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Editorial

Engineering and Sustainable Challenges: Latest Advances in Computing and Systemic Tools

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Modeling highly nonlinear, coupled systems with a large number of variables is a current challenge in engineering and sustainability. These models are used for the identification, optimization, control, and estimation of various tasks [1–3]. Mathematical, systemic, and computational models now include sustainable aspects crucial in today's engineering and urban development systems [4,5]. The new indicators being developed consider various aspects such as social, human, health, and cultural factors that must be preserved or improved to maintain an adequate and environmentally friendly level of service and human development. These indicators go beyond the economic or service objectives previously used in these models [6,7].

Optimizing complex systems in multiple dimensions presents a challenging task that requires new algorithms based on metaheuristics and emerging systemic and computational tools. Classical mathematical and computational tools are no longer sufficient to find quasi-optimal solutions in a reasonable time [8,9].

Another set of challenges in engineering and urban development involves finding ways to use indicators and low-impact solutions to promote energy resilience and sustainable development while maintaining a balance of natural resources in the face of population growth. Often, these two needs are closely linked and must be addressed simultaneously [10,11].

In problems with multiple dimensions, both for discrete and continuous cases, there is a tendency to propose and test new computational metaheuristics for optimization [12,13]. In the discrete case, combining metaheuristic techniques with new local search models is a current research topic. For the continuous case, it is impossible to propose an algorithm better than all others for all cases by the NFL (no free lunch) theorem, so researchers focus on proposing new metaheuristics inspired by natural or artificial systems. These metaheuristics must be simple to implement and provide acceptable results in an adequate time [14,15].

Many of the problems organizations face today are not only quantitative but also qualitative and can be difficult to measure. To address these problems, soft systems have been combined with systems engineering concepts to model, improve, and optimize organizational systems. This approach takes a more human, social, and sustainable perspective and investigates the context in which organizations operate to achieve continuous improvement [16,17].

Ensuring sustainable development of both new and existing urban sites, along with improving their resilience to cope with limited access to water resources, energy, green spaces, and essential services such as health, leisure, education, and culture, has become an increasingly complex problem. Finding sustainable solutions for this issue requires accounting for a vast range of heterogeneous variables and adopting low-impact, environmentally friendly technologies during implementation [18,19].

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It is possible to use decision-making tools to optimize building design parameters that will reduce carbon emissions, as stated in reference [20]. Additionally, poor-quality buildings can lead to health problems and decreased productivity in work environments, [21]. Urban sprawl harms the environment, causing the loss of natural resources. However, low-impact alternatives can be adapted to existing urban areas, which can address a range of issues that affect the population. For example, such alternatives can provide food locally, extend the useful life of sewage and drainage systems by capturing and reusing water, mitigate floods, reduce travel times in urban areas, and reduce the adverse effects of heat islands, among other benefits [22–26]. Multi-objective optimization models are also used to achieve more sustainable urban growth, seeking economically feasible solutions that can be adapted on an increasingly larger scale [27].

The issues above present diverse and stimulating fields for future exploration that shall continue to evolve in light of the rising demand for sustainable and low-impact engineering and urban development solutions to address increasingly complex and pressing problems. There is a pressing need for scientific advancement and research that combines various engineering, mathematical, computational, and systemic techniques to identify innovative and cutting-edge solutions to address these complex and high-priority challenges.

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References

1. Patriarca, R.; Bergström, J.; Di Gravio, G.; Costantino, F. Resilience engineering: Current status of the research and future challenges. *Saf. Sci.* **2018**, *102*, 79–100. [CrossRef]
2. Tseng, M.L.; Tran, T.P.T.; Ha, H.M.; Bui, T.D.; Lim, M.K. Sustainable industrial and operation engineering trends and challenges Toward Industry 4.0: A data driven analysis. *J. Ind. Prod. Eng.* **2021**, *38*, 581–598. [CrossRef]
3. Heo, S.; Han, S.; Shin, Y.; Na, S. Challenges of data refining process during the artificial intelligence development projects in the architecture, engineering and construction industry. *Appl. Sci.* **2021**, *11*, 10919. [CrossRef]
4. Mishra, U.; Wu, J.Z.; Sarkar, B. A sustainable production-inventory model for a controllable carbon emissions rate under shortages. *J. Clean. Prod.* **2020**, *256*, 120268. [CrossRef]
5. Naha, A.; Antony, S.; Nath, S.; Sharma, D.; Mishra, A.; Biju, D.T.; Madhavan, A.; Binod, P.; Varjani, S.; Sindhu, R. A hypothetical model of multi-layered cost-effective wastewater treatment plant integrating microbial fuel cell and nanofiltration technology: A comprehensive review on wastewater treatment and sustainable remediation. *Environ. Pollut.* **2023**, *323*, 121274. [CrossRef] [PubMed]
6. Laveneziana, L.; Prussi, M.; Chiaramonti, D. Critical review of energy planning models for the sustainable development at company level. *Energy Strategy Rev.* **2023**, *49*, 101136. [CrossRef]
7. Singh, A. Sustainable Waste Management Through Systems Engineering Models and Remote Sensing Approaches. *Circ. Econ. Sustain.* **2022**, *2*, 1105–1126. [CrossRef]
8. Pal, R.; Das, P.; Chattaraj, P.K. Global Optimization: A Soft Computing Perspective. *J. Phys. Chem. Lett.* **2023**, *14*, 3468–3482. [CrossRef]
9. Molina, D.; LaTorre, A.; Herrera, F. An insight into bio-inspired and evolutionary algorithms for global optimization: Review, analysis, and lessons learnt over a decade of competitions. *Cogn. Comput.* **2018**, *10*, 517–544. [CrossRef]
10. Guo, Y.; Zhao, H.; Zhang, S.; Wang, Y.; Chow, D. Modeling and optimization of environment in agricultural greenhouses for improving cleaner and sustainable crop production. *J. Clean. Prod.* **2021**, *285*, 124843. [CrossRef]
11. Tovar-Facio, J.; Martín, M.; Ponce-Ortega, J.M. Sustainable energy transition: Modeling and optimization. *Curr. Opin. Chem. Eng.* **2021**, *31*, 100661. [CrossRef]
12. Gholizadeh, H.; Goh, M.; Fazlollahtabar, H.; Mamashli, Z. Modelling uncertainty in sustainable-green integrated reverse logistics network using metaheuristics optimization. *Comput. Ind. Eng.* **2022**, *163*, 107828. [CrossRef]
13. Abualigah, L.; Hanandeh, E.S.; Zitar, R.A.; Thanh, C.L.; Khatir, S.; Gandomi, A.H. Revolutionizing sustainable supply chain management: A review of metaheuristics. *Eng. Appl. Artif. Intell.* **2023**, *126*, 106839. [CrossRef]
14. Maier, H.R.; Razavi, S.; Kapelan, Z.; Matott, L.S.; Kasprzyk, J.; Tolson, B.A. Introductory overview: Optimization using evolutionary algorithms and other metaheuristics. *Environ. Model. Softw.* **2019**, *114*, 195–213. [CrossRef]
15. Liu, Q.; Li, X.; Liu, H.; Guo, Z. Multi-objective metaheuristics for discrete optimization problems: A review of the state-of-the-art. *Appl. Soft Comput.* **2020**, *93*, 106382. [CrossRef]

16. Yeh, S.C.; Hsieh, Y.L.; Yu, H.C.; Tseng, Y.H. The trends and content of research related to the Sustainable Development Goals: A systemic review. *Appl. Sci.* **2022**, *12*, 6820. [CrossRef]
17. Inigo, E.A.; Albareda, L. Understanding sustainable innovation as a complex adaptive system: A systemic approach to the firm. *J. Clean. Prod.* **2016**, *126*, 1–20. [CrossRef]
18. Tonne, C.; Adair, L.; Adlakha, D.; Anguelovski, I.; Belesova, K.; Berger, M.; Dadvand, P.; Dimitrova, A.; Giles-Corti, B.; Heinz, A.; et al. Defining pathways to healthy sustainable urban development. *Environ. Int.* **2021**, *146*, 106236. [CrossRef]
19. Peng, F.L.; Qiao, Y.K.; Sabri, S.; Atazadeh, B.; Rajabifard, A. A collaborative approach for urban underground space development toward sustainable development goals: Critical dimensions and future directions. *Front. Struct. Civ. Eng.* **2021**, *15*, 20–45. [CrossRef]
20. Elbeltagi, E.; Wefki, H.; Khallaf, R. Sustainable Building Optimization Model for Early-Stage Design. *Buildings* **2023**, *13*, 74. [CrossRef]
21. Castro-Lacouture, D.; Sefair, J.A.; Flórez, L.; Medaglia, A.L. Optimization model for the selection of materials using a LEED-based green building rating system in Colombia. *Build. Environ.* **2009**, *44*, 1162–1170. [CrossRef]
22. Ziaee, S.; Gholampour, Z.; Soleymani, M.; Doraj, P.; Eskandani, O.H.; Kadaei, S. Optimization of Energy in Sustainable Architecture and Green Roofs in Construction: A Review of Challenges and Advantages. *Complexity* **2022**, *2022*, 1–15. [CrossRef]
23. Mehta, R. Optimal Design and Modeling of Sustainable Buildings Based on Multivariate Fuzzy Logic. *Int. J. Sustain. Dev. Plan.* **2021**, *16*, 195–206. [CrossRef]
24. Avin, L.; Nourzad, H.; Hossein, S.; Vahid, F. Optimizing Sustainability of Infrastructure Projects Through the Integration of Building Information Modeling and Envision Rating System at the Design Stage. *Digit. Arch.* **2022**, *84*, 104013.
25. Garba, A.; Olaleye, Y.O.; Jibrin, N.S. Material Resources Optimization for Sustainable Construction in Nigeria. *J. Eng. Archit.* **2016**, *4*, 33–47.
26. Latifi, M.; Rakhshandehroo, G.; Reza-Nikoo, M.; Sadegh, M. A game theoretical low impact development optimization model for urban storm water management. *J. Clean. Prod.* **2019**, *241*, 118323. [CrossRef]
27. Abouhelal, D.; Kamel, W.; Bassioni, H. Informatic Analysis and Review of Literature on the Optimum Selection of Sustainable Materials Used in Construction Projects. *Int. J. Sustain. Constr. Eng. Technol.* **2023**, *14*, 97–109. [CrossRef]