

Smart, Low-Carbon, and Competitive: Prioritizing Carbon Border Adjustment Mechanism Readiness Criteria for Free Industrial Zones Using Fuzzy Multi-Criteria Decision-Making Framework

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ABSTRACT

The competitiveness of free industrial zones critical nodes in global urban and economic networks is increasingly determined by carbon-regulated trade, particularly following the European Union's Carbon Border Adjustment Mechanism (CBAM). While these zones have traditionally relied on spatial and fiscal incentives, CBAM introduces a new competitiveness logic that demands intelligent monitoring systems, digital carbon reporting, and smart low-carbon infrastructure. This study identifies and prioritizes the key criteria needed for Mediterranean free zones to transition into smart, sustainable industrial hubs capable of competing under CBAM, with particular relevance to Libya. Eight CBAM-readiness criteria were evaluated: intelligent carbon emissions measurement and reporting, access to smart low-carbon energy grids, industrial decarbonization capability, digital CBAM compliance support, EU market exposure, green logistics and port decarbonization, financial risk management, and green investment clustering. Using Multi-Criteria Decision-Making model represented by the Fuzzy Criteria Importance Assessment (F-CIMAS) method with expert linguistic judgments and triangular fuzzy numbers, the results show that Carbon Emissions Measurement and Reporting Readiness which depends heavily on robust data intelligence systems is the most critical criterion, followed by Access to Low-Carbon Energy. These findings indicate that free zones must prioritize the digital and technical architecture for emissions tracking before broader green investment strategies can succeed. The study contributes to the literature on urban intelligence and sustainable industrial development by shifting the analytical focus from traditional incentives to digitally enabled, CBAM-ready export platforms.

1. Introduction

The competitiveness of free zones has traditionally been explained through their ability to reduce investment and trade frictions by offering fiscal incentives, customs exemptions, simplified administrative procedures, developed infrastructure, and access to regional and international

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markets [1]. For decades, special economic zones and free zones have been used by developing and emerging economies as instruments for export promotion, foreign direct investment attraction, industrial upgrading, employment creation, and integration into global value chains [2]. However, the conventional competitiveness model of free zones is increasingly being challenged by structural changes in global production and trade. Investors and exporters are no longer concerned only with tax advantages, logistics costs, or customs facilitation; they are also required to comply with environmental, social, and carbon-related requirements imposed by destination markets [3]. This means that the future competitiveness of free zones, particularly those located near the European market, will depend not only on their ability to move goods efficiently, but also on their ability to support low-carbon, traceable, and compliant production systems [4].

This shift has become more urgent with the introduction of the European Union Carbon Border Adjustment Mechanism (CBAM). Regulation (EU) 2023/956 establishes CBAM as a mechanism to address greenhouse gas emissions embedded in selected imported goods entering the EU customs territory, with the stated purpose of preventing carbon leakage and aligning the carbon cost of imports with the carbon cost faced by EU producers [5]. The mechanism initially covers carbon-intensive sectors such as cement, iron and steel, aluminium, fertilisers, electricity, and hydrogen. During the transitional phase, importers were mainly required to report embedded emissions; however, the definitive phase beginning in 2026 introduces stronger obligations related to authorised CBAM declarants, emissions declarations, and the surrender of CBAM certificates. As a result, CBAM transforms carbon intensity from a purely environmental issue into a market-access, compliance, and competitiveness issue for non-EU exporters [6].

Recent literature and policy analysis suggest that CBAM may reshape international trade flows by creating advantages for countries and firms with lower-carbon production systems. OECD analysis indicates that CBAM can mitigate carbon leakage by redirecting EU imports from less carbon-efficient countries toward more carbon-efficient producers, while also creating new competitiveness pressures for exporters and downstream sectors [7]. In the Mediterranean context, this is particularly important because many economies around the Union for the Mediterranean depend on trade with the EU, yet may face technological, financial, and institutional constraints in meeting carbon-related standards [8]. Therefore, CBAM should not be treated merely as an EU environmental policy; it represents a new trade-regulatory environment in which carbon measurement, energy structure, industrial decarbonisation, verification capacity, and carbon-cost management become determinants of export competitiveness [9].

At the same time, the role of free zones themselves is evolving. UNCTAD has emphasized that special economic zones are moving beyond traditional economic objectives and increasingly incorporating sustainability goals, including environmental performance, circular economy models, innovation, and alignment with national net-zero strategies [10]. This evolution creates a new research problem: if free zones are expected to remain competitive as export platforms, they must develop the institutional, industrial, energy, and logistics capabilities required to help investors comply with carbon-related market requirements. Existing studies on free zones have widely examined investment incentives, logistics performance, governance, trade facilitation, and infrastructure readiness. However, limited attention has been given to how free zones can prepare for carbon border regulations, and even less research has attempted to prioritize the criteria that define CBAM readiness from a multi-criteria decision-making perspective [11].

Libya provides a particularly relevant context for this research [12]. The country's free zones have generally been promoted as tools for economic diversification, foreign investment attraction, industrial development, and trade facilitation [13]. Among them, Misurata Free Zone is the most

developed and strategically visible case. Established in 2000, it is located on the Mediterranean coast and is directly linked to Libya's largest and busiest commercial seaport, which is reported by the Misurata Free Zone authority to handle around 40% of the country's non-oil trade [14]. The zone offers investors tax and customs exemptions and positions itself as a gateway connecting Libya with African, Mediterranean, and global markets. Nevertheless, the traditional advantages of location, incentives, and port access may not be sufficient in the emerging carbon-regulated trade environment. If Libyan free zones aim to attract export-oriented industries serving European markets, they will increasingly need to demonstrate readiness in emissions measurement, low-carbon energy access, industrial decarbonisation, compliance support, and green logistics [15].

The relevance of this issue has increased further following the recent strategic partnership announced by Misurata Free Zone in January 2026. The agreement with Maha Capital Partners and Terminal Investment Limited, the investment and operating arm of the MSC Group, aims to develop, modernize, and expand Misurata Free Zone Port into a major Mediterranean logistics gateway and regional transshipment hub [16]. The announced project includes phased capacity expansion, upgrades to operating systems, equipment, berths, and yards, integration of advanced Terminal Operating Systems, facilities capable of accommodating large container vessels, and closer integration between the port, the free zone, and the surrounding industrial and logistics ecosystem. While this agreement strengthens the logistics and investment position of the zone, it also raises an important strategic question: can the modernization of the free-zone port be aligned with the emerging requirements of carbon-regulated export competitiveness? In other words, the future role of Misurata Free Zone should not be assessed only through container capacity, shipping connectivity, or logistics efficiency, but also through its ability to become a CBAM-ready platform for low-carbon industrial and trade activities.

Accordingly, this paper aims to identify and prioritize the key criteria required for Mediterranean free zones, with particular relevance to the Libyan context, to compete under the EU Carbon Border Adjustment Mechanism. The study applies the Fuzzy Criteria Importance Assessment (F-CIMAS) method to weight a set of CBAM-readiness criteria under expert judgment and uncertainty. The proposed criteria include carbon emissions measurement and reporting readiness, access to low-carbon energy, industrial decarbonisation capability, CBAM compliance and verification support, EU market exposure and sectoral vulnerability, green logistics and port decarbonisation, carbon cost and financial risk management, and green investment attraction and industrial clustering. By prioritizing these criteria, the paper contributes to the literature on free-zone competitiveness, sustainable industrial development, and carbon-regulated trade by shifting the analytical focus from traditional investment incentives toward carbon-compliant export readiness.

2. Methodology

The proposed F-CIMAS method integrates the experience-based weighting of the original CIMAS approach with fuzzy logic principles to derive criteria weights. The steps of the proposed method are detailed below [17]. The main steps have been depicted in Figure 1.

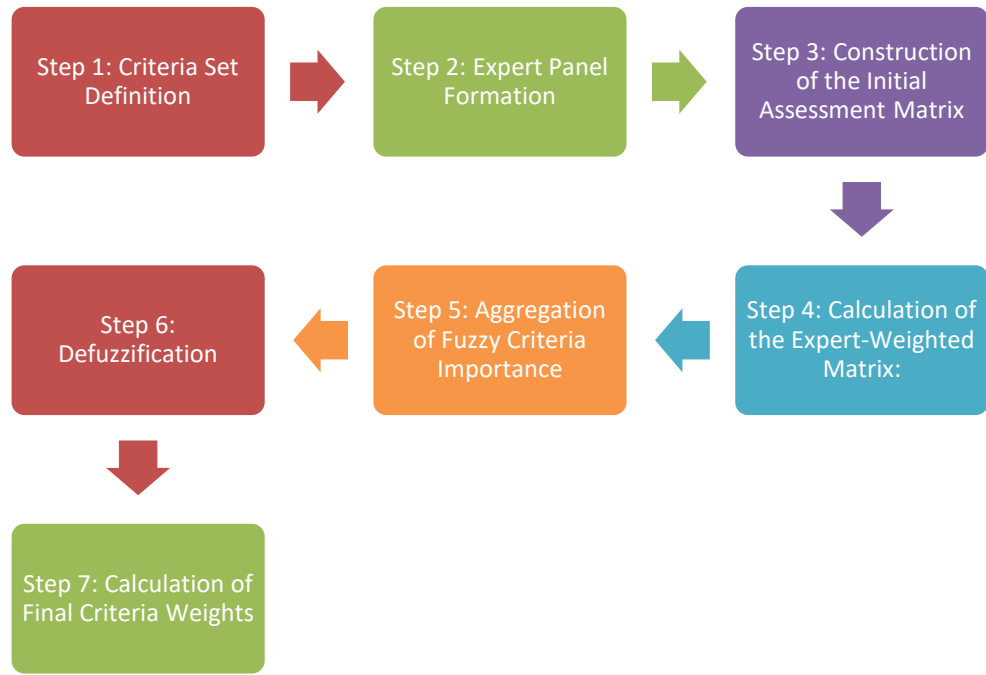


Fig. 1. The main steps of the adopted fuzzy decision-making model

Step 1: Criteria Set Definition

Define the decision framework by identifying the set of evaluation criteria, $C_1, C_2, C_3, \dots, C_n$ and the panel of experts $E_1, E_2, E_3, \dots, E_q$ participating in the study.

Step 2: Expert Panel Formation

The relative importance, or weight, of each expert is determined based on their years of experience. Equation (1) is used to calculate these weights, ensuring that the sum of all expert weights equals one.

$$W^{E_i} = \frac{E_i}{\sum_{i=1}^q E_i}, i = 1, 2, \dots, q \quad (1)$$

Step 3: Construction of the Initial Assessment Matrix

Experts assess the importance of each criterion using the predefined linguistic scale presented in Table 1.

Table 1
Fuzzy linguistic evaluation scale

Linguistic terms	Membership function
Extremely Low (EL)	(0,0,1)
Very Low (VL)	(1,1,2)
Medium Low (ML)	(2,3,4)
Medium (M)	(4,5,6)
Medium High (MH)	(5,6,7)
High (H)	(6,7,8)
Very High (VH)	(8,9,10)
Extremely High (EH)	(9,10,10)

These ratings are compiled into an initial decision matrix, as illustrated in Table 2, where $\tilde{x}_{ij}$ represents the score assigned by expert E_i to criterion C_j .

Table 2
Initial decision matrix

Experts/ Criteria	C1	C2	...	Cj	...	Cp	Expert's weights
E_1	$\tilde{x}_{11}$	$\tilde{x}_{12}$	...	$\tilde{x}_{1j}$	...	$\tilde{x}_{1p}$	W^{E_1}
E_2	$\tilde{x}_{21}$	$\tilde{x}_{22}$	...	$\tilde{x}_{2j}$	...	$\tilde{x}_{2p}$	W^{E_2}
E_i	...	...	...	$\tilde{x}_{ij}$	...	...	...
E_q	$\tilde{x}_{q1}$	$\tilde{x}_{q2}$	...	$\tilde{x}_{qj}$	...	$\tilde{x}_{qp}$	W^{E_q}

Step 4: Calculation of the Expert-Weighted Matrix:

To account for the varying reliability of experts, each fuzzy assessment is weighted by the expert's specific weight W_i^E derived in Step 2. The weighted fuzzy value $\tilde{v}_{ij}$ is calculated using equation 2.

$$\tilde{v}_{ij} = \tilde{x}_{ij} \otimes W_i^E = (l_{ij} \cdot W_i^E, m_{ij} \cdot W_i^E, u_{ij} \cdot W_i^E) \quad (2)$$

Step 5: Aggregation of Fuzzy Criteria Importance

The total fuzzy importance score $\tilde{S}_j$ for each criterion C_j is obtained by aggregating the weighted assessments from all experts using fuzzy addition using equation 3.

$$\tilde{S}_j = \sum_{i=1}^k \tilde{v}_{ij} = (\sum_{i=1}^k l_{ij} W_i^E, \sum_{i=1}^k m_{ij} W_i^E, \sum_{i=1}^k u_{ij} W_i^E) \quad (3)$$

Step 6: Defuzzification

To rank the criteria and determine usable weights, the aggregated fuzzy scores $\tilde{S}_j = (L_j, M_j, U_j)$ are converted into crisp values K_j . This study applies the Center of Area (CoA) method showed in equation 4.

$$K_j = \frac{L_j + M_j + U_j}{3} \quad (4)$$

Step 7: Calculation of Final Criteria Weights

Finally, the crisp values are normalized to ensure that the sum of all weights equals 1. The final weight w_j for criterion j is calculated using equation 5.

$$w_j = \frac{K_j}{\sum_{j=1}^n K_j} \quad (5)$$

3. Results

To ensure the validity and reliability of the research findings, a panel of five experts was consulted. The decision-making framework identifies eight main criteria for evaluating CBAM readiness in Mediterranean free zones: Carbon Emissions Measurement and Reporting Readiness, Access to Low-Carbon Energy, Industrial Decarbonization Capability, CBAM Compliance and Verification Support, EU Market Exposure and Sectoral Vulnerability, Green Logistics and Port Decarbonization, Carbon Cost and Financial Risk Management, and Green Investment Attraction and Industrial Clustering, as detailed in Table 3. The experts used the fuzzy linguistic evaluation scale presented in Table 1 to assess the relative importance of each criterion. Their judgments were then processed using the F-CIMAS method, with expert weights determined based on years of professional experience.

Table 3

Criteria used in the study

Criteria No	Description
C1	Carbon Emissions Measurement and Reporting Readiness
C2	Access to Low-Carbon Energy
C3	Industrial Decarbonization Capability
C4	CBAM Compliance and Verification Support
C5	EU Market Exposure and Sectoral Vulnerability
C6	Green Logistics and Port Decarbonization
C7	Carbon Cost and Financial Risk Management
C8	Green Investment Attraction and Industrial Clustering

The F-CIMAS method was applied to the data provided by the five experts. The analysis commenced with the determination of expert weights, followed by the aggregation of fuzzy assessments and the final derivation of crisp criteria weights.

Step 1: Determination of Expert Weights: The relative influence of each expert was quantified according to their professional experience to ensure that the resulting criteria weights reflect the panel's collective expertise. The cumulative professional experience of the panel was calculated as 63 years. Using Equation (1), the individual weight (W_i^E) for each expert was derived by normalizing their years of experience against the group total and presented in table 4.

Table 4
Expert Profiles and Weights

Expert	Experience (Years)	Yi/T	Weight
E1	15	15/63	0.238
E2	8	8/63	0.127
E3	12	12/63	0.191
E4	10	10/63	0.159
E5	18	18/63	0.286

Step 2: Aggregation and Defuzzification: Following the established methodology, the expert panel evaluated the eight criteria using the predefined linguistic scale illustrated in Table 4. These assessments were transformed into Triangular Fuzzy Numbers (TFNs), weighted by the respective expert weights, and aggregated to establish the fuzzy importance score ($\tilde{S}_j$) for each criterion. Finally, the Center of Area method was used to defuzzify these scores into crisp values (Kj), which were normalized to obtain the final global weights (wj).

Table 5
Initial decision matrix

Expert	C1	C2	C3	C4	C5	C6	C7	C8
E1	VH	VH	M	VH	H	M	M	M
E2	VH	H	MH	VH	MH	M	M	ML
E3	VH	VH	H	VH	M	ML	ML	M
E4	H	VH	MH	H	M	ML	M	ML
E5	VH	H	M	H	M	MH	M	M

Table 6 presents the aggregated fuzzy importance scores ($\tilde{S}_j$) for the eight evaluation criteria. These values are expressed as Triangular Fuzzy Numbers (TFNs), characterized by a lower bound (l), a modal value (m), and an upper bound (u). This fuzzy representation captures the collective judgment of the expert panel while preserving the inherent subjectivity and vagueness associated with linguistic assessments. For instance, the high-magnitude fuzzy scores obtained for Carbon Emissions Measurement and Reporting Readiness (C1), Access to Low-Carbon Energy (C2), and CBAM Compliance and Verification Support (C4) indicate that the experts considered these criteria to be the most critical requirements for enhancing the readiness of Mediterranean free zones to compete under CBAM-related trade conditions.

Table 6
Aggregated Fuzzy Criteria Weights

Dimension	Aggregate Fuzzy Number $\tilde{S}_j(l, m, u)$	Defuzzified score K_j
C1	(7.6825, 8.6825, 9.6825)	8.6825
C2	(7.1746, 8.1746, 9.1746)	8.1746
C3	(4.6667, 5.6667, 6.6667)	5.6667
C4	(7.1111, 8.1111, 9.1111)	8.1111
C5	(4.6032, 5.6032, 6.6032)	5.6032
C6	(3.5873, 4.5873, 5.5873)	4.5873
C7	(3.6190, 4.6190, 5.6190)	4.6190
C8	(3.4286, 4.4286, 5.4286)	4.4286

Tables 6 and 7 depicts the final prioritization of the criteria following the defuzzification and normalization phases. The crisp scores (K_j), derived via the Center of Area method, provide a single representative value for each criterion, transforming the fuzzy data into actionable metrics for direct comparison. These scores were subsequently normalized to produce the final global weights (w_j), which determine the hierarchical ranking of the factors from most to least critical. The resulting hierarchy provides a clear prioritization of the CBAM-readiness criteria, identifying Carbon Emissions Measurement and Reporting Readiness (C1) as the most significant requirement, followed by Access to Low-Carbon Energy (C2) and CBAM Compliance and Verification Support (C4). In contrast, Green Investment Attraction and Industrial Clustering (C8) received the lowest relative weight. This does not imply that it is unimportant; rather, it suggests that experts perceive it as a longer-term outcome that depends on the prior establishment of reliable emissions measurement systems, cleaner energy access, and effective compliance-support mechanisms. Therefore, the results provide policymakers, free-zone authorities, and investors with a structured roadmap for prioritizing interventions that can strengthen the CBAM readiness and carbon competitiveness of Mediterranean free zones.

Table 7
Crisp Scores, Final Weights, and Ranking

Dimension	Final Weight (w_j)	Rank
C1	0.1741	1
C2	0.1639	2
C3	0.1136	4
C4	0.1626	3
C5	0.1123	5
C6	0.0920	7
C7	0.0926	6
C8	0.0888	8

4. Conclusions

This paper addressed the emerging need to rethink the competitiveness of Mediterranean free zones under the European Union Carbon Border Adjustment Mechanism. While free zones have traditionally competed through fiscal incentives, customs facilitation, logistics advantages, and access to regional markets, CBAM introduces a new competitiveness logic in which carbon performance, emissions transparency, compliance capacity, and low-carbon industrial readiness

become decisive factors. By applying the F-CIMAS method, the study prioritized eight CBAM-readiness criteria relevant to free zones seeking to maintain or strengthen their role as export-oriented platforms. The results indicate that Carbon Emissions Measurement and Reporting Readiness, Access to Low-Carbon Energy, and CBAM Compliance and Verification Support are the most critical criteria. This suggests that the first challenge for free zones is not only to reduce emissions, but also to build the institutional and technical capacity required to measure, document, verify, and manage carbon-related obligations.

The findings have important implications for Libya and other Mediterranean economies aiming to position their free zones as competitive gateways to European markets. In the case of Misurata Free Zone, recent developments in port modernization and international partnership provide a strategic opportunity to align logistics expansion with carbon-regulated trade requirements. However, infrastructure development alone will not be sufficient unless accompanied by clear CBAM-support mechanisms, access to cleaner energy, industrial decarbonization pathways, and green logistics practices. Therefore, policymakers and free-zone authorities should treat CBAM readiness as a strategic component of investment attraction and export competitiveness. Future research may extend this study by evaluating the actual performance of selected Mediterranean free zones against the proposed criteria, comparing expert groups, or integrating the F-CIMAS weights with ranking methods to assess alternative policy scenarios or free-zone development strategies, moreover, the CIMAS can be adopted in other fuzzy environments to compare the results, such as, q-Rung Orthopair Spherical Fuzzy sets [18], Decomposed Pythagorean Fuzzy sets [19], Fermatean picture fuzzy sets [20], and using other MCDM methods, such as, AHP, TOPSIS, BWM, LOGSTA and SWARA [21-25].

Author Contributions

Conceptualization, I.B.; methodology, I.B.; validation, J.M.; formal analysis, I.B.; writing original draft preparation, I.B.; writing review and editing, J.M.; project administration, I.B. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- [1] Frick, S.A. and A. Rodríguez-Pose. (2023). What draws investment to special economic zones? Lessons from developing countries. *J Regional Studies*, 57(11), 2136-2147. <https://doi.org/10.1080/00343404.2023.2185218>
- [2] Alansary, O.S.-a. and T. Al-Ansari. (2023). Defining 'free zones': A systematic review of literature. *J Heliyon*, 9(4), <https://doi.org/10.1016/j.heliyon.2023.e15344>
- [3] Amiri, M.J., V. Moghaddamzadeh, and G. Nabi Bidhendi. (2024). Development of an integrated model of planning and management in free zones with an emphasis on environmental pressures. *J Journal of Public Administration*, 16(1), 182-205.
- [4] Liu, J., et al. (2025). Carbon border adjustment mechanism as a catalyst for greenfield investment: Evidence from chinese listed firms using a difference-in-differences model. *J Sustainability*, 17(8), 3492. <https://doi.org/10.3390/su17083492>

- [5] Wróblewskaa, M. and M. Zmitrowiczb. (2024). Carbon border adjustment mechanism as proposed eu regulation to combat climate change. *J Interaction of Law Economics: Sustainable Development*, 260. <https://doi.org/10.2478/9788367405331-030>
- [6] Walczak, N., K. Huremović, and A. Rungi. (2025). Evaluating the eu carbon border adjustment mechanism with a quantitative trade model. *J arXiv preprint arXiv*, 2506. <https://doi.org/10.2139/ssrn.5738322>
- [7] Magacho, G., E. Espagne, and A. Godin. (2024). Impacts of the cbam on eu trade partners: Consequences for developing countries. *J Climate policy*, 24(2), 243-259. <https://doi.org/10.1080/14693062.2023.2200758>
- [8] Dechezleprêtre, A., et al. (2025). Carbon border adjustments: The potential effects of the eu cbam along the supply chain. *J OECD Science, Technology*, 2025(02), <https://doi.org/10.1787/e8c3d060-en>
- [9] Zhong, J. and J. Pei. (2024). Carbon border adjustment mechanism: A systematic literature review of the latest developments. *J Climate Policy*, 24(2), 228-242. <https://doi.org/10.1080/14693062.2023.2190074>
- [10] Liu, X., et al. (2022). Can the special economic zones promote the green technology innovation of enterprises? An evidence from china. *J Frontiers in Environmental Science*, 10(870019). <https://doi.org/10.3389/fenvs.2022.870019>
- [11] Wang, Y. and Q. Kong. (2024). The impact of free trade zones on corporate sustainability performance: An empirical examination from the dual perspectives of financial and environmental performance. *J Sustainability*, 16(21), 9376. <https://doi.org/10.3390/su16219376>
- [12] Badi, I., et al. (2025). Advancing sustainable logistics and transport systems in free trade zones: A multi-criteria decision-making approach for strategic sustainable development. *J International journal of sustainable development goals*, 1(45-55). <https://doi.org/10.59543/ijisdg.v1i.14213>
- [13] Badi, I.Z.S.M.B. (2023). Evaluating free zone industrial plant proposals using a combined full consistency method-grey-cocoso model. *J J. Ind Intell*, 1(2), 101-109. <https://doi.org/10.56578/jii010203>
- [14] Badi, I. and A. Abdulshahid. (2023). Unlocking economic opportunities: Libya as a maritime gateway for landlocked african countries. *J African Transport Studies*, 1(100004). <https://doi.org/10.1016/j.afran.2024.10000>
- [15] Pamucar, D., I. Badi, and Z. Stevic. (2022). An integrated fucom-rafsi model for assessing the potential of a new gateway port in libya for some african landlocked countries. *J International Journal for Quality Research*, 16(2), <https://doi.org/10.24874/IJQR16.02-17>
- [16] MFZ, M.F.Z. [cited 2026 26/4/2026]; Available from: <https://www.mfzly.com/en/>
- [17] Memarpour Ghiaci, A., M. Abbasi, and J. Gheidari-Kheljani. (2025). Enhancing sustainability in modular megaprojects through an sf-cimas approach for identifying and prioritizing supplier evaluation criteria. *J Research in Production Operations Management*, 16(3), 99-130.
- [18] Prashar, A., Devi, P., Kumar, A., Dhiman, N., Devi, M., Kumar, A., & Guleria, A. (2026). Exponential Similarity Measures Under q-Rung Orthopair Spherical Fuzzy Environment Application To Multi-Criteria Decision-Making. *Intelligent Systems Research and Applications Journal*, 2, 230-251. <https://doi.org/10.59543/ry100w60>
- [19] Turgay, S., Torkul, B., Aydin, A., & Özyurt, F. (2026). A Novel Decomposed Pythagorean Fuzzy CODAS Framework for Precision Customer Segmentation in Complex Market Environments. *Intelligent Systems Research and Applications Journal*, 2, 160-198. Ali, U., Li, J., <https://doi.org/10.59543/r8xsq450>
- [20] T Senapati, T., Edalatpanah, S. A., Duleba, S., & Moslem, S. (2026). A hybrid decision-making model in a complex Fermatean picture fuzzy environment with application to emergency management. *Complex & Intelligent Systems*, 12(1), 15. <https://doi.org/10.1007/s40747-025-02112-3>
- [21] Ekici, Ü., Akay, M. E., & Moslem, S. (2026). Determination of logistics center locations in Türkiye using AHP-based TOPSIS methods. *Transportation Research Interdisciplinary Perspectives*, 37, 101967. <https://doi.org/10.1016/j.trip.2026.101967>
- [22] Jorshary, K. M., Sassani, M., Raoufi, S., & Khamoushi, S. (2025). Ranking of AI-Driven Strategies for Optimizing the Health Tourism Supply Chain Using Stratified BWM. *Knowledge and Decision Systems with Applications*, 1, 295-315. <https://doi.org/10.59543/kadsa.v1i.15051>
- [23] Akbulut, O. Y. (2026). A Novel Integrated MCDM Framework for ESG Risk Assessment in Manufacturing Firms: The LOGSTA-SPC-MUNRA Hybrid Model. *Knowledge and Decision Systems with Applications*, 2, 502-523. <https://doi.org/10.59543/krvgw760>
- [24] Solieman, H., & Al-lami, A. (2025). Integrating Analytic Hierarchy Process and Parsimonious Preference Information for Socio-Economic Sustainability Assessment in Urban Public Transport. *International Journal of Sustainable Development Goals*, 1, 387-408. <https://doi.org/10.59543/ijisdg.v1i.17011>
- [25] Moslem, S., Stević, Ž., Tanackov, I., & Pilla, F. (2023). Sustainable development solutions of public transportation: An integrated IMF SWARA and Fuzzy Bonferroni operator. *Sustainable cities and society*, 93, 104530. <https://doi.org/10.1016/j.scs.2023.104530>