APEM journal

Advances in Production Engineering & Management
Volume 20 | Number 2 | June 2025 | pp 205–223
https://doi.org/10.14743/apem2025.2.536

ISSN 1854-6250
Journal home: apem-journal.org
Original scientific paper

A multi-objective approach for optimizing emergency material locations in natural disasters

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A B S T R A C T

In response to the increasing frequency of natural disasters globally, and particularly in the Guangxi Zhuang Autonomous Region, this study aims to optimize the site selection for emergency supplies storage facilities. Traditional methods for predicting emergency supplies demand rely heavily on expert judgment, lacking sophisticated forecasting methodologies, which further complicates research due to the inherent unpredictability of natural disasters. This paper adopts a multi-objective programming approach, leveraging historical data and the proposed emergency supplies demand model to systematically address the spatial layout planning problem of emergency material reserve nodes. After comprehensively considering various factors, including risk, economic, and time-related aspects, a 0-1 integer programming model was established, aiming to fulfill all regional requirements for essential resources within minimal rescue timeframes while minimizing overall costs. Through the application of the AHP-Entropy weight method, data standardization and indicator weighting were conducted, resulting in a hierarchical site selection framework that ensures timely emergency response across the region without incurring prohibitive costs. This study represents a significant contribution to the literature by focusing on the unique challenges and requirements of Guangxi and proposing a tailored approach to optimizing the site selection and layout of emergency supplies storage facilities, thereby enhancing disaster preparedness and response strategies effectively.

A R T I C L E   I N F O

Keywords:
Natural disasters;
Emergency rescue;
Emergency supplies storage;
Location optimization;
Risk level;
Grade-based location selection system;
Cross-reginal distribution;
0-1 integer programming model;
Multi-objective optimization;
Analytic hierarchy process (AHP)

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Article history:
Received 30 September 2024
Revised 25 June 2025
Accepted 28 June 2025

References

[1] Feng, S. (2024). Implementation of decision support system for ecological environment planning of urban green space, *Ecological Chemistry and Engineering S*, Vol. 31, No. 2, 177-192, doi: 10.2478/eces-2024-0012.

[2] Shi, P., Wang, J., Zhang, G., Kong, F., Wang, J.A. (2017). Research review and prospects of natural disasters regionalization in China, *Geographical Research*, Vol. 36, No. 8, 1401-1414, doi: 10.11821/dlyj201708001.

[3] Xiong, X. (2024). Does the chief executive officer green experience contribute to the low-carbon transition of the organisation?, *Ecological Chemistry and Engineering S*, Vol. 31, No. 2, 215-224, doi: 10.2478/eces-2024-0015.

[4] Park, H., Shafahi, A., Haghani, A. (2016). A stochastic emergency response location model considering secondary incidents on freeways, *IEEE Transactions on Intelligent Transportation System*, Vol. 17, No. 9, 2528-2540, doi: 10.1109/TITS.2016.2519043.

[5] Du, B., Zhou, H. (2016). A two-stage robust optimization model for emergency facility location problems under uncertainties, *Industrial Engineering Journal*, Vol. 19, No. 5, 45-50, doi: 10.3969/j.issn.1007-7375.2016.05.007.

[6] Wu, K., Song, Y., Lyu, W. (2017). Research on siting of urban emergency resources depots and layout optimization considering rainstorm disaster and distribution route, *China Safety Science Journal*, Vol. 27, No. 9, 170-174, doi: 10.16265/j.cnki.issn1003-3033.2017.09.029.

[7] Banyai, A. (2023). Impact of agile, condition-based maintenance strategy on cost efficiency of production systems, *Advances in Production Engineering & Management*, Vol. 18, No. 3, 317-326, doi: 10.14743/apem2023.3.475.

[8] Elabbas, M.A.E., Camacho, L.O., Pérez-Arriaga, I. (2025). InfraFair: Infrastructure cost allocation, *Software X*, Vol. 29, Article No. 102069, doi: 10.1016/j.softx.2025.102069.

[9] Niu, X.Y., Liu, S.F., Huang, Q.L. (2022). End-of-line delivery vehicle routing optimization based on large-scale neighbourhood search algorithms considering customer-consumer delivery location preferences, *Advances in Production Engineering & Management*, Vol. 17, No. 4, 439-454, doi: 10.14743/apem2022.4.447.

[10] Bîlbîie, R., Dimon, C., Popescu, D. (2024). Efficiency for routing networks management in supplier-customer distribution systems, *Studies in Informatics and Control*, Vol. 33, No. 2, 51-58, doi: 10.24846/v33i2y202405.

[11] Drezner, Z., Eiselt, H.A. (2024). Competitive location models: A review, *European Journal of Operational Research*, Vol. 316, No. 1, 5-18, doi: 10.1016/j.ejor.2023.10.030.

[12] Maleki, M., Majlesinasab, N., Sepehri, M.M. (2014). Two new models for redeployment of ambulances, *Computers & Industrial Engineering*, Vol. 78, No. 10, 271-284, doi: 10.1016/j.cie.2014.05.019.

[13] Fu, D., Zhang, W. (2015). Bi-objective emergency reserve depot location model considering the capacity of the reserve depot, *Journal of Chongqing of Posts and Telecommunications (Natural Science Edition)*, Vol. 27, No. 3, 392-396.

[14] Sudtachat, K., Mayorga, M.E., Mclay, L.A. (2016). A nested-compliance table policy for emergency medical service systems under relocation, *Omega*, Vol. 58, 154-168, doi: 10.1016/j.omega.2015.06.001.

[15] Feng, J., Gai, W. (2018). Research on multi-objective optimization model and algorithm for reserve site selection of emergency materials, *Journal of Safety Science and Technology*, Vol. 14, No. 6, 64-69.

[16] AlHaffar, H., Kazah, R., Akkad, R., Hmicho, C., Khnouf, V. (2023). The effects of the earthquake natural disasters on sustainable corporate social responsibility, *Journal of Service, Innovation and Sustainable Development*, Vol. 4, No. 2, 1-14, doi: 10.33168/SISD.2023.0201.

[17] Alvarez-Campana, P., Villafanez, F., Acebes, F., Poza, D. (2024). Simulation-based approach for multiproject scheduling based on composite priority rules, *International Journal of Simulation Modelling*, Vol. 23, No. 1, 29-40, doi: 10.2507/IJSIMM23-1-667.

[18] de Almeida, V.N. Alegre, L.N., Bazzan, A.L.C. (2024). Knowledge transfer in multi-objective multi-agent reinforcement learning via generalized policy improvement, *Computer Science and Information Systems*, Vol. 21, No. 1, 335-362, doi: 10.2298/CSIS221210071A.

[19] Liu, A.Y., Yue, D.Z., Chen, J.L., Chen, H. (2024). Deep learning for intelligent production scheduling optimization, *International Journal of Simulation Modelling*, Vol. 23, No. 1, 172-183, doi: 10.2507/IJSIMM23-1-CO4.

[20] Cao, J., Han, H., Wang, Y.J., Han, T.C. (2023). Optimal logistics scheduling with dynamic information in emergency response: Case studies for humanitarian objectives, *Advances in Production Engineering & Management*, Vol. 18, No. 3, 381-395, doi: 10.14743/apem2023.3.480.

[21] Hanan, F.A., Mutalib, S., Yunus, A.M., Rashid, M.F.A., Kamarudin, S.N.K., Rahman, S.A. (2023). A study on social media responses on road infrastructure using sentiment analysis, *Journal of Logistics, Informatics and Service Science*, Vol. 10, No. 2, 1-14, doi: 10.33168/JLISS.2023.0201.

[22] Ye, F., Zhao, Q., Xi, M., Desstouky, M. (2015). Chinese national emergency warehouse location research based on VNS algorithm, *Electronic Notes in Discrete Mathematics*, Vol. 47, 61-68, doi: 10.1016/j.endm.2014.11.009.

[23] Cao, Q., Chen, W. (2019). Research review of emergency facility location problem, *Computer Engineering*, Vol. 45, No. 12, 26-37, doi: 10.19678/j.issn.1000-3428.0054292.

[24] Du, H., Chen, J. (2023). An improved ant colony algorithm for new energy industry resource allocation in cloud environment, *Tehnicki Vjesnik – Technical Gazette*, Vol. 30, No. 1, 153-157, doi: 10.17559/TV-20220712164019.

[25] Pramudita, A., Taniguchi, E., Qureshi, A.G. (2014). Location and routing problems of debris collection operation after disasters with realistic case study, *Procedia - Social and Behavioral Sciences*, Vol. 125, 445-458, doi: 10.1016/j.sbspro.2014.01.1487

[26] Kurnia, A., Oktavia, T. (2024). A multi-criteria decision approach for optimized route planning in retail distribution, *Journal of Logistics, Informatics and Service Science*, Vol. 11, No. 9, 37-53, doi: 10.33168/JLISS.2024.0903.

[27] Jin, X., Choi, Y.-S. (2024). Coupling evaluation and spatial analysis of regional economy and logistics development based on digital twin, *Journal of Logistics, Informatics and Service Science*, Vol. 11, No. 2, 10-26, doi: 10.33168/JLISS.2024.0202.

[28] Chanta, S., Mayorga, M.E., Mclay, L.A. (2014). The minimum p-envy location problem with requirement on minimum survival rate, *Computers & Industrial Engineering,* Vol. 74, 228-239, doi: 10.1016/j.cie.2014.06.001.

[29] Bozali, B., Oztürk, A., Tosun, S., Hoş, B. (2023). Optimal PMU placement for Türkiye 400 kV interconnected power system observability with dragonfly algorithm, *Tehnicki Vjesnik – Technical Gazette*, Vol. 30, No. 3, 733-741, doi: 10.17559/TV-20220708091029.

[30] Rădulescu, I.-C. (2024). robust model predictive control for systems affected by constant and norm 2 bounded disturbance, *Studies in Informatics and Control*, Vol. 33, No. 1, 99-106, doi: 10.24846/v33i1y202409.

[31] Gobbi, H.U., dos Santos, G.D., Bazzan, A.L.C. (2024). Comparing reinforcement learning algorithms for a trip building task: A multiobjective approach using non-local information, *Computer Science and Information Systems*, Vol. 21, No. 1, 291-308, doi: 10.2298/CSIS221210072G.