Title: A Framework for Multi-Stakeholder Decision-Making and Conflict Resolution

Author: Alexander W. Dowling Gerardo Ruiz-Mercado Victor M. Zavala

PII: S0098-1354(16)30096-5
DOI: http://dx.doi.org/doi:10.1016/j.compchemeng.2016.03.034
Reference: CACE 5418

To appear in: *Computers and Chemical Engineering*

Received date: 18-2-2016
Revised date: 23-3-2016
Accepted date: 30-3-2016

Please cite this article as: Alexander W. Dowling, Gerardo Ruiz-Mercado, Victor M. Zavala, A Framework for Multi-Stakeholder Decision-Making and Conflict Resolution, *<![CDATA[Computers and Chemical Engineering]]>* (2016), http://dx.doi.org/10.1016/j.compchemeng.2016.03.034

A Framework for Multi-Stakeholder Decision-Making and Conflict Resolution

Alexander W. Dowling¶, Gerardo Ruiz-Mercado†, and Victor M. Zavala¶

¶ Department of Chemical and Biological Engineering
University of Wisconsin, 1415 Engineering Dr, Madison, WI 53706, USA

†Office of Research and Development, National Risk Management Research Laboratory
U.S. Environmental Protection Agency, 26 West Martin Luther King Drive, Cincinnati, Ohio 45268, USA

Abstract

We propose a decision-making framework to compute compromise solutions that balance conflicting priorities of multiple stakeholders on multiple objectives. In our setting, we shape the stakeholder dissatisfaction distribution by solving a conditional-value-at-risk (CVaR) minimization problem. The CVaR problem is parameterized by a probability level that shapes the tail of the dissatisfaction distribution. The proposed approach allows us to compute a family of compromise solutions and generalizes multi-stakeholder settings previously proposed in the literature that minimize average and worst-case dissatisfactions. We use the concept of the CVaR norm to give a geometric interpretation to this problem and use the properties of this norm to prove that the CVaR minimization problem yields Pareto optimal solutions for any choice of the probability level. We discuss a broad range of potential applications of the framework that involve complex decision-making processes. We demonstrate the developments using a biowaste facility location case study in which we seek to balance stakeholder priorities on transportation, safety, water quality, and capital costs.

Keywords: multi-stakeholder, multiobjective, optimization, Pareto optimality, compromise, conditional value-at-risk.

1 Introduction

The design and control of engineering systems is a complex decision-making process in which multiple conflicting objectives of social, economic, and environmental nature must be taken into account. Multiobjective optimization techniques have been applied to many domains in chemical engineering which include separations [37, 55], crystallization [58], chromatography [73, 45, 36], control system tuning [28], and chemical reactors [59, 66, 41, 56, 44, 7, 31]. In such settings engineers seek to understand the trade-offs in technology performance metrics such as purity, recovery, operating cost, and yield. There has also been interest in balancing economic and environmental metrics using life cycle assessment methods to integrate process and enterprise-wide