Computers & Industrial Engineering 76 (2014) 307–317

Contents lists available at ScienceDirect

Computers & Industrial Engineering

journal homepage: www.elsevier.com/locate/caie

Even easier multi-issue negotiation through Modified Even-Swaps considering practically dominated alternatives ☆

Koray Altun *,[1], Turkay Dereli

Department of Industrial Engineering, Gaziantep University, 27310 Gaziantep, Turkey

ARTICLE INFO

Article history:
Received 30 December 2013
Received in revised form 19 July 2014
Accepted 20 August 2014
Available online 3 September 2014

Keywords:
Modified Even-Swaps
Multi-issue negotiation
Practical dominance concept

ABSTRACT

"Modified Even-Swaps" is a mechanism recently developed for multi-issue negotiation, which is highly complicated to realize and therefore more dependent to sophisticated information and communication technologies (ICTs) when compared to single-issue (price-only) negotiation. This mechanism is based on a modified version of Even-Swaps method finding differences among alternatives in terms of negotiable issues and then making use of those differences to assess value of multi-issue offers. A fuzzy-inference system supports this mechanism for bargaining on several issues simultaneously as well. Number of trade-offs performed significantly influences routines of the Modified Even-Swaps mechanism. In this study, a novel approach providing practical dominance reinforcement is introduced to accelerate the mechanism through eliminating unnecessary trade-offs. This approach proposes to use of "Simple Additive Weighting" (SAW) method in order to combine issues which have high variation among consequences of alternatives under consideration. As a result, these issues utilize a combined consequence for each alternative. Phase of the mechanism aiming to identify dominated alternatives is executed by using revised decision-matrix including consequences of issues having high variation as combined. This revision allows the mechanism to identify dominated alternatives more practically. Possible improvements are demonstrated and discussed with some cases in this study.

1. Introduction

"Even-Swaps" is a multi-criteria decision making method known as rational and easy-to-use trade-off methodology. Hammond, Keeney, and Raiffa (1998) developed this method by following a kernel idea in a letter written in 1772 by Benjamin Franklin to Joseph Priestly (Franklin, 1956). In context of this method, the term "even" has a meaning of "equivalence" and the term "swap" represents "exchange" (Li & Ma, 2008). This method is based on even-swaps operations. In this method, trade-offs are performed by even-swaps, hypothetically changing consequence of an alternative in an issue and compensating this change with a preferentially equal consequence change in another issue (Elahi & Yu, 2012; Mustajoki & Hamalainen, 2005).

These even-swaps enable decision makers to think about issue weights implicitly by representing value of an issue in terms of another one. Basically, these even-swaps aim to make issues "irrelevant" and to make alternatives "dominated". If an issue has equal consequence for each alternative, it is said that this issue is an "irrelevant issue". Such an issue can be ignored since it does not make a sense on the decision made for specification of the most preferred alternative. If an alternative is worse than any another alternative on some issues and not better than on all other issues, it is said that this alternative is a "dominated alternative". Such an alternative can be ruled out as well since it has disadvantages without providing any advantage over others. The method tries to reach to the most preferred alternative through even-swaps aiming at each phase to create irrelevant issues and dominated alternatives until one alternative, i.e. the most preferred one remains in the ultimate decision-matrix.

Multi-issue negotiation can be defined as a negotiation process aiming to reach a mutual agreement between parties by considering more than one negotiable issue all at once. Multi-issue negotiation can be accomplished through a well-defined agreement area in order to perform main negotiation activities such as evaluation of multi dimensional offers appropriately and generation of counter-offers rationally. Even-Swaps method allows finding difference among alternatives in terms of any issue. This feature can be really helpful to clarify agreement area in a multi-issue negotiation

☆ This manuscript was processed by Area Editor Mitsuo Gen.

* Corresponding author. Tel.: +90 (342) 317 2621; fax: +90 (342) 360 4383.
E-mail addresses: kaltun@gantep.edu.tr, koray.altun@yandex.com (K. Altun).

[1] This paper is an extension of a preliminary version presented in *CIE43*: *The 43rd International Conference on Computers & Industrial Engineering*, 16–18 October, Hong Kong, 2013.

http://dx.doi.org/10.1016/j.cie.2014.08.015
0360-8352/

environment. However, existing version of Even-Swaps method has a rigid structure trying to reveal only the best alternative. Other than this useful feature, Even-Swaps method performs trade-offs by generating hypothetical questions to decision maker. These questions can be transformed to automated negotiation messages through some modifications. With these features of this method in mind, we proposed an automated multi-issue negotiation mechanism, namely; "Modified Even-Swaps" in one of our previous studies (Dereli & Altun, 2012). Instead determination of the most preferred alternative only, modified structure of the Even-Swaps method provides a pool of negotiable alternatives that negotiator will decide which one is the best in a negotiation environment. Modified Even-Swaps mechanism can intrinsically improve the total utility by raising win–win solutions as a result of rational multi-issue negotiation process.

Performance of the Modified Even-Swaps mechanism depends significantly on the number of trade-offs performed. It can be said that performing trade-offs by even-swaps provides more reliable reasoning in decision making when compared to methods based on explicitly weighting. Because assigning a weight for issues under consideration may not be suitable or possible to reflect decision makers' judgments straightforwardly. Some kind of trade-offs (e.g. design trade-offs) are generally tacit and therefore they are generally hard to articulate, capture and disseminate. Besides, performing trade-offs by even-swaps enables decision makers/negotiators to play active role and to make their reasonings when required. In such an environment, decision makers/negotiators can make more robust reasoning because they make their reasonings in an iterative way rather than at the beginning solely as in many multi-criteria decision making methods. Corresponding reasonings can be better extracted when decision makers/negotiators see the effects of their reasonings in updated decision-matrix in other words when they come closer to the final solution. Although even-swaps enable decision makers /negotiators to make more robust reasonings, they become unreasonable when the decision-matrix includes lots of alternatives and decision issues. In those cases, other methods above-mentioned seems more practical although even-swaps provide more robust trade-offs. Although performing even-swaps provides more robust reasonings as a result of its special structure that is iterative and not requires explicit weightings, it does not seem practical reasonably when decision-matrix includes high variation among consequences.

There is a trade-off between "robustness of trade-offs performed" and "being practical". This study aims to strike a happy medium between them. We therefore propose a hybrid approach to make even-swaps more practical in this study. This approach adapts a simple multi-criteria decision making method, namely; "Simple Additive Weighting" (SAW) method (also known as "weighted linear combination method" or "scoring method") for issues which have high variation among their consequences. By using SAW method, a combined consequence of the issues having high variation is obtained for each alternative. Decision-matrix is revised by taking these combined consequences into account. Phase of the mechanism which aims to identify dominated alternatives is executed by using revised decision-matrix including consequences of the issues having high variation as combined. This revision enables decision makers /negotiators to identify dominated alternatives more practically.

The reminder of this study is organized as follows. Section 2 gives a comprehensive review on Even-Swaps applications and theoretical contributions to Even-Swaps. Section 3 discusses procedure of the Modified Even-Swaps mechanism. The proposed approach is presented in Section 4. Conclusions are given in the final section.

2. Literature review

2.1. Applications of Even-Swaps

Diverse applications of Even-Swaps method are available in the literature. Kajanus, Ahola, Kurtilla, and Pesonen (2001) utilized Even-Swaps method while strategy selection in a rural enterprise. Kangas, Kangas, and Kurtilla (2008) used it while supporting decisions on forest management. Luo (2008) and Luo and Cheng (2006) applied while analysing the resignation decisions of eleven nurses who have experience with the care of SARS patients. Even-Swaps method was also utilized while selecting an Unmanned Aerial Surveillance and Target Acquisition System (UASTAS) (Hurley & Andrews, 2003). It was especially preferred in this selection process due to its characteristic that most intelligent decision makers can easily understand it. Gregory and Wellman (2001) used it on environmental planning for simplification a policy choice by making sequential trade-offs between pairs of objectives to establish equivalences on one dimension (to make an irrelevant dimension). Baykasoglu, Dereli, and Altun (2011) applied Even-Swaps method while making decision on buying used-trucks. Wakshull (2002) demonstrated the useful application of Even-Swaps to project risk management. Elahi and Yu (2009) used Even-Swaps in security requirements engineering. They adapted Even-Swaps method to incorporate the consequences of the mistrust condition for the trust trade-off analysis. Keser (2005) developed an interactive approach for multi-criteria sorting problems. Even-Swaps method was utilized in this approach for both making an estimation of the underlying utility function and generating possible dominance among the alternatives under consideration. Wachowicz (2010) proposed the use of Even-Swaps method for eliciting preferences of negotiator in the pre-negotiation phase. Geslin (2006) also used the Even-Swaps method in pre-negotiation phase in collaborative engineering design.

Therewithal some studies highlight the importance and usefulness of the Even-Swaps method as well. Kask, Kline, and Lamoureux (2011) find useful Even-Swaps method in modelling tourist and community decision making for especially communities with limited expertise. Gregory and Keeney (2002) addressed importance of Even-Swaps method for making smarter environmental management decisions. The importance of Even-Swaps was also addressed while making sense of site selection by Augustin (1999). Dolan (2010) discussed advantages and potential problems of using Even-Swaps method in multi-criteria clinical decision support to promote evidence-based, patient-centred healthcare.

2.2. Theoretical contributions to Even-Swaps

Despite the fact that Even-Swaps method provides some useful features to decision makers, it also has some inadequacies. Li and Ma (2008) reported these inadequacies item by item as follows:

- Only the most preferred alternative is found. In an actual decision environment, decision maker may also want to know the second or the third preferred alternative.
- Some trade-offs of criteria values, as specified by the decision maker, may not be consistent with each other. Current methods have no mechanism to check the consistency of these trade-offs.
- The similarities among alternatives are not taken into account. Actually, the decision maker does not only want to know what the best option is but also the differences (or similarities) among alternatives.