شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

HANAA ALY

VULNERABILITY BASED INFRASTRUCTURE FUND ALLOCATION OPTIMIZATION MODEL

By

Mohamed Ahmed Bahaa EL-Din Ahmed El-Khayat

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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Title of Thesis:

Vulnerability Based Infrastructure Fund Allocation Optimization Model

Key Words:
Optimization; Funding Decisions; Vulnerability; Deterioration Modeling; Infrastructure Rehabilitation.

Summary:

Infrastructure bills are in permanent increase due to the continuous deterioration with time, and the presence of a gap between the infrastructure rehabilitation needs and the available fund. Accordingly, a fund allocation model became necessary to be created to face this everlasting problem. Many budget allocation models were created, but all these efforts failed to face the fast deterioration rates for infrastructure assets due to neglecting the effect of some factors that accelerate the deterioration rates beyond the expected. The research purpose is to develop a new fund allocation optimization model which maximizes the assets overall physical conditions and with the presence of funding constrains taking in consideration the effect of normal deterioration rates and the vulnerability factors effect by using Markov Chains stochastic deterioration modeling.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Mohamed Ahmed Bahaa EL-Din Ahmed Date: / /2021

Signature:

Dedication

To My Mother & Father

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Foremost, I would like to express my sincere gratitude to my supervisors Dr. Prof. Hesham Osman, and Dr. Dina Atef Saad, for their valuable supervision, continuous support, and guidance throughout all stages of my MSc. thesis progress. Their academic and technical experience directed me to make the current thesis achievable, which made me very thankful to them. I would also like to gratefully thank all the participated interviewees for their valuable time providing me with the relevant information and necessary data required to build the thesis model.

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Table of Contents

List of Tables

List of Figures

Abstract

Infrastructure assets are one of the essential assets in any community for its sustainability and livability. Like any asset, infrastructure ones deteriorate with time, thus their bills are in continuous increase. Due to the massive needs for many assets to be intervened after deterioration with the presence of budget constraints, decision makers may take many rehabilitation decisions that may be effective and maybe not. Many efforts were made in order to help those who take the rehabilitation decisions to select the best and effective assets to be rehabilitated, however, most of these decisions weren't effective because most of these efforts didn't consider the fast deterioration of infrastructure assets due to its vulnerability to external factors. Accordingly, a fund-allocation optimization model that maximizes the physical performance of infrastructure, while considering budget constraints and infrastructure vulnerability factors using stochastic modeling is proposed in this research. Before developing the model, the vulnerability factors were previously selected knowing the degree of influence for each one, after that model will calculate the vulnerability index for each asset as differs from an asset to another. The vulnerability index is then used in the stochastic deterioration model using Makrov chain in order to develop the yearly expected condition index for each asset under the vulnerability effect. To measure the performance of the model, it is applied to a road network as one type of infrastructure. Thus, the unexpected factors that accelerates road deterioration by increasing its vulnerability were captured using this study, including excessive traffic loading, neighboring disturbance, climate change, etc. Applying the model and comparing it against the existing models, results demonstrated rationality behind the generated funding decisions using the proposed model, and the cumbersome consequences of ignoring vulnerability. Thus, the model can help policymakers make realistic funding decisions to maintain infrastructure performance.