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Decarbonizing the Maritime Industry: A Collaborative Path Forward

Yudan Whulanza[1]*, Eny Kusrini[2,3,4], Muhamad Arif Budiyanto[1], Arnas[1], Yanuar[1]

[1]*Department of Mechanical Engineering, Faculty of Engineering, Universitas Indonesia, Kampus Baru UI, Depok 16424, Indonesia*
[2]*Department of Chemical Engineering, Faculty of Engineering, Universitas Indonesia, Kampus Baru UI, Depok 16424, Indonesia*
[3]*Research Group of Green Product and Fine Chemical Engineering, Laboratory of Chemical Product Engineering, Department of Chemical Engineering, Universitas Indonesia, Kampus Baru UI, Depok, 16424, Indonesia*
[4]*Tropical Renewable Energy Research Center, Faculty of Engineering, Universitas Indonesia, Kampus Baru UI, Depok, 16424, Indonesia*

The maritime industry is embarking on an ambitious journey to decarbonize its operations, driven by collective frameworks and practical innovations that prioritize sustainability. The maritime industry's decarbonization journey is deeply influenced by international policies and regulatory frameworks. Key initiatives such as the IMO 2023 targets, the Energy Efficiency Existing Ship Index (EEXI), and the Carbon Intensity Indicator (CII) have created a strong mandate for reducing greenhouse gas emissions (IMO, 2023). Shipping industry leaders have emphasized the importance of collaboration, transparency, and data-driven strategies to reduce emissions and achieve environmental goals.

At the heart of this transformation lies the Sea Cargo Charter, a framework promoting accountability and transparency in emissions reporting. A leading shipping company, Chevron, adoption of the charter has been transformative. By implementing robust systems for data collection and benchmarking, the company integrated emissions data into its chartering decisions, reshaping its operational practices. This collaborative framework also allowed Chevron to compare performance across its operated, spot, and time-chartered fleets, fostering a culture of continuous improvement (Beullens, Ge, and Hudson, 2023; Chen *et al.,* 2023; Sun *et al.,* 2023).

Practical measures are central to the industry's decarbonization strategy. Biofuels, for instance, offer an immediate and impactful solution. A cargo operator highlighted the success of their biofuel program, which has supplied 100,000 tons of biofuels in hubs like Rotterdam and Singapore. This initiative not only showcases the feasibility of biofuel adoption but also underscores its potential as a short-term measure to reduce emissions without requiring major infrastructure investments (Bouzekri, Alpan, and Giard, 2023; Argüello *et al.,* 2022).

Technological innovation is another cornerstone of the industry's efforts. Energy-saving devices, such as wind wings and rotor sails, are harnessing the power of wind to reduce fuel consumption. Digital tools, including route optimization software, are further aiding emissions reduction by identifying the most fuel-efficient routes. These advancements demonstrate the industry's commitment to integrating technology for operational efficiency

*Corresponding author's email: yudan.whulanza@ui.ac.id, Tel.: +62-217270032; Fax.: +62-217270033
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and environmental impact (Kjeldsberg and Munim, 2024; Polemis and Bentsos, 2024). Data standardization has proven essential in accelerating these efforts. Initially, ship owners were hesitant to share operational data, but the Sea Cargo Charter's data-sharing clause has since become an industry standard. This shift has enabled stakeholders to pinpoint inefficiencies across trade lanes, identify congestion hotspots, and optimize fuel usage (Sung, Zografakis, and Nielsen, 2022). By simplifying and standardizing data ecosystems, the industry is creating a foundation for informed decision-making and meaningful change.

Operational measures, while effective in reducing emissions, also deliver tangible financial benefits. Chevron's eco-steaming program is a prime example, saving 2,000 tons of CO2 in one year through optimized vessel speeds (Yuan, Shi, and He, 2024). These savings not only reduce environmental impact but also cut fuel costs, demonstrating the economic viability of sustainability initiatives. The return on investment for such measures is often immediate, providing strong incentives for widespread adoption.

Looking to the future, the maritime industry is investing in long-term solutions to maintain momentum in its decarbonization journey. A cargo operator shared plans for the delivery of five dual-fuel vessels by 2025, designed to be 20-30% more fuel-efficient than existing ships (Fadiga, Ferreira, and Bigotte, 2024). In parallel, advancements in anti-fouling systems and just-in-time arrival technologies are further enhancing operational efficiency and reducing emissions.

Frameworks like the ambition statement are instrumental in uniting stakeholders and accelerating progress. These initiatives provide a platform for knowledge sharing, collaboration, and innovation, amplifying individual efforts into collective achievements. Industry leaders have encouraged broader participation in these frameworks, emphasizing that collective action is essential to achieving meaningful results.

The maritime industry's commitment to decarbonization is not only a response to environmental imperatives but also a recognition of the economic and operational benefits of sustainability. By embracing innovation, data-driven strategies, and collaborative frameworks, the industry is charting a course toward a cleaner, more efficient future. As stakeholders continue to align their efforts, the promise of a sustainable maritime sector becomes increasingly achievable. Moreover, maritime decarbonization aligns seamlessly with global sustainable development goals. Initiatives like emissions reporting and transparency standards are fostering greater accountability across stakeholders, reinforcing the industry's role in driving global environmental progress. Together, these collaborative efforts underscore the interconnected nature of maritime decarbonization and its critical position within the wider push for a sustainable future.

This issue

This volume provides documentation of the investigation of human well-being, energy-environment partnerships, and industrial practices. In addition, studies were created regarding a proof of concept that involved the maritime and manufacturing industries.

The first article is written by Leenawong, C., and Ritthipakdee, A. It introduces a 0-1 Mixed-Integer Linear Programming (MILP) model for optimizing fuel costs in long-haul flights with refueling layovers. The model evaluates routes, aircraft types, and refueling points, considering fuel prices and consumption. A case study revealed that an indirect route with a layover and the Airbus A330-300 minimized costs, reducing total fuel expenses to $33,855.06. The study demonstrates the model's adaptability to fluctuating fuel prices and its potential for efficient airline operations and environmental benefits.

The second article by Nelfia, L.O., Haq, A.B.N., Nugroho, A., Rinanti, A., Yuwono, B.E., Syamsunur, D., Sunarno, Y., and Amiri, O., investigates the use of nickel slag as fine and

coarse aggregate in high-performance concrete. By incorporating up to 20% Ground Granulated Blast Furnace Slag (GGBFS) as cement substitute, Mix 2, with 40% nickel slag replacement, achieved the highest compressive strength of 69.43 MPa, exceeding reference concrete by 11.56%. XRD analysis revealed dominant compounds like SiO2 and (Fe, Mg)SiO3, contributing to improved durability and mechanical properties. The study highlights nickel slag's potential for sustainable construction applications.

The third article is written by Joseph, A., Dhruvan, A., Anandh, K.S., Adamu, M., Ibrahim, Y.E. It investigates the cyclic behavior of Double Skin Composite (DSC) shear walls with different faceplate configurations using finite element analysis in ANSYS. Among trapezoidal, zig-zag, curved, and flat profiles, trapezoidal faceplates demonstrated the highest energy dissipation, ductility ratio, and reduced stress levels. Trapezoidal profiles showed a 37.57% higher energy dissipation than zig-zag and 42.66% more than flat profiles, making them optimal for seismic applications. The study highlights the benefits of trapezoidal configurations for improved structural performance under lateral loads.

The fourth article is written by Indriyantho, B.B., Purnomo, J., Purwanto, Ottele, M., Han, A.L., and Gan, B.S. It develops a multicriteria sensitivity analysis for validating numerical models of load-displacement responses in structural mechanics. Using a Rigid Body Spring Model (RBSM), the method accurately simulates experimental behavior by addressing imperfections and irregularities in concrete structures. The analysis, which incorporates peak load, energy dissipation, and toughness, proves effective for modeling geopolymer and conventional concrete members. The study highlights its applicability for improving model precision in finite element analysis and structural simulations.

The Fifth article by Ramadhan, F.A., Sasongko, R.A., Gunawan, L., Akbar, M., and Widagdo, D., investigates the effect of fiber orientation and crack on the dynamic characteristics of a unidirectional composite cantilevered wing plate. Using Finite Element Method (FEM) and Modal Assurance Criteria (MAC), the study reveals that fiber orientation influences natural frequencies but not mode shape order. Crack length and location significantly reduce natural frequencies, particularly in fundamental bending and torsion modes, by approximately 20% when cracks are near the root. These findings are critical for evaluating aeroelastic stability in composite structures.

The sixth article is written by Srisurin, P., Guerra, A., and Jarumaneeroj, P. It compares isolated signal timing and network optimization approaches to manage traffic at six oversaturated intersections in Bangkok, Thailand. Using Synchro simulations, the study found that the network optimization approach reduced delays by 43.5% and queue lengths by 61.9%, outperforming isolated signal timing. The findings highlight the effectiveness of coordinated green intervals in managing urban traffic congestion, particularly in dense networks with oversaturated intersections.

The seventh article is written by Racero-Galaraga, D.A., Sofan-German, S.J., Arteaga-Ramos, J.P., and Mendoza-Fandino, J.M. It develops a multiple linear regression model to predict the calorific value of sugarcane bagasse subjected to oxidative torrefaction. By analyzing temperature and oxygen concentration as variables, the study achieved a predictive accuracy of 88.29%. The findings show higher calorific values with increased temperatures and reduced oxygen levels, optimizing energy efficiency in biomass processing. This model offers a precise tool for enhancing sustainable energy practices and promoting effective biomass utilization in renewable energy production.

The eight article is written by Romahadi, D., Feleke, A.G., and Youlia, R.P. It evaluates the implementation of the Laplacian Spatial Filter (LSF) in detecting driver vigilance using EEG signals and linear classifiers. The study finds that LSF did not improve classification accuracy and even reduced precision for some models, with the SVM model achieving the

highest accuracy (84.27% intra-subject, 70.39% cross-subject) without LSF. The findings suggest that LSF may not be effective for EEG-based driver vigilance detection, highlighting the need for alternative preprocessing techniques.

The ninth article written by Nacarino A., La-Rosa, A., Quiespe, Y., Castro, K., Valer, F.S., Cornejo, J., Vargas, M., Castro, R., Palomares, R., Sanchez, B., Allcca, D., Nacarino, G., and Cruz-Vargas J.A.D.L. It details the bio-mechatronic design and manufacturing of an arm exoskeleton for passive elbow rehabilitation using an electro-pneumatic mechanism. The study utilized Computer-Aided Design (CAD) and Finite Element Analysis (FEA) to optimize the exoskeleton, achieving a total angular displacement of 74.5° with a force of 18 N. Incorporating an AD8832 EMG sensor for control, the exoskeleton demonstrated effective rehabilitation capabilities, offering a low-cost, personalized solution for improving patient recovery outcomes.

The tenth article is written by Jusuf, A., Jarwadi, M.H., Hastungkorojati, D.G., Gunawan, L., Akbar, M., Zakaria, K., Izzaturrahman, M.F., and Palar, P.S. It explores the design optimization of a 20-corner crash box under axial loading using Gaussian Process Regression (GPR). This novel design significantly improves Specific Energy Absorption (SEA) and Crushing Force Efficiency (CFE), achieving an 8-9% performance enhancement compared to other shapes. The study highlights GPR's capability in handling complex nonlinear functions while reducing computational costs, offering valuable insights for crashworthiness and transportation safety through advanced structural engineering solutions.

The eleventh article by Susanto, D., Shahab, R.H., Alkadri, M.F., and Brahim, S., investigates the reuse and recycling of disaster waste materials for post-disaster shelter construction in Cianjur, Indonesia. Compressive strength tests were conducted on red bricks, ceramic tiles, and roof tiles from disaster waste, with results showing that roof tiles and ceramic tiles met the required standards (21.8 MPa and 17.7 MPa, respectively). The study highlights the potential for using disaster waste as a sustainable and cost-effective solution for temporary shelter, promoting environmental and resource efficiency in disaster recovery efforts.

The twelfth article by Firzandy, H., Sihombing, A., Fuad, A.H., and Adam, M. It examines the potential of co-housing as a sustainable architectural model to support cultural communities in urban areas. Focusing on the Miss Tjitjih community in Jakarta, the study highlights how co-housing enhances social interaction, mental well-being, and resource efficiency through shared spaces and community-centered design. The research emphasizes co-housing's role in promoting cultural sustainability, environmental conservation, and social cohesion, offering a cost-effective solution to urban housing challenges for marginalized groups.

The thirteenth article by Siripath, N., Jantepa, N., Sucharitpwatskul, S., and Suranuntchai, S., integrates the Taguchi method and Finite Element Method (FEM) to optimize the hot forging process for precision ball joints using AISI 1045 medium carbon steel. Key parameters—billet temperature, billet length, and friction factor—were analyzed, with temperature and friction identified as the most influential factors. The optimized conditions reduced forging loads and stress while predicting microstructural evolution with high accuracy. Experimental validation confirmed defect-free die filling, demonstrating the method’s effectiveness for improving product quality and minimizing waste in forging processes.

The fourteenth article by Benchekroun S., Soulami, M., Meyabe, M.-H., Rhouiri, M., Bensouda, M., Aiboud-Benchekroun, B., and Marghich, A., examines the influence of digital marketing practices—emailing, content marketing, and social media—on student

experience in Moroccan public universities. Using structural equation modeling (PLS-SEM) on survey data from 302 students, the study found that emailing and content marketing significantly improved student experience, while social media had no notable impact. The findings emphasize the importance of tailored digital strategies for enhancing engagement and satisfaction, offering valuable insights for higher education institutions.

The fifteenth article is written by Ulyah, S.M., Susanti, R., and Andreas, C., Rahmayanti, I.A., Rifada, M., Fitriyani, N.L., and Ana, E., It applies a multivariate regression with time series errors to forecast the Jakarta Composite Index (JCI) and banking industry stock prices in Indonesia during the COVID-19 pandemic. The study demonstrates a significant impact of the pandemic on stock prices, revealing a dependency between JCI and banking stock prices. Using dummy variables for pandemic phases, the model achieved high forecast accuracy, offering insights for policymakers to stabilize financial systems and guide investment strategies.

The sixteenth article is written by Pratama, N.R., and Agustin, P.A. It presents an improvement design for the packaged juice production process using Business Process Reengineering (BPR). By implementing automated machinery and optimizing the production layout, the study achieved a 34.9% reduction in distance traveled and a 50.54% reduction in total processing time. The research highlights the use of BPR best practices to address production inefficiencies, demonstrating its potential for enhancing productivity and reducing waste in manufacturing processes.

The seventeenth article is written by Shiddiqi, A.A.A., Sutjiningsih, D., Tjahjono, T., Darmajanti, L., and Suprayoga, G.B. It investigates the potential for a modal shift to public transport in Jakarta under fiscal-based policies, including biofuel usage, congestion charging, and increased parking fees. Using a stated preference survey and binomial logit model, the study found that commuters outside Jakarta were more willing to pay higher costs to switch to public transport than city residents. The research highlights fiscal policies' effectiveness in reducing private vehicle use and encouraging sustainable transportation choices.

The eighteenth article is written by Haryono, I., Ma'ruf, M., Fajar, R., and Mansur, D. It analyzes the deposits formed on locomotive fuel filters using palm biodiesel (B20) compared to diesel fuel (B0). The study found that B20 produced more deposits in the main filter but fewer in the twin filter, with deposits primarily comprising hydrocarbons and fatty acid methyl esters. Despite the higher deposit content, the formation remained within tolerance levels, suggesting that with improved handling and storage practices, B20 can be effectively utilized in locomotive applications.

The nineteenth article by Budhijanto, B., Pancasakti, B.P., and Hartanto, D.T. It evaluates the quality enhancement of cassava starch-based wood bioadhesive by incorporating polyvinyl alcohol (PVA). The study found that PVA significantly improved the adhesive's properties, including viscosity, solid content, and both dry and wet shear strength, with a 678% increase in wet shear strength at optimal composition. Excessive PVA, however, negatively affected viscosity and shelf life. The findings suggest a balanced PVA ratio is critical for optimizing bioadhesive performance, supporting sustainable adhesive development.

The twentieth article is written by Enjarlis, E, Wijaya, K., Karomah, E.F., and Huda, S. It explores the inactivation of Avian Influenza (AI) virus subtypes H5N1 and H9N1 in vaccine industrial wastewater using an Advanced Oxidation Process (AOP) combining ozone and hydrogen peroxide (O3/H2O2). The study showed that this method effectively inactivated the viruses and reduced COD, BOD, and TSS levels by 49-58%. The findings recommend

AOP as a sustainable and efficient wastewater treatment solution for the vaccine industry, ensuring environmental safety and public health protection.

The twenty first article is written by Zakia, I., and Brata, M. It presents a joint user-centric clustering and pilot allocation method for scalable cell-free massive MIMO systems. Combining the Gale-Shapley clustering algorithm with scalable and graph-coloring pilot allocation methods, the study achieves uniform spectral efficiency across user equipments (UEs). Results demonstrate that the scalable method outperforms graph-based allocation in spectral efficiency and computational complexity, making it a promising solution for future dense networks, particularly in optimizing 5G and beyond technologies.

The twenty-second article is written by Farozan, I., and Indartono, Y.S. It evaluates the performance of Savonius wind rotors with semi-circular blades enhanced by check valves. The study shows that adding valves near the rotor tip significantly improves the power coefficient, achieving a maximum of 0.199 at a Reynolds number of 73,000. Performance decreased as the valve opening area ratio and Reynolds number increased. The research highlights the potential of valve-aided Savonius rotors for efficient wind energy generation in urban and low-wind-speed areas.

The twenty third article is written by Ali, F., Lestari, D.L., Putri, M.D., and Azmi, K.N. It assesses sanitation risks at the hamlet level in Central Jakarta using indicators like hazard, exposure, vulnerability, and capacity. Most areas showed low risk due to sufficient sanitation infrastructure, but some high-risk areas, especially in flood-prone regions, require improvements. The study highlights the importance of risk-based prioritization for sanitation development and provides insights for policymakers to allocate resources effectively, ensuring sustainable sanitation and public health management in urban areas.

The twenty-fourth article is written by Aviantara, D.B., Suciati, F., Hadiko, G., Indrasti, N.S., and Yani, M. It investigates the microwave-assisted impregnation of zinc metal ions onto quenched pulverized shrimp shell waste. The study found that microwave power significantly affects zinc impregnation efficiency, with 100% power achieving double the zinc levels compared to 50% power. Heating treatments increased the material's crystallinity and surface area, enhancing its suitability for catalytic applications. The findings suggest potential for using shrimp shell waste in preparing heterogeneous catalysts for environmental protection purposes.

The twenty-fifth article is written by Apriyanti, E., Susanto, H., and Widiasa, I.N., It investigates the preparation and performance of TiO2-incorporated fly ash/kaolin ceramic membranes for oil/water separation. The membrane demonstrated excellent properties, achieving over 95% oil rejection and a permeate flux of 116 $L/m^2/h$, with a composition of fly ash:kaolin:alumina:TiO2 at 20%:40%:30%:10%. The study highlights the potential of using low-cost natural materials for wastewater treatment, offering a sustainable solution for clean water reclamation while addressing the global water scarcity challenge.

The twenty-sixth article is written by Yusupandi, F., Ilham, M., Yafi, I.A., Widiatmoko, P., Nurdin, I., Khairunnisa, S.F., Devianto, H. It improves an anode-supported Intermediate Temperature Solid Oxide Fuel Cell (IT-SOFC) using spray-coated Calcia-Stabilized Zirconia (CSZ) electrolytes. The study highlights that increasing electrolyte coatings enhanced power density, achieving 1.08 mW/cm^2 at 800°C, with ohmic resistance significantly reduced to 26.78 Ω. However, multiple coatings increased curvature, compromising mechanical stability. The research underscores the potential of CSZ for cost-effective IT-SOFCs while suggesting further optimization to achieve denser and thinner electrolytes to minimize fuel crossover and curvature issues.

The twenty-seventh article is written by Sapei, L, Savitri, E., Jati, I.R.A.P., Indrawanto, R., Darsono, H.E., Anggraeni, Y., and Sumampouw, C. It studies the stability and destabilization

kinetics of vitamin C-containing double emulsions using hydrogenated (HCNO) and medium-chain triglyceride (MCT) coconut oils. HCNO-based emulsions showed higher long-term stability (above 85% after 4 days) and a lower destabilization rate constant (4.5×10^{-3} h^{-1}) compared to MCT-based emulsions (70% stability, 6.8×10^{-3} h^{-1}). These findings highlight the potential of coconut oil-based double emulsions for functional food applications, particularly for vitamin encapsulation and stabilization.

The twenty-eight article is written by Kusrini, E., Rifqi. A.B., Wilson, L.D., Degirmenci, V., Abdullah, M.A.A., and Sofyan, N. It evaluates the performance of heterogeneous catalysts derived from natural Bangka kaolin for biodiesel production via acid and base activation processes. The Kb2M catalyst, activated with 2M NaOH, achieved the highest methyl ester yield of 96.3% and a 69.4% FAME yield at a 1:6 oil-to-methanol ratio. The findings demonstrate the potential of base-activated kaolin as an efficient, low-cost catalyst for biodiesel production, contributing to renewable energy development and sustainable practices.

The twenty-ninth article is written by Negim, E-S., Shalash, M.A.A., Sagatbekovna, M.Z., Kairatovna, B.A., Konstantinovich, A.T., Adlikhanovna, N.A., Ermekovna, K.A., and Ravindran, B. It explores the synthesis and characterization of polyurethane-acrylic (PU/AK) hybrid coatings for anticorrosion applications. By varying acrylic content, the study found that 10% acrylic provided the best chemical and corrosion resistance while enhancing mechanical properties like tensile strength, adhesion, and hardness. The hybrid polymers demonstrated significant potential for use in protective coatings for metals in various industries. The research highlights the importance of optimizing hybrid compositions to balance durability and corrosion resistance.

The thirty article by Meyliana Wulandari M., Zahratussaadah, Z., Andreas, A., Nofrizal, N., Adriany, R., Saaid, M., and Urraca, J.L., develops a method for separating and quantifying tannins (catechin, epicatechin, EGCG) and caffeine in black tea using modified microwave-assisted extraction (MAE) and high-performance liquid chromatography (HPLC). Optimal conditions were achieved at 1500 W microwave power, 80°C, and methanol as the solvent, enabling separation within 10 minutes. The method showed excellent repeatability (RSD ≤ 2%) and accuracy (96.7–102.5%). The findings highlight its efficiency, offering a fast, accurate, and environmentally friendly approach for tea analysis.

The thirty-first article by Wichapa, N., Pawaree, N., Nasawat, P., Chourwong, P., and Sriburum, A., and Khanthirat, W. It presents a novel hybrid method combining Data Envelopment Analysis Variant (DEAV) with the Taguchi method for multi-response optimization in manufacturing. Validated using a fish scale scraping machine and CNC turning of ST37 steel, the DEAV-Taguchi method improved surface roughness and material removal rate while efficiently addressing conflicting objectives. The study highlights the method's robustness and adaptability, offering a systematic framework for optimizing complex manufacturing processes and suggesting future applications across diverse industries.

The thirty-two article s written by Nukeshev, S., Sugirbay A., Dulatbay, Y., Tanbaev, K., Yeskhozhin, K., Chen, J., Nazarbayev, Y., and Sugirbaeva, Z. It focuses on the development of an offset straight-tooth roller for applying granular mineral fertilizer using the Discrete Element Method (DEM). The study optimized the roller's design, experimenting with different gap lengths to enhance fertilizer distribution uniformity. The addition of side gaps improved discharge rates and distribution.

New possibilities have been made possible by the integration of contemporary technology with the latest developments in order to tackle challenging problems in a range of fields. It is quite likely that innovation will become more and more important in shaping

our future as scientific knowledge continues to advance. Ijtech happily accepts your papers and extends a warm invitation to publish them so that our audience can learn about your research.

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Greetings from Jakarta,

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