E-ISSN: 2676-6159 | P-ISSN: 2538-5079

Journal of Decisions and Operations Research

www.journal-dmor.ir

J. Decis. Oper. Res. Vol. x, No. x (xx) x–x.

Paper Type: Original Article

Modeling and Solving the Multi-objective Robust Facilities Layout Under Uncertainty with Multi-objective Meta-heuristic Algorithms

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Citation:

LastName, (Abreviation of FirstName)., & LastName, (Abreviation of FirstName. (Date). Paper Title. *Journal of decisions and operations research,* Volume (Issue), PP.

Received: Reviewed: Revised: Accept:

Abstract

Purpose: The present paper deals with modeling and solving a multi-objective problem of robust facility layout problem under uncertainty with NSGA II, MOPSO and MOGWO algorithms. Since the problem of facility layout is NP-Hard, the need to use meta-algorithms by providing a suitable chromosome to achieve near-optimal solutions has been investigated in this article. The issue under consideration in this article includes several departments that are based on 5 different aspects (minimizing the flow time between departments, maximizing the number of equipment and facilities, minimizing the distance traveled to access firefighting equipment, minimizing the distance to access Optimal climatic conditions and maximization of noisy departments from each other) should be arranged in different parts of the hall. In order to achieve the above objective functions at the same time, assigning departments to each section, equipping each section with different equipments and arranging the departments together are among the main objectives of the article.

Methodology: In this paper, GA, PSO and GWO single-objective meta-heuristic algorithms and NSGA II, MOPSO and MOGWO multi-objective meta-heuristic algorithms have been used to solve the problem.

Findings: Computational results show that GA, PSO and GWO single-objective algorithms have high efficiency in achieving the optimal value of the objective function in a much shorter time, and their multi-objective methods show the high efficiency of the NSGA II algorithm in achieving the average value of the objective function. First, second and fifth; The MOPSO algorithm has the highest expansion and metric distance in achieving the average number of efficient answers and computational time, and finally the MOGWO algorithm in obtaining the average value of the third and fourth objective functions. Statistical comparisons also showed a significant difference between the means of computational time. To evaluate and rank the algorithms, the TOPSIS method is used and the results show the high efficiency of the MOGWO algorithm in solving the model.

Originality/Value: In this paper, a new model of the multi-objective robust facility layout problem under uncertainty conditions is modeled with respect to health and environmental safety aspects.

Keywords: Multi-objective meta-heuristic algorithms, Robust facility layout, Fuzzy planning, Safety and environmental health.

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https://doi.org/10.22105/dmor.2021.289735.1418

تصمیم‌گیری و تحقیق در عملیات

دوره x، شماره (x)، (xx)، x-x

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نوع مقاله: پژوهشی

مدل‌سازی و حل مسئله چندهدفه چیدمان استوار تسهیلات در شرایط عدم قطعیت با الگوریتم‌های فرا ابتکاری چندهدفه

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چکیده:

هدف: مقاله حاضر به مدل‌سازی و حل یک مسئله چندهدفه چیدمان استوار تسهیلات در شرایط عدم قطعیت با الگوریتم‌های *NSGA II*، *MOPSO* و *MOGWO* پرداخته است. از آنجایی که مسئله چیدمان تسهیلات از نوع NP-Hard می‌باشد لذا لزوم به کارگیری الگوریتم‌های فراابتکاری با ارائه یک کروموزوم مناسب جهت دستیابی به جواب‌های نزدیک به بهینه در این مقاله مورد بررسی قرار گرفته است. مسئله مورد بررسی در این مقاله شامل چندین دپارتمان می‌باشد که بر اساس ۵ جنبه مختلف (کمینه‌سازی زمان انتقال جریان بین دپارتمان‌ها، بیشینه سازی تعداد تجهیزات و امکانات، کمینه‌سازی مسافت طی شده برای دسترسی به تجهیزات اطفاء حریق، کمینه‌سازی مسافت دسترسی به شرایط اقلیمی مطلوب و بیشینه سازی دپارتمان‌های پر سر و صدا از یکدیگر) بایستی در بخش‌های مختلف سالن چیدمان شوند. جهت دستیابی همزمان به توابع هدف فوق، تخصیص دپارتمان‌ها به هر بخش، تجهیز هر بخش با تجهیزات مختلف و چیدمان دپارتمان‌ها در کنار یکدیگر جزو اصلی ترین هدف‌های مقاله می‌باشد.

روش‌شناسی پژوهش: در این مقاله برای حل مسئله از الگوریتم‌های فرا ابتکاری تک هدفه *GA*، *PSO* و *GWO* و الگوریتم‌های فرا ابتکاری چندهدفه *NSGA II*، *MOPSO* و *MOGWO* استفاده شده است.

یافته‌ها: نتایج محاسباتی نشان می‌دهد که الگوریتم‌های تک هدفه *GA*، *PSO* و *GWO* از کارایی بالایی در دستیابی به مقدار بهینه تابع هدف در زمان بسیار کوتاه تر برخوردارند و روش‌های چندهدفه آنها نشان از کارایی بالای الگوریتم *NSGA II* در دستابی به مقدار میانگین تابع هدف اول، دوم و پنجم؛ الگوریتم *MOPSO* در دستیابی به میانگین تعداد جواب کارا و زمان محاسباتی و در نهایت الگوریتم *MOGWO* در کسب مقدار میانگین تابع هدف سوم، چهارم، بیشترین گسترش و فاصله متریک دارد. همچنین مقایسات آماری نشان از وجود اختلاف معنادار بین میانگین‌های زمان محاسباتی را داشته است. برای ارزیابی و رتبه بندی الگوریتم‌ها از روش تاپسیس استفاده و نتایج نشان از کارایی بالای الگوریتم *MOGWO* در حل مدل دارد.

اصالت/ارزش افزوده علمی: در این مقاله مدل نوینی از مسئله چندهدفه چیدمان استوار تحت شرایط عدم قطعیت با توجه به جنبه‌های ایمنی بهداشت و زیست محیطی مدل‌سازی شده است.

کلیدواژه‌ها: الگوریتم‌های فرا ابتکاری چندهدفه، چیدمان استوار تسهیلات، برنامه‌ریزی فازی، ایمنی و بهداشت زیست محیطی

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