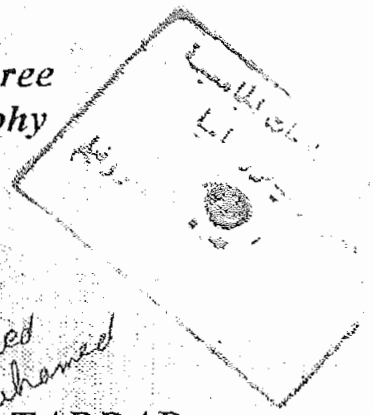
RECENT METHODS IN SOLVING MULTICRITERIA DECISION MAKING PROBLEMS

Thesis
Submitted for the Degree
of Doctor of Philosophy

In
Pure Mathematics



By

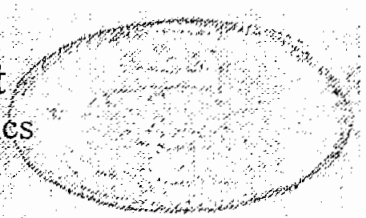
MONA MOHAMED M. M. TARRAD
Department of Mathematics,
University College for Women,
Ain Shams University

Supervised By

Prof.Dr.
Mohamed S.A. Osman
Prof. of Pure Math. and Operations Research,
Head of Basic Sciences Department
Higher Technological Institute,
Tenth of Ramadan City, EGYPT.

Prof.Dr.
Soraya A. Sherif
Prof. of Pure Mathematics
University College for Women,
Ain Shams University, Cairo
EGYPT

Dr. Elsayed A.M. Eltelt
Assistant Prof. of Pure Mathematics
MTC. Cairo, Egypt.
Ain Shams University



1995

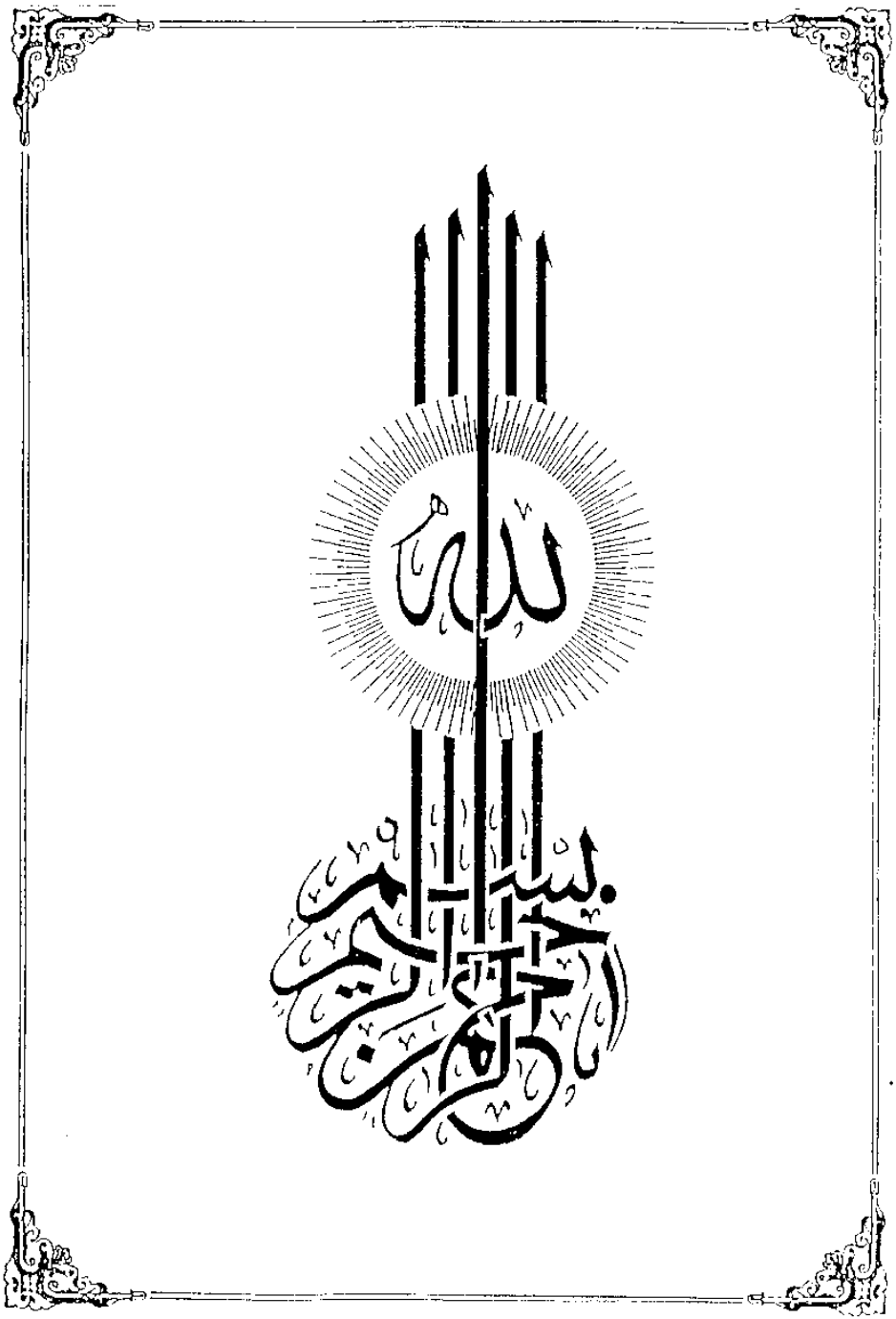
بسم الله الرحمن الرحيم

وقل ربِّ زدني علماً

صدق الله العظيم

سورة طه

من آيه رقم ١١٤



Ain Shams University
University College for Women
Mathematics Department

Ph.D. Thesis (Pure Mathematics)

Title of Thesis:

RECENT METHODS IN SOLVING MULTICRITERIA DECISION MAKING PROBLEMS.

Thesis Supervisors:

1- Prof. Dr.: **Mohamed Sayed Ali Osman**
Prof. of Pure Math, and Operations Research,
Head of Basic Sciences Department,
Higher Technological Institute,
Tenth of Ramadan City, EGYPT.

2- Prof. Dr.: **Soraya Abd El-Halim Sherif**
Prof. of Pure Math.
Univeristy College for Women
Ain Shams University

3- Dr. : **Elsayed A. M. Eltelt**
Assistant Prof. of Pure Math. MTC, Cairo,
Egypt

Head of Mathematics Department

(Prof. Dr. Farouk Ayoub)

THE EXAMINING COMMITTEE

.Prof. Dr. Abdel Razik A. Abou El Nour,
'rof. of Systems Enginering, Faculty of Engineering, Zagazig Jniversity, Egypt.

?- Prof. Dr. Abou-Zaid Hamouda El- Banna
?rof. of Pure Mathematics,Faculty. of Science,Tanta University, Tanta, Egypt.

3- Prof. Dr. Mohamed Said Ali Osman
Prof. Dr.of Pure Mathematics, Head of Department of Basic Sciences, Higher Technological Institute, Tenth of Ramadan city, Egypt.

4- Prof.Dr Soraya Abd El-Halim Sherif,
Prof. Of Pure Mathematics, University College for Women, Ain Shams University, Egypt.

CURRICULUM VITAL

Name	: **Mona Mohamed M. M. Tarrad**
Date of Birth	: **24/1/1957**
Locality	: **Cairo**
Nationality	: **Egyptian**
Qualifications	: **1) B.Sc. degree in (Mathematics) 1979 with grade "Excellent" from College for Women, Ain Shams University.**
	: **2) M.Sc. degree in Pure Mathematics, 1985. College for Women, Ain Shams University**
Experience	: **Demonestrator (15/12/1979) and then Assistant Lecturer at Department of Mathematics (15/1/1986), University College for Women, Ain Shams University**

Head of Mathematics Department

F. Ayoub

(Prof. Dr. Farouk Ayoub)

ACKNOWLEDGEMENT

I would like to express my deepest gratitude and thanks to ***Prof. Dr. M. S. A. Osman***, Professor of Pure Mathematics and Operations Research and Head of Department of Basic sciences higher Technological Institute, Tenth of Ramadan City for suggesting the problems, his continuous help and active discussions throughout the developement of this thesis. His kind supervision has been most helpful at all stages.

My sincere thanks are also due to ***Prof. Dr. Soraya Sherif***, Professor of Pure Mathematics, University College for Women, Ain Shams University for her encouragement and her kind help.

I must acknowledge also ***Dr. Elsayed A. H. Eltelt***, Assistant Prof. of Pure Mathematics MTC, Cairo, Egypt, for revising the manuscript of this thesis, and for helpful suggestions.

Mona Mohamed M.M. Tarrad

ABBREVIATIONS AND NOTATIONS

M-CDMP = Multi -Criterion Decision Making Problem.
VOA = Vector Optimization Approach.
GPA = Goal Programming Approach.
DIA= Decision Interactive Approach.
VOP = Vector Optimization Problem.
GTN = Generalized Tchebycheff Norm.
(P_T) = Augmented weighted Tchebycheff Program.
GPP = Goal Programming Problem.
GP = Goal Programming.
MDP= Multiobjective Decision Problem.
DR = Decision Rule
DM = Decision Maker.
SWT =Surrogate Worth Trade - off.
KTCN= Kuhn -Tucker Conditions For Noninforiority.
KTSCN= Kuhn -Tucker Saddle Point Conditins For Noninforiority.
M-ONLPP = Multi-Objectives Nonlinear Programming Problems.
GDF = Dyer, Geoffrion and Feinberg.
MOMD = Multi-Objective Mathematical Programming
DV = Decision Variable.
S = Feasible Set.
OS = Objective Space
DS = Decision Space.
U = Utility Function.
Q = Pairwise Preference Criteria.
QL = Least - Preferred Alternative.
QM = Most - Preferred Alternative
Uqv = Quasiconcave Utility Function
Uqx = Quasiconvex Utility Function.
AR = Relaxed Assumptions
$(IM\text{-}ONLPP)_C$ = Interactive Approach For Solving Multi-objective Nonlinear Programming Problems Combined.

$(IM\text{-}ONLPP)_u$ = Interactive Approach For Solving Mukltiobjective Nonlinear Programming Problems Unified.

IGGPP = Interactive Generalized Goal Programming Problem.

IEM = Interactive Efficient Method.

IM-ONLPP = Interactive Multiobjective Nonlinear Programming Problems.

LLP = Linear Programming Problem.

NLPP= Nonlinear Programming Problem.

FVOP = Vector Optimization Problems With Fuzzy Parameters.

FGGPP = Generalized Goal Programming Problems With Fuzzy Parameters.

α - VOP= Nonfuzzy Vector Optimization Problem.

α-GGPP= Non fuzzy Generalized Goal Programming problem.

LP= Linear Programming

MOPP= Multiobjective Programming Problem.

CPP= Convex Programming Problem

NLP= Nonlinear Programming

KTSP= Kuhn-Tucker Saddle Point

GGPP= Generalized Goal Programming Problem

ABSTRACT

This work aims to give a comprehensive study in recent methods for solving multicriteria decision making problems (M-CDMP). Also a new method to determine the stability set of the first kind has been introduced for M-CDMP without differentiability.

The author presents two interactive algorithms for solving multi-objective nonlinear programming problems. She makes also a comparative study between them and an interactive algorithm for solving generalized goal programming problem.

The researcher presents two interactive algorithms for solving M-CDMP under fuzzy environment in both vector optimization problems and goal programming problems.

The author presents method for determining the stability set of the first kind for M-ONLPP without differentiability. This method depends on the procedure for solving the problem.

INTRODUCTION

Multiple criteria decision making (M-CDMP) is concerned with methods and procedures by which multiple criteria can be formally incorporated into the analytical process.

The (M-CDMP) elicits in wide variety of problems, such as vector maximization, goal programming, group decision problems (with several criteria), multi - attribute problems, and utility and theory of measurements.

Vector optimization problems (VOP), or multiobjective optimization problems are one main branch of mathematical optimization. (VOP) appear when a decision maker must take a decision satisfying the optimization of more than one conflicting objectives.

Stability analysis in multiobjective nonlinear programming has been extensively investigated from the qualitative point of view. The stability notions are the sets of parameters that retain specific features for the optimal solutions of the multiobjective nonlinear programming problems.

This thesis consists of six chapters for a characterization and further investigation of the solution of multicriteria decision making problems (M-CDMP).

Chapter 1 is a survey on some approaches for treating multiciteria decision making (M-CDMP) problems.

In Chapter 2, the author presents interactive algorithms for solving multiobjective nonlinear programming (M-ONLP) problems. She presents an interactive method for solving general nonlinear multiple objective optimization problems (NLMOOP) to get the best compromise solution in situations

B 6/11 H. 02

with an implicitly defined utility functions which are quasiconcave. She presents also an interactive method for solving multiobjective nonlinear programming problems (M-ONLPP) she uses a combined Tchebycheff and aspiration criterion vector techniques.

In Chapter 3, the author presents an interactive algorithm for solving Generalized Goal Programming (GGPP) problems by using visual interactive method. And she presents also a comparative study between the algorithms and solve an illustrative example by the three methods respectively.

In Chapter 4, the author presents interactive algorithms for solving (M-CDMP) problems under fuzzy environment in both (VOP) problems and (GPP) problems. By using a combined Tchebycheff and Aspiration criterion methods for VOP and visual interactive methods for GPP.

In Chapter 5, the researcher presents a method for determining the stability set of the first kind for multiobjective nonlinear programming problems without differentiability. She uses several examples with parameters in the objective functions or in the constraint functions to clarify the method.

Chapter 6 contains the conclusions of this thesis and the recommendations for further research in this field.

CONTENTS