شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

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CASE STUDY FOR HEURISTIC MODEL ANALYSIS USING FUZZY LOGIC TO SOLVE UNCERTAINTY IN RISK MANAGEMENT

By

WALID ABDALLAH ELSAYED MOUSA

A THESIS SUBMITTED TO THE
FACULTY OF ENGINEERING AT CAIRO UNIVERSITY
IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
INTERDISCIPLINARY - MASTER OF SCIENCE
IN
RISK ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
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CASE STUDY FOR HEURISTIC MODEL ANALYSIS USING FUZZY LOGIC TO SOLVE UNCERTAINTY IN RISK MANAGEMENT

Key Words:
Risk Management; Uncertainty; QRA; Heuristic Model; Fuzzy Logic

Summary:

A heuristic model using fuzzy simulator present on MATLAB software was designed to solve part of the uncertainty fuzzy nature and was tailored to handle aspects influencing the decision-making process in Risk Management. This model has been tested using the results of a case study in published World Applied Programming Journal for a gas transport at an island in the Gulf which applied fuzzy logic technique. Test results revealed that the uncertainty generated from the Model was sensitive to μ and σ of the original data, a finding which was not mentioned in the published work. This test confirmed that uncertainty is sensitive to different parameters such as μ and σ. Overall, The developed Heuristic Model's results are more accurate than traditional QRA tools.

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.

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Acknowledgement

Foremost, I would like to express my sincere gratitude to my advisors Dr. Tarek Abd-Al Hamed, Dr. Mohamed Taha and Dr. Yasser El-Shayeb for continuous support of my Master study and research, for their patience, motivation, enthusiasm, and immense knowledge. their guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better advisors and mentors for my master study.

Besides my advisors, I would like to thank Prof. Dr. Fouad Khalaf for his encouragement, insightful comments, and hard questions in addition to his motivated initiations and building creativity learning environment for me and Risk engineering team.

I thank my fellows in Risk Engineering master, for the stimulating discussions.

Last but not the least; I would like to thank my colleges in works and my family supporting me spiritually throughout my life.

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Abstract

At process industries, the hazards and risks associated to many processes and has important impact on business performance, the decision-making process is required to mitigate the risks with additional fund for resources and sometimes has significant impact on project's budget.

The main challenge for decision makers and risk analysts that the data which representing hazards or risks associated with uncertainties data resulted from the different stages of risk assessment process. Several efforts conducted in this area to identify the type of uncertainties and try to treat it and get optimum decisions.

Fuzzy logic theory used as AI (Artificial intelligent methods) to overcome some of uncertainty data and easily can be applied on risk management process.

This thesis examines the effectiveness of establishing heuristic model using fuzzy logic approach in QRA (Quantitative Risk Assessment) process. Thesis's works started with validation the results of risk assessment for a case study using fuzzy approach's; The validation process revealed some important factors that affect the risk assessment results accuracy such as the dimension of the risk assessment matrix, mean and standard deviation for likelihood and severity curves representatives. Based on literature review and validation's results, A Heuristic model was developed to be used in different areas with different conditions that treat some of uncertainty data types and get precise results from risk assessment process, such results support decision makers to rank risks then prioritize the mitigation control actions.

Chapter 1: Introduction

1.1. Statement of the Research Problem and Objective

At process industries, the decision-making process for hazards and risk mitigation are very important due to the consequences of undesired events that negatively impacts people, assets, environment and business performance …. etc. The problem is part of data used in risk assessment is uncertain and it is difficult to recognize. Consequently, the outcome of risk assessment is become not accurate and often not convincing the decision makers.

The Thesis's Objective is focus on developing an Effective Heuristic Model using Fuzzy Logic that treat some types of uncertain data in Quantitative Risk Assessment (QRA) stages. Although, Quantitative risk assessment is one of the most integrated tools which combined qualitative and quantitative methods to evaluate the risks in the form of numbers that can be measured, but this traditional method is not solving the problem of uncertainty data. Many researches utilize artificial intelligent (AI) methods to overcome part of the uncertainty data such as fuzzy logic theory and applied it on risk assessment categories, as fuzzy logic method used to treat some types of uncertainty such as linguistic uncertainty type.
This thesis examines the effectiveness of using the fuzzy logic in QRA tool by validating the results of a case study; Gas transport at islands in the Gulf. Then developing a heuristic model on MATLAB simulator using the fuzzy module to be used in different areas or conditions.

1.2. Rationale

The importance of this study is to evaluate and validate using the fuzzy logic approach which applied on QRA and how it can affect the risk management and decision-making. From literature review; the previous literatures done by risk analysts or international organizations are not validating the results of fuzzy approach, also evaluating the impact of heuristic model when applied in different area on risk categories, the previous literatures work on the differentiation between the traditional methods and fuzzy approach results in QRA process.
Therefore, this study is an opportunity to develop and evaluate the heuristic model aspects that will lead to improve Heuristic Model and solve a part of the uncertainty data, also providing a user-friendly initiating software applicable for any industry.

1.3. Methodology

This research outline ordered as following as shown in (Figure 1.1):
In chapter 1, Introduction about the use of quantitative risk assessment and industrial process also the problems that associated the risk assessment process due to the uncertainty data. Then clarifying the objective of the thesis is to develop a heuristic model to treat some of uncertainty types.
Chapter 2 Defining the system component to establish the heuristic model in risk assessment. The system consists of decision-making theories and models, then defining the heuristic process and the quantitative risk assessment process.