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## Enterprise generative artificial intelligence technologies, Internet of Things and blockchain-based fintech management, and digital twin industrial metaverse in the cognitive algorithmic economy

**JEL Classification:** E42; J33; O14

**Keywords:** *enterprise generative artificial intelligence; Internet of Thing; blockchain; fintech; digital twin industrial metaverse; cognitive algorithmic economy*

### Abstract

**Research background:** Enterprise generative AI system-based worker behavior tracking and monitoring, socially responsible organizational practices, employee performance management satisfaction, and human resource management procedures, relationships, and outcomes develop on hiring and objective performance assessment algorithms in terms of human resource management activities, functions, processes, practices, policies, and productivity. Deep reinforcement and machine learning techniques, operational and analytical generative AI and cloud capabilities, and real-time anomalous behavior recognition systems further fintech development for credit and lending services, payment analytics processes, and risk assessment, monitoring, and mitigation. Generative AI tools can bolster predictive analytics by collaborative and interconnected sensor and machine data for tailored, seamless, and fine-tuned product, operational process, and organizational workflow development, efficiency, and innovation, driving agile transformative changes in digital twin industrial metaverse.

**Purpose of the article:** We show that enterprise generative AI-driven schedule prediction tools, job search and algorithmic hiring systems, and synthetic training data can improve team selection, job performance and firing decisions, hiring decision processes, and workforce productivity in terms of prediction and decision-making by use of algorithmic management, system performance, and production process tracking tools. Blockchain-based fintech operations can shape cloud-based financial and digital banking services, quote-to-cash process automation, cash-settled crypto futures, digital loan decisioning, asset tokenization simulated transactions, transaction switching and routing operations, tailored peer-to-peer lending, and proactive credit line management. Collaborative unstructured enterprise data processing, infrastructure, and governance can develop on AI decision and behavior automation technology, retrieval augmented generation and development management systems, and real-time data descriptive and predictive analytics, driving productivity surges and competitive advantage in digital twin industrial metaverse.

**Methods:** Reference and review management tools, together with evidence synthesis screening software, harnessed were Abstrackr, AMSTAR, ASReview Lab, CASP, Catchii, Citation-chaser, DistillerSR, JBI SUMARI, Litstream, PICO Portal, and Rayyan.

**Findings & value added:** The current state of the art is improved for theory on organizational issues and for policy making as deep learning-based generative AI tools and workplace monitoring systems can augment performance and productivity, gauge employee effectiveness, build resilient, satisfied, and engaged workforce, assess human capital, skill, and career development, drive employee and productivity expectations in relation to flexibility and stability, and shape turnover, retention, and loyalty. Cloud and account servicing technologies can be deployed in generative AI fintechs for embedded cryptocurrency trading, transaction moni-

toring and processing, digital asset transfers, payment screening, corporate and retail banking operations, and fraud prevention. Generative AI technologies can reshape jobs and reimagine meaningful work, involving creativity and innovation and adaptable and resilient sustained performance, providing valuable constructive feedback, optimizing workplace flexibility and psychological safety, and measuring and supporting autonomy and flexibility-based efficiency, performance, and productivity, while configuring demanding, engaging, and rewarding experiences by cloud and edge computing devices in digital twin industrial metaverse.

## **Introduction**

This collective article covers the three main and hot topics typifying the cognitive algorithmic economy: enterprise generative artificial intelligence (AI) technologies, Internet of Things (IoT)- and blockchain-based fintech management, and industrial digital twin metaverse, articulating the current state of the art and the main current literature gaps in terms of generative AI algorithms and cognitive computing systems in meaningful creative and collaborative work (Agrawal, 2023; Agrawal *et al.*, 2023; Ali *et al.*, 2023; Altrock *et al.*, 2023; Castañé *et al.*, 2023; Cebulla *et al.*, 2023; Chang & Ke, 2023; Chen *et al.*, 2023a, b; Choudhary *et al.*, 2023; Kambur & Yildirim, 2023; Kanbach *et al.*, 2023; Lăzăroiu *et al.*, 2022; Malhan & Gupta, 2023; Nagy & Lăzăroiu, 2022; Nagy *et al.*, 2023), generative AI algorithms and adaptive self-organizing systems in workforce management (Andronie *et al.*, 2021a, b; Ayhan & Elal, 2023; Bankins *et al.*, 2023; Bartelheimer *et al.*, 2023; Bilgram & Laarmann, 2023; Cortez & Maslej, 2023; Einola & Khoreva, 2023; Ferrari & McKelvey, 2023; Fosso Wamba *et al.*, 2023; França *et al.*, 2023; Kemp, 2023; Kliestik *et al.*, 2023; Koivisto & Grassini, 2023; Kolbjørnsrud, 2023; Mazarakis *et al.*, 2023; Pan & Froese, 2023), generative AI and workforce management forecasting algorithms shaping organizational performance (Birkbeck & Rowe, 2023; Booyse & Scheepers, 2023; Bouschery *et al.*, 2023; Böhmer & Schinnenburg, 2023; Budhwar *et al.*, 2023; Carmel & Sawyer, 2023; Furendal & Jebari, 2023; Gama & Magistretti, 2023; Gandhi *et al.*, 2023; Garibay *et al.*, 2023; Guliyev, 2023; Jarrahi *et al.*, 2023; Kanitz *et al.*, 2023; Kar *et al.*, 2023; Kraus *et al.*, 2023; Naz *et al.*, 2024; Pelau *et al.*, 2021; Peters *et al.*, 2024), generative AI-assisted decision-making and predictive analytics tools across blockchain-enabled decentralized interoperable payment infrastructures (Abakah *et al.*, 2023; Ahelegbey *et al.*, 2023; Akmal *et al.*, 2023; Alaassar *et al.*, 2023; Almansour, 2023; Arora *et al.*, 2023; Dong & Yu, 2023; Doumpos *et al.*, 2023; Edo *et al.*, 2023; Gonçalves *et al.*, 2023; Guang-Wen & Siddik, 2023; Guo *et al.*, 2023; Mirza *et al.*, 2023a, b; Rafiuddin *et al.*, 2023;

Sharma *et al.*, 2023a; Su & Xu, 2023; Yang *et al.*, 2023), generative AI fintechns in investment operation and payment process automation and streamlining (Awais *et al.*, 2023; Babaei *et al.*, 2023; Barbu *et al.*, 2021; Ben Romdhane *et al.*, 2023; Bhutto *et al.*, 2023; Campanella *et al.*, 2023; Guo & Zhang, 2023; Ha, 2023; He *et al.*, 2023a, b; Jiang, 2023; Kazachenok *et al.*, 2023; Osei-Assibey Bonsu *et al.*, 2023; Sun *et al.*, 2023; Thomas *et al.*, 2023; Upreti *et al.*, 2023; Wu *et al.*, 2023b; Yan, 2023), generative AI-powered automated scheduling and predictive analytics algorithms in blockchain-based fintech management and decentralized finance (Caragea *et al.*, 2023; Chaklader *et al.*, 2023; Chen & Guo, 2023; Chen *et al.*, 2023c; Cheng, 2023; Cheng & Qu, 2023; Khan *et al.*, 2023; Lai *et al.*, 2023; Lisha *et al.*, 2023; Mahmud *et al.*, 2023; Mikhaylov *et al.*, 2023; Qiu *et al.*, 2023; Rjoub *et al.*, 2023; Sampat *et al.*, 2024; Sharma *et al.*, 2023b; Sun & Zhang, 2023; Tan *et al.*, 2023; Zhao *et al.*, 2023), neuro-symbolic augmented generative AI deep learning simulation algorithms in digital twin industrial metaverse (Agarwal & Alathur, 2023; Bellalouna & Puljiz, 2023; Bhattacharya *et al.*, 2023; Kaarlela *et al.*, 2023; Kshetri, 2023; Lee & Kundu, 2022; Negri & Abdel-Aty, 2023; Stary, 2023; Wu *et al.*, 2023a), and neuromorphic generative AI computing architectures in digital twin industrial metaverse (Cao *et al.*, 2023; Jagatheesaperumal & Rahouti, 2022; Jagatheesaperumal *et al.*, 2023; Jaimini *et al.*, 2022; Liu *et al.*, 2023; Lyu & Fridenfalk, 2024; Magalhães *et al.*, 2022; Mourad *et al.*, 2023; Starly *et al.*, 2023; Xinyi *et al.*, 2023; Yang *et al.*, 2022; Zaidan *et al.*, 2023).

Enterprise generative AI-driven schedule prediction and production process tracking tools, job search and algorithmic hiring systems, and synthetic training data can improve team selection, job performance and firing decisions, hiring decision processes, and workforce productivity in terms of prediction and decision-making. Performance management systems can develop on generative AI-based recruitment tools, hiring processes and decisions, and workplace performance evaluations, with sustained economic development, shaping individual wage determination and employment losses, assessing job commitment and human labor value, and possibly leading to massive layoffs and unemployment. Workplace skill-based hiring, retention, condition tracking and monitoring, and promotion processes, robust and accurate performance assessment, and staff training and upskilling, together with tech-enabled capability building and employee development, shape organizational AI governance by algorithmic management and system performance tools.

Cryptocurrency mobile banking and corporate lending apps, cloud-based cash management and workflow automation tools, and app-based investment and online merchant payment services configure blockchain-based fintech management. Digital asset-based blockchain tokenization, generative AI credit modeling and scoring, and credit monitoring and cash-flow management fintech tools articulate AI-driven fintech services in terms of investment diversification, credit risk monitoring, and portfolio management. Big data-driven fintech can assist in financial market infrastructure and processes, in transaction reliability optimization, in ongoing customer screening and transaction monitoring automation, and in trade finance digitization across massive volumes of transactions, increasing approval rates, streamlining lending processes, and mitigating credit risks. Artificial IoT fintech algorithms enable corporate spend and financial product management by use of transaction monitoring and engine, behavioral data-based automated decision support, and digital payment token systems. Deep reinforcement and machine learning techniques, operational and analytical generative AI and cloud capabilities, and real-time anomalous behavior recognition systems further fintech development for credit and lending services, payment analytics processes, and risk assessment, monitoring, and mitigation.

Data management and governance algorithms can streamline operational capabilities, employee onboarding and turnover, and critical infrastructure and processes across data-driven generative AI systems in interconnected digital twin and IoT-based enterprise environments, increasing performance and productivity in digital twin industrial metaverse. Generative AI technologies can reshape jobs and reimagine meaningful work, involving creativity and innovation and adaptable and resilient sustained performance, providing valuable constructive feedback, optimizing workplace flexibility and psychological safety, and measuring and supporting autonomy and flexibility-based efficiency, performance, and productivity, while configuring demanding, engaging, and rewarding experiences by cloud and edge computing devices. Generative AI technologies can complement collaborative and creative team effectiveness, social-emotional skill building, and high-level cognitive and knowledge work, resulting in quantifiable sustainable and innovative coordination, engagement, interdependence, and productivity, through training, support, decision making, supervision, and guidance across objective consistent and equitable performance management systems in digital twin industrial metaverse.

## Methods

Reference and review management tools, together with evidence synthesis screening software, harnessed were Abstrackr (web-based annotation tool and semi-automatic citation screening software for abstract organization by use of machine learning technologies), AMSTAR (for publication bias identification and quantification), ASReview Lab (for decision-based publication inclusion or exclusion through continuous screening and ranking), CASP (for quality appraisal of thematic synthesized evidence in terms of methodology research, design, rigour, and validity), Catchii (for eligible title and abstract screening and identification, included article data extraction, relevance and quality assessment, and duplicate record detection), Citationchaser (for finite and definable relevant bibliographic record assessment across various reference lists in terms of accurate quantification, automated deduplication, co-citation analysis, semantically disconnected related topics, and interactive visualisation and inconsistent terminology networks in evidence base), DistillerSR (for abstract and full-text collection, configuration, screening, and assessment management), JBI SUMARI (critical appraisal tools in quantitative study designs assisting in evaluation of the trustworthiness, significance, and outcomes of published content), Litstream (for machine learning-based study quality assessment, text screening, topic extraction, data integration, visualization, and analysis, supervised clustering, automated data collection and document tracking, and keyword-based streamlined literature characterization), PICO Portal (assisting in relevant study type and citation identification, full-text deduplication and screening, article eligibility prediction, and evidence mapping by use of AI), and Rayyan (for study screening and selection). These quality assessment tools have been selected so as to cover the most relevant sources identifiable across ProQuest, Scopus, and the Web of Science databases.

## **Generative AI algorithms and cognitive computing systems in meaningful creative and collaborative work**

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Generative AI talent capabilities integrate staff engagement, satisfaction, productivity, retention, and attraction for meaningful creative and collaborative work, by use of reliable and supportive technological, critical thinking, cognitive, decision making, and social-emotional skills (Agrawal *et al.*, 2023; Castañé *et al.*, 2023; Kambur & Yildirim, 2023), shaping careers, workplace flexibility, and job choices. Generative AI tools and algorithmic monitoring systems can boost engaged workforce performance and productivity, innovative thinking measurement and management, supportive and collaborative work practices, and schedule control, flexibility, and autonomy in high-performing organizations. Generative AI-augmented reliability and virtual maintenance tools, cloud computing technologies, and predictive analytics can ease labor shortages in knowledge-based businesses, driving workforce efficiency and meaningful value.

Virtual team performance tools and multi-sensory augmented reality algorithms can reward high performance and bolster workforce participation and productivity (Agrawal, 2023; Cebulla *et al.*, 2023; Kanbach *et al.*, 2023), while driving dissatisfaction, low performance, and disengagement among disillusioned and undervalued talent and harming employee engagement, empowerment, guidance, and involvement, shaping on-the-job top talent hiring, training, retention, reskilling, and rotation investment. Performance management systems, process and task mining tools, and task automation technologies can improve turnover rates and low engagement, fuelling hyper-productivity and typifying a sense of connection and cohesion in workspace digital twins in terms of augmented and virtual reality-based workforce recruiting and upskilling. Algorithmic generative AI and data visualization tools can downsize workforce while improving employee upskilling, abilities, and training across data and algorithmic management for business model innovation.

Generative AI-enabled predictive analytics, machine learning capability augmentation, and staff collaboration tools can support hire onboarding and employee upskilling (Ali *et al.*, 2023; Chang & Ke, 2023; Lăzăroiu *et al.*, 2022), streamlining human resource tasks, tailoring context-specific training, automating away massive volumes of jobs, and redefining organizational performance. By interpreting huge datasets, amplified generative AI and automation technologies can speed up tedious processes and tasks, craft individualized pay equity and rewards for fulfilled and engaged personnel, optimize job design and process execution, and articulate interactive upskilling experiences and employee outcomes. Generative AI algorithms and cognitive computing systems can streamline task assignment, production skills, talent management, resource allocation, organizational effectiveness, and performance evaluation, building flexible and resilient workforce.

Generative AI and automation technologies can replace jobs at scale while providing employee support, real-time feedback, and increased time to spend on significant work, identifying suitable talent and staff (Altrock *et al.*, 2023; Chen *et al.*, 2023a; Malhan & Gupta, 2023), enhancing workplace productivity, augmenting workforce, and causing job reductions. Generative AI and robotic process automation can replace, redesign, and reimagine tasks and jobs, rebuild work processes, streamline and fuel informed decision-making, and bridge and augment knowledge and skills, optimizing talent marketplaces and workforce transformation. Deep and machine learning-based data-driven generative AI algorithms can augment meaningful creative and cognitive work performed interactively, supporting talent management and employee experience through precise service delivery and resource allocation.

Generative AI technologies can simultaneously erode employee productivity and meaningful work, creating attrition, disengagement, dissatisfaction, and underperformance (Andronie *et al.*, 2021a; Chen *et al.*, 2023b; Nagy & Lăzăroiu, 2022), and boost employee satisfaction, engagement, commitment, retention, performance, productivity, and well-being in working conditions. Lack of meaningful work, of career development and advancement, and of meaningful work, together with inadequate total compensation and unsustainable work expectations, due to generative AI deployment, can lead to highly dissatisfied employees, increasing dissatisfaction and attrition. Actively disengaged employees can behave counter-

productively, while work–life imbalance may result in increased dissatisfaction and low productivity.

Organizational and managerial challenges, policy implications, and barriers in, and negative sides of, implementation include how generative AI technologies can shape hiring and onboarding talent management, labor shortages, long-term turnover outcomes, and low employee engagement (Andronie *et al.*, 2021b; Choudhary *et al.*, 2023; Nagy *et al.*, 2023), impacting career development building and positive recruiting and offboarding process. Computer-based teamwork simulations and generative AI technologies can improve retention and workforce productivity with agile reskilling and mobilizing talent practices, driving positive business outcomes and building brand trust. Generative AI technologies can establish talent development plans, career progression, mismatched job expectations, and skill preparedness, lead to increased attrition, and shape employee experience, performance, and engagement.

### **Generative AI algorithms and adaptive self-organizing systems in workforce management**

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Autonomous AI systems can reduce counterproductive work behaviors and work-related stress (Andronie *et al.*, 2023a; Cortez & Maslej, 2023; Pan & Froese, 2023), leading to job displacement and mass job loss, while increasing employee efficiency and productivity by tracking staff behavior and location data. Generative AI-based collaborative task augmentation, employee listening, talent development, internal knowledge and career management, and skill training can design virtual reality-based training and career paths, shape human capital recruitment and productivity, and improve performance feedback and data-driven business decision making practices. Generative AI tools can boost productivity and streamline operations, impacting staff training and engagement, job cut planning, and pro-

cess automation, while augmenting talented workers and driving operational performance.

Generative AI-based planning process automation, deep and machine learning algorithms, and demand sensing technologies (Andronie *et al.*, 2023b; Einola & Khoreva, 2023; Kolbjørnsrud, 2023) enable agile data-driven decision-making augmentation through real-time data analytics. Algorithmic machines can complement critical staff capabilities and skills, manage business processes and collaborative tasks, and reduce labor costs, being pivotal in talented workforce attraction and retention for organizational effectiveness. Organizations can integrate generative AI into business operations and processes, redefining attractive employment opportunities, performance and productivity levels, occupational shifts, and workforce training and upskilling.

Generative AI technologies can ensure business continuity, identify employee disengagement, create sustainable business value, augment employee capabilities by task automation (Ayhan & Elal, 2023; França *et al.*, 2023; Koivisto & Grassini, 2023), evaluate business decisions, drive talent acquisition, and assess and mitigate operational risks. Generative AI algorithms can shape shrinking occupations, workforce attrition and disengagement, and labor shortages, impacting workplace flexibility and productivity, skill training and mismatches, and scheduling, organizing, and planning activities. Performance management systems and visual task-tracking tools can optimize algorithmic workspace planning, career pathing and development, skill-based talent practices, candidate screening and hiring, smart meeting management, and internal mobility in immersive workplaces.

Generative AI algorithms affect job displacement and re-instatement processes (Bankins *et al.*, 2023; Ferrari & McKelvey, 2023; Kemp, 2023), job availability and quality, candidate sourcing and screening, wages, recruiting, hiring, and training expenses, and labor demand. Workforce management and automated employment decision tools can drive productivity gains by employee absence monitoring, performance appraisal processes, and job candidate management by integrating face recognition, biometric authentication, and liveness verification technologies. AI-augmented recruitment tools and enterprise data management technologies can review job applications, identify well-qualified job applicants, make hiring decisions, and automatically track employee attendance.

Generative AI algorithms and adaptive self-organizing systems can automate administrative tasks, meet growing talent demands, build employee value proposition, improve staff retention and low engagement, and measure employee performance (Bartelheimer *et al.*, 2023; Fosso Wamba *et al.*, 2023; Kliestik *et al.*, 2023), driving staffing to demand matching, labor cost forecasting, and conversions. Spatial data mining algorithms, generative AI systems, and 3D virtual simulation technologies are pivotal in career planning, hiring and promotion decisions, performance management and assessment, working conditions, expertise estimation, employee data, personalized coaching plans, and turnover prediction and retention. AI-based hiring systems and image processing computational algorithms can design workplaces, affect labor demand and working conditions, and support employee training, empowerment, and engagement, leading to occupational deskilling process intensification and job polarization.

Organizational and managerial challenges, policy implications, and barriers in, and negative sides of, implementation include how organizational data analytics can enhance employee effectiveness, training, engagement, and productivity (Bilgram & Laarmann, 2023; França *et al.*, 2023; Mazarakis *et al.*, 2023), articulating creativity-driven business process monitoring and governance, social capital and team bond building and strengthening, business performance management, and top talent attraction and retention for digitally connected workforce. Generative AI systems and job automation technologies can shape change management, skill building and taxonomies, leadership structures, pay equity and transparency, career pathways, organization and team design, and employee hiring, mobility, retention, promotion, engagement, upskilling, and retraining across talent marketplaces. Performance management software and dynamic scheduling systems enable group capability building prioritization, complex problem solving and purposeful coaching engagement, and top talent attraction, development, and retention through real-time data capture and analysis.

## **Generative AI and workforce management forecasting algorithms shaping organizational performance**

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Generative AI and digital collaboration tools can support creativity and innovation throughout employee communication and coordination in productive shared remote work, fostering bonding ties and knowledge expansion, and cementing disruptive organizational structures (Birkbeck & Rowe, 2023; Furendal & Jebari, 2023; Kar *et al.*, 2023) with regard to workforce management control and flexibility. Cognitive automation and generative AI technologies can be leveraged in scale skill-based recruitment and hiring, strategic workforce planning, applicant skill-assessment scoring, performance management, productivity monitoring, and promotion decisions. Generative AI algorithms can augment knowledge creation and enterprise-wide business processes and products, handle talent demands, increase workforce productivity, and alleviate skill shortages, strengthening emotional, experiential, and personalized connections and relationships.

Generative AI can boost talent productivity, time management efficiency, and organizational performance, prioritize operational value creation, and drive up attrition and vacancy rates (Böhmer & Schinnenburg, 2023; Gama & Magistretti, 2023; Peters *et al.*, 2024), fostering high-performance cultures and creating value through adopting effective microhabits and operational improvements. Broad-spectrum AI technologies can accelerate new hire onboarding, improve productivity, support continuous employee upskilling, and ease labor shortages by operational and performance data analysis, driving meaningful value. Augmentative brain-computer interface technology for cognitive enhancement assists human decision-making capabilities in attention modulation and memory regulation.

Generative AI algorithms can redefine workplace flexibility and increase productivity levels across supportive environments (Booyse & Scheepers, 2023; Gandhi *et al.*, 2023; Naz *et al.*, 2024), leading to high-demand talent retention and organizational innovation. Generative AI tools

can reduce steady employment and labor costs, enhance job quality, and expedite time-consuming or tedious tasks by leveraging creative and cognitive automation tools, upending financially viable careers and driving up profits. Generative AI technologies can augment human creativity, while negatively impacting jobs, automating administrative tasks, and undermining financial stability and career advancement.

Biometric sensor technologies and workplace tracking systems can increase talent acquisition and productivity, decrease recruitment time and turnover (Bouschery *et al.*, 2023; Garibay *et al.*, 2023; Pelau *et al.*, 2021) by skill identification and assessment, virtual and augmented reality-assisted employee training, talent pool strengthening, and in-demand talent attraction and recruitment. Image processing computational algorithms and virtual team performance tools are instrumental in shaping team-building management, predictive workforce planning, and employee performance predictions, leading to sustainable organizational agility, growth, and competitiveness. Generative AI-enhanced analytics-driven business intelligence and cognitive decision-making tools can enhance talent identification, skilled labor shortages, and employee training by historical data capture in terms of productivity and performance, talent and workplace management, and human resource analytic data.

Machine learning algorithms and production automation technologies can increase productivity and displace labor, manage workplace relationships, build competitive advantage, and augment human capabilities and creative processes (Budhwar *et al.*, 2023; Guliyev, 2023; Kanitz *et al.*, 2023), being pivotal in onboarding and training journey development, collaborative planning and scheduling processes, and job augmentation and substitution. Generative AI-based algorithmic hiring services can evaluate job candidates, shape recruitment processes, and augment workforce development, creativity, and productivity by in-app notifications, facial and fingerprint recognition, web authentication technology, and identification codes for ID checks. Machine learning algorithms and cognitive automation technologies can increase workforce agility and productivity, displace labor, build talent acquisition, agility, and recruitment processes, and reduce disengagement and attrition among skilled and productive employees.

Organizational and managerial challenges, policy implications, and barriers in, and negative sides of, implementation include how generative AI and workforce management forecasting algorithms can enable produc-

tive and creative teams, mass job destruction and displacement, flexible working practices, and talent planning, expanding, upskilling, and migration (Carmel & Sawyer, 2023; Jarrahi *et al.*, 2023; Kraus *et al.*, 2023) by virtual reality simulation-based workplace training. AI-based automated hiring decisions and systems can bring about wide-ranging job augmentation, creation, substitution, loss, destruction, and displacement. Recruitment and employment self-supervised learning-based AI systems can assist highly skilled workforce through decision-making process augmentation and virtual reality and immersive workplace training.

### **Generative AI-assisted decision making and predictive analytics tools across blockchain-enabled decentralized interoperable payment infrastructures**

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Financial planning, transaction monitoring, and reporting process automation tools, data reconciliation and payment automation services, and generative AI-powered business credit scores (Abakah *et al.*, 2023; Dong & Yu, 2023; Mirza *et al.*, 2023a) configure fintech operations. Real-time analytics and reporting automation, predictive risk monitoring and deposit forecasting tools, and business loan credit decisioning processes articulate blockchain-based fintech operations. Credit journey score improvement and generative AI-powered embedded financing tools, transaction monitoring and fraud prevention capabilities, and app-based mobile authentication assist in fintech development.

Business credit decisioning and forward-looking algorithm-based lending tools, onboarding and screening capabilities, and transactional behavior monitoring enable fintech mobile payments (Ahelegbey *et al.*, 2023; Doumpos *et al.*, 2023; Rafiuddin *et al.*, 2023) across blockchain-enabled decentralized interoperable payment infrastructures. AI-powered business credit scores, business loan credit decisioning processes, and predictive risk monitoring and credit data transparent application tools further generative AI

fintechs. Financing transaction planning, self-service and embedded analytics, and accurate business credit scoring and financial profiling shape fintech transactions.

Data and risk analytics, financial planning software, and credit score and decisioning process management (Akmal *et al.*, 2023; Edo *et al.*, 2023; Sharma *et al.*, 2023a) optimize generative AI fintech in business financing environment. Transaction risk management and credit modeling technologies can secure digital transactions, mitigate financial risk, and prevent payment frauds. Metaverse fintech can be harnessed in bitcoin money laundering, blockchain technology-based digital asset and crypto trading services, and financial goal setting and tracking, developing and securing payment services and integrated financial infrastructures.

Augmented reality-powered payment interfaces, business accounts payable and receivable operations, and financial products and services (Alaassar *et al.*, 2023; Gonçalves *et al.*, 2023; Yang *et al.*, 2023) can be deployed in blockchain-based fintech management. Banking and cryptocurrency technologies, predictive trade and debt portfolio analytics, and predictive analysis-based fraud detection and data-backed decision-making tools can be leveraged in fintech services. Generative AI-assisted decision-making and predictive analytics tools impact underlying structures of financial data visualization, governance, and interoperability with regard to investment modeling behaviors.

Organizational and managerial challenges, policy implications, and barriers in, and negative sides of, implementation include how generative AI-driven fintech, expense management tools, and cash disbursement services develop on financial behavior predictions, cloud-based payment and digital banking technologies, and spend management and digital asset infrastructures (Almansour, 2023; Guang-Wen & Siddik, 2023; Mirza *et al.*, 2023b), enabling e-wallet fund storing and blockchain-based digital wallets. Deep learning generative AI fintech services integrate derivatives trading and fraud detection operations, financial automation and decisioning software, and tokenized asset trading, borrowing, and lending. Big data-driven fintechs require workload and workflow management tools, distributed ledger and digital currency technologies, and generative AI-enabled schedule algorithms and predictions.

Financial data management and transaction monitoring systems, loan origination and management services, and blockchain-based digital bonds (Arora *et al.*, 2023; Guo *et al.*, 2023; Su & Xu, 2023) necessitate artificial IoT

fintech algorithms. Fintech operations streamline client risk assessments, cryptocurrency-specific accounting functions, modular embedded payments, tokenized asset transactions, and multi-asset trading products. Crypto-enabled cash flow forecasting, cloud-based computation tools, and cross-border transactions can streamline business financing processes. Generative AI-assisted credit checks, digital lending products, payment processing functionalities, investment portfolio monitoring, multi-asset trading optimization, and financial crime detection develop on generative AI fintech. Metaverse fintech integrates mortgage and loan servicing, synthetic identity fraud and financial data management, credit score monitoring tools, data-informed risk management analytics, blockchain-based fund transfer networks, and automated financial workflows.

### **Generative AI fintechs in investment operation and payment process automation and streamlining**

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Credit automation and financial modeling tools, risk management and proprietary data analytics, and error prevention and data management capabilities (Awais *et al.*, 2023; Guo & Zhang, 2023; Wu *et al.*, 2023b) are pivotal in fintech development. Data-driven enterprise resource planning tools can improve fraud protection, streamline and automate accounts receivables and payment processes, generate financial rebates, and manage cash flow. Blockchain technologies and automated trade finance tools can assist interoperable digital token and transaction banking services, cryptocurrency payment processing, and instant cross-border payments, increasing core cash management capabilities.

Blockchain technologies, smart contract-based instant payment capabilities, and cash management tools can expedite transaction time (Babaei *et al.*, 2023; Ha, 2023; Sun *et al.*, 2023) across the trade finance ecosystem. Cash flow monitoring and spending tracking, tokenization and non-fungible tokens (NFTs), on-chain credit risk assessments, and cloud-based enter-

prise financial crime and fraud management and prevention configure fintech mobile payments. Multi-asset class enterprise risk options, robust NFT-related risk-managed metaverse transactions, and tokenized asset tracking, valuation, and servicing are instrumental in blockchain-based fintech operations, reducing fraud losses and optimizing complaint handling.

Generative AI-based order-to-cash workflow automation streamlines real-time payment processing and reconciliation, risk and financial operations, lending and investing procedures, and cryptoasset custody services (Barbu *et al.*, 2021; He *et al.*, 2023a; Upreti *et al.*, 2023), accelerating fintech connectivity. Machine readable data-based generative AI systems can assess credit product affordance and transaction alerts, speed up lending automation and investment decision processes, fight financial crime, and detect money laundering. Blockchain-based digital deposit tokens can reduce cross-border payments. Blockchain and digital asset technologies, wallet management services, and deep and machine learning algorithms articulate generative AI fintechs.

Embedded lending and mobile money transfer services, digitized real world and tokenized assets, and financial planning and portfolio construction tools assist fintech transactions (Ben Romdhane *et al.*, 2023; He *et al.*, 2023b; Osei-Assibey Bonsu *et al.*, 2023), streamlining lending operations, credit score checking, and digital product and payment capability expansion. Digital financial tools and mobile banking apps as fintech and technology-driven automation services can manage spend and lending workflows, process payments, ensure automated data management and deep core system integration, reduce fraud risk, and track payroll expenses. Financial planning and liquidity management tools, together with trade finance digitization, assist generative AI technology-based unstructured data verification and classification in trade finance operation risk mitigation and in investment operation and payment process automation and streamlining.

Generative AI-based digital financial planning tools (Bhutto *et al.*, 2023; Jiang, 2023; Thomas *et al.*, 2023) can streamline and manage deal pipelines, investment operations, transaction and revenue-tracking functionalities, and borrower financials. Generative AI technologies can streamline tailored financial planning and fraud detection systems, automate routine tasks, optimize personalized real-time risk assessment accuracy and customer service, and adjust credit limits according to historical behavior-

based spending needs, shaping seamless payment experiences in terms of convenience and flexibility. Deep and machine learning algorithms bolster embedded credit card services and payment system resilience by personalized transaction, payment instruments, and usage data, for cutting-edge digital products and services.

Organizational and managerial challenges, policy implications, and barriers in, and negative sides of, implementation include how generative AI trading analytics, deep learning-based order-to-cash workflow and accounts payable operation automation, and algorithmic auditing (Campanella *et al.*, 2023; Kazachenok *et al.*, 2023; Yan, 2023) can enhance the predictive capabilities of financial market operations and transactions through data processing and analysis, historical pattern detection, and intricate and interconnected financial instruments for rapid informed decisions. Deep and machine learning techniques, safe and streamlined cross-currency transaction pricing and exchange mechanisms, and data governance in financial and cryptocurrency services can optimize trading algorithm predictive capabilities through complex pattern detection, processing, analysis, and interpretation of massive volumes of historical and real-time data, forecasting stock price changes. Computer vision and natural language processing algorithms, automated loan approval and fraud detection and prevention tools, and generative AI and machine learning-based intelligent lending and payment process automation in digital operations can gauge market sentiment, track real-time economic operations, and provide personalized investment advice, while integrating trading analytics with regard to quantitative price forecasts.

### **Generative AI-powered automated scheduling and predictive analytics algorithms in blockchain-based fintech management and decentralized finance**

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AI predictive analytics, deep learning algorithms, and neural network techniques (Caragea *et al.*, 2023; Khan *et al.*, 2023; Sun & Zhang, 2023) enable low risk trading and complex algorithmic trading for profit increasing and performance tracking by financial data analysis. AI trading analytics, cloud computing technologies, and automated machine learning tools can integrate complex data analysis, interpretation, and simulation for business value and scaling. Generative AI and decentralized financial tools, blockchain technologies, and peer-to-peer transfer apps can optimize creditworthiness assessment, crypto asset services, sustainable risk evaluation and financial management, algorithmic trading, and back-office process automation for fintech digital products, shaping customer-buying decisions.

Fraud prevention and detection algorithms, performance monitoring and reporting tools, and cloud computing and virtualization technologies (Chen & Guo, 2023; Lai *et al.*, 2023; Sharma *et al.*, 2023b) enable generative AI fintech. Cryptocurrency and digital asset management, contactless payment cards and mobile wallets, asset purchase-related blockchain-driven payments, and scale-up financial function automation further metaverse fintech. Asset-backed stablecoins, cryptocurrencies, instant payment system interlinking, and enterprise financial automation and payment processing tools shape blockchain-based fintech management and decentralized finance.

Financial service and enterprise productivity operating systems, crypto and blockchain technologies, and factor risk models (Chen *et al.*, 2023c; Lisha *et al.*, 2023; Rjoub *et al.*, 2023) optimize generative AI-driven fintech services. Real-time cash position visibility and precision forecasting, machine learning-based fraud prevention and mobile banking tools, and cloud location intelligence can be harnessed in big data-driven fintech. Artificial IoT fintech algorithms can be deployed in digital asset marketplaces, in spend management automation, in corporate real-time payments, and in cross-border payment tokenization.

Crypto and blockchain technologies, generative AI-powered automated scheduling and predictive analytics algorithms, and cross-border mobile payment networks (Chaklader *et al.*, 2023; Mahmud *et al.*, 2023; Tan *et al.*, 2023) can be leveraged in fintech development. Blockchain technology-based interoperable distributed ledger apps can carry out atomic transactions. Blockchain-based fintech operations develop on credit worthiness measurement, financial risk assessment, instant and mobile payments, 5G-routed loan and credit apps, and distributed ledger and risk management

technologies. Cloud-based digital asset banking and financial products and services, customer management capabilities, and deep learning computing and financial data visualization-based investment and trading decisions require blockchain-based fintech management. Blockchain-based virtual and digital lending products, asset finance and payment processing services, and cloud machine learning-based financial management necessitate big data-driven fintech.

Organizational and managerial challenges, policy implications, and barriers in, and negative sides of, implementation include how fintech mobile payments (Cheng, 2023; Mikhaylov *et al.*, 2023; Zhao *et al.*, 2023) integrate mobile payment and digital banking services, credit decisioning and financial monitoring processes, and AI-powered risk modeling and instant payment systems. Generative AI fintechs require digital onboarding, embedded data analytics, and self-service capabilities by use of deep learning-based predictive modeling. Fintech transactions necessitate credit risk management and fraud detection capabilities, decentralized financial and cloud computing-based banking systems, and AI-based credit scoring and mobile payment services.

Generative AI fintech (Cheng & Qu, 2023; Qiu *et al.*, 2023; Sampat *et al.*, 2024) is pivotal in repeat fraud identification, in mobile instant payments, in corporate and investment banking tools, in credit risk assessment, and in financial task real-time visibility. Metaverse fintech is instrumental in real-time cross-border payment and smart-contract blockchain networks, business lending and accounts payable operations, and AI-based cognitive assistant and instant payment services. Predictive AI algorithms can detect suspicious fraud patterns by identity verification, financial behavior, and payment authentication tools. Generative AI loan infrastructure systems integrate mobile payment and identity verification services, corporate cash management and risk modeling tools, digital transaction geotagging in financial flow tracking, and data automation and payment acceptance technologies.

## **Neuro-symbolic augmented generative AI deep learning simulation algorithms in digital twin industrial metaverse**

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Generative AI-based task automation and computer vision and swarm intelligence algorithms can increase operational efficiency, leading to equipment and device digital control and industrial productivity, connectivity, efficiency, networking, and scalability on the factory floor and across the industrial automation landscape (Agarwal & Alathur, 2023; Kaarlela *et al.*, 2023; Negri & Abdel-Aty, 2023) by multiple interconnected industrial network infrastructure and devices. Generative AI algorithms and enterprise digital twins, enhanced operational efficiency and edge devices, and industrial and computing automation technologies enable smooth industrial IoT data acquisition and communication in connected factories. Generative AI tools and decentralized knowledge graphs can augment and automate data-driven decision making for connected smart manufacturing systems, operations, and processes, cutting down unplanned downtime, streamlining assets, and optimizing overall equipment effectiveness in terms of enterprise connectivity by computer vision systems and pattern recognition technologies, industrial 3D cameras, and design and product development creative processes.

Prescriptive 3D generative AI simulation augmentation and machine learning-based decision intelligence tools (Bellalouna & Puljiz, 2023; Kshetri, 2023; Stary, 2023) can integrate natural language processing, synthetic data, and geospatial analytics for organizational decision-making modeling in digital twin industrial metaverse. Neuro-symbolic and generative AI technologies can increase productivity and optimize business processes and 5G network performance by synthetic data analytics across multiagent simulation systems in digital twin smart manufacturing by computer vision algorithms. Predictive maintenance and augmented reality tools, knowledge representation and natural language processing techniques, and deep and machine learning algorithms can leverage IoT data in business and engineering modeling.

Organizational and managerial challenges, policy implications, and barriers in, and negative sides of, implementation include how self-regulating reasoning mechanisms of agile and resilient neuro-symbolic generative AI computational multiagent autonomous systems can tackle scalable complex tasks by decentralized decision-making tools for network optimization, environment monitoring, and fault detection (Bhattacharya *et al.*, 2023; Lee & Kundu, 2022; Wu *et al.*, 2023a) across business and industrial processes in simulation environments by machine learning and reinforcement learning techniques. Robust and reliable neuro-symbolic augmented generative AI deep learning simulation algorithms, geospatial analytics tools, and natural language processing systems can enable coherent multi-cloud and edge IoT enterprise development by synthetic data generation, traceability, and replicability, maximizing business value in virtual environments. Autonomous AI deep learning agents and systems, predictive and prescriptive analytics tools, and computer vision and natural language processing algorithms can optimize the resiliency, interpretability, and sustainability of smart business processes through collaborative decision augmentation and automation management in complex unpredictable and unstructured environments in digital twin industrial metaverse.

## **Neuromorphic generative AI computing architectures in digital twin industrial metaverse**

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Neuromorphic computing architectures, augmented data and swarm management tools, and high-performance processing devices further production edge enterprise-managed cloud-based generative AI and IoT systems and smart autonomous industrial mobile machines (Cao *et al.*, 2023; Liu *et al.*, 2023; Xinyi *et al.*, 2023), ensuring multifaceted business value by remote

operation support and ubiquitous wireless connectivity in digital twin industrial metaverse. Smart autonomous robotic decisions, multimodal deep neural network architectures, and edge AI technologies can assess self-supervised product capability and cloud computing resources, improving workforce productivity across industrial, enterprise, and business functions. Generative AI technologies, natural language processing tools, and computer vision algorithms are instrumental in digital twin-based product development by edge and synthetic data simulation for reliable predictive maintenance, decision support, and industrial control.

Resilient and adaptive edge AI and IoT systems, machine and deep learning techniques, and neuromorphic computing and Web3 algorithms can optimize manufacturing production quality (Jagatheesaperumal & Rahouti, 2022; Lyu & Fridenfalk, 2024; Yang *et al.*, 2022) by robust decision-making and robotic process automation and augmentation in industrial digital twin metaverse. Generative AI-based IoT autonomous sensing, perception, and localization systems can support data-driven decision functionality and workflow in business operation forecasting, augmentation, and automation. Extended reality and semantic AI technologies can support decision augmentation and automation in composable business architectures in digital twin industrial metaverse by sensor fusion algorithms throughout meaningful contextual big synthetic data management processes.

Big data-driven IoT, generative AI, and cloud computing technologies can be deployed in urban environmental sustainability digital transformation mapping and decision-making processes, and can optimize organizational practices, capabilities, and performance (Jagatheesaperumal *et al.*, 2023; Magalhães *et al.*, 2022; Zaidan *et al.*, 2023) with regard to waste management and pollution control, driving competitive advantage. Generative AI-based virtual agents and cloud-enabled business transformations can streamline complex process mining and business operations, reduce maintenance times, deliver personalized services, and increase workforce productivity and creativity in industrial digital twin metaverse. AI-powered planning systems, collaborative robotic technologies, and cloud-based data gathering and predictive analytics tools can reconfigure workflows and automate design in small-batch responsive manufacturing processes across interconnected production facilities in machine learning-based smart factories.

Organizational and managerial challenges, policy implications, and barriers in, and negative sides of, implementation include how generative AI technologies can reduce physical product design and packaging life cycles and processes significantly (Jaimini *et al.*, 2022; Mourad *et al.*, 2023; Starly *et al.*, 2023), improve inventory turnover and consumer experience, expectation, sentiment, preference, and taste personalization, and create feasible augmented business value and inspirational conceptual images. Automated data modeling and visualization tools target structural product performance objectives through testing and refinement, building a simulation engineering and immersive visual tangible knowledge baseline with regard to creative meaningful manufacturability, serviceability, and sustainability. Generative AI tools and machine learning algorithms can harness contextualized structured enterprise and industrial data and knowledge graphs, boosting productivity by high value task management. Deep learning algorithms and convolutional neural networks can monitor operational behaviors and decisions through data analytics automation, increasing profitability in digital twin industrial metaverse.

## **Conclusions**

Enterprise generative AI system-based worker behavior tracking and monitoring, socially responsible organizational practices, employee performance management satisfaction, and human resource management procedures, relationships, and outcomes develop on hiring and objective performance assessment algorithms in terms of human resource management activities, functions, processes, practices, policies, and productivity. Blockchain-based fintech operations can shape cloud-based financial and digital banking services, quote-to-cash process automation, cash-settled crypto futures, digital loan decisioning, asset tokenization simulated transactions, transaction switching and routing operations, tailored peer-to-peer lending, and proactive credit line management. Distributed ledger and payment processing technologies, machine learning-based real-time cash flow data analysis, and accounts payable automation and payment invoice processing services can optimize business spend management fintech. Generative AI-based credit risk decisioning, cloud-native core banking and blockchain payment technologies, and loan and risk management software can be harnessed in fintech mobile payments. Generative AI tools can bolster

predictive analytics by collaborative and interconnected sensor and machine data for tailored, seamless, and fine-tuned product, operational process, and organizational workflow development, efficiency, and innovation, driving agile transformative changes in digital twin industrial metaverse.

The contribution of this paper to the state of the art gives the main value for business practice and theoretical managerial science with regard to how deep learning-based generative AI tools and workplace monitoring systems can augment performance and productivity, gauge employee effectiveness, build resilient, satisfied, and engaged workforce, assess human capital, skill, and career development, drive employee and productivity expectations in relation to flexibility and stability, and shape turnover, retention, and loyalty; to how cloud and account servicing technologies can be deployed in generative AI fintechs for embedded cryptocurrency trading, transaction monitoring and processing, digital asset transfers, payment screening, corporate and retail banking operations, and fraud prevention; and to how big data-based generative AI algorithms, cloud computing technologies, and infrastructure maintenance tools can enhance task decomposition and execution through enterprise data modeling, architecture, and governance, forecasting demand, bolstering network connectivity and predictability, and driving real-time investment decisions across collaborative valuable and trustworthy business operations and practices.

Limitations and further research include how deep learning and productivity tool techniques can build productive teams, talent shortage optimization, and people management strategies, shaping workforce retention and employment practices in terms of behavioral motivations and emotional connections; how corporate card, financial planning, and expense management software can be leveraged in fintech transactions for embedded fintech and digital asset services, asset, investment data, and liability management, and bond, derivative, and crypto trading and investment in asset-based finance marketplaces; and how collaborative unstructured enterprise data processing, infrastructure, and governance can develop on AI decision and behavior automation technology, retrieval augmented generation and development management systems, and real-time data descriptive and predictive analytics, driving productivity surges and competitive advantage in digital twin industrial metaverse.

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All data generated or analyzed are included in the published article. The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation. The raw anonymized data can be provided by emailing the primary author.

### **Author contributions**

All listed authors have made a substantial, direct and intellectual contribution to the work, and approved it for publication. The authors take full responsibility for the accuracy and the integrity of the source analysis.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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