Abstract

Decision making is one of the main abilities of human beings that distinguishes them from other creatures. Nowadays, decision making analysis is an important part of *Operational Research* (OR) as well as *Management Sciences* (MS), and possibly it is as old as the history of mankind. In many real-world problems, the DM likes to pursue more than one target or to consider more than one factor or measure. Such a desire transforms the decision-making problem into a multi-objective decision-making problem. There are many decision-making problems whose information is spatial (geographical). These kinds of decisions are called location decisions. Location decisions are now a major part of OR and MS (named location science). Facility location problems, location science, and location models are termed that can be used alternatively. From an application point of view, there is no limitation for location science. Many application areas including public facilities, military environment, business areas, and national and international scopes are there.

Due to the complexity of real-life situations, uncertainties arise to determine the parameters information in most of the practical problems. This imprecision/uncertainty is inevitable and hence the data is not precise all the time and is given as estimates. These types of uncertainties are difficult to tackle by classical set or crisp set. To overcome these situations, several uncertain environments such as fuzzy environment, intuitionistic fuzzy environment, neutrosophic environment, type-2 fuzzy environment, etc. are introduced.

The objective of this dissertation is to explore facility location problems in the light of various uncertain environments. Especially, here, six (06) optimization problems in facility location problems are discussed. The first problem is to locate a certain number of new facilities among several existing facilities such that the total transportation cost from existing facility sites to the new facilities will be minimized. Two approaches are presented to solve the proposed problem and corresponding results are compared. An experimental analysis is incorporated to expose the efficiency and effectiveness of our proposed study in reality. The second problem is the fixed-charge transportation-location problem which makes a bridge between fixed-charge transportation problem and facility location problem. We have to seek where and how we impose the new facilities with the goal that the aggregate transportation cost from the existing facility sites to the potential facility sites along with the fixed cost will be minimized. A new approximation approach is incorporated based on the Balinski's approximation and a heuristic approach to get an optimal solution within a relatively short computational time for large scale entries. An experimental design is consolidated to demonstrate the proficiency and viability of the proposed consideration in connection with reality. The third problem is the solid transportation-location problem, a generalization of the first problem, in which the idea of different types of transportation modes on the entire supply chain is incorporated. This is one of the most important problems in the transportation system and the location research areas. Two heuristic approaches are

developed to solve this problem: a locate-allocate heuristic and an approximate heuristic. Thereafter, the performance of the proposed model and the heuristics are evaluated by an application example, and the obtained results are compared. Moreover, a sensitivity analysis is introduced to investigate the resiliency of the proposed model. The fourth problem is an integrated nonlinear optimization model based on FLP and TP under a carbon tax, cap, and trade policy. The model finds the decision regarding the assignment from multiple existing facilities to multiple potential facilities in the continuous planner surface with a hyperbolic approximation of Euclidean distance. Thereafter, a hybrid approach is improved based on an alternating locate-allocate heuristic and the neutrosophic compromise programming to obtain the non-dominated solution. Numerical experiments are made to show the efficiency and complexity of our optimization models. The fifth problem is an unprecedented nonlinear mathematical formulation that incorporates FLP, STP, and inventory management under a multi-objective environment. The aims of this problem are multi-fold: *(i)* seek the optimum locations for potential facilities in Euclidean plane; *(ii)* find the amount of distributed commodities; and *(iii)* reduce the overall transportation cost, transportation time, and inventory cost along with the carbon emission cost. After that, a new hybrid approach is introduced dependent on an alternating locate-allocate heuristic and the intuitionistic fuzzy programming to get a Pareto-optimal solution of the proposed formulation. The performances of our findings are discussed with a numerical example. Sensitivity analysis is executed to check the resiliency of the parameters. In the sixth problem, a type-2 intuitionistic fuzzy multi-objective green solid transportation-location problem is designed. A new ranking defuzzification technique is presented for conversion into a deterministic form. After that, a fuzzy technique and a non-fuzzy technique are used to get the Pareto-optimal solution of the proposed problem. The performances of our findings are discussed with industrial-based application examples. Moreover, a comparative study with particular cases is explored among the other existing techniques.

Keywords: Facility location problem; Transportation problem; Fixed-charge transportation problem; Solid transportation problem; Multi-objective transportation problem; Inventory management; Carbon emission; Carbon tax policy; Fuzzy environment; Intuitionistic fuzzy environment; Neutrosophic environment; Type-2 fuzzy environment; Exact approach; Locate-allocate (Loc-Alloc) heuristic; Balinski's approximation; Alternating Locate-allocate (Loc-Alloc) heuristic; Approximation approach; Hybrid approach; Fuzzy programming; Intuitionistic fuzzy programming; Neutrosophic compromise programming; Global criterion method; Ranking function; Optimization.