

*Editorial Note***Expanding Additive Manufacturing Applications toward Green Industrialization**

Yudan Whulanza^{1*}, Eny Kusri^{2,3,4}, Teuku Yuri M. Zagloel⁵, Akhmad Hidayatno⁵, Angi Skhvediani⁶

¹Department of Mechanical Engineering, Universitas Indonesia, Kampus Baru UI, Depok 16424, Indonesia

²Department of Chemical Engineering, Universitas Indonesia, Kampus Baru UI, Depok 16424, Indonesia

³Green Product and Fine Chemical Engineering Research Group, Laboratory of Chemical Product Engineering, Universitas Indonesia, Kampus Baru UI, Depok, 16424, Indonesia

⁴Advanced Materials Research Center, Faculty of Engineering, Universitas Indonesia, Kampus Baru UI, Depok, 16424, Indonesia

⁵Department of Industrial Engineering, Universitas Indonesia, Kampus Baru UI, Depok 16424, Indonesia

⁶Peter the Great St. Petersburg Polytechnic University, 195251 St. Petersburg, Russia

*Corresponding author's email: yudan.whulanza@ui.ac.id; Tel.: +62-217270032; Fax.: +62-217270033

The global manufacturing sector accounts for approximately one-fifth of the total energy-related CO₂ emissions, making its decarbonization a central priority in both industrial policy and engineering research (IEA, 2023). In this context, additive manufacturing (AM) has attracted attention as a process technology with structural advantages over conventional subtractive and formative methods: it builds components layer by layer from digital models, requiring only the material the part demands, whereas conventional metal cutting can waste up to 95% of the input stock (Maware et al., 2024). Research output on AM and sustainability has grown substantially, with Scopus-indexed publications on the topic projected to exceed 900 in 2025 (Su et al., 2024). However, the carbon credentials of AM are not uniform across sectors or process types, and establishing them requires the same analytical rigor that the technology brings to engineering design.

Application Domains

AM has established a mature and growing presence. Patient-specific implants, orthopedic devices, surgical guides, and prosthetics can be directly produced from patient imaging data, enabling anatomical geometries and internal porous architectures that conventional machining cannot achieve (Li et al., 2025). The global healthcare AM market was estimated at USD 1.17 billion in 2024 and is projected to grow at a compound annual growth rate of 17.5% through 2029 (GlobalData, 2025). Bioprinting, the AM of cell-laden hydrogel constructs, has demonstrated capacity for vascularized tissue fabrication in experimental contexts, while dental AM has become commercially routine for crowns, bridges, surgical templates, and custom orthodontic devices (Elhadad et al., 2026). The production logic in healthcare AM is one of precision and personalization at low volumes, a demand profile to which AM's design flexibility and material efficiency are well suited (Rahyussalim et al., 2017).

AM represents an emerging application domain with notable structural implications. Three-dimensional food printing enables the deposition of edible materials in precise geometries, textures, and compositional profiles that conventional processing cannot achieve (Ehsan et al., 2025). Identified applications include personalized nutritional formulations for specific dietary requirements, textured foods for patients with dysphagia, and the fabrication of alternative protein products, including plant-based and cell-cultured meat analogs, where scaffold geometry influences consumer acceptance (Prithviraj et al., 2025). The on-demand production logic of

food AM also reduces the overproduction and perishability losses that contribute to approximately one-third of the currently wasted global food output, a sustainability dimension that extends beyond the manufacturing process itself (Taqqdissillah et al., 2026).

AM operates at higher production volumes in the aerospace and automotive sectors, and its decarbonization implications are correspondingly more consequential (Alami et al., 2023). The primary mechanism in aerospace is lightweighting: components designed for additive production through topology optimization can match the structural performance of conventionally manufactured parts at substantially lower mass. A model has been established that every kilogram saved in aircraft weight prevents approximately 25 tonnes of CO₂ over the aircraft's operational lifetime (Menouni et al., 2021). GE Aerospace's additively manufactured fuel nozzle for the LEAP engine combined 20 previously separate components into a single part (Najmon et al., 2019). This redesign reduced weight by 25%, increased durability fivefold, and delivered measurable fuel-efficiency gains across the Airbus A320neo, Boeing 737 MAX, and COMAC C919 fleets (Metal-AM, 2025). In the automotive industry, AM primarily contributes to tooling, prototyping, and topology-optimized structural components in EV platforms, where weight reduction directly extends the operational range (Tuazon et al., 2022).

Carbon Question: Evidence and Conditions

The proposition that AM reduces carbon emissions relative to conventional manufacturing is supported by life cycle assessment evidence, although the relationship is conditional rather than categorical. A systematic review of 158 empirical and conceptual studies concluded that AM can achieve measurable reductions in waste generation, emission production, and carbon footprint, alongside time and cost advantages, relative to conventional manufacturing (Maware et al., 2024). AM enables reductions in material use for final parts by 35%–80%, which directly impacts energy consumption throughout the supply chain and manufacturing process (Raigar et al., 2025). A laser-based powder bed fusion study of precious metal components found a carbon footprint of 2.23 kg CO_{2e} per piece against 3.17 kg CO_{2e} by conventional methods, a reduction of approximately 30% (Schmidt et al., 2024). Aggregate modeling projected reductions of 9%–35% in primary energy consumption and 8%–19% in CO₂ contributions from AM deployment in aerospace and automotive manufacturing relative to conventional production baselines (Huang et al., 2017).

Additive manufacturing was not designed as a decarbonization technology (Klejnowska et al., 2026). In several process variants, its energy intensity per unit volume of material processed is, in several process variants, higher than that of conventional manufacturing, particularly for metal powder bed fusion systems operating under high-energy laser or electron beam conditions (Kokare et al., 2024; Qosim et al., 2018). The sustainability of AM depends on the comparison being made. It is generally more material-efficient and produces less waste, but its energy consumption varies with the process. The greatest environmental benefits occur in aerospace applications, where lighter parts reduce fuel use and emissions throughout the product's life (Price et al., 2025). Machine learning approaches for the pre-production estimation of the carbon footprint from process parameters and part geometry are being developed to address the current limitation that sustainability assessments are available only retrospectively (Hauck et al., 2025).

The production volume question also conditions the assessment. The material and supply-chain efficiencies are most pronounced for low-to-medium volume production, geometrically complex parts, and distributed manufacturing scenarios. Conventional mass manufacturing processes retain cost and energy efficiency advantages for high-volume production of geometrically simple components. Therefore, a considered green industrialization strategy would therefore apply AM selectively in applications where lifecycle analysis confirms a carbon advantage, rather than as a categorical substitute for established processes.

This Issue

IJTech encourages interdisciplinary submissions that contribute to sustainable engineering and technological development. Research on sustainability assessment frameworks, energy-efficient processes, sustainable materials, and circular economy approaches will play a critical role in supporting the design, deployment, and long-term impact of emerging technologies.

Blagoy et al., 2026 develops a reproducible framework for segmenting manufacturing firms by operational–financial profiles. This study combines standardized corporate data, principal component analysis, k-means clustering, panel-level label consolidation, and peer-normalized benchmarking. It identifies five distinct profiles across 6,479 firms and shows that compared with industry-wide averages, cluster-based comparison can better reveal productivity reserves, capital-turnover opportunities, and targeted digital investment priorities than industry-wide averages (Blagoy et al., 2026).

Dwinata et al., 2026 investigates strain-rate-dependent behavior of SLA-printed PLA–hydroxyapatite composites for biomedical applications. This study combines compression testing at two strain rates with simplified Zhu–Wang–Tang constitutive modeling, wettability analysis, and scanning electron microscopy (SEM) characterization. The model accurately captures the rate-dependent response, while increasing HA improves hydrophilicity but promotes particle clustering and microvoid formation at higher contents (Dwinata et al., 2026).

Helianty et al., 2026 developed a humidified packed-bed column bioreactor for enhanced laccase production by *Trichoderma asperellum* using rice straw. This study applies CCD–RSM to optimize the bed height, airflow, and fermentation time. It achieves 253.8 U/L laccase activity at 11 cm, 1 L/min, and 4 days, representing a 339.9% increase over optimized flask-based SSF (Helianty et al., 2026).

Qolbiyah et al., 2026 developed a prediction-informed autonomous UAV landing framework integrating Kalman state prediction with outer-loop velocity PID control. This study evaluates the proposed method through simulation and outdoor flight experiments using monocular ArUco tracking. Without additional landing sensors, it reduces steady-state positional error by 86.7% and improves longitudinal and lateral RMSE by 20.8% and 21.3%, respectively, without additional landing sensors (Qolbiyah et al., 2026).

The fifth study, written by Pandyaswargo et al., 2026 examined public perceptions of automated waste sorting in Indonesia using a quota-based online survey of 1,000 adults. This study applies descriptive statistics, MCA, chi-square tests, Cramer's V, and residual analysis. The study found that perceived helpfulness is higher among younger respondents, active waste sorters, and those experiencing reliable pickup services, highlighting the importance of service quality for technology receptivity (Pandyaswargo et al., 2026).

Pospelov and Gintciak, 2026, develops a mathematical control model that incorporates bounded rationality in production and socioeconomic systems. This study represents control objects within a multidimensional phase space and formalizes agent objectives, system states, and transitions. Accounting for bounded rationality can broaden forecasted decision outcomes, reduce erroneous predictions, and improve the adequacy of decision-support systems (Pospelov & Gintciak, 2026).

Samrit et al., 2026 developed a self-healing soft actuator inspired by eukaryotic flagellar locomotion. This study uses a gelatin–silk amino acid–glycerol hydrogel and three independently controlled pneumatic chambers to enable multidirectional bending. It achieves 156.8% elongation at break and recovers approximately 58% of its bending performance after puncture and room-temperature healing, supporting resilient bio-inspired soft robotics (Samrit et al., 2026).

The eighth study, written by Ibadurrohman et al., 2026, compares graphene and graphitic carbon nitride as promoters in Ni-modified TiO₂ photocatalysts for hydrogen production. This study synthesized and characterized Ni-G/TiO₂ and Ni-g-C₃N₄/TiO₂ and tests them in water–glycerol mixtures under UV irradiation. Ni-G/TiO₂ performs best, producing 12.8 mL hydrogen through more efficient electron transfer and reduced charge recombination (Ibadurrohman et al., 2026).

In the ninth study, written by Hadiyanto et al., 2026, shrimp shell waste was transformed into chitosan for the green harvesting of *Chlorella vulgaris*. This study characterized chitosan and evaluated its dosage, pH, contact time, and harvesting kinetics. It achieves over 95% harvesting efficiency at 10 mg/L chitosan, pH 6, and 10 min, supporting a sustainable circular-bioeconomy approach to microalgae biomass recovery (Hadiyanto et al., 2026).

Al-Ajooli et al., 2026 developed a multifunctional MXene–TiO₂ nanofiltration membrane for contaminant removal using low-grade heat. This study integrates thermocatalytic degradation, molecular separation, and antifouling in a GO–HAL matrix. It achieves about 97%–94% BPA rejection during 18-h filtration and nearly 52% thermocatalytic BPA removal, while maintaining catalytic-phase stability and improving wastewater TOC removal (Al-Ajooli et al., 2026).

Shlimas et al., 2026 investigated annealing-induced recrystallization and phase evolution in indented magnesia-stabilized zirconia ceramics. Raman spectroscopy was used to track local phase changes after indentation and annealing at 1000°C–1200°C. The tetragonal phase recovers at 1000°C, whereas higher temperatures promote cubic-to-monoclinic transformation and substantial grain growth, revealing metastable phase behavior under combined mechanical and thermal loading (Shlimas et al., 2026).

Korolkov et al., 2026, develops magneto-plasmonic Co@Ag microtubes as controllable substrates for SERS. This study combines template-assisted cobalt deposition, electroless silver coating, structural characterization, and magnetic analysis. It demonstrates rhodamine 6G detection down to 10^{−9} M with enhancement factors around 10⁶, while retaining magnetic responsiveness for EFA positioning and alignment (Korolkov et al., 2026).

The thirteenth study, written by Mansjur et al., 2026, investigated HA-coated Ti-29Nb-13Ta-4.6Zr alloy for orthopedic biomaterial applications. In this study, HVOF spray distances of 20, 25, and 30 cm using surface profilometry and nanoindentation. The optimal distance is 25 cm, providing the best balance between high surface roughness for cell attachment and suitable mechanical properties of the coating (Mansjur et al., 2026).

The fourteenth study, written by Sharipov et al., 2026, investigated selective nickel recovery from the magnetic fraction of chrysotile asbestos beneficiation waste using organic acids. This study compares citric, acetic, oxalic, and tartaric acids using kinetic modeling. Citric acid achieves the highest nickel extraction of 82.6% while maintaining low iron dissolution and revealing a mixed reaction–diffusion mechanism, supporting the sustainable valorization of technogenic waste (Sharipov et al., 2026).

The fifteenth study, written by Galymzhan et al., 2026, valorizes chrysotile asbestos waste into a porous adsorbent for heavy-oil demetallization. This study combines magnetic separation, acid leaching, thermal activation, and comprehensive structural characterization of aqueous solution. It produces a high-surface-area silica-rich adsorbent with active defect sites that selectively removes vanadium and nickel species under thermal-contact conditions while simultaneously eliminating the original waste's hazardous fibrous morphology (Galymzhan et al., 2026).

The sixteenth study develops NiFe₂O₄ nanoparticles from natural iron sand for solar-driven photocatalysis. This study investigates the influence of synthesis pH on structural, optical, magnetic, and photocatalytic properties. It identifies pH 13 as optimal, achieving up to 98% dye degradation and 86% tetracycline degradation while retaining soft magnetic behavior that enables catalyst recovery and reuse for sustainable wastewater treatment (Rahmayeni et al., 2026).

Zhou et al., 2026 developed a deep reinforcement learning approach for scheduling series-parallel mixed-model production lines. This study describes a MILP model and applies a multi-agent double-deep Q-network to jointly optimize tardiness and transition energy consumption. Compared with benchmark methods, it achieves faster convergence, greater stability, and higher-quality Pareto solutions in 49 of 50 test instances compared with benchmark methods (Zhou et al., 2026).

Wulandari and Yastica, 2026 developed a market-oriented digital health co-creation framework for stunting prevention in developing countries. This study integrates SSM with the Triple

Bottom Line Co-Creation Canvas to map stakeholders, governance, collaboration, and sustainability. Key user groups and clarifies how coordinated roles and shared digital resources can support integrated and sustainable stunting management is clarified (Wulandari & Yastica, 2026).

Arvinintyas and Muslim, 2026 study, written examines haptic feedback effects on upper-extremity muscle activity during VR-based strength exergames. This study compared conventional dumbbell exercise with three vibrotactile feedback levels using sEMG, perceived exertion, and presence measures. It shows that haptic vibration can modulate muscle activity, particularly in the triceps, but cannot reproduce the neuromuscular demands of conventional resistance training (Arvinintyas & Muslim, 2026).

Dash et al., 2026 developed PneumaScan, a DenseNet121-based deep learning model for automated pneumonia detection from chest X-ray images. This study applies TL and strategic layer unfreezing to improve generalization while reducing model complexity. Overall accuracy and macro-average precision are 93.42% and 93.72%, respectively, demonstrating the potential for rapid pneumonia screening in resource-constrained clinical settings (Dash et al., 2026).

Hasymi et al., 2026 developed an integrated FEA–surrogate modeling framework for high-torsionality stepped ultrasonic horns in micro-milling. This study evaluates slit geometry using ANSYS and compares MLR, ANN, RSM, polynomial regression, Kriging, random forest, and XGBoost. It shows that slit depth most strongly governs torsionality, while Kriging provides the highest predictive accuracy and ANN substantially outperforms conventional MLR (Hasymi et al., 2026).

Hutabarat et al., 2026 developed a GIS-adjusted rural access screening framework for solar PV intervention planning in Indonesia. This study combines road accessibility, electricity need, solar resource, construction cost, and port-access sensitivity into a provincial typology. It identifies persistent rural accessibility constraints and distinguishes near-term, strategic, design-check, solar-opportunity, and monitoring categories to guide subsequent feasibility studies at the village level (Hutabarat et al., 2026).

Research practices that support collaboration and improve accessibility in frontier technologies are increasingly vital to technological advancement and societal impact. IJTech welcomes original manuscripts that address these dimensions and cordially invites authors to submit their work for consideration for publication.

References

- Al-Ajooli, S., Kassim, M. A., Khazaaal, K. H., Alwash, O. A., & Al-Mashhadi, R. N. (2026). An MXene–titania nanofiltration membrane with thermocatalytic activity for water pollution removal. *International Journal of Technology*, 17(5), 1765–1779. <https://doi.org/10.14716/ijtech.v17i5.8534>
- Alami, A. H., Olabi, A. G., Alashkar, A., Alasad, S., Aljaghoub, H., Rezk, H., & Abdelkareem, M. A. (2023). Additive manufacturing in the aerospace and automotive industries: Recent trends and role in achieving sustainable development goals. *Ain Shams Engineering Journal*, 14(102516). <https://doi.org/10.1016/j.asej.2023.102516>
- Arvinintyas, E., & Muslim, K. (2026). The role of haptic feedback on upper extremity muscle activity, perceived exertion, and presence in VR-based exergames. *International Journal of Technology*, 17(5), 1918–1939. <https://doi.org/10.14716/ijtech.v17i5.8328>
- Blagoy, N., Dmitriev, N., Lavrova, O., Zaytsev, A., & Rodionov, D. (2026). Segmentation of manufacturing enterprises by operational–financial profiles based on digital analysis of corporate data. *International Journal of Technology*, 17(5), 1610–1627. <https://doi.org/10.14716/ijtech.v17i5.8239>
- Dash, S. K., Nanda, B., Ahmed, M. A., & Mohammed, Q. (2026). PneumaScan: A two-phase fine-tuning framework using DenseNet121 for pneumonia detection. *International Journal of Technology*, 17(5), 1940–1959. <https://doi.org/10.14716/ijtech.v17i5.8592>

- Dwinata, B., Budiwantoro, B., Kariem, M. A., Mahyuddin, A. I., Budi, M. N. S., & Faisham, W. I. (2026). Strain-rate-dependent behavior and constitutive modeling of stereolithography-printed polylactic acid and hydroxyapatite composites. *International Journal of Technology*, 17(5), 1628–1648. <https://doi.org/10.14716/ijtech.v17i5.8437>
- Ehsan, M., Shankar, A., Chohan, J. S., Rasheed, B., Imran, A., Usman, I., Rasheed, M., Saeed, F., Afzaal, M., Islam, F., & Ndagire, C. T. (2025). Three-dimensional (3D) food printing applications, techniques, and consumer acceptance. *eFood*, 6(6). <https://doi.org/10.1002/efd2.70106>
- Elhadad, A., Cañete, R., Mena, D., Saad, M., Mogassabi, W., Dawoud, A., Fatima, F., Chowdhury, M., Almuzafar, A., Alqashouti, H., & Torres, Y. (2026). Advanced additive manufacturing and printing technologies for dental applications: A narrative review. *International Journal of Advanced Manufacturing Technology*, 143, 1–27. <https://doi.org/10.1007/s00170-025-17220-0>
- Galymzhan, M., Rustam, S., Ridhwan, A. M., Raushan, U., Omirserik, B., Yaseen, Z. M., Mendeke, M., & Hosseini-Bandegharai, A. (2026). Valorization of chrysotile asbestos waste into hierarchically porous adsorbents for thermal-contact demetallization of heavy oil: Mechanistic insights and process optimization. *International Journal of Technology*, 17(5), 1841–1859. <https://doi.org/10.14716/ijtech.v17i5.8872>
- GlobalData. (2025). Game-changing 3D printing manufacturing trends for 2025. *Medical Technology*, 82. <https://medical-technology.nridigital.com/medical-technology-jan25/3d-printing-manufacturing-trends-for-2025>
- Hadiyanto, H., Sumantri, I., Djaeni, M., Widiyasa, N., Suherman, Zakaria, Z. A. B., Pratama, W. D., Hafizh, D., Muzaki, R. P., & Pratiwi, W. Z. (2026). Valorization of shrimp shell waste into chitosan for efficient green harvesting of *Chlorella vulgaris* through physico-chemical and performance evaluation. *International Journal of Technology*, 17(5), 1747–1764. <https://doi.org/10.14716/ijtech.v17i5.8527>
- Hasymi, Z., Kiswanto, G., Baskoro, A. S., Istiyanto, J., & Kurniawan, R. (2026). Predicting the high torsionality of stepped ultrasonic horn design in longitudinal-torsional vibration-assisted micro milling using finite element analysis and surrogate models. *International Journal of Technology*, 17(5), 1960–1976. <https://doi.org/10.14716/ijtech.v17i5.8636>
- Hauck, S., Greif, L., Benner, N., & Ovtcharova, J. (2025). Advancing sustainable additive manufacturing: Analyzing parameter influences and machine learning approaches for CO₂ prediction. *Sustainability*, 17, Article 3804. <https://doi.org/10.3390/su17093804>
- Helianty, S., Ramadhan, G., Nurulita, Y., Utama, P. S., & Nugroho, T. T. (2026). Humidified column solid-state bioreactor for enhanced laccase production under forced aeration. *International Journal of Technology*, 17(5), 1649–1666. <https://doi.org/10.14716/ijtech.v17i5.8658>
- Huang, R., Riddle, M. E., Graziano, D., Das, S., Nimbalkar, S., Cresko, J., & Masanet, E. (2017). Environmental and economic implications of distributed additive manufacturing: The case of injection mold tooling. *Journal of Industrial Ecology*, 21, S130–S143. <https://doi.org/10.1111/jiec.12641>
- Hutabarat, A. M., Dalimi, R., Setiabudy, R., & Sudiarto, B. (2026). Geographic information system-adjusted rural access screening framework for solar photovoltaic intervention planning in indonesia. *International Journal of Technology*, 17(5), 1977–1996. <https://doi.org/10.14716/ijtech.v17i5.8726>
- Ibadurrohman, M., Azzahra, J., & Mumtazah, N. (2026). Promotion of nickel-modified titanium dioxide photocatalysts with graphene and graphitic carbon nitride for hydrogen production from water–glycerol mixtures. *International Journal of Technology*, 17(5), 1732–1746. <https://doi.org/10.14716/ijtech.v17i5.8544>
- IEA. (2023). *Industry — tracking clean energy progress 2023*. International Energy Agency. <https://www.iea.org/energy-system/industry>

- Klejnowska, K., Yusufova, N., & Faludi, J. (2026). Sustainability evaluation of ambient-temperature biocomposite additive manufacturing using life cycle assessment. *Sustainability*, 18, 1223. <https://doi.org/10.3390/su18031223>
- Kokare, S., Shen, J., Fonseca, P. P., Lopes, J. G., Machado, C. M., Santos, T. G., Oliveira, J. P., & Godina, R. (2024). Wire arc additive manufacturing of a high-strength low-alloy steel part: Environmental impacts, costs, and mechanical properties. *International Journal of Advanced Manufacturing Technology*, 134, 453–475. <https://doi.org/10.1007/s00170-024-14144-z>
- Korolkov, I. V., Shumskaya, A., Bekbol, Z. A., Zhappar, N. K., Khairusheva, A. B., & Shakayeva, A. K. (2026). Silver-coated cobalt microtubes for surface-enhanced raman sensing. *International Journal of Technology*, 17(5), 1792–1805. <https://doi.org/10.14716/ijtech.v17i5.8449>
- Li, Y., Jiang, D., Zhu, R., Yang, C., Wang, L., & Zhang, L.-C. (2025). Revolutionizing medical implant fabrication: Advances in additive manufacturing of biomedical metals. *International Journal of Extreme Manufacturing*, 7(2). <https://doi.org/10.1088/2631-7990/ad92cc>
- Mansjur, Z., Hutasoit, X. C. A., Tengker, S. M. T., Arafat, A., Jujur, I. N., Wibisono, M., Suryadi, S., Gunawarman, G., Niinomi, M., & Akahori, T. (2026). Mechanical and surface characterization of titanium–29niobium–13tantalum–4.6zirconium alloy coated with hydroxyapatite using high-velocity oxy-fuel spraying for biomaterial applications. *International Journal of Technology*, 17(5), 1806–1821. <https://doi.org/10.14716/ijtech.v17i5.8696>
- Maware, C., Muvunzi, R., Machingura, T., & Daniyan, I. (2024). Examining the progress in additive manufacturing in supporting lean, green and sustainable manufacturing: A systematic review. *Applied Sciences*, 14(14), 6041. <https://doi.org/10.3390/app14146041>
- Menouni, A. E., Kretov, A., & Zhijin, W. (2021). Assessment of the passenger aircraft mass and efficiency with a fuselage without portholes. *Journal of Physics: Conference Series*, 1780(1), Article 012011. <https://doi.org/10.1088/1742-6596/1780/1/012011>
- Metal-AM. (2025). *Metal additive manufacturing in the aerospace sector*. <https://www.metal-am.com/articles/metal-am-in-the-aerospace-sector-from-early-successes-to-the-transformation-of-an-industry/>
- Najmon, J. C., Raeisi, S., & Tovar, A. (2019). Review of additive manufacturing technologies and applications in the aerospace industry. In *Additive manufacturing for the aerospace industry*. <https://doi.org/10.1016/B978-0-12-814062-8.00002-9>
- Pandiyaswargo, A. H., Maghfiroh, M. F. N., Rachman, I., & Onoda, H. (2026). Perceived helpfulness of automated waste sorting in indonesia is associated with pickup-service reliability and waste-sorting behavior. *International Journal of Technology*, 17(5), 1689–1704. <https://doi.org/10.14716/ijtech.v17i5.8457>
- Pospelov, K. N., & Gintciak, A. M. (2026). Organizational systems control model with bounded rationality of the control subjects. *International Journal of Technology*, 17(5), 1705–1718. <https://doi.org/10.14716/ijtech.v17i5.8374>
- Price, C., Armstrong, K., Kamath, D., Nimbalkar, S., & Cresko, J. (2025). Novel tools for analyzing life cycle energy use, carbon emissions, and cost of additive manufacturing. *Journal of Manufacturing and Materials Processing*, 9, 214. <https://doi.org/10.3390/jmmp9070214>
- Prithviraj, V., Díaz, L. P., Lemus-Mondaca, R., Ullah, A., & Roopesh, M. S. (2025). Emerging advancements in 3D food printing. *Frontiers in Food Science and Technology*, 5, Article 1607449. <https://doi.org/10.3389/frfst.2025.1607449>
- Qolbiyah, N. S., Khoirurrijal, M. F., Faizal, F., & Purnama, I. (2026). Integration of kalman state prediction and outer-loop velocity PID control for robust autonomous monocular unmanned aerial vehicle landing. *International Journal of Technology*, 17(5), 1667–1688. <https://doi.org/10.14716/ijtech.v17i5.8473>

- Qosim, N., Supriadi, S., Saragih, A. S., & Whulanza, Y. (2018). Surface treatments of Ti-alloy based bone implant manufactured by electrical discharge machining. *Ingeniería y Universidad*, 22(2). <https://doi.org/10.11144/Javeriana.iyu22-2.sttb>
- Rahmayeni, Dwitami, A. R., Stiadi, D. R., Wendari, T. P., Stiadi, Y., & Zulhadjri. (2026). Structural, optical, and magnetic characteristics of NiFe₂O₄ nanoparticles synthesized from natural iron sand for solar-driven photocatalysis. *International Journal of Technology*, 17(5), 1860–1878. <https://doi.org/10.14716/ijtech.v17i5.8395>
- Rahyussalim, A. J., Kurniawati, T., Aprilya, R., D. Anggraini, Ramahdita, G., & Whulanza, Y. (2017). Toxicity and biocompatibility profile of 3D bone scaffold developed by Universitas Indonesia: A preliminary study. *AIP Conference Proceedings*, 1817, Article 020004. <https://doi.org/10.1063/1.4976756>
- Raigar, J., Ramachandran, M. K., Kannan, M., & Velu, R. (2025). Impact of additive manufacturing on the environment and supply chain management. In *Additively manufactured smart materials and structures: Design, processing, and applications*. <https://doi.org/10.1016/B978-0-443-16144-5.00014-4>
- Samrit, C., Tirasuntarakul, N., & Joochim, O. (2026). Self-healing actuators inspired by locomotion of unicellular organisms. *International Journal of Technology*, 17(5), 1719–1731. <https://doi.org/10.14716/ijtech.v17i5.8499>
- Schmidt, M., Heinrich, J., & Huensche, I. (2024). Carbon footprint of additively manufactured precious metals products. *Resources*, 13(11), Article 162. <https://doi.org/10.3390/resources13110162>
- Sharipov, R., Maldybayev, G., Dagubayeva, A., Wirzal, M. D. H., Kurniawan, S. B., Yaseen, Z. M., Baigenzhenov, O., & Hosseini-Bandegharai, A. (2026). Selective nickel recovery from the magnetic fraction of chrysotile asbestos beneficiation waste using organic acids. *International Journal of Technology*, 17(5), 1822–1840. <https://doi.org/10.14716/ijtech.v17i5.8880>
- Shlimas, D., Volodina, N., Shakirzyanov, R., Garanin, Y., Kozlovskiy, A., Kaliyekperov, M., & Zdorovets, M. (2026). Annealed-induced recrystallization and phase evolution in indented magnesia-stabilized zirconia ceramics. *International Journal of Technology*, 17(5), 1780–1791. <https://doi.org/10.14716/ijtech.v17i5.8413>
- Su, J., Ng, W. L., An, J., Yeong, W. Y., Chua, C. K., & Sing, S. L. (2024). Achieving sustainability by additive manufacturing: A state-of-the-art review and perspectives. *Virtual and Physical Prototyping*, 20(1). <https://doi.org/10.1080/17452759.2024.2438899>
- Taqdissillah, D., Mubarak, W., Nurhayati, R. W., Sakai, S., & Whulanza, Y. (2026). 3D printing of cincau perdu (*Premna oblongifolia*) hydrogel for dysphagia patient's food application. *Foods*, 15(5), Article 960. <https://doi.org/10.3390/foods15050960>
- Tuazon, B., Custodio, N. A. V., Basuel, R., & Dizon, J. R. C. (2022). 3D printing technology and materials for automotive application: A mini-review. *Key Engineering Materials*, 913, 3–16. <https://doi.org/10.4028/p-26o076>
- Wulandari, S., & Yastica, T. V. (2026). Market-oriented digital health co-creation framework for stunting prevention in developing countries: Evidence from indonesia. *International Journal of Technology*, 17(5), 1898–1917. <https://doi.org/10.14716/ijtech.v17i5.8369>
- Zhou, Z., Wang, J., Yin, G., Zhou, J., Zhang, Y., Guo, J., & Zhang, J. (2026). A deep reinforcement learning scheduling approach for production lines in series. *International Journal of Technology*, 17(5), 1879–1897. <https://doi.org/10.14716/ijtech.v17i5.8191>