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Model for Multiple Attribute Decision Making Based on Picture 2-Tuple Linguistic Power Aggregation Operators

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ABSTRACT

In this article, the authors investigate the multiple attribute decision making problems with picture 2-tuple linguistic information. The utilized power average and power geometric operations used to develop some picture 2-tuple linguistic power aggregation operators: picture 2-tuple linguistic power weighted average (P2TLPWA) operator, picture 2-tuple linguistic power weighted geometric (P2TLPWG) operator, picture 2-tuple linguistic power ordered weighted average (P2TLPOWA) operator, picture 2-tuple linguistic power ordered weighted geometric (P2TLPOWG) operator, picture 2-tuple linguistic power hybrid average (P2TLPHA) operator and picture 2-tuple linguistic power hybrid geometric (P2TLPHG) operator. The prominent characteristic of these proposed operators is studied. This article has utilized these operators to develop some approaches to solve the picture 2-tuple linguistic multiple attribute decision making problems. Finally, a practical example for enterprise resource planning (ERP) system selection is given to verify the developed approach and to demonstrate its practicality and effectiveness.

KEYWORDS

Enterprise Resource Planning (ERP) System Selection, Multiple Attribute Decision Making, Picture 2-Tuple Linguistic Power Weighted Average (P2TLPWA) Operator, Picture 2-Tuple Linguistic Power Weighted Geometric (P2TLPWG) Operator, Picture 2-Tuple Linguistic Set

1. INTRODUCTION

Multiple attribute decision making (MADM) problems under linguistic environment are an interesting research topic having received more and more attention during the last several years. One of the well-known linguistic information processing models are the 2-tuple linguistic computational model (Beg & Rashid, 2016; Dutta & Guha, 2015; Herrera, Herrera-Viedma 2000a, 2000b; Herrera et al., 2005; Herrera & Martínez, 2001; Martínez-López et al., 2015; Lin et al., 2014; Wei, 2009a, 2010a, 2010b, 2010c, 2010d, 2011c, 2011d, 2011e, 2013; Wei et al., 2013, 2014; Wei & Merigó 2012; Wei & Zhao, 2012; Wu et al., 2015; Zhang & Liu, 2010; Zhang & Chu, 2009). Herrera and Martínez (1991) show 2-tuple linguistic information processing manner can effectively avoid the loss and distortion of information. Herrera, Herrera-Viedma (2000a) developed 2-tuple arithmetic average (TAA) operator, 2-tuple weighted average (TWA) operator, 2-tuple ordered weighted average (TOWA) operator and

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extended 2-tuple weighted average (ET-WA) operator. Herrera et al. (2005) presented the group decision making model for managing non-homogeneous information processing. Herrera-Viedma et al. (2005) developed the consensus support system with multi-granular linguistic preference relations. Liao et al. (2007) used linguistic information processing model for selecting an ERP system. Herrera et al. (2008) proposed a fuzzy linguistic methodology to deal with unbalanced linguistic term sets. Wang (2009) presented a 2-tuple fuzzy linguistic evaluation model for selecting appropriate agile manufacturing system. Tai and Chen (2009) developed the intellectual capital evaluation model linguistic variable. Fan et al. (2009) evaluated knowledge management capability of organizations by using a fuzzy linguistic method. Wei (2010a) extended TOPSIS method to multiple attribute group decision making with 2-tuple linguistic information. Wei (2010b) proposed ET-WG and ET-OWG operators for multiple attribute group decision making with 2-tuple linguistic information. Fan and Liu (2010) developed the multi-granularity uncertain linguistic group decision making model. Chang and Wen (2010) developed a novel efficient approach for DFMEA combining 2-tuple and the OWA operator. Jiang & Wei (2014) proposed some Bonferroni mean operators with 2-tuple linguistic information. Xu et al. (2014) developed some methods to deal with unacceptable incomplete 2-tuple fuzzy linguistic preference relations in group decision making. Liu et al. (2014) proposed the dependent interval 2-tuple linguistic aggregation operators for multiple attribute group decision making. Dutta et al. (2015) developed a model based on linguistic 2-tuples for dealing with heterogeneous relationship among attributes in multi-expert decision making. Dong & Herrera-Viedma (2015) proposed the consistency-driven automatic methodology to set interval numerical scales of 2-tuple linguistic term sets and its use in the linguistic GDM with preference relation. Wang et al. (2015) developed the multi-criteria group decision making method based on interval 2-tuple linguistic information and Choquet integral aggregation operators. Qin & Liu (2016) proposed the 2-tuple linguistic Muirhead mean operators for multiple attribute group decision making and its application to supplier selection. Zhang et al. (2016) developed the consensus reaching model for 2-tuple linguistic multiple attribute group decision making with incomplete weight information.

Recently, Cuong (2013) proposed picture fuzzy set (PFS) and investigated some basic operations and properties of PFS. The picture fuzzy set is characterized by three functions expressing the degree of membership, the degree of neutral membership and the degree of non-membership. The only constraint is that the sum of the three degrees must not exceed 1. Basically, PFS based models can be applied to situations requiring human opinions involving more answers of types: yes, abstain, no, refusal, which can't be accurately expressed in the traditional FS and IFS. Until now, some progress has been made in the research of the PFS theory. Singh (2014) investigated the correlation coefficients for picture fuzzy set and apply the correlation coefficient to clustering analysis with picture fuzzy information. Son (2015) and Thong & Son (2015) introduced several novel fuzzy clustering algorithms on the basis of picture fuzzy sets and applications to time series forecasting and weather forecasting. Thong (2015) developed a novel hybrid model between picture fuzzy clustering and intuitionistic fuzzy recommender systems for medical diagnosis and application to health care support systems.

Although, picture fuzzy set theory has been successfully applied in some areas, but there are situations in real life which can't be represented by picture fuzzy sets. Voting can be a good example of such situation as the human voters may be divided into four groups of those who: vote for, abstain, refusal of voting. Basically, picture fuzzy sets (Cuong, 2013) based models may be adequate in situations when we face human opinions involving more answers of the type: yes, abstain, no, refusal. However, all the above approaches are unsuitable to describe the degree of positive membership, degree of neutral membership, degree of negative membership and degree of refusal membership of an element to a linguistic label, which can reflect the decision maker's confidence level when they are making an evaluation. In order to overcome this limit, Wei (2016) and Wei et al. (2016) proposed the concept of picture 2-tuple linguistic set to solve this problem based on the picture fuzzy sets (Cuong, 2013) and 2-tuple linguistic information processing model (Herrera & Martínez, 2000a; Herrera & Martínez, 2000b). Thus, how to aggregate these picture 2-tuple linguistic numbers which take into