FACULTY OF ENGINEERING AND INFORMATION TECHNOLOGY

Multilevel Decision Making for Supply Chain Management

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CERTIFICATE OF AUTHORSHIP/ORIGINALITY

This thesis is the result of a research candidature conducted jointly with another University as part of a collaborative Doctoral degree. I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as part of the collaborative doctoral degree and/or fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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ABSTRACT

Multilevel decision-making techniques aim to handle decentralized decision problems that feature multiple decision entities distributed throughout a hierarchical organization. Decision entities at the upper level and the lower level are respectively termed the *leader* and the *follower*. Three challenges have appeared in the current developments in multilevel decision-making: (1) large-scale - multilevel decision problems become large-scale owing to high-dimensional decision variables; (2) uncertainty - uncertain information makes related decision parameters and conditions imprecisely or ambiguously known to decision entities; (3) diversification - multiple decision entities that have a variety of relationships with one another may exist at each decision level. However, existing decision models or solution approaches cannot completely and effectively handle these large-scale, uncertain and diversified multilevel decision problems.

To overcome these three challenges, this thesis addresses theoretical techniques for handling three categories of unsolved multilevel decision problems and applies the proposed techniques to deal with real-world problems in supply chain management (SCM). First, the thesis presents a heuristics-based particle swarm optimization (PSO) algorithm for solving large-scale nonlinear bi-level decision problems and then extends the bi-level PSO algorithm to solve tri-level decision problems. Second, based on a commonly used fuzzy number ranking method, the thesis develops a compromise-based PSO algorithm for solving fuzzy nonlinear bi-level decision problems. Third, to handle tri-level decision problems with multiple followers at the middle and bottom levels, the thesis provides different tri-level multi-follower (TLMF) decision models to describe various relationships between multiple followers and

develops a TLMF *K*th-Best algorithm; moreover, an evaluation method based on fuzzy programming is proposed to assess the satisfaction of decision entities towards the obtained solution. Lastly, these proposed multilevel decision-making techniques are applied to handle decentralized production and inventory operational problems in SCM.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES