Table S2. Study-level methodological quality appraisal

Study	Title	Primary enabling technology	Human-centricity	Human-centric contribution pathway	Sustainability	Sustainability contribution pathway	Resilience	Resilience contribution pathway	Mapped dimensions	DOI link
Bettahar et al. (2022)	Robotic Threading from a Gel-like Substance Based on Impedance Control with Force Tracking	Theme 1. Robotic automation and computer vision for process execution robotics/automation	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; personalisation and customisation	—	—	—	—	1	https://doi.org/10.1109/LRA.2021.3116697
Zhang and Wei (2024)	Automatic loading method for robot guided by 3D vision for scattered and stacked shoe soles	Theme 1. Robotic automation and computer vision for process execution robotics/automation; AI/computer vision; IoT/digital connectivity	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; reduced manual workload	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; reduced resource or labour dependency	2	https://doi.org/10.1088/2631-8695/ad4256
Borrell Mendez et al. (2020)	Robotic Pick-And-Place Time Optimization: Application to Footwear Production	Theme 1. Robotic automation and computer vision for process execution robotics/automation; AI/computer vision; simulation/digital twin/FEA	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; real-time monitoring and decision support; digital integration and continuity	2	https://doi.org/10.1109/ACCESS.2020.3037145
Majeed and Rupasinghe (2017)	Internet of things (IoT) embedded future supply chains for industry 4.0: An assessment from an ERP-based fashion apparel and footwear industry	Theme 5. Supply-chain digitisation and sustainability enablers IoT/digital connectivity; operations/supply-chain analytics	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	
Yardimci et al. (2026)	Deep learning-based forecasting of temperature and humidity in footwear using multi-sensor data	Theme 6. Smart and functional footwear systems enabled by advanced manufacturing AI/computer vision; IoT/digital connectivity; operations/supply-chain analytics	Indirect/inferred	comfort and biomechanical performance	Indirect/inferred	material and waste reduction; energy efficiency or recovery; resource and process efficiency	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; real-time monitoring and decision support; digital integration and continuity	3	https://doi.org/10.1177/18761364261433172
Shamsuzzoha et al. (2016)	ICT-based solution approach for collaborative delivery of customised products	Theme 5. Supply-chain digitisation and sustainability enablers IoT/digital connectivity	Directly addressed	skills, training and decision support; personalisation and customisation	Indirect/inferred	environmental contribution	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.1080/09537287.2015.1123322
Seul et al. (2023)	The Influence of Materials on Footwear Behaviour: A Finite Element Simulation Study	Theme 2. Additive manufacturing and computational design for product customisation simulation/digital twin/FEA	Indirect/inferred	worker safety; ergonomics and well-being; personalisation and customisation; comfort and biomechanical performance	Indirect/inferred	environmental contribution	—	—	2	https://doi.org/10.3390/ma16227203
Jianlin et al. (2024)	A knitted smart sneaker system based on piezoresistive strain sensing for stride counting	Theme 6. Smart and functional footwear systems enabled by advanced manufacturing IoT/digital connectivity; smart/functional materials	Directly addressed	ergonomics and well-being; personalisation and customisation; comfort and biomechanical performance	Indirect/inferred	material and waste reduction; energy efficiency or recovery; carbon and environmental-footprint reduction; cleaner processing and reduced chemicals	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.35530/IT.075.01.20232
Huang et al. (2025)	Real-Time 3D Vision-Based Robotic Path Planning for Automated Adhesive Spraying on Lasted Uppers in Footwear Manufacturing	Theme 1. Robotic automation and computer vision for process execution robotics/automation	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; human oversight and retained expertise	Indirect/inferred	material and waste reduction; energy efficiency or recovery; cleaner processing and reduced chemicals; resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; digital integration and continuity	3	https://doi.org/10.3390/app15116365
Baranowski et al. (2024)	Influence of 3D-printed cellular shoe soles on plantar pressure during running − Experimental and numerical studies	Theme 2. Additive manufacturing and computational design for product customisation additive manufacturing	Directly addressed	personalisation and customisation; comfort and biomechanical performance	Indirect/inferred	material and waste reduction; sustainable materials	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; decentralised or local production	3	https://doi.org/10.1016/j.bbe.2024.11.004
García Rojas et al. (2026)	Additive Manufacturing of High Heels Using the Input–Transformation–Output Model: Comparative Evaluation of PLA, ABS and ABS Photopolymer Resin Materials	Theme 2. Additive manufacturing and computational design for product customisation additive manufacturing; simulation/digital twin/FEA	Indirect/inferred	human–robot collaboration; skills, training and decision support; personalisation and customisation	Indirect/inferred	material and waste reduction; energy efficiency or recovery; carbon and environmental-footprint reduction; cleaner processing and reduced chemicals	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.3390/jmmp10040119
Tafuro et al. (2025)	Self-supervised Vision-driven Trajectory Planning for Intelligent Robotic Deburring	Theme 1. Robotic automation and computer vision for process execution robotics/automation; AI/computer vision; simulation/digital twin/FEA	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; real-time monitoring and decision support; disruption and operational-risk management	2	https://doi.org/10.1007/s11633-025-1560-6
Macchion and Fornasiero (2021)	Global–local supply chain configurations for different production strategies: a comparison between traditional and customized productions	Theme 3. Digital intelligence and data-driven systems additive manufacturing; operations/supply-chain analytics	Directly addressed	human–robot collaboration; worker safety; personalisation and customisation	—	—	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.1108/JFMM-12-2019-0269

Sheward et al. (2026)	Artificial Muscles for Footwear Technology: Knitting Structures With Variable Elasticity	Theme 6. Smart and functional footwear systems enabled by advanced manufacturing smart/functional materials	Directly addressed	comfort and biomechanical performance	—	—	—	—	1	https://doi.org/10.1155/amse/9046033
Gracia et al. (2017)	Robotic manipulation for the shoe-packaging process	Theme 1. Robotic automation and computer vision for process execution robotics/automation; AI/computer vision; additive manufacturing	Indirect/inferred	human–robot collaboration; worker safety; human oversight and retained expertise	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; real-time monitoring and decision support	2	https://doi.org/10.1007/s00170-017-0212-6
Forlini et al. (2025)	Smart automation in luxury leather shoe polishing: a human centric robotic approach	Theme 1. Robotic automation and computer vision for process execution robotics/automation	Directly addressed	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; real-time monitoring and decision support	2	https://doi.org/10.1080/0951192X.2024.2421313
Papetti et al. (2020)	A method to improve workers' well-being toward human-centered connected factories	Theme 4. Human-centric and worker-centred technologies IoT/digital connectivity	Directly addressed	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.1093/jcde/qwaa047
Gelaziene and Milasiene (2023)	Influence of the Type of Plastic and Printing Technologies on the Compressive Behavior of 3D-Printed Heel Prototypes	Theme 2. Additive manufacturing and computational design for product customisation additive manufacturing	Indirect/inferred	ergonomics and well-being; personalisation and customisation; comfort and biomechanical performance	Indirect/inferred	material and waste reduction; resource and process efficiency; circularity, reuse or recycling	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; digital integration and continuity	3	https://doi.org/10.3390/ma16051930
B. Zhang et al. (2026)	Unveiling the resolution-induced variability in product carbon footprints: Evidence from multi-level electricity consumption data in footwear manufacturing	Theme 3. Digital intelligence and data-driven systems AI/computer vision; IoT/digital connectivity	—	—	Directly addressed	energy efficiency or recovery; carbon and environmental-footprint reduction; cleaner processing and reduced chemicals; resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; real-time monitoring and decision support; digital integration and continuity	2	https://doi.org/10.1016/j.resconrec.2026.108938
Chiu et al. (2022)	A novel directional object detection method for piled objects using a hybrid region-based convolutional neural network	Theme 1. Robotic automation and computer vision for process execution AI/computer vision	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; digital integration and continuity	2	https://doi.org/10.1016/j.aei.2021.101448
Lu et al. (2025)	Parametric cushioning lattice insole based on finite element method and machine learning: A preliminary computational analysis	Theme 2. Additive manufacturing and computational design for product customisation robotics/automation; AI/computer vision; additive manufacturing	Indirect/inferred	skills, training and decision support; personalisation and customisation; comfort and biomechanical performance	Indirect/inferred	material and waste reduction; energy efficiency or recovery; resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; maintenance, reliability and reduced downtime; disruption and operational-risk management	3	https://doi.org/10.1016/j.jbiomech.2025.112674
Mofatteh et al. (2026)	Blockchain enabled sustainable packaging for carbon footprint reduction in the European footwear industry	Theme 5. Supply-chain digitisation and sustainability enablers robotics/automation; IoT/digital connectivity	—	—	Directly addressed	carbon and environmental-footprint reduction; resource and process efficiency; circularity, reuse or recycling	Indirect/inferred	supply-chain visibility and traceability; real-time monitoring and decision support; digital integration and continuity; reduced resource or labour dependency	2	https://doi.org/10.1016/j.grets.2026.100401
Pancu et al. (2024)	Inverse Kinematics Proposal to Automatize the 3D Scanning of Handball Shoes by Using a Robotic Arm with 3 Actuated Joints	Theme 1. Robotic automation and computer vision for process execution robotics/automation	Indirect/inferred	skills, training and decision support; personalisation and customisation; comfort and biomechanical performance	Indirect/inferred	material and waste reduction; energy efficiency or recovery; resource and process efficiency; circularity, reuse or recycling	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.3390/app14010297
Saraçoğlu et al. (2021)	Minimizing makespan and flowtime in a parallel multi-stage cellular manufacturing company	Theme 3. Digital intelligence and data-driven systems mathematical programming; genetic algorithms; manpower allocation and cellular scheduling	—	—	Indirect/inferred	Potential resource/process efficiency through coordinated allocation and cellular scheduling; no material, energy, emissions or other environmental outcome was evaluated.	Indirect/inferred	Production-planning flexibility through alternative workforce allocations and product-to-cell assignments; resilience under uncertainty or disruption was not evaluated.	2	https://doi.org/10.1016/j.rcim.2021.102182
Kashfi et al. (2022)	A novel approach to determining piezoelectric properties of nanogenerators based on PVDF nanofibers using iterative finite element simulation for walking energy harvesting	Theme 6. Smart and functional footwear systems enabled by advanced manufacturing simulation/digital twin/FEA; smart/functional materials	Indirect/inferred	human–robot collaboration; worker safety; skills, training and decision support; personalisation and customisation	Directly addressed	material and waste reduction; energy efficiency or recovery; resource and process efficiency; sustainable materials	—	—	2	https://doi.org/10.1177/1528083720926493
Sarlak et al. (2026)	Current strategies and priorities for diabetic footwear design and production: a cross-European exploratory survey of clinicians and shoemakers	Theme 6. Smart and functional footwear systems enabled by advanced manufacturing AI/computer vision; additive manufacturing	Directly addressed	personalisation and customisation; comfort and biomechanical performance; human oversight and retained expertise	Indirect/inferred	material and waste reduction; carbon and environmental-footprint reduction; cleaner processing and reduced chemicals; resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; digital integration and continuity; reduced resource or labour dependency	3	https://doi.org/10.1007/s00592-026-02669-6

Chiu and Yang (2024)	Integrating explainable AI and depth cameras to achieve automation in grasping Operations: A case study of shoe company	Theme 1. Robotic automation and computer vision for process execution robotics/automation; AI/computer vision	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.1016/j.aei.2024.102583
Rodrigues et al. (2021)	Assessing the compressive and impact behavior of plastic safety toe caps through computational modelling	Theme 2. Additive manufacturing and computational design for product customisation simulation/digital twin/FEA	Indirect/inferred	ergonomics and well-being; comfort and biomechanical performance	Indirect/inferred	material and waste reduction; resource and process efficiency; sustainable materials	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.3390/polym13244332
Luximon et al. (2020)	Sizing and grading methods with consideration of footwear styles	Theme 2. Additive manufacturing and computational design for product customisation robotics/automation	Directly addressed	personalisation and customisation; comfort and biomechanical performance	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; reduced resource or labour dependency	2	https://doi.org/10.1016/j.ergon.2020.102960
Huang and Hsieh (2026)	Adaptive junction line detection for robotic footwear assembly using contour sensing and shoe-last-based geometric matching	Theme 1. Robotic automation and computer vision for process execution robotics/automation; IoT/digital connectivity	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; real-time monitoring and decision support	2	https://doi.org/10.1007/s00170-026-18316-x
Silvestre et al. (2022)	Implementation of a Lean Manufacturing and SLP-based system for a footwear company	Theme 3. Digital intelligence and data-driven systems operations/supply-chain analytics	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	Directly addressed	material and waste reduction; cleaner processing and reduced chemicals; resource and process efficiency; circularity, reuse or recycling	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.1590/0103-6513.20210072
Wu et al. (2016)	An automatic shoe-groove feature extraction method based on robot and structural laser scanning	Theme 1. Robotic automation and computer vision for process execution robotics/automation; AI/computer vision	Directly addressed	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.1177/1729881416678135
Amorim et al. (2025)	Development and Evaluation of a Piezoelectret Insole for Energy Harvesting Applications	Theme 6. Smart and functional footwear systems enabled by advanced manufacturing smart/functional materials	Indirect/inferred	ergonomics and well-being; comfort and biomechanical performance	Directly addressed	material and waste reduction; energy efficiency or recovery; carbon and environmental-footprint reduction; resource and process efficiency	—	—	2	https://doi.org/10.3390/electronics14214254
Calderón-Andrade et al. (2020)	Productivity improvement through reengineering and simulation: A case study in a footwear-industry	Theme 3. Digital intelligence and data-driven systems simulation/digital twin/FEA	—	—	—	—	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness	1	https://doi.org/10.3390/app10165590
Kim et al. (2022)	Robot-Based Automation for Upper and Sole Manufacturing in Shoe Production	Theme 1. Robotic automation and computer vision for process execution robotics/automation	Indirect/inferred	worker safety; ergonomics and well-being; user safety and protection	Indirect/inferred	cleaner processing and reduced chemicals; resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.3390/machines10040255
Mihai et al. (2022)	Mechanical Parameters of Leather in Relation to Technological Processing of the Footwear Uppers	Theme 2. Additive manufacturing and computational design for product customisation simulation/digital twin/FEA	Indirect/inferred	worker safety; personalisation and customisation; comfort and biomechanical performance	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; maintenance, reliability and reduced downtime; digital integration and continuity	2	https://doi.org/10.3390/ma15155107
Devireddy et al. (2026)	Reducing Carbon Emissions in Shoe Manufacturing Through Digital Twin-Enabled Project Management †	Theme 3. Digital intelligence and data-driven systems IoT/digital connectivity; simulation/digital twin/FEA	—	—	Directly addressed	energy efficiency or recovery; carbon and environmental-footprint reduction; cleaner processing and reduced chemicals; resource and process efficiency	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.3390/engproc2026130003
Paiva et al. (2017)	Multiobjective optimization of mechanical properties based on the composition of adhesives	Theme 2. Additive manufacturing and computational design for product customisation operations/supply-chain analytics	Indirect/inferred	worker safety; ergonomics and well-being; skills, training and decision support; personalisation and customisation	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; disruption and operational risk management	2	https://doi.org/10.1007/s10999-015-9313-2
Borrell Méndez et al. (2021)	Conceptual and preliminary design of a shoe manufacturing plant	Theme 3. Digital intelligence and data-driven systems decision-support system; expert systems; discrete-event simulation	Indirect/inferred	human–robot collaboration; skills, training and decision support; personalisation and customisation; human oversight and retained expertise	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; real-time monitoring and decision support; decentralised or local production	2	https://doi.org/10.3390/app112211055

Tsai et al. (2020)	Utilization of a reinforcement learning algorithm for the accurate alignment of a robotic arm in a complete soft fabric shoe tongues automation process	Theme 1. Robotic automation and computer vision for process execution robotics/automation; AI/computer vision	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; personalisation and customisation	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.1016/j.jmsy.2020.07.001
Lucas et al. (2024)	Simulation model to analyze the impact of work on absenteeism	Theme 4. Human-centric and worker-centred technologies system-dynamics simulation in Vensim; ergonomic work analysis	Directly addressed	Modelled effects of overtime and physical recovery on worker overload, leave requests and absenteeism; no post-intervention workplace outcomes were evaluated.	—	—	Indirect/inferred	Potential support for workforce availability and production continuity through managing overload and absenteeism; inferred from links between absence, task reallocation, operational knowledge and production.	2	https://doi.org/10.1002/hfm.21052
Sadeghi et al. (2018)	Balancing mixed-model assembly systems in the footwear industry with a variable neighbourhood descent method	Theme 3. Digital intelligence and data-driven systems robotics/automation	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.1016/j.cie.2018.05.020
Li et al. (2026)	Driving Factors and the Role of Sustainable Supplier Development in Blockchain-Enabled Supply Chains: Evidence From the Fashion Manufacturing Industry	Theme 5. Supply-chain digitisation and sustainability enablers IoT/digital connectivity; operations/supply-chain analytics	Indirect/inferred	human/user-centred outcome	Directly addressed	carbon and environmental-footprint reduction; cleaner processing and reduced chemicals; resource and process efficiency; circularity, reuse or recycling	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.1002/csr.70490
Pagano et al. (2020)	A vision guided robotic system for flexible gluing process in the footwear industry	Theme 1. Robotic automation and computer vision for process execution robotics/automation	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; reduced resource or labour dependency	2	https://doi.org/10.1016/j.rcim.2020.101965
González et al. (2024)	Development of a collaborative robotic system to polish leather surfaces	Theme 1. Robotic automation and computer vision for process execution robotics/automation; simulation/digital twin/FEA	Directly addressed	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.1080/0951192X.2023.2209874
Zhang et al. (2023)	Research on the path extraction method of shoe upper grinding based on 3D vision	Theme 1. Robotic automation and computer vision for process execution robotics/automation; IoT/digital connectivity	Directly addressed	human–robot collaboration; worker safety; skills, training and decision support; comfort and biomechanical performance	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; reduced resource or labour dependency	2	https://doi.org/10.1088/2631-8695/ad0f77
Hernández-Vázquez et al. (2025)	MULTI-OBJECTIVE OPTIMIZATION OF THE BUFFER ALLOCATION PROBLEM CONSIDERING THE OVERALL EQUIPMENT EFFECTIVENESS INDICATOR	Theme 3. Digital intelligence and data-driven systems operations/supply-chain analytics	—	—	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	1	https://doi.org/10.23055/ijietap.2025.32.5.11019
Xu et al. (2025)	Wear Resistance of Additively Manufactured Footwear Soles	Theme 2. Additive manufacturing and computational design for product customisation additive manufacturing	Indirect/inferred	personalisation and customisation; comfort and biomechanical performance	Indirect/inferred	material and waste reduction; energy efficiency or recovery; resource and process efficiency; sustainable materials	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.3390/lubricants13020089
Yalçın and Karavana (2025)	Footwear breathability test machine: A new method and system design for testing footwear breathability and its thermal comfort, case study on leather boot	Theme 6. Smart and functional footwear systems enabled by advanced manufacturing robotics/automation; additive manufacturing; IoT/digital connectivity	Directly addressed	personalisation and customisation; comfort and biomechanical performance	—	—	—	—	1	https://doi.org/10.1177/15280837251346790
Alam et al. (2024)	Analyzing the impact of opportunistic maintenance optimization on manufacturing industries in Bangladesh: An empirical study	Theme 3. Digital intelligence and data-driven systems operations/supply-chain analytics	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	Indirect/inferred	material and waste reduction; energy efficiency or recovery; resource and process efficiency	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.1016/j.tbench.2024.100172
Shih et al. (2020)	A biomechanical investigation of athletic footwear traction performance: Integration of gait analysis with computational simulation	Theme 2. Additive manufacturing and computational design for product customisation simulation/digital twin/FEA	Directly addressed	worker safety; ergonomics and well-being; personalisation and customisation; comfort and biomechanical performance	Indirect/inferred	material and waste reduction; energy efficiency or recovery; carbon and environmental-footprint reduction; resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; real-time monitoring and decision support; disruption and operational-risk management	3	https://doi.org/10.3390/app10051672
Tsang et al. (2025)	Demonstration of curing degree estimation approach of EVA foam during injection moulding by integrating thermal–physical characteristics and FEA simulation	Theme 2. Additive manufacturing and computational design for product customisation additive manufacturing; simulation/digital twin/FEA; operations/supply-chain analytics	Indirect/inferred	comfort and biomechanical performance	Indirect/inferred	material and waste reduction; carbon and environmental-footprint reduction; resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; maintenance, reliability and reduced downtime; digital integration and continuity	3	https://doi.org/10.1007/s00289-024-05568-4

Rahman et al. (2026)	Human-Centric Industry 5.0 for Sustainable Business: Implementation Challenges and Strategies	Theme 4. Human-centric and worker-centred technologies robotics/automation; additive manufacturing; IoT/digital connectivity	Directly addressed	human–robot collaboration; skills, training and decision support; personalisation and customisation; comfort and biomechanical performance	Directly addressed	material and waste reduction; energy efficiency or recovery; cleaner processing and reduced chemicals; resource and process efficiency	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.1002/bsd2.70342
Román-Ibáñez, Jimeno-Morenilla, Pujol-López, and Salas-Pérez (2018)	Online simulation as a collision prevention layer in automated shoe sole adhesive spraying	Theme 1. Robotic automation and computer vision for process execution robotic simulation; online trajectory checking; collision prevention	Indirect/inferred	Potential worker protection through checking robot trajectories against the defined user work area; worker safety outcomes were not measured.	—	—	Directly addressed	Online collision checking and technical reliability evaluated for a robotic spraying cell; wider production-continuity benefits are inferred, not tested disruption resilience.	2	https://doi.org/10.1007/s00170-017-1257-2
Wang et al. (2022)	A Hybrid OPA and Fuzzy MARCOS Methodology for Sustainable Supplier Selection with Technology 4.0 Evaluation	Theme 5. Supply-chain digitisation and sustainability enablers other enabling technology	—	—	Directly addressed	material and waste reduction; energy efficiency or recovery; carbon and environmental-footprint reduction; cleaner processing and reduced chemicals	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.3390/pr10112351
Liu and Yang (2020)	An improved value stream mapping to prioritize lean optimization scenarios using simulation and multiple-attribute decision-making method	Theme 3. Digital intelligence and data-driven systems value stream mapping; discrete-event simulation; grey Taguchi method; multi-attribute decision-making	—	—	Indirect/inferred	Potential resource efficiency through lower work-in-process inventory and improved process configuration; material consumption, energy use and environmental impacts were not evaluated.	Indirect/inferred	Simulation-based comparison and prioritisation of alternative production configurations; demand variation and wider supply-chain effects are future work, not tested disruption resilience.	2	https://doi.org/10.1109/ACCESS.2020.3037660
Gomez-Hernandez et al. (2024)	Development of an Integrated Robotic Workcell for Automated Bonding in Footwear Manufacturing	Theme 1. Robotic automation and computer vision for process execution robotics/automation	Indirect/inferred	worker safety; ergonomics and well-being; reduced manual workload	Indirect/inferred	carbon and environmental-footprint reduction; cleaner processing and reduced chemicals; resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; digital integration and continuity	3	https://doi.org/10.1109/ACCESS.2024.3350441
Lau et al. (2025)	Estimating the slip resistant quality of winter footwear using Artificial Intelligence	Theme 3. Digital intelligence and data-driven systems AI/computer vision	Directly addressed	worker safety; ergonomics and well-being; skills, training and decision support	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.1016/j.ssci.2024.106686
Castelli et al. (2021)	A feasibility study of a robotic approach for the gluing process in the footwear industry†	Theme 1. Robotic automation and computer vision for process execution robotics/automation; additive manufacturing	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; decentralised or local production	2	https://doi.org/10.3390/robotics10010006
Borrell et al. (2023)	Cooperative human–robot polishing for the task of patina growing on high-quality leather shoes	Theme 1. Robotic automation and computer vision for process execution robotics/automation; AI/computer vision	Directly addressed	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; real-time monitoring and decision support; digital integration and continuity	2	https://doi.org/10.1007/s00170-022-10620-6
Ruzafa-Silvestre et al. (2022)	Robotised atmospheric plasma treatment to improve the adhesion of vulcanised and thermoplastic rubber materials for a more sustainable footwear	Theme 1. Robotic automation and computer vision for process execution robotics/automation	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; reduced manual workload	Directly addressed	cleaner processing and reduced chemicals; resource and process efficiency; sustainable materials	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.1016/j.ijadhadh.2021.103010
Chang (2020)	Evaluation of smart alarm systems for industry 4.0 technologies	Theme 3. Digital intelligence and data-driven systems other enabling technology	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.3390/app10062022
Negre et al. (2024)	Prediction of footwear demand using Prophet and SARIMA	Theme 3. Digital intelligence and data-driven systems AI/computer vision; operations/supply-chain analytics	—	—	Indirect/inferred	resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	2	https://doi.org/10.1016/j.eswa.2024.124512
Wu et al. (2025)	AI-Driven Supply Chain Transformation in Industry 5.0: Enhancing Resilience and Sustainability	Theme 5. Supply-chain digitisation and sustainability enablers AI/computer vision; IoT/digital connectivity; simulation/digital twin/FEA	Indirect/inferred	worker safety; skills, training and decision support; reduced manual workload	Directly addressed	material and waste reduction; energy efficiency or recovery; carbon and environmental-footprint reduction; resource and process efficiency	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; real-time monitoring and decision support	3	https://doi.org/10.1007/s13132-024-01999-6
Kropidłowska et al. (2023)	Analysis of the Impact Resistance of Toecaps by the Finite Element Method: Preliminary Studies	Theme 2. Additive manufacturing and computational design for product customisation simulation/digital twin/FEA	Directly addressed	worker safety; comfort and biomechanical performance; user safety and protection	Indirect/inferred	material and waste reduction; resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; real-time monitoring and decision support	3	https://doi.org/10.3390/ijerph20010152

Akhtar (2023)	Prioritisation of criteria for sustainable and agile global manufacturing outsourcing partner selection using simulation based stochastic fuzzy PIPRECIA method	Theme 5. Supply-chain digitisation and sustainability enablers simulation/digital twin/FEA	Indirect/inferred	worker safety; ergonomics and well-being; skills, training and decision support	Directly addressed	energy efficiency or recovery	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	3	https://doi.org/10.1590/0103-6513.20230035
Oliver et al. (2021)	Towards footwear manufacturing 4.0: shoe sole robotic grasping in assembling operations	Theme 1. Robotic automation and computer vision for process execution robotics/automation; simulation/digital twin/FEA	—	—	—	—	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; maintenance, reliability and reduced downtime	1	https://doi.org/10.1007/s00170-021-06697-0
Borrell et al. (2024)	Optimization of the pick-and-place sequence of a bimanual collaborative robot in an industrial production line	Theme 1. Robotic automation and computer vision for process execution robotics/automation; additive manufacturing; smart/functional materials	Directly addressed	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	Indirect/inferred	material and waste reduction; energy efficiency or recovery; resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; reduced resource or labour dependency	3	https://doi.org/10.1007/s00170-023-12922-9
Turner et al. (2019)	Sustainable production in a circular economy: A business model for re-distributed manufacturing	Theme 5. Supply-chain digitisation and sustainability enablers additive manufacturing	—	—	Directly addressed	carbon and environmental-footprint reduction; circularity, reuse or recycling; localised or redistributed production	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; decentralised or local production	2	https://doi.org/10.3390/su11164291
Z. Zhang et al. (2026)	Teaming Finite Element Analysis and Deep Learning to Advance Inverse Design of Metamaterial With Adaptive Pressure Response in Footwear Design	Theme 2. Additive manufacturing and computational design for product customisation AI/computer vision; simulation/digital twin/FEA; smart/functional materials	Directly addressed	personalisation and customisation; comfort and biomechanical performance	Indirect/inferred	material and waste reduction	Directly addressed	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; reduced resource or labour dependency	3	https://doi.org/10.1115/1.4071847
Zhang et al. (2024)	Pressure-Reducing Design of 3D-Printed Diabetic Shoe Midsole Utilizing Auxetic Lattice Structure	Theme 2. Additive manufacturing and computational design for product customisation additive manufacturing	Directly addressed	personalisation and customisation; comfort and biomechanical performance	Indirect/inferred	material and waste reduction; resource and process efficiency	Indirect/inferred	adaptability and manufacturing flexibility; demand and product-variety responsiveness; supply-chain visibility and traceability; decentralised or local production	3	https://doi.org/10.3390/app14125291
Intalar et al. (2021)	Towards Industry 4.0: Digital transformation of traditional safety shoes manufacturer in Thailand with a development of production tracking system	Theme 3. Digital intelligence and data-driven systems other enabling technology	Indirect/inferred	human–robot collaboration; worker safety; ergonomics and well-being; skills, training and decision support	—	—	Directly addressed	supply-chain visibility and traceability; maintenance, reliability and reduced downtime; real-time monitoring and decision support; digital integration and continuity	2	https://doi.org/10.2478/emj-2021-0033
Román-Ibáñez, Jimeno-Morenilla, and Pujol-López (2018)	Distributed monitoring of heterogeneous robotic cells. A proposal for the footwear industry 4.0	Theme 1. Robotic automation and computer vision for process execution robotics/automation	—	—	—	—	Directly addressed	adaptability and manufacturing flexibility; real-time monitoring and decision support; digital integration and continuity; reduced resource or labour dependency	1	https://doi.org/10.1080/0951192X.2018.1529432
Wang et al. (2025)	3-D Reconstruction and Trajectory Planning for Real-Time Shoe Upper Glue Spraying System	Theme 1. Robotic automation and computer vision for process execution 3D reconstruction; computer vision; robotic adhesive-spraying trajectory planning	Indirect/inferred	Potential reduction of manual gluing effort and adhesive exposure; no measured worker effects.	Indirect/inferred	Potential reduction of adhesive losses through improved spraying accuracy and control of overflow; adhesive consumption and environmental savings were not measured.	Directly addressed	Trajectory adaptation across shoe shapes and robustness to noise; pilot/production-line verification.	3	https://doi.org/10.1109/TIM.2025.3623792
Shaulian et al. (2022)	A novel graded-stiffness footwear device for heel ulcer prevention and treatment: a finite element-based study	Theme 2. Additive manufacturing and computational design for product customisation finite element analysis; graded-stiffness offloading design	Directly addressed	Modelled heel-tissue stress redistribution and proposed patient-specific offloading; no clinical validation.	—	—	—	—	1	https://doi.org/10.1007/s10237-022-01614-0
Sultana et al. (2021)	Numerical assessment of directional energy performance for 3D printed midsole structures	Theme 2. Additive manufacturing and computational design for product customisation numerical modelling; finite element analysis; midsole structures	Indirect/inferred	Proposed forward energy return and cushioning benefits; numerical structural evaluation without human testing.	—	—	—	—	1	https://doi.org/10.3934/mbe.2021224
Jadhav et al. (2019)	Ergonomics design and evaluation of the stitching workstation for the hand-crafted Kolhapuri footwear using a digital human modeling approach	Theme 4. Human-centric and worker-centred technologies digital human modelling; CAD; virtual ergonomic evaluation	Directly addressed	Artisan-informed workstation design assessed virtually for posture and anthropometric accommodation.	—	—	—	—	1	https://doi.org/10.1080/21681015.2019.1702593
Fay and Hosoi (2024)	Modeling Running via Optimal Control for Shoe Design	Theme 2. Additive manufacturing and computational design for product customisation optimal-control modelling; computational shoe design	Directly addressed	Modelled running gait and performance under shoe conditions; comparison with existing gait data.	—	—	—	—	1	https://doi.org/10.1115/1.4064405

Cracknell et al. (2025)	Static and dynamic optimisation of fluid-filled responsive orthotic insoles	Theme 6. Smart and functional footwear systems enabled by advanced manufacturing additive manufacturing; fluid-filled orthotic design; optimisation	Directly addressed	Customised insole with experimentally evaluated plantar-pressure reduction in one participant; comfort/clinical benefit not established.	—	—	—	—	1	https://doi.org/10.1007/s10237-025-01935-w
Kim et al. (2026)	Shoe-CLIP: Attribute-Based Semantic Similarity Evaluation With Explainable Evidence for Sneaker Design	Theme 3. Digital intelligence and data-driven systems vision-language AI; explainable image similarity; design support	Directly addressed	Model similarity scores compared with seven designers; support for design decisions is proposed.	—	—	—	—	1	https://doi.org/10.1109/ACCESS.2026.3711993
Hou and Li (2024)	3-D Trajectory Planning Scheme for Shoe Upper Processing	Theme 1. Robotic automation and computer vision for process execution robotics/automation; 3D vision; trajectory planning	Indirect/inferred	Reduced manual trajectory teaching and potential exposure reduction; no worker outcomes measured.	—	—	Directly addressed	Adaptability across shoe styles and robustness to camera displacement evaluated; disruption resilience not tested.	2	https://doi.org/10.1109/TIM.2024.3476594
Amjad et al. (2022)	Optimizing Production Efficiency in Pakistani Shoe Manufacturing: A Simulation-Based Analysis	Theme 3. Digital intelligence and data-driven systems discrete-event/process simulation; production optimisation	Indirect/inferred	Modelled worker utilisation and workload allocation; no demonstrated wellbeing, safety or ergonomic improvement.	—	—	—	—	1	
Xie et al. (2021)	Study on Design and Additive Manufacturing of Customized Bionic Sports Sole for the Elderly	Theme 2. Additive manufacturing and computational design for product customisation 3D scanning/design; additive manufacturing; finite element analysis	Directly addressed	Customised soles for older adults; friction testing and simulated stress response, without wearer comfort/safety testing.	Indirect/inferred	Expected material saving and lightweight design; no measured environmental metric.	—	—	2	https://doi.org/10.1109/ACCESS.2021.3078162
Wang et al. (2026)	Influence of Unit-Cell Geometry on 3D-Printed Chiral-Inspired Tubular Metamaterials: Auxeticity and Energy Absorption in Athletic Footwear Applications	Theme 2. Additive manufacturing and computational design for product customisation additive manufacturing; auxetic metamaterials; finite element analysis	Indirect/inferred	Potential cushioning, support and impact dissipation from mechanical specimen tests; no wearer evaluation.	Indirect/inferred	Lightweight-design sustainability potential only; no environmental measurement.	—	—	2	https://doi.org/10.1002/pat.70732
Arshad and Ramish (2026)	The role of big data analytics in the footwear supply chains: a multiple case study perspective	Theme 5. Supply-chain digitisation and sustainability enablers big data analytics; supply-chain decision support; conceptual framework	Indirect/inferred	Proposed stakeholder participation, workforce skills and decision support; no measured worker improvement.	Directly addressed	Qualitative reports of recycling, reuse, solar energy and packaging initiatives; effects not quantified or attributed to BDA.	Indirect/inferred	Proposed data-enabled responsiveness and supplier coordination; no tested disruption resilience.	3	https://doi.org/10.1108/JSTPM-12-2023-0214