage Buildings. The Weighted-Sum decision making technique is applied on a case-study of Heritage Building conservation project in order to reach the final preferences, rank the alternative restoration techniques and consequently come-up with the most appropriate restoration technique. Sensitivity analysis is performed to determine the most critical factors of the key-list. Additionally, several scenarios are investigated to verify that the most important factor of the key-list does not necessarily be the most critical factor. A real-life Heritage Building conservation project was then considered to verify the developed HBRM model. The final decision of HBRM is tested against the experts' decision in that project. It was concluded that the final decision obtained from the proposed HBRM matches the one that was implemented in the real project.

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Abstract

Heritage Buildings perform a pivotal and very important role in the history of the nation, culture and express the wealth of it. In order to expand life and increase the strength of heritage buildings, conservation is a very important process for future generations to keep knowledge about how humans lived in the past ages. Conservation of heritage buildings keep values of the countries cultural, Moreover, conservation enables heritage buildings to be given a second life and a profitable investment. Conservation of Heritage Building projects is considered the complex process that is associated with many factors that affect the decision of selecting restoration technique. A structured questionnaire was distributed among the experts in the field of Heritage Building conservation projects in order to determine the factors affecting the decision of restoration technique. A statistical analysis was carried out on the collected questionnaire to reach the importance and weights of each factor.

In Heritage Building conservation projects, Value engineering (VE) is considered a fertile area for the implementation of multi-criteria decision making (MCDM) due to the existence of different alternative combinations that are studied by the decision maker to reach a satisfactory restoration technique. The research presents the development of Heritage Building Restoration Model (HBRM) that uses MCDM technique which assists Heritage Building owners to decide on the best restoration technique in order to conserve and adapt the reuse of their Heritage Buildings. The model implements Simo's procedure to determine the importance and weights of the factors that influence the decision of restoration and rehabilitation of Heritage Buildings. The Weighted-Sum decision making technique is applied on a case-study of Heritage Building conservation project in order to reach the final preferences, rank the alternative restoration techniques and consequently come-up with the most appropriate restoration technique.

Sensitivity analysis is performed to determine the most critical factors of the key-list. Additionally, several scenarios are investigated to verify that the most important factor of the key-list does not necessarily be the most critical factor.

A real-life Heritage Building conservation project was then considered to verify the developed HBRM model. The final decision of HBRM is tested against the experts' decision in that project. It was concluded that the final decision obtained from the proposed HBRM matches the one that was implemented in the real project.

Chapter 1

Introduction

1.1 General

Egypt has a very rich historical background which is evident from various buildings, pyramids, temples, landscapes, objects of the historic era. Fragrant narrates the history of the past more than a century but negligence is the master of the situation. In any country heritage buildings and monuments are the mute symbols of the country great history [Meli et. al, 2007] [1]. These buildings were designed with many different materials, structure and construction systems. The successive rapid development in modern life puts a pressure on the owners of these buildings as there is a need to reach best usage of the interior spaces which resulted in the conversion of the interior building designs from historical buildings to modern internal designs taking into consideration the historic authentic of the building and façade. The pressure appears in the restoration cost in the light of the economic return of the project.

Restoration of Heritage Buildings is a complex and very expensive process which consists of several steps; survey, diagnosis, safety evaluation, the choice of factors and techniques of interventions, and finally the controls .The most important one is to detect the state of the building according to its historical state which was built in the past and restores it back to its first state taking into consideration its heritage value. On the other side, value engineering is a well- organized process aimed to reduce the lifecycle cost as much as possible while achieving the best function. Because of the many factors affect the selection decision of the most suitable restoration technique, So Value engineering (VE) is considered a rich area for the implementation of Multi-Criteria Decision Making Techniques.

1.2 Problem Statement

Egypt has several heritage buildings that are distributed through the history passing through different eras, these building and monuments represent the religious, military, political or economic powers of the past. The current function and use of these Heritage buildings are mainly determined by their current state. Heritage Buildings that have no use or maintenance are deteriorating at a larger rate than the other buildings that are under operation which have greater chances of regular maintenance (Steinberg, 1996) [2]. It's very difficult to restore a heritage building to its original condition, especially if that building was left over the time without preservation or maintenance through its past life The fact that restoration and rehabilitation of heritage buildings while preserving architectural character archaeological are very challenging due to the difficulty to identify the most suitable restoration technique as well as the extent of new technologies, modern space programs and the investment in heritage buildings.

This fact emphasizes the need to optimize the restoration technique using value engineering concept, which could realize better usage of the heritage building and life extension with minimum restoration cost under the consideration of different factors affecting decision making.

1.3 Research Objectives

The main objective of this research is to provide a methodology for selecting the most suitable restoration technique while taking into consideration the different factors affecting the restoration of heritage buildings (HB), implementing value engineering (VE) and multi-criteria decision making (MCDM) technique to assist HB owners to decide on the best restoration technique. To achieve this main objective, the following sub-objectives are fulfilled:

- Defining the importance, objectives, principals, the different affecting factors, economic benefits of HB restoration and the application of VE and MCDM in projects.
- Getting the relative importance of the factors affecting the final decision making of selecting the most suitable restoration technique of HB.
- Developing a heritage building restoration model (HBRM) incorporating multi-criteria decision making tool to assist in ranking the different restoration techniques is.
- Testing and verifying the model (HBRM).
- Identifying the most critical factor.

1.4 Research Scope

The research scope is to study the alternatives and the implementation of Value Engineering in deciding on the most appropriate restoration technique that can be used in restoration and rehabilitation of HB projects using MCDM. This study as well can assist the owners, experts to decide on the most suitable restoration technique and evaluate their previous projects and restoration decisions that were taken before. However, the developed model is focusing on the most suitable alternative technique that can be used in restoration and rehabilitation of heritage building's structural elements.

1.5 Research Methodology

The methodology of this research is comprised of the following steps:

- A literature review on the restoration techniques of heritage buildings is carried out in order to develop a list of factors that should be considered in the decision making.
- A questionnaire of the identified factors is distributed among the experts in the field of Restoration of Heritage Buildings to determine the relative importance of each factor.
- A statistical analysis of the questionnaire results is carried out to determine the frequency index (FI) for the identified factors.
- Determining the weights for the different factors using Simos' procedure.