Another Empirical Application of the Similarity Confirmation Method in Evaluating the MADM Methods for a Type-selection Decision Case before Bulk Purchase

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Abstract

A 'similarity confirmation method' (SCM) was recently proposed for comparing the final results obtained using different multi-attribute decision-making (MADM) models. In a 2018 study entitled 'Rank-based comparative research flow benchmarking the effectiveness of AHP-GTMA on aiding decisions of shredder selection by reference to AHP-TOPSIS', the rank order vectors (ROVs) obtained using AHP-GTMA and AHP-TOPSIS are treated as two statistical samples. So, the supporting evidence that 'the two samples are not (drawn) from non-identical populations' was found to further justify the similarity observed between them using traditional measures (e.g., difference, absolute distance and Euclidean distance), and this 'intangible statistics measure' used the Mann-Whitney U test. This thought-provoking concept inspired the proposal of the systematic SCM in 2019 (see the paper: 'The effectiveness of IF-MADM for group decisions: Methods and an empirical assessment for the selection of a senior centre'). In the SCM, another common K-S (Kolmogorov-Smirnov) test in data analytics was applied to show further evidence that 'the two samples are not (drawn) from non-identical distributions'. This provided more evidence regarding the similarity present between the results. In addition, the SCM allows more methods to be compared in a pair-wise manner. This property was applied to support the efficacy of the intuitionistic-fuzzy (IF-)MADM method because of the similarities rendered in the results between IF-MADM and other widely applied 'credible' methods (i.e., AHP and TOPSIS).

This study presents another empirical application of the SCM using real decision data sourced from an earlier 2017 study entitled 'Modelling the decision of paper shredder selection using analytic hierarchy process and graph theory and matrix approach', in which AHP-GTMA, another relatively new method, was used for aiding the product-selection decisions for bulk purchase. The SCM is applied to the same data, and together with the use of AHP-TOPSIS, the AHP-SAW (i.e., AHP with simple-additive weighting at the second stage) is also introduced for comparison. After rounds of SCM experiments, the observed similarity between each pair of ROVs is confirmed because there is little evidence to support the claim that any pair of these three methods are not similar in terms of their results, as the p values of the non-parametric tests are high (=1 or ~1). This not only cross-validates the methods (i.e., the results are all very similar using these methods; this is key for using these MADM models in practice) but also reconfirms that the AHP-GTMA model is effective, too, by using the systematic SCM. However, as AHP-GTMA yields a result more similar (in fact, almost identical) to that of AHP-SAW than to that of AHP-TOPSIS, it is worthwhile to obtain more knowledge by investigating the score vectors that are behind the ROVs (and that have determined these ROVs, e.g., the relative closeness index in TOPSIS) and/or to utilise other credible MADM methods, the already-verified IF-MADM or even the outranking ones. All this can be done by using the SCM in the future, and the results can further be compared with those produced using other measures, e.g., the 'Value of Similarity' (WS) coefficient.

Keywords

Similarity Confirmation Method, Multi-attribute Decision-making, Data-driven Decision-making, Rank Order Vector

over Alternatives and Uni-type Product Selection Problem for Bulk Purchase.

Acknowledgements
Research Grant #: 109-2410-H-992-015, Ministry of Science and Technology, Taiwan (ROC).

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