

## **An innovative heuristic algorithm for multi-objective transportation problems using improved ant colony algorithm**

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The transportation problem is a well-known optimization challenge that aims at minimizing the total costs for distributing resources from different sources to numerous destinations. In complicated logistical situations, many objectives such as cost, time, and distance are optimized together. This leads to the multi objective transportation problem where a productive compromise solution is sought. Although literature has established various methods like goal and fuzzy programming, these approaches often fall short for large-scale instances due to high computational demands. In this study, an innovative heuristic algorithm is established using an Improved Ant Colony Optimization approach combined with a harmonic cost matrix to aggregate conflicting goals. The incremental novelty of this work is distinguished by the introduction of a static probabilistic penalty mechanism. Unlike traditional methods requiring dynamic recalculations, this deterministic approach utilizes a desirability matrix to simplify decision-making. Furthermore, this research eliminates the standard reliance on dummy variables, maintaining the original problem dimensionality and saving significant computational resources. The efficiency of this technique is validated through benchmarks comparing the Improved ant colony optimization method to other methods. Performance results demonstrate superior outcomes: Example 1 achieves a 3.8% reduction in distance; Examples 2 and 5 yield identical optimal solutions; Example 3 reduces time by 5.8%; and Example 4 achieves a 28.6% cost improvement. It can definitely be concluded that the algorithm could be a highly powerful, flexible, and efficient tool for dealing with large classes of optimization problems likely to occur in real-world logistics.

**Keywords:** *Ant Colony Optimization; Multi-Objective Optimization; Transportation Problem*