List of Publications

Publications in SCOPUS/SCIE/SCI journals

1. **S.K. Das**, S.K. Roy and G.W. Weber (2020). An exact and a heuristic approach for transportation-p-facility location problem.***Computational Management Science, Springer, Scopus indexed***.

2. **S.K. Das**, S.K. Roy and G.W. Weber (2019). Heuristic approaches for solid transportation-p-facility location problem. ***Central European Journal of Operations Research, Springer, SCIE, I.F: 2.000***.

3. **S.K. Das** and S.K. Roy (2019). Effect of variable carbon emission in a multi-objective transportation-p-facility location problem under neutrosophic environment. ***Computers & Industrial Engineering, Elsevier, SCI, I.F: 4.135***.

4. **S.K. Das**, S.K. Roy and G.W. Weber (2020). Application of type-2 fuzzy logic to a multi-objective green solid transportation–location problem with dwell time under carbon tax, cap, and offset policy: fuzzy versus nonfuzzy techniques, ***IEEE Transactions on Fuzzy Systems, IEEE, SCIE, I.F: 9.518***.

5. **S.K. Das**, M. Pervin, S.K. Roy and G.W. Weber (2021). Multi-objective solid transportation-location problem with variable carbon emission in inventory management: a hybrid approach, ***Annals of Operations Research, SCI, I.F: 2.583***.

List of Communicated Papers

6. **S.K. Das** and S.K. Roy. An approximation approach for fixed-charge transportation-p-facility location problem, **Revision Submitted in Journal of Industrial & Management Optimization, SCIE, I.F: 1.366**.

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ORIGINAL PAPER

An exact and a heuristic approach for the transportation-p-facility location problem

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Abstract

The delineation of the transportation network is a strategic issue for all over the place. The problem of locating new facilities among several existing facilities and minimizing the total transportation cost are the main topics of the location network system. This paper addresses the *transportation-p-facility location problem* (T-p-FLP) which makes a connection between the facility location problem and the transportation problem, where p corresponds to the number of facilities. The T-p-FLP is a generalization of the classical transportation problem in which we have to seek where and how we impose the p-number of facilities such that the total transportation cost from existing facility sites to the potential facility sites will be minimized. The exact approach, based on the iterative procedure, and a heuristic approach as applied to the T-p-FLP are discussed and corresponding results are compared. An experimental example is incorporated to explore the efficiency and effectiveness of our proposed study in reality. Finally, a summary is given together with suggestions for future studies.

Keywords Facility location problem · Transportation problem · Transportation-p-facility location problem · Optimization · Exact approach · Heuristic approach

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ORIGINAL PAPER

Heuristic approaches for solid transportation-*p*-facility location problem

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Abstract

Determining optimum places for the facilities and optimum transportation from existing sites to the facilities belongs to the main problems in supply chain management. The *solid transportation-p-facility location problem* (ST-p-FLP) is an integration between the *facility location problem* and the *solid transportation problem* (STP). This paper delineates the ST-p-FLP, a generalization of the classical STP in which location of p-potential facility sites are sought so that the total transportation cost by means of conveyances from existing facility sites to potential facility sites will be minimized. This is one of the most important problems in the transportation systems and the location research areas. Two heuristic approaches are developed to solve such type of 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. Finally, conclusions and an outlook to future research works are provided.

Keywords Facility location problem · Solid transportation problem · Solid transportation-p-facility location · Optimization · Heuristic approaches

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Effect of variable carbon emission in a multi-objective transportation-*p*-facility location problem under neutrosophic environment

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ABSTRACT

Several industries locate a pre-assigned number of facilities in order to determine a transportation way for optimizing the objective functions simultaneously. The multi-objective transportation-*p*-facility location problem is an optimization based model to integrate the facility location problem and the transportation problem under the multi-objective environment. This study delineates the stated formulation in which we need to seek the locations of *p*-facilities in the Euclidean plane, and the amounts of transported products so that the total transportation cost, transportation time, and carbon emission cost from existing sites to *p*-facilities will be minimized. In fact, variable carbon emission under carbon tax, cap and trade regulation is considered due to the locations of *p*-facilities and the amounts of transported flow. Thereafter, a hybrid approach is improved based on an alternating locate-allocate heuristic and the neutrosophic compromise programming to obtain the non-dominated solution. Additionally, the performance of our findings are evaluated by an application example. Furthermore, a sensitivity analysis is incorporated to explore the resiliency of the designed model. Finally, conclusions and further research areas conclude the paper.

1. Introduction

The *facility location problem* (FLP) is a crucial integrant of strategic planning for a wide spectrum of the public as well as the private sector. In fact, it deals with locating facilities among existing sites with the goal of optimizing the economic criteria (e.g., transportation cost, transportation time, carbon emission cost and good service). The traditional FLP is described by four given sets, (i) a set of existing sites with capacity, (ii) a set of weights associated with the existing site, (iii) a set of potential facility sites with demand, and (iv) a set of objective functions. It can be cataloged into different categories depending on the assumptions. Industrial organizations locate assembly plants and depots. Warehouses are situated by the retailers. The performance of the manufacturing, productivity, and marketing of goods is dependent on the location of the facilities. Moreover, the government also selects the location of hospitals, offices, schools, fire stations, etc. Everywhere, the quality of service is dependent on the location of the facilities. The FLP was studied by several researchers. A few of them are depicted here. Farahani, SteadieSeifi, and Asgari (2010) made a comprehensive survey of the facility location problems in a multi-criteria environment. Then, Bieniek (2015) presented a note on the FLP where the demands follow the arbitrary distribution. Later, Chen, He, and Wu (2016) solved a single FLP with random weights. Moreover, the FLP can be applied in a broad area of transportation networks, supply chain management, plant location problem, and green logistics such as Mišković, Stanimirović, and Grujičić (2017), Melo, Nickel, and Saldanha-da-Gama (2009), Amin and Baki (2017), Saif and Elhedhli (2016), and Harris, Mumford, and Naima (2014).

In the real scenario, the *transportation problem* (TP) plays a vital role in global competition for minimizing transportation cost, time and providing service. Generally, the classical TP consists of three major components: (a) a set of all sources, (b) a set of all destinations, and (c) single-objective function as total transportation cost. Mainly, in the TP, homogeneous goods are sent from sources to destinations, and the total transportation cost is directly proportional to the amount of goods to be transported. It was the first introduced by Hitchcock (1941). However, the traditional TP is not sufficient for handling real-life application problems. Due to this reason, the multi-objective environment is introduced here on the TP in which the objectives are conflicting and non-commensurable in nature. In fact, the *multi-objective TP* (MOTP) was analyzed by so many researchers in different environments. Some works are annexed here. Mahapatra, Roy, and Biswal (2013) solved a multi-choice stochastic TP where the supply and demand parameters follow extreme value distribution. Thereafter, Sabbagh, Ghafari, and Mousavi (2015) proposed a hybrid approach for the balanced TP. Maity, Roy, and Verdegay (2016) discussed a MOTP with cost reliability

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Application of type-2 fuzzy logic to a multi-objective green solid transportation-location problem with dwell time under carbon tax, cap and offset policy: Fuzzy vs. Non-fuzzy techniques

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***Abstract*—We are observing more often extreme climate incidents because of global warming. There is a dire requirement for governments, enterprises, the overall population, and academics to take facilitated activities so as to handle the difficulties forced by environmental change. The most important strategic issue is to design an effective and environmentally concerned logistics system as transportation is one of the fundamental reasons for carbon emanations. Having this goal and mentioned highly important contributions in the field, our paper introduces an unprecedented integrated mathematical model for a green solid transportation system with dwell time to execute the carbon tax, cap and offset regulation. Due to market fluctuations, the supply and demand parameters are not always of crisp nature. Hence, a two-fold (type-2 intuitionistic) uncertainty is incorporated in this study to provide a realistic transportation system. 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 is explored among the other relevant existing techniques. Managerial insights, conclusions, and avenues of future scopes are offered at the end of this study.**

***Index Terms*—Fuzzy multi-objective optimization, facility location problem (FLP), solid transportation problem (STP), carbon tax, cap and offset policy, type-2 intuitionistic fuzzy set.**

I. INTRODUCTION

IN recent decades, an unnatural weather change has drawn a lot of attention as there occurred increasingly extreme weather events. Recently, we have seen further cataclysmic events, e.g., the scorching temperature in Kuwait, water resources, glacier retreat, sea-level rise, drought and flood in some areas of Asia, declines in Arctic sea ice, global temperature high, changes in the timing of the seasonal events. It is well known that the increase of CO_2 emission is considered as one of the key factor of these incidents [1]–[3]. On the other hand, as can be seen in Figure 1, transportation [4] can be treated as a significant source of CO_2 emission. Governments and other policymakers endorse a couple of strategies for reducing carbon discharge, wherein a carbon emission tax, cap and offset policy (cf. [5]–[7]) is commonly accepted. They provide a limited amount of annual permits that allow organizations to emit a specific measure of CO_2. The aggregate sum allowed along these lines turns into the "cap" on emission. According to this policy, organizations are initially constrained to a carbon cap in taxes per unit emission; if the cap is exceeded then they have to pay penalties. Nevertheless, organizations can support carbon offset projects to increase its carbon cap. The carbon offset project is also addressed as "*The Clean Development Mechanism*" (see https://cdm.unfccc.int) defined in the *Kyoto Protocol (2007) [8]*; it aims at a reduction of CO_2 emission by compensating the organizations' emission. There are a few research studies in this direction. Some of them are highlighted here. Elhedhli and Merrick [9] provided an integrated model between carbon emission and vehicle weight. Turken et al. [10] highlighted the impact of carbon emission due to transportations in the environment. Wu et al. [11] studied the effect of carbon emission cost of an integrated production-location model. The motivation of this study is to design a strategic green transportation network to reduce CO_2 emission in the atmosphere.

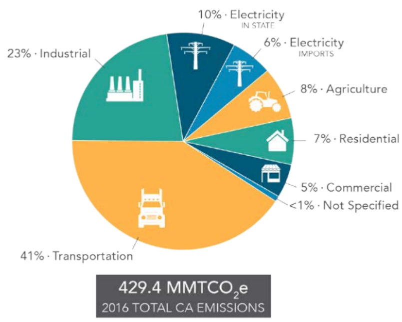

Fig. 1: Global CO_2 emission by different economic sectors in 2016-2017[4] (MMT: Million Metric Tones).

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[4]Source: https://ww2.arb.ca.gov/ghg-inventory-data

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ORIGINAL - OR MODELING/CASE STUDY

Multi-objective solid transportation-location problem with variable carbon emission in inventory management: a hybrid approach

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Abstract

The most important strategic issue for several industries is where to find facilities so as to discover a transportation path for optimizing the objectives at the same time. This paper acquaints a streamlining model with incorporate the facility location problem, solid transportation problem, and inventory management under multi-objective environment. The aims of the stated formulation are multi-fold: (i) to seek the optimum locations for potential facilities in Euclidean plane; (ii) to find the amount of distributed commodities; and (iii) to reduce the overall transportation cost, transportation time, and inventory cost along with the carbon emission cost. Here, variable carbon emission cost is taken into consideration because of the variable locations of facilities and the amount of distributed products. After that, a new hybrid approach is introduced dependent on an alternating locate-allocate heuristic and the intuitionistic fuzzy programming to get the Pareto-optimal solution of the proposed formulation. In fact, the performances of our findings are discussed with two numerical examples. Sensitivity analysis is executed to check the resiliency of the parameters. Ultimately, managerial insights, conclusions and avenues of future studies are offered at the end of this study.

Keywords Facility location problem · Solid transportation problem · Inventory management · Variable carbon emission · Hybrid approach · Multi-objective decision making

Abbreviations

FLP	Facility location problem,
STP	Solid transportation problem,
MOST-LP	Multi-objective solid transportation-location problem,
DM	Decision maker
FS	Fuzzy set
IFS	Intuitionistic fuzzy set

Extended author information available on the last page of the article

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