



# Complex $q$ -rung orthopair fuzzy 2-tuple linguistic group decision-making framework with Muirhead mean operators

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## Abstract

In this study, we aim to develop a method for solving multi-attribute group decision-making (MAGDM) problems with complex  $q$ -rung orthopair fuzzy 2-tuple linguistic sets. First, a complex  $q$ -rung orthopair fuzzy 2-tuple linguistic set ( $Cq$ -ROFTLS) is presented by combining the idea of 2-tuple linguistic set (2TLS) with complex  $q$ -rung orthopair fuzzy set ( $Cq$ -ROFS).  $Cq$ -ROFTLS is the best mechanism to deal with the imprecise and uncertain data in decision-making problems, characterized by 2TL complex-valued membership degree and non-membership degree and deals with two-dimensional data in one set at the same time by using extra terms known as phase terms related to periodicity and providing more space for decision makers (DMs) to explain their opinions. Muirhead mean (MM) operator can capture the interrelationships among all input arguments by changing a parameter vector. Considering the benefits of MM operator, we propose some new aggregation operators, including complex  $q$ -rung orthopair fuzzy 2-tuple linguistic Muirhead mean ( $Cq$ -ROFTLMM) operator, weighted Muirhead mean ( $Cq$ -ROFTLWMM) operator, complex  $q$ -rung orthopair fuzzy 2-tuple linguistic dual Muirhead mean ( $Cq$ -ROFTLDMM) operator, and weighted dual Muirhead mean ( $Cq$ -ROFTLWDM) operator under  $Cq$ -ROFTL environment to expand its applied fields. Some properties and special cases related to the parameter vector are also proposed along with the aggregation operators. Furthermore, a method to MAGDM problem is developed, and the proposed aggregation operators are used to solve the MAGDM problems related to the best choice of medication for pneumonia with  $Cq$ -ROFTL numbers ( $Cq$ -ROFTLNs). Finally, comparative analysis is presented with some existing methods.

**Keywords** Complex  $q$ -rung orthopair fuzzy 2-tuple linguistic set · Muirhead mean operator · Dual Muirhead mean operator · Pneumonia disease

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