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An Iterative Transient Rank Aggregation Technique for Mitigation of Rank Reversal

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ABSTRACT

With the advent of decision science, significant elucidation has been sought in the literature of multi criteria decision making. Often, it is observed that for the same MCDM problem, different methods fetch way-apart ranks and the phenomenon leads to rank reversal. To alleviate this problem, different methodologies like the Borda rule, the Copeland method, the Condorcet method, the statistical Thurstone scaling, and linear programming methods are readily available in the literature. In connection with the same, the authors proposed a novel technique to aggregate the ranks laid by different methods. The algorithm initially assigns equal weights to the methods involved to avoid biasness to a particular method and a simple average rank was obtained. Then, after the separation measures of individual methods with respect to average rank were calculated. Considering the separation measure the higher the weightage, the dynamic weights are ascertained to declare the weighted aggregate rank subjected to the terminal condition which include whether the previous rank equals to the current rank or not. To substantiate the proposed algorithm, a materials selection problem was taken into consideration and solved with the proposed technique. Moreover, the same problem was solved by existing voting techniques like the Borda and the Copeland-Condoract methods. The authors found a correlation of more than 85% between the proposed and existing methodologies.

KEYWORDS

Dynamic Weights, Iteration, Rank Aggregation, Rank Reversal, Separation Measure

INTRODUCTION

During past decades, multiple criteria decision-making (MCDM) has advocated itself as a vital strategy for decision support systems which essentially require numerous alternatives, to deem their aptness subjected to a set of attributes as revealed by Yue (2011), Hwang and Yoon (1981) and Zeleny (1982). Multi-Criteria Decision Making methods like, TOPSIS, VIKOR, SAW, MOORA, PSI, COPRAS, ELECTRE, EVAMIX, EXPROM, MAUT, QFD, UTA, OCRA, MCDM-BOD, etc. have been successfully engaged to explain Multi criteria choice problem for diverse engineering application. The usage of above mentioned methods are authenticated with exclusive logical and mathematical algorithms which made them yardstick in the arena of decision support system. But no existence proof guideline is still present in the literature to opt for the most appropriate decision-making method as adopted by Cicek and Celik (2010). It has also been reported by Yeh (2002) that, different MCDM

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methods generate different ranks for a set of alternatives and leads to rank reversal. Voogd (1983) discovered that there seems to be a minimum of 40% probability of divergence of rank acquired by one method with respect to the others. Furthermore, Hajkowicz & Collins K. (2007) affirmed the non-existence of any rule in implementing a particular technique which is essentially superior to others. To dispose of this paucity, researchers have recommended implementing a number of MCDM methods concurrently as a substitute to judge the feasibility by mapping the decisions fetched by the different methods as discussed by Hwang and Lin (1987). Bairagi et al. (2014) & (2015) also encountered the problem of rank reversal while selecting the robots which certainly questions the suitability of their approached fuzzy MCDM techniques. Rao and Padmanabhan (2006) and Agrawal et al. (1991) encountered rank reversal problem during Industrial robot selection. Even in material selection problems, contradictory ranking order problem has been sought in the investigations by Rao and Patel (2010), Manshadi et al. (2007) and Chatterjee et al. (2009). To mitigate these problems, concepts of averaging function for integration of ranks achieved by different MCDM techniques was initiated by Ataei (2010). Moreover, to alleviate this requirement, BORDA and COPELAND voting rules are comparatively more prevalent. As per BORDA rule, elements higher ranks are provided more weightage than the lower one and accumulate up these points over all individual MCDM techniques. Unfortunately, both BORDA and COPELAND voting rules may obtain tied situation in ranking, whereas Jahan et al. (2011) introduced a software-based rank aggregation technique, but at the cost of more computational time. Amalgamating relative merits and demerits of the rank aggregation methods, the authors proposes an initial floating rank aggregation technique which goes on changing in an iterative way and ultimately saturates to determine the final aggregate rank.

The present investigation focuses on the introduction of a novel rank aggregation technique capable of determining accurate and an exclusive order preference to each alternative without the intervention of the group decision maker. This new approach in aggregation essentially eradicates rank reversal and perplexity in decision making. Motivation behind the present research seems the rank reversal phenomenon noticed in the literature which leads the group decision makers in quandary to choose, evaluate and differentiate alternatives. The originality of the current paper can be pointed as follows.

1. This study explores a new avenue for accurate order preference and assortment of alternative in MCDM.
2. This study introduces a separation-based rank aggregation technique without intervention of the personal choice of the group decision maker.
3. This approach eliminates rank reversal in multi-criteria decision-making aggregation.
4. The investigation uses the upshots of ranks laid by group of conventional methods.

THE PROPOSED AGGREGATION METHODOLOGY

Multi Criteria Decision Making techniques are suitably ascertaining the rank orders for a set of alternatives (say *k*) subjected to a set of criteria. Therefore, for a particular method the rank orders can be presented in an '*k*' dimensional Euclidean coordinate system. The upshots (rank orders) for the other methods can also be ascertained and represented in the same frame. Anomalies arise when the different methods result in rank reversal, which puts the group decision maker into quandary to obtain the final decision in terms of aggregated rank. Figure 1 illustrates the separation of rank laid down by two methods (decision makers, *i* and *i'*) in the Euclidean Frame. The separation measure is considered as the linear distance in-between the ranks in the Euclidean space.

Figure 2 illustrates the comprehensive outline of the projected rank aggregation methodology. Suppose '*n*' numbers of different multi criteria decision making methods are being adopted for ranking of '*k*' numbers of alternatives subjected to '*l*' numbers of criteria. According to the proposed methodology initially it is assumed that every method is rationally given equal weightage abiding simple aggregate ranking as per Ataei (2010). Then the separation measures ($\Delta R_{avg}, R_i$) in between