Tech Trends Series: EY India

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Building a better working world

Tech Trends 2024

Foreword

As the Nobel laureate in Physics, Niels Bohr famously noted, "Prediction is very difficult, especially if it's about the future." While many technological innovations may not endure, a select few evolve into indispensable tools for specialized enterprise applications, with only a handful achieving widespread recognition. At EY Tech Trends, we dedicate ourselves to understanding the potential of emerging technologies and their future impact on the business landscape.

Launched in 2023, the EY Tech Trends series presents a curated list of breakthrough technologies poised to revolutionize the enterprise world. It offers a comprehensive package of articles, podcasts, and videos designed to help business and technology leaders distinguish transformative advancements from fleeting trends, guiding them to harness technology's potential for business innovation.

In an era where generative AI is rapidly advancing, it is crucial for organizations to maintain an integrated business strategy, a robust technological foundation, and a creative workforce. Our research focuses on strategic technology trends that will shape business and technology decisions over the next three years, emphasizing the importance of prioritizing investments in the age of AI. EY encourages you to assess the impacts and benefits of each trend, identifying the innovations—or strategic combinations—that will drive significant success for your organization.

In this year's EY Tech Trends 2.0, we delve into six emerging technologies: AI-augmented software development, sustainable coding, industry cloud, digital twins, responsible AI, and next-generation employee tech. While some of these technologies are rapidly gaining traction across various industries, others are still being explored for their potential to deliver scalable business value.

As we navigate an era dominated by generative machines, it is crucial for organizations to maintain an integrated business strategy, a robust technology foundation, and a creative workforce. By embracing these advancements, your organization can unlock real value and achieve business impact through technological convergence.

Explore EY's insights on these critical topics and discover how these trends can shape the future of your enterprise.

01

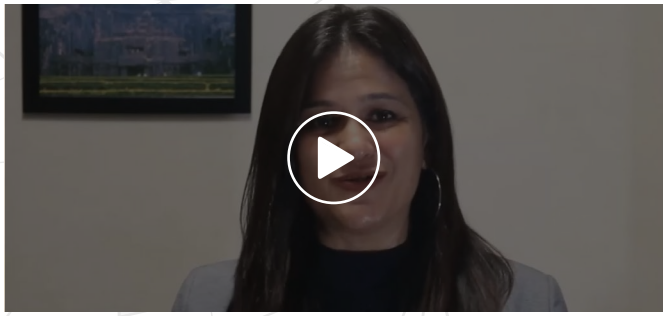
AI-augmented software development: A new era of efficiency and innovation

Radhika Saigal
EY India Technology Consulting Partner

> Generative AI-assisted tools are enhancing productivity and innovation in software development.

In brief

- GenAI tools analyze extensive data, including customer requests, market trends, and user feedback for software requirement planning.
- GenAI tools like GitHub's Copilot and Jasper can significantly boost developer productivity by swiftly generating code.
- AI is automating various aspects of the software development and delivery processes in DevOps.
- Developers can also optimize their workload in cloud resources using GenAI.



In May 2017, at NVIDIA's GPU Technology Conference (GTC), its CEO Jensen Huang made a bold prediction: "Software is eating the world, but AI is eating software." This statement, inspired by Marc Andreessen's seminal essay "Why Software Is Eating the World," captured the essence of the transformative power of artificial intelligence (AI) in software development.

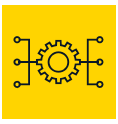
At the time, Huang's prediction may have seemed ambitious, as the transformative potential of transformer models, now integral to contemporary GenAI models, was undiscovered. Fast forward to 2023 and software development has witnessed a significant change, with generative tools playing an important role in addressing software quality issues, offering real-time code suggestions, automating various steps in the software development life cycle, thus validating Huang's prediction.

AI has long been streamlining routine software development tasks, from code review and bug detection to software testing and project optimization. These tools, often acting as spell- and grammar-checkers for code, have undoubtedly reduced the time and effort required for software development by minimizing keystrokes. At present, with the advent of GenAI, AI-augmented software development has ascended to new heights, creating more efficient and reliable software solutions that align with the contemporary requirements. GenAI tools, such as GitHub's Copilot, Microsoft's Intellicode, and Jasper, are fundamentally changing the way developers approach software creation. These tools treat computer languages as natural languages, opening up new possibilities for software engineering. Over the next few years, GenAI is set to dominate software development, extending its influence, and reshaping of companies' digital transformation. Gartner predicts that by 2028, 75% of enterprise software engineers will use AI coding assistants, up from less than 10% in early 2023.

The impact of AI on software development will mainly reshape four key areas: requirement planning, enhancing developer productivity, DevOps and deployment, and workload optimization.

Requirement planning: GenAI tools, exemplified by various applications, exhibit the capacity to analyze copious amounts of data, including customer requests, market trends, and user feedback. These tools can generate user stories based on requirements, propose ideas for prototype/application design, and outline high-level architecture diagrams. Additionally, they can recommend suitable technologies based on specified constraints, such as performance, scalability, security, and best practices.

Developer productivity: Code development marks the arena where GenAI is taking remarkable strides. There are platforms that are transforming the software creation process, treating computer languages as just another form of language. These tools draft code based on contextual cues from input code or natural language, enabling faster and smoother coding with reduced friction. Code generators are adept at swiftly producing code for routine tasks, saving developers a considerable amount of time, and allowing them to focus on more intricate tasks. By 2025, according to Gartner estimates, 80% of the software development life cycle will involve GenAI code generation, enhancing developer productivity up to 75% in various use cases.



DevOps: From automation of testing and deployment to resource management and security enhancement, AI is reshaping the current process. Leveraging historical code changes, GenAI identifies patterns, detects potential issues, and offers intelligent recommendations for automated testing and deployment, thereby streamlining the

development pipeline. AI-integrated next-generation ChatOps (interaction systems to communicate with bots and perform instructions for deployment, monitoring, and incident response) will not only detect anomalies but also generate optimal solutions based on historical data and real-time insights.

Enterprise-grade machine learning applications, which took 6 to 12 months to deploy, can now be operational in a matter of weeks, significantly reducing development costs. GenAI tools that can also generate deployment scripts - currently in the pilot phase - will significantly reduce development time and costs. GenAI can also generate infrastructure as code scripts based on natural language queries for high-level infrastructure requirements and can generate workflow configuration files that can specify the settings and parameters of various applications.

Workload optimization: GenAI can excel in cloud resources workload optimization. By analyzing historical data and predicting resource needs, it generates actionable recommendations that optimize resource allocation, enhancing performance resources. The tools also recommend cost-cutting strategies like downsizing instances, adjusting auto-scaling, and utilizing reserved instances for optimal spending. Predictive AI allows the team to address potential issues before they impact the users, enhancing overall reliability. Cloud Service Providers (CSPs) are now integrating GenAI capabilities to their existing set of services where operations can query large data sets or logs using natural language.

While GenAI and software development form a synergistic partnership, it is essential to recognize that AI cannot function autonomously. At present, AI draws its power from the data it processes, lacking the touch of human intelligence. Moreover, issues such as hallucinated responses and biased outputs underscore the need to address data privacy concerns. As regulations in this sector evolve, these challenges are expected to be mitigated.

Despite these challenges, the potential benefits of GenAI are undeniable. Through accelerated coding, automation, and performance optimization, AI can transform the software development industry, pushing the boundaries of innovation and efficiency.

As many tools have displayed, GenAI can transform key areas of software development and, the challenges notwithstanding, undeniably offer benefits such as higher efficiency and innovation. Enterprise software engineers are expected to increasingly adopt AI. The synergy between GenAI and software development is reshaping the industry, pushing boundaries, and driving digital transformation, even as the regulatory framework evolves.

Summary

Generative AI (GenAI) tools are helping software development in several crucial areas. They enhance resource planning, boost developer productivity with fast code generation, automate DevOps, speed up deploying machine learning apps, and excel in workload optimization of cloud resources. AI-embedded tools let engineers spend less time coding, enabling them to focus more on higher-level tasks. Despite challenges like AI's reliance on data, which may have bias and privacy concerns, GenAI is reshaping the industry, pushing boundaries, and driving digital transformation.

02

Sustainable coding is the need for a greener tomorrow

Alexy Thomas
EY India Technology Consulting Partner

> Software industry must adopt green coding and efficient algorithms to curb rising carbon emissions.

In brief

- Sustainable software development involves optimizing code for energy efficiency, utilizing energy-efficient algorithms, and integrating low-power hardware.
- A key challenge in sustainable coding involves addressing poor coding standards and a lack of knowledge in green software development.
- Efficient architecture, including optimized cache policies, minimized data exchange, and careful data lifecycle management, plays a crucial role in reducing energy consumption in software design.
- Green coding principles extend to intelligent workload orchestration, addressing the threat of embedded carbon by efficiently managing workloads and reducing the need for new hardware.

In May 2021, industry giants Microsoft, Thoughtworks, Accenture, and GitHub teamed up with the Joint Development Foundation Projects and The Linux Foundation to launch the Green Software Foundation. This non-profit is laser-focused on building a community for eco-friendly software development. The driving forces? A growing corporate awareness of the energy toll exacted by software development and operation— a pressing concern in our digital space. Until recently, sustainability in software and architectures took a back seat, with many companies mistakenly assuming that, unlike hardware, software did not pose environmental challenges. However, this perception shifted as it became clear that while software does not directly consume energy, poor development practices and its influence on computer hardware significantly impact overall energy consumption and carbon emissions.

As computationally inefficient software drives increased energy consumption, the imperative for green software grows alongside the booming global software market, projected to hit a trillion dollars by 2024 from $825 billion in 2022. IDC states the AI-centric software sector is set to surge with a 30%+ CAGR, reaching $251 billion by 2027. Currently, the Information and Communications Technology (ICT) industry contributes 3.9% to global greenhouse gas emissions, up from 1.6% in 2007, with a predicted 14% share by 2040. Notably, training a single neural network model today emits as much carbon as five cars throughout their lifetimes.

To mitigate emissions, the software industry must transition to sustainable practices, starting with green coding. Sustainable or green coding development is an approach to software engineering that prioritizes energy-efficient patterns and processes throughout the software delivery lifecycle. It involves optimizing code to minimize energy consumption and resource usage, promoting sustainable development practices, and utilizing low-power hardware or energy-efficient infrastructure.

Sustainable software integrates energy-efficient algorithms that execute computing operations more swiftly and effectively than standard software implementing green coding principles reducing application footprint, memory, CPU, network, and data footprint. The benefits of sustainable software extend beyond environmental considerations, including a less complicated architecture, faster computing speeds, and cost savings.

Employing green coding practices

A significant challenge in sustainable coding lies in poor coding standards and a lack of knowledge in green software development. First and foremost, companies should articulate a green strategy during software development that guides trade-offs and allows for flexibility. This strategy should also include creating new software standards that extend devices' lifecycles, thereby reducing total e-waste.

Developers should adopt application development practices, such as optimizing code, to minimize energy consumption and computation requirements. A thoughtful code base that applies pure functions and limits abstraction layers can reduce overall computation effort. Organizations can implement logic to clean, validate, and aggregate incoming data within the code base to avoid redundant tasks.

Choosing algorithms, programming languages, APIs, and libraries should consider their carbon emissions. Efficient algorithms with linear time complexity and compiled languages like C and C++ are preferable to energy-intensive interpretive languages like Python. For instance, Python takes up as much as 76 times more energy than C. Making AI greener involves developing and using less power-consuming ML models, creating reproducible code, and using specialized hardware optimized for AI workloads.

Monitoring real-time power consumption through dynamic code analysis is crucial for understanding the gaps between design choices and actual energy profiles. From a design perspective, the libraries

chosen significantly influence energy efficiency. Organizations should challenge assumptions about end-user expectations and reduce file sizes of text, images, and videos during design.

While many aspects may be beyond the control of individual developers, organizations should embed these principles into their frameworks.

Sustainable architecture and workload management

Properly architecting applications' energy consumption requires reducing the application footprint and designing with the right architecture. Efficient cache policies, minimized data exchange, and managing the lifecycle of stored data contribute to reducing energy consumption. Running applications in more efficient data centers, powered by recycled or renewable energy, further minimizes the overall carbon footprint.

Green coding principles also involve the intelligent orchestration of workloads. Embedded carbon poses a significant threat, and efficiently managing workloads reduces the need for new hardware. Developers can contribute by implementing instrumentation, measuring the carbon footprint during both application development and deployment, and monitoring real-time energy consumption to identify modules that can be optimized.

Writing energy-efficient software is challenging. It requires a shift in mindset for developers and designers. Achieving progress in sustainability needs action at multiple levels. While developers can reduce carbon emissions by implementing some of the best practises and being aware of the environmental impact of their choices, organizations can make environmental sustainability by having a green coding framework and evaluating its performance based on energy efficiency, alongside traditional parameters. Embracing green software development practices allows developers to make a significant contribution to environmental sustainability, reducing the carbon footprint of software solutions through optimized energy efficiency and resource management, sustainable development practices, and user education. Every step counts in this collective effort. Even single optimization can make a significant impact on the environment.

How to measure the carbon intensity of software

According to Green Software Foundation, to calculate the operational emissions associate with software, multiply the electricity consumption of the hardware the software is running on by the regional, granular marginal emissions rate. The marginal emissions rate reflects the change in emissions associated with a change in demand.

Testing formula for Sustainability

$$SCI = (E * I) + M \text{ per } R$$

Where:

E = Energy Consumption (kilowatt hours) for different components of the software boundary over a given time period

I = Emissions Factors – available from GHG Protocol, but should be tracked down to the regional level if possible

M = Embodied emissions data for servers, laptops and other devices used in the relevant area.

R = Functional Unit being used (e.g., CO2e; days; etc.)

Putting principles into practice

What you can do

Architect: Engineers and architects have to work more closely together to produce the most sustainable code. Architect should choose the best possible framework.

Developer: They can control code reuse, select patterns, choose language and how to build CD/CI release trains. Developers can also utilize IDE plugins and other tools to monitor electricity use in real time.

Tester: Testing and measuring application software's carbon intensity at various release and deployment cycles.

UX designer: Reimagine every step of the user journey and design process infused with sustainability. User journeys should be under constant review and improvement.

Infra architect: Adopt shared and managed services model to reduce amount of infra needed.

DevOps engineer: Should have clear test goals. Deploy DevOps processes that will support environmental testing in CD/CI cycles, utilizing standard industry.

Summary

As technology adoption continues to accelerate worldwide, the software industry's contribution to global carbon emissions is increasing. To mitigate its environmental impact, the industry needs to embrace sustainable practices, including green coding, the use of energy-efficient algorithms, and low-power hardware. It must address subpar coding standards, and implement a green strategy, guiding trade-offs and setting standards to prolong device lifecycles. Developers play a crucial role in this shift, employing strategies like code optimization and algorithm selection to minimize carbon emissions. With an emphasis on efficient architecture and intelligent workload orchestration, the industry's significance in promoting environmental sustainability becomes apparent.

03

Empowering industries: The rising significance of industry clouds

Abhinav Johri
EY India Technology Consulting Partner

> Industry clouds deliver solutions that fit the most critical use cases within specific sectors.

In brief

- The emergence of industry clouds reflects a shift towards sector-specific growth in the public cloud landscape.
- Industry clouds prioritize vertical integration, aligning with the unique requirements of sectors such as BFSI, healthcare, and telecom, offering a comprehensive ecosystem.
- Sovereign clouds address industry-specific security and compliance requirements for seamless workload migration.

Fueled by the ever-growing need for speed to market, automation, unified technology experience and access to innovative technologies like Generative AI, the public cloud market is booming. Recent reports show that a staggering 60% of corporate data now resides in the cloud, compared to just 30% in 2015. However, as companies worldwide embrace cloud solutions for data management, many discover that general-purpose offerings fall short of addressing their industry-specific requirements.

This gap has paved the way for industry cloud platforms, tailored to deliver solutions that fit the most critical use cases within specific sectors. Unlike the horizontal approach of generic clouds, industry cloud platforms, also known as vertical clouds, are designed with the unique needs of industries in mind. Instead of a one-size-fits-all approach, they offer a curated collection of cloud solutions and applications specific to industry.

Why industry cloud?

Industry cloud solutions prioritize deep integration and vertical alignment, catering to the specific business, operational, legal, regulatory, and security needs of an industry. Instead of aiming for broad applicability, they focus on maximizing value within well-defined industry parameters. Such parameters can range from providing infrastructure stack compliant to regulatory requirements to software with out-of-the-box business processes aligned to the value chain.

Beyond just tailored solutions, industry clouds offer a curated ecosystem of innovative tools, applications, and datasets. These elements flawlessly integrate with the full range of cloud services, including Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS). This creates a comprehensive, ready-to-deploy stack that empowers companies with superior agility in managing workloads and go-to-market.

Since industry clouds come pre-loaded with solutions and best practices of specific industries, they streamline implementation, saving businesses time and effort. Additionally, cloud service providers (CSPs) offering industry clouds have deep expertise in industry-specific regulations, data protection, and security needs. They integrate these compliance rules directly into their cloud solutions, known as sovereign clouds, which offer businesses greater control and ownership over their data. This ensures data is stored and managed according to local regulations and laws, often including keeping data within specific countries or regions. Sovereign clouds also address industry-specific security and compliance requirements, providing both infrastructure and tools for seamless workload migration. It is a massive opportunity as the focus on sovereign clouds can empower Indian data center businesses to become leading indigenous CSPs.

Built upon technologies designed for immediate business deployment, industry clouds promote shared resources by allowing multiple organizations to utilize the same underlying infrastructure. A shared resource model promotes more efficient utilization of computing resources, resulting in lower overall costs for the organizations involved. CSPs offering industry clouds further contribute to a smoother operational environment by providing automatic software updates and conducting behind-the-scenes maintenance, significantly alleviating concerns and expenses associated with downtime.

That said, industry clouds are neither a new concept nor a new solution. But their relevance in the current times, when being digital for legacy or a modern business is an existential need, has steadily increased. As a result, major CSPs rose to the top of the cloud industry and smaller cloud providers became industry specific. Major cloud service providers now offer industry clouds as a solution for specific types of enterprises. This is a logical progression in their service portfolio as more customers subscribe to cloud services and seek to maximize the value of their investment.

Sector adoption

Prominent early adopters of industry cloud span diverse sectors, such as telecommunications, IT services, banking, and discrete manufacturing industries. Following closely are professional services, investment, and insurance sectors. Non-traditional sectors such as media and agriculture are now embracing industry clouds. Although agriculture remains an emerging sector, its applications include curated solutions for managing crop data, predicting weather patterns, and optimizing a farm-to-fork supply chain.

Below we discuss a few advantages of industry cloud for various sectors.

BFSI: Banking-specific solutions enable targeted upgrades of various banking systems, minimizing risk. Payment modernization solutions enhance efficiency in operations teams with real-time payment data, allowing customers to send money seamlessly. Insurance-specific cloud solutions offer advanced analytics that combine financial, actuarial, investment, and risk data to drive better decision-making across the enterprise. By linking legacy systems with modern applications, insurance-specific solutions can also reduce the need for physical property inspections during underwriting while improving accuracy through AI-powered property analysis.

Energy utilities: These solutions support the entire customer journey from lead generation to field service, offering a unified view of customers and connected products for manufacturing clients. They also enable the implementation of smart grids, enhancing the monitoring and control of energy distribution networks. By leveraging advanced analytics and connecting various technology platforms, energy utilities can gain insights into risks and operational costs, optimize assets, manage portfolios, implement proactive maintenance, and more. This ultimately leads to faster returns on IoT investments and accelerates smart factory transformation.

Healthcare: Protecting sensitive patient data is paramount for healthcare companies. Cloud solutions tailored to the healthcare sector provide a secure and patient-centric cloud-based platform that enables remote monitoring, real-time patient data collection, and innovative patient engagement techniques, improving the overall clinical experience. These solutions leverage advanced analytics for population health management, predictive

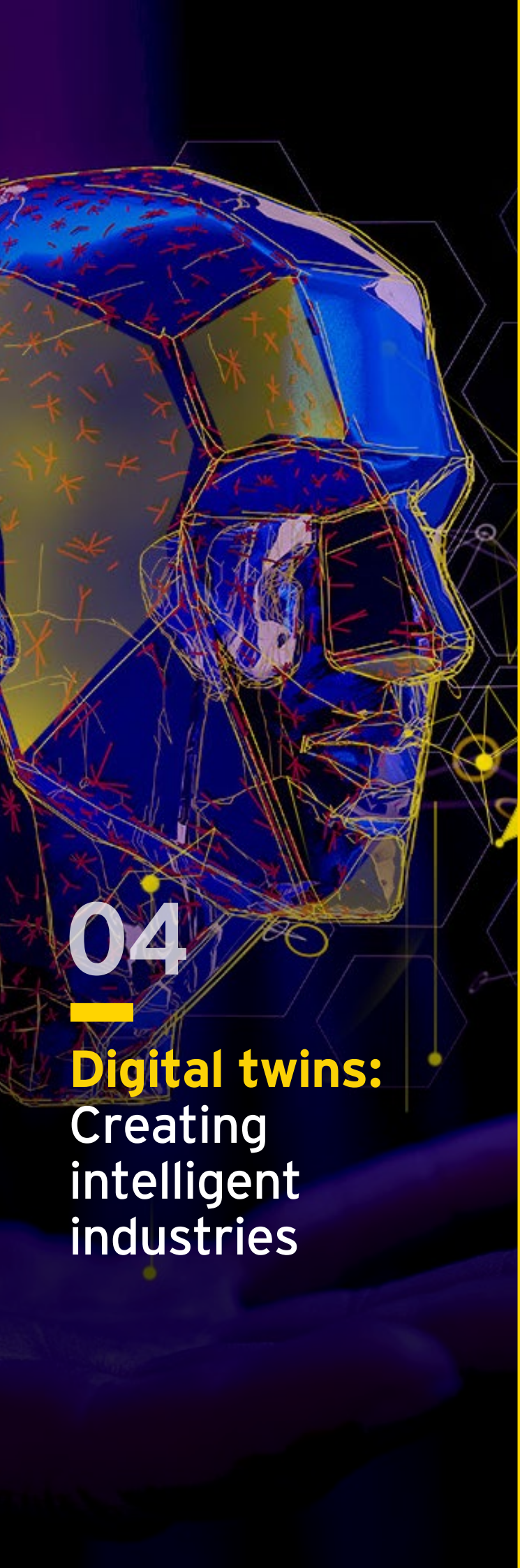
analytics, and personalized medicine, all while adhering to strict healthcare regulations to ensure patient data privacy and security.

TMT (technology, media and entertainment, and telecom): Industry clouds offer specialized infrastructure services that streamline the software development lifecycle with integrated tools for coding, testing, and deployment. They also feature built-in cybersecurity capabilities for advanced threat detection, vulnerability assessments, and compliance management, helping TMT organizations protect their IT assets. For telecom companies, specific cloud solutions provide tools for optimizing network performance, managing traffic, and ensuring high availability, enabling them to deploy new services such as 5G-enabled applications.

While each industry — and the companies within them — is unique, it is crucial to identify the vertical CSP that provides solutions suited to their business needs, minimizing data risk. As the industry cloud technology is still in nascent stages, companies should thoroughly evaluate solutions before selecting a vertical cloud provider to safeguard their data and access best-in-class services.

Summary

Industry clouds empower organizations to integrate components from Cloud Service Providers (CSPs), focusing on vertical integration for various sectors. They offer tailored solutions, emphasizing vertical alignment with business, legal, and security requirements. They create comprehensive ecosystems with modernized tools seamlessly integrated into SaaS, PaaS, and IaaS. These clouds streamline business processes, featuring pre-configured solutions, and adhere to industry-specific regulations. Notable sectors adopting industry clouds include telecommunications, banking, energy utilities, healthcare, and technology. The technology is still evolving, urging companies to carefully assess solutions for data protection and optimal services.



04

Digital twins: Creating intelligent industries

Ram Deshpande
EY India Technology Consulting Partner

> Digital twins will redefine industries but require meticulous implementation.

In brief

- The global digital twin market, valued at nearly US$9 billion in 2022, is projected to reach US$137.67 billion by 2030.
- Component twins analyze, optimize designs; system twins predict component interactions; process twins reduce defects and enhance productivity.
- Digital twins are applied across sectors with significant adoption by original equipment manufacturers (OEMs) and in new manufacturing operations.
- Organizations should develop concrete roadmaps, conduct proof-of-concept (POC) projects, and ensure full-scale implementation with continuous monitoring.

If the consumer metaverse was creating all the buzz in 2022, the year that followed has seen Generative AI (GenAI) take center stage. But away from the limelight, digital twins, the foundation of the enterprise metaverse, has matured as a technology and its use cases are going up in multiple sectors.

In fact, the global digital twin market had reached almost US$9 billion in 2022, with 29% of global manufacturing companies having either fully or partially implemented their digital twin strategies – an increase from 20% in 2020, according to research agencies. However, it is projected to soar to US$137.67 billion by 2030, which translates into a CAGR of 42.6%, as reported by Fortune Business Insights. The Asia-Pacific region is projected to grow faster, at a CAGR of 45.9%, led by countries such as South Korea, Japan, India, and China.

Unlocking efficiency

While there are many ways in which digital twin technology can be used, three main types have emerged, depending on purpose and scope.

The first is the component digital twin that helps in experimenting with new component designs before choosing the final one for production. These twins utilize digital counterparts to analyze, predict, and optimize the performance of individual components. They excel at assessing factors such as stress and strain in mechanical components, electrical load in electrical ones, or flow characteristics in fluid components, thus preventing premature malfunctions or breakdowns.

The second type can be termed as the system digital twins, and they provide a predictive analysis by offering insights into how components interact and perform together. They serve as comprehensive digital replicas crucial for predictive analysis and understanding of the complex interplay among various components.

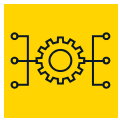
Finally, the process digital twins intricately model specific segments or entire manufacturing processes, providing highly detailed virtual representations. These advanced models play a key role in optimizing processes, increasing productivity, reducing defects, and ultimately adding significant value to operations.

It is critical to identify use cases relevant for the business and ensure early prioritization based on business benefits, availability of technology and skills. In addition, change management's impact to mitigate adoption risk is a critical consideration as organizations embark on this journey.

Diverse digital twin applications

Digital twins' applications vary by sector due to factors such as technology, network connectivity, skills, interoperability, data standardization, and governance. But OEMs are the biggest adopters, especially in new manufacturing operations. The automotive sector holds more than 15% of the market share of digital twin adoption, with significant demand in the electric vehicle (EV) segment. In fact, a global EV major employs component digital twins to monitor vehicle parts in real time and predict issues before they manifest. This enhances the overall lifecycle, safety, and performance of its EV cars.

Other early and heavy adopters include manufacturing, healthcare, infrastructure, smart cities, and agriculture sectors.



Manufacturing: Organizations are using virtual replicas of production lines, machinery, and factories to simulate and optimize processes, improving production planning, minimizing downtime, and reducing maintenance costs. A global aviation company is using component digital twins to predict 99.9% of anomalies in its jet engine parts, while a manufacturing company is using process digital twins to optimize various parameters, resulting in a reduction of

defective products by 75%. An oil company has deployed process digital twins to optimize the drilling process on its oil rigs, resulting in reported savings of up to US$1 million per day.

Healthcare: A medical center in the US is developing digital twins of patients' kidneys to improve surgical outcomes and provide enhanced training for surgeons. Similarly, an Indian healthcare company is utilizing this technology to develop patient-specific heart models, enabling treatment simulation and evaluation without invasive procedures. Personalized treatments are now possible by creating virtual patient models for precise diagnosis and treatment planning. To improve skills and minimize errors, surgeons are using process digital twins to simulate complex procedures.

Infrastructure and smart cities: Digital twins are being utilized to simulate human behavior, including crowd dynamics in urban environments or emergency scenarios, addressing critical political and societal decision-making needs. The Survey of India is actively creating digital twins of major cities that accurately mirror the urban landscapes and physical assets. These detailed models not only aid in city planning and policymaking, but also enhance disaster management efforts. Recently, the Indian government launched Sangam, an initiative focused on digital twins for future infrastructure planning and design, leveraging innovative integration of advanced technologies such as AI and 5G.

Agriculture and precision farming: While manufacturing and healthcare were early adopters of digital twin, agriculture is an emerging sector. Digital twins empower farmers with data-driven insights for precision farming. Virtual models of crops and farmland help optimize irrigation, fertilization, and pest control or can continuously monitor and predict a milch animal's poor health, equipment malfunction, soil dryness, or temperature change. With a significant portion of the Indian population reliant on agriculture for employment, adopting digital twins in this sector has the potential to modernize traditional farming practices and bolster food security.

A comprehensive table below describes more industry applications and various use cases that are getting implemented.

Sector	Type of digital twin	Use cases
 Discrete manufacturing	Product digital twin	Product design and prototyping
	Product digital twin	Production optimization
	Asset digital twin	Predictive maintenance
 Process and batch manufacturing	Process digital twin	Process optimization
	Product digital twin	Quality control
	System digital twin	Supply chain integration
 Healthcare	Patient digital twin	Patient monitoring
	Process digital twin	Surgical planning
	Biological digital twin	Drug development
 Construction	Project digital twin	Project planning and simulation
	Asset digital twin	Resource management
	Building digital twin	Building lifecycle management
 Public services	City digital twin	Urban planning
	City digital twin	Emergency response planning
	Infrastructure digital twin	Infrastructure monitoring
 Logistics	System digital twin	Supply chain optimization
	Facility digital twin	Warehouse management
	System digital twin	Fleet tracking and optimization
 Education	Campus digital twin	Campus planning and optimization
	Student digital twin	Student performance monitoring
	Learning environment digital twin	Virtual learning environments
 Telecommunication	Infrastructure digital twin	Network planning
	Asset digital twin	Performance monitoring
	System digital twin	Fault detection

Challenges in adoption

While digital twins offer significant opportunities, there are several challenges to successful implementation. Upgrading infrastructure and enhancing connectivity, particularly in rural areas, is crucial as unreliable or slow internet access hinders real-time data exchange. Security and regulatory compliance also pose hurdles, with rising cyber threats necessitating prioritization of cybersecurity measures. Interoperability and standardization across OEMs is critical for adoption and success of digital twin solutions. The shortage of skilled professionals in data analytics, simulation modeling, and cybersecurity underscores the importance of aligning educational programs with market demands. Moreover, the substantial upfront costs can be especially daunting for small and medium-sized enterprises (SMEs). Demonstrating return on investment and integrating with legacy systems add to the complexity, requiring meticulous planning and execution. Addressing these challenges comprehensively is vital for widespread adoption of digital twin technology in India.

Building a future roadmap

As the ecosystem matures, digital twins will redefine industries and innovation. Integration of GenAI and Internet of Things (IoT) will enhance predictive capabilities, further boosting effectiveness. We can expect increased collaboration between technology providers, businesses, and research institutions. Organizations should develop a concrete roadmap, understanding advantages and challenges, evaluating requirements and resources, partnering with experts, conducting POC projects, and testing and reviewing efficacy. Full-scale implementation with continuous monitoring and maintenance will ensure sustained functionality.

Summary

Digital twins have matured as a foundational technology, with diverse applications across industries. Digital twins, categorized into component, system, and process types, optimize efficiency and predictive analysis. Major adopters like automotive and healthcare leverage digital twins for enhanced outcomes, while infrastructure and smart cities utilize it for urban planning, enhancing disaster management, and future infrastructure planning and design. However, challenges such as infrastructure upgrades, security, and skill shortages must be addressed for widespread adoption. With GenAI and IoT integration, digital twins are poised to reshape industries, demanding meticulous planning and collaboration for successful implementation.

05

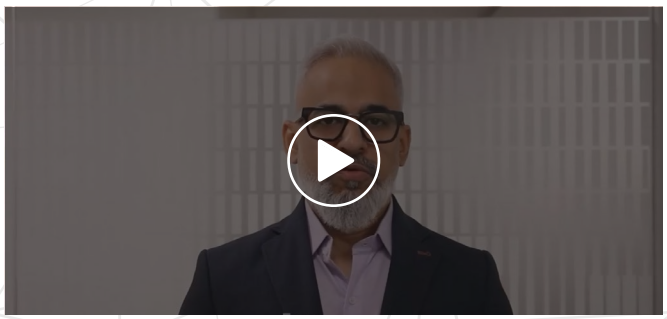
Responsible AI: Building a sustainable framework

Kartik Shinde
EY India Cybersecurity Consulting Partner

> Without adequate controls, adopting AI poses regulatory, reputational, and business risks to organizations.

In brief

- Responsible AI aims to identify and mitigate bias, ensuring that AI systems make fair and unbiased decisions.
- Organizations must revamp AI policies, establish trusted frameworks, and undergo trust assessment to adopt AI responsibly.
- Global AI regulations vary in scope and approach, reflecting the growing recognition of the need to govern AI technologies responsibly.
- Collaboration among stakeholders is crucial for navigating this complex landscape and realizing the potential of GenAI responsibly.



Recently, a Hong Kong multinational company lost over $25.6 million because of a deepfake video made using AI. The video avatar looked so credible that employees were convinced that they were talking to their CFO during a conference video call and proceeded to execute a series of transactions. Not only did the imposter appear authentic, but it also sounded convincing. In India, too, there are several reported cases of deepfake videos and AI-generated voices, including a recent case of a woman falling victim to an AI-generated voice fraud and losing money. In early 2024, two separate deepfake videos of star Indian cricketers went viral on social media. In the videos, their voices have been manipulated to promote an online game and a betting app. The intense competition surrounding AI development, with countries and companies vying for supremacy, has raised crucial discussions about responsible AI. The ascent of large language models (LLMs) is giving rise to urgent questions on the boundaries of fair use.

The concept of responsible AI is not new. Back in 2016, Big Tech companies banded together to establish a partnership on AI, laying the groundwork for ethical AI practices. However, as the GenAI landscape evolves, fresh and complex challenges are emerging.

GenAI risks

Risks associated with GenAI, especially in LLMs, include model-induced hallucinations, ownership, and technological vulnerabilities such as data breaches, as well as compliance challenges arising from biased and toxic responses. There have been recent examples of authors being credited with non-existent articles and fake legal cases have been cited by GenAI tools. Inadequate control over LLMs trained on confidential data can lead to data breaches, which, according to a recent EY survey, is the single biggest hurdle to GenAI adoption in India.

Toxic information and data poisoning, intensified by insufficient data quality controls and inadequate cyber and privacy safeguards, adds another layer of complexity, diminishing the reliability of GenAI outputs and jeopardizing informed decision-making. Additionally, the broader spectrum of technology risks of deepfakes to facilitate crime, fabricate evidence and erode trust necessitates proactive measures for secure GenAI adoption.

Potential intellectual property rights (IPR) violations during content and product creation also raise legal and ethical questions about the origin and ownership of generated work.

Other risks include:

- Bias and discriminationMisuse of personal data
- Explainability
- Misuse of personal data
- Predictability
- Employee experimentation
- Unreliable outputs
- Limitations of knowledge
- Evolving regulation
- Legal risks

Building guardrails against risks

To capitalize on the competitive advantage and drive business, GenAI models and solutions are implementing safety guardrails to build more trust. The tech giants have created the frontier model forum. Its objectives include advancing AI safety research, identifying best practices, and collaborating with policymakers, academics, civil society, and companies. The forum aims to ensure that AI developments are handled responsibly and deployed responsibly. A model's performance is evaluated and measured against designated test sets and quality considerations. Model monitoring and performance insights are leveraged to maintain high quality standards.

With various models evolving, implementing robust data governance policies that comply with privacy regulations will help companies mitigate risks. There are seven key domains to establish a robust framework and governance processes that align with industry-leading standards of responsible AI. These are business resiliency, security operations, model design development, governance, identity and access management, data management, and model security.

Such a framework assesses an organization's existing policies, procedures, and security standard documents to determine the adequacy of governance processes and controls associated with GenAI and evaluates implementation effectiveness.

Regulations so far

The growing need for AI regulations has resulted in a complex and diverse array of global regulations to navigate AI risks. China has been a forerunner in designing a new law that focuses on algorithm recommendations, including generative and synthetic algorithms. EU's AI Act is the first major legislation to stress on a risk-based approach. It categorizes AI applications into different risk levels, ranging from unacceptable to low and with high-risk applications subject to more stringent requirements. The law prohibits AI systems that pose an 'unacceptable risk,' such as those utilizing biometric data to deduce sensitive traits like individuals' sexual orientation. Developers of high-risk applications, such as the ones that use AI in recruitment and law enforcement, must show that their models are safe and transparent.

While India is developing its own law, the Ministry of Electronics and IT (Meity) has recently issued an advisory to AI platforms to take permission before launching AI products in the country. The government has asked intermediaries to tag any potentially deceptive content with distinctive metadata or identifiers to trace its source and thus aid in tracking misinformation or deepfakes and its creators. Meanwhile, in the US, the AI Executive Order directs agencies to move toward adoption with safeguards in place.

The G20 nations have also committed to promoting responsible AI in achieving the Sustainable Development Goals (SDGs). Additionally, 28 countries, including India, China, the US, and the UK, signed the Bletchley Declaration AI summit, pledging to address AI risks and collaborate on safety research. Also, HITRUST has released the latest version of the Common Security Framework comprising areas specifically addressing AI risk management. Along with the global agreements, Responsible AI needs local regulations as well.

Artificial Intelligence (AI) evolution has triggered multiple regulations across the world

Canada
- Publication: the Digital Charter Implementation Act, Bill C-27
- Date: June 2022

US
- Biden Executive Order
- Date: Oct 2023

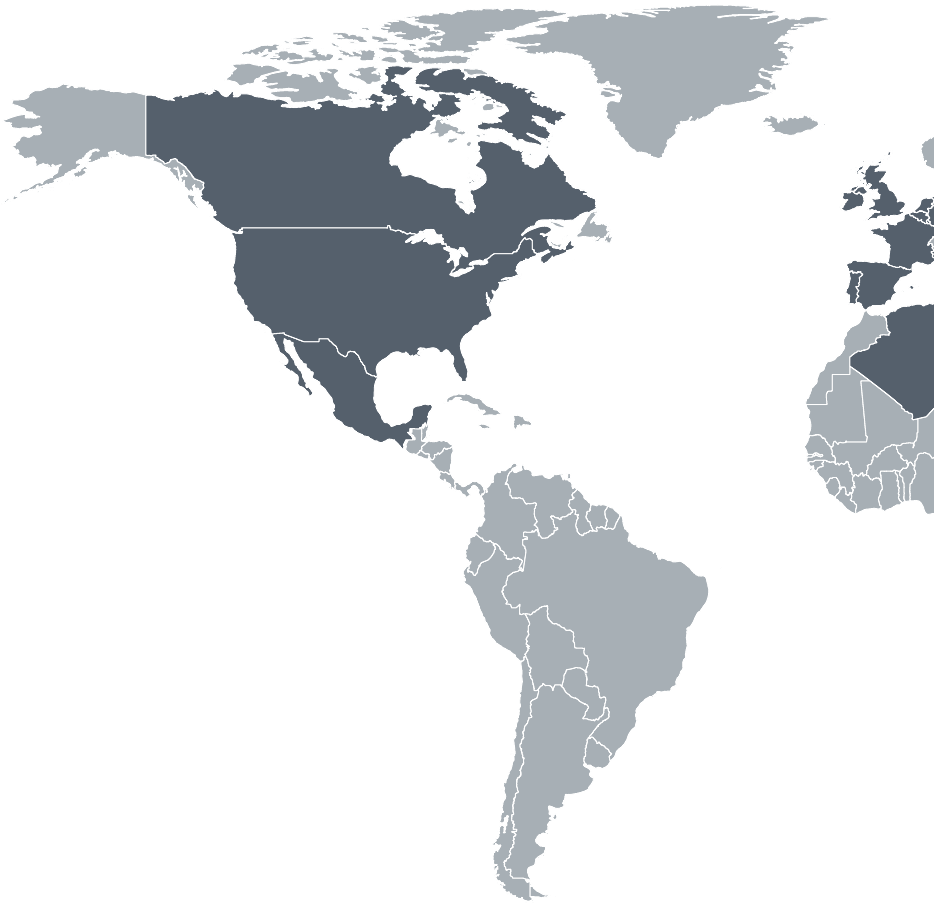
Mexico
- Law for the Ethical Regulation of Artificial Intelligence for the Mexican United States

EU
- EU Parliament voted on draft AI law
- Date June 2023
- Publication: the EU Artificial Intelligence Act (AIA)
- Date: April 2021

UK
- UK Launches AI regulation roadmap
- Publication: Guidance on AI and data protection;
- Date: July 2020

Germany
- Publication: AI Cloud Service Compliance Criteria Catalogue (AIC4)
- Date: Feb 2021

Saudi Arabia
- SA proposes AI regulation via the new Intellectual Property Law
- Date: May 2023



Scoring Factors
- AI regulations
- Data Regulations (data, cyber and privacy)
- Strategy, roadmap and investment
- Infrastructure and Tooling
- Skill and Education

Algeria
- Presented national strategy on research and innovation in AI
- Date: Jan 2021

South Africa
- Launches "AI for Africa" blueprint in collaboration with other African nations
- Date: Nov 2021

Ethiopia
- Finalizing the preparation of national policy on AI
- Date: June 2023

Rising global guidelines/regulations on Responsible AI signal urgency

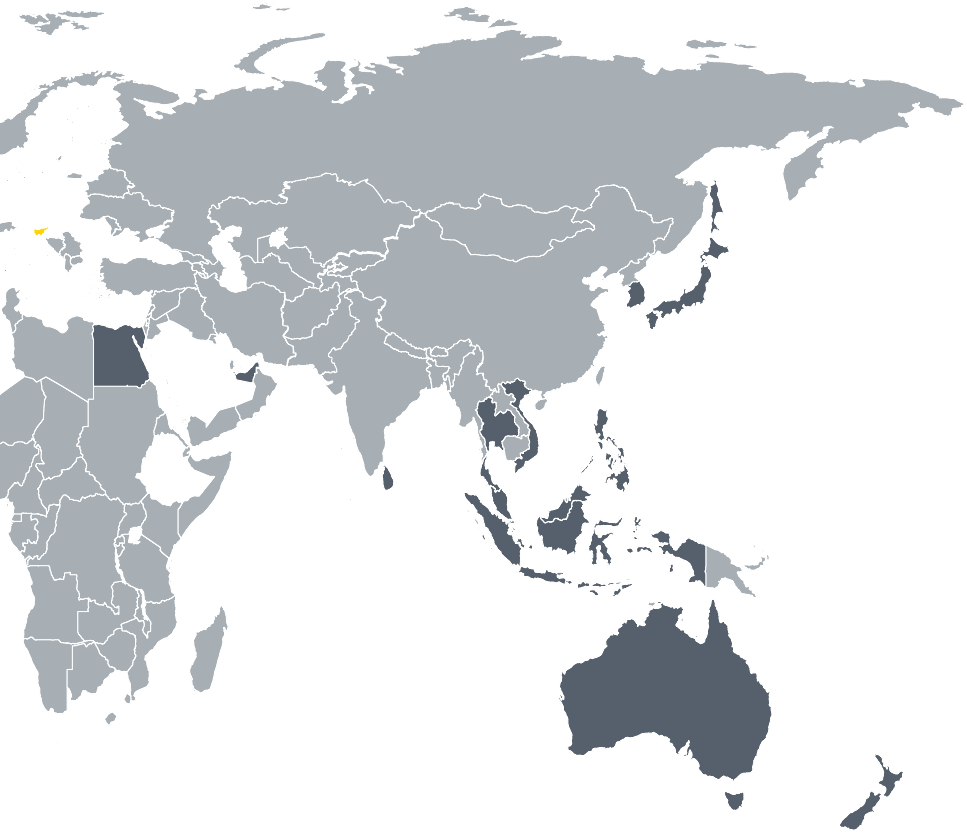
Egypt
- Egypt's National Council for AI announces the launch of "Egyptian Charter for Responsible AI"
- Date: April 2023

UAE
- UAE launches Generative AI guide
- Date: April 2023

Vietnam
- Instructs cross border platforms to use AI and remove toxic content
- Date: June 2023

S Korea
- PIPC publishes guidelines on personal data processing in AI
- Date: Aug 2023

Japan
- Amendment that allows level four automated driving
- Date: April 2023



Thailand
- ETDA proposes three new AI laws
- Date: Sep 2023

Philippines
- University of Philippines released draft set of AI regulations
- Date: July 2023

Indonesia
- MCI is drafting ethical guidelines for privacy protection
- Date: Aug 2023

Sri Lanka
- Announces 1 Billion fund for AI
- Date: Sep 2023

Malaysia
- Considering a new law to label AI generative products either "AI-generated" or "AI-assisted"
- Date: July 2023

Australia
- Royal Commission Report into Robodebt Scheme
- Date: July 2023

New Zealand
- NZ government releases Digital Strategy for Aotearoa
- Date: Sep 2022

Singapore
- Singapore and the EU signed a Digital Partnership
- Date Feb 2023
- Publication: the Model AI Governance Framework
- Date: Jan 2019

While governments are working on regulations, Big Tech and industrial bodies are implementing their own set of safeguards, including continuous monitoring and auditing, investing in cyber security measures, red-teaming GenAI models, using frontier AI models, reporting inappropriate uses and bias, watermarking on audio and visual content, and so on.

Responsible AI adoption: key steps

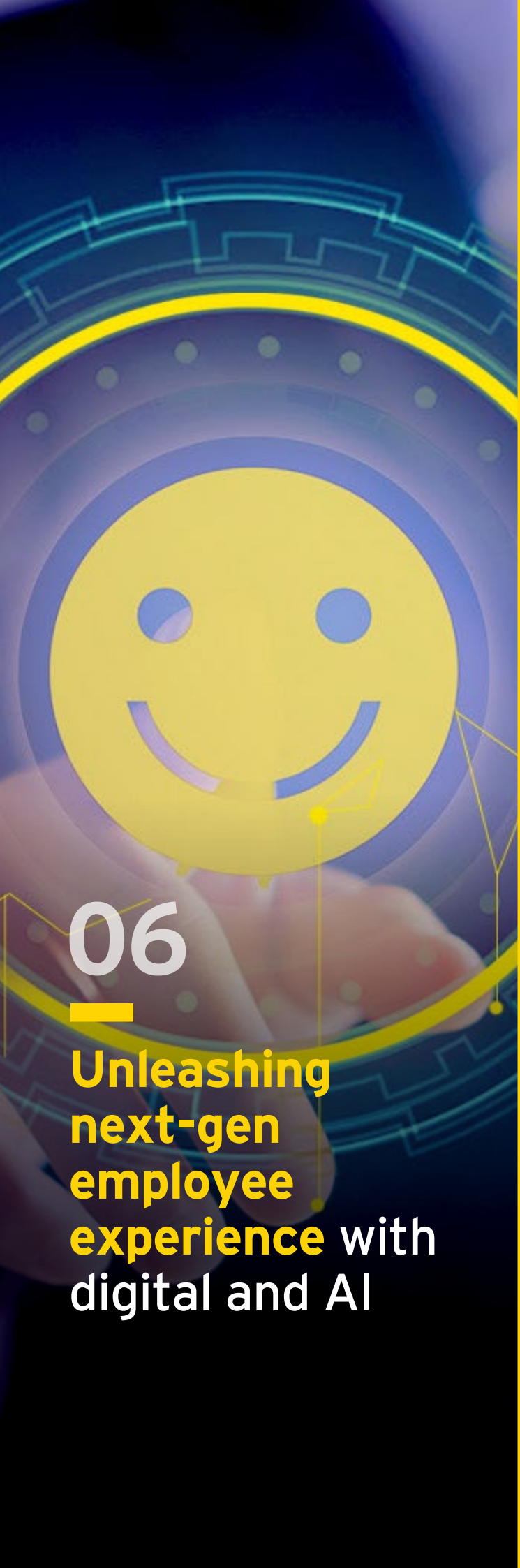
While countries are framing global agreements and regulations and models are implementing guardrails, organizations must consider several key points in adopting AI safely and responsibly.

- Redesign AI policies and design standards.
- Build a trusted AI framework for your organizational needs: Decide the type of AI appropriate for your organization, ensuring ethics, social responsibility, accountability and reliability. Creating trust in AI will require both technical and cultural solutions. This framework should emphasize bias, resiliency, explainability, transparency, and performance.
- Form GenAI ethics board: Ensure a diverse mix of legal experts, technology leaders, security innovators, and human rights scholars.
- Perform HITRUST Assessment: Conduct HITRUST certification assessment to demonstrate assurance of the security and operational controls within the AI system.
- Train employees: Deliver AI risk management training and ensure technical skill development for employees.
- Put in place a new data privacy and security architecture.
- Implement technology and data quality controls: Evaluate controls implemented for AI risk management and review current state to ascertain applicability of the National Institute of Science and Technology AI Risk Management Framework security and privacy requirement. Deploy tools to monitor cyber and data poisoning attacks, data privacy, monitor for hallucinations, manage third-party risks, prompt injections and malicious attacks.

Navigating the complex landscape of responsible AI requires a multifaceted approach. While technological advancements offer immense potential, mitigating associated risks necessitates proactive collaboration among governments, organizations, and global communities. Establishing trusted AI systems, fostering responsible AI development practices, and prioritizing human-centered design are essential steps toward harnessing the power of GenAI for a sustainable and equitable future. The journey toward responsible AI will require continuous learning, adaptation, and a commitment to ethical and inclusive practices.

Summary

Building trust in AI systems is essential for their acceptance and adoption. The risks associated with GenAI, particularly in Large Language Models (LLMs), include model-induced hallucinations, ownership disputes, and technological vulnerabilities such as data breaches, along with compliance challenges due to biased or toxic responses. Intellectual property rights violations, bias, discrimination, and legal risks are additional concerns. To address these risks, safety guardrails are being implemented, and regulations are evolving globally. Responsible AI adoption involves redesigning policies, establishing trusted frameworks, forming ethics boards, training employees, and implementing robust security measures.



06

Unleashing next-gen employee experience with digital and AI

Ajay Gachhi
EY India Technology Consulting Partner

> AI can revolutionize employee experience, placing humans at the center and shaping the future of work.

In brief

- The explosion of HR vendors and capabilities has led to a profusion of platforms within organizations. In this context, creating a single, consumer-grade digital employee experience is essential for fostering an engaged and empowered workforce.
- Digital and AI technologies, including GenAI, Intelligent Automation, Conversational AI, Big Data, social and immersive technologies, offer significant value across the entire hire-to-retire spectrum.
- Organizations investing in EX witness higher profits, revenues, productivity, and employee retention compared to those that do not prioritize EX.

The next-generation employee experience is pivotal for organizations striving to attract, retain and nurture top talent in a competitive landscape. Creating a single, consumer-grade experience for the organization's workforce, leveraging digital technologies, will positively impact every HR process and dimension of an employee's work life. Employee experience (EX) remains at the core of the Chief Human Resources Officer's agenda and a top focus for organizations today.

Companies that invest in EX witness compelling value compared to those that do not. They have been shown to have four times higher average profits and two times higher average revenues. Moreover, they are 11 times more likely to be featured on employee review sites as best places to work and more than two times as often among the World's Most Innovative Companies. Additionally, their teams are 21% more productive, and employees are 60% more likely to stay with their employer, as per EY analysis.

With the market evolving, the HR tech space is exciting, brimming with intense activity from thousands of vendors currently active. In 2023 alone, the space witnessed more than US$4 billion in startup funding and around 300 funding rounds. In addition, the space also witnessed more than 200 mergers and acquisitions according to various reports.

Deep personalization is key

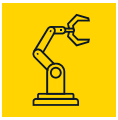
EX design uses the lens of 'significant moments' and 'personas' to envision the entire work life of an employee along with processes of an organization. It personalizes the design completely through these personas, weaving the hundreds of significant moments relevant to the persona as a digital journey. The personalization goes deeper by aligning fully with the employees' context, needs, objectives, behaviors, and personal preferences.

Thus, instead of a generic "one size fits all" approach, the EX design is akin to a personalized work design that constantly adapts, evolves, and improves for each organization and employee. With AI entering the HR space, EX personalization is only getting further accelerated.

How AI aids a quantum jump in HR and EX

AI is revolutionizing every aspect of HR and EX. With Generative AI (GenAI) entering the sector, CoPilots abound, and every AI dimension is evolving exponentially with tremendous business impact. While individual AI and digital dimensions are powerful by themselves, in combination, they are even more potent. Conversational AI, NLP are one example of how technologies work great together and build upon each other. Another illustration is the combination of GenAI, ML and analytics, among numerous other possible combinations.

A few additional examples of HR Process use cases leveraging AI include:



Robotic Process Automation (RPA): Robotic Process Automation (RPA) goes beyond basic automation. Intelligent Bots can handle repetitive, manual, high-volume tasks and offer a wide range of use cases. This allows employees, HR personnel, and managers to dedicate their attention to more value-added activities, thereby enhancing EX. RPA has hundreds of use cases across all functions including examples such as conducting pre-employment checks, processing department changes, drafting employment contracts, payroll streamlining, administering leave, reducing exit process redundancies, enabling timesheet submissions, managing tax deductions, enrolling in benefits, and many more.

Conversational AI, chatbots, and virtual assistants: These are fairly common now and have a big impact on engagement and EX. These technologies are evolving

and now going up the maturity curve to include learning capabilities beyond frequently asked questions (FAQs), such as problem-solving abilities, providing advice, incorporating NLP, handling both text and voice interactions, managing complex transactions, offering advanced features, advanced voice recognition, supporting multiple languages, conducting sentiment analysis, and many other evolving advanced features. They have the potential to reduce handling times by 50%, save a majority of processing costs, eliminate errors, maintain full auditability and 24*7 availability.

Machine learning and deep learning tools: These are self-learning technologies across machine learning methodologies like supervised, unsupervised, reinforced, and deep learning. Their use cases are in almost every process, and a few examples include enhancing employee engagement, recommending career paths, analyzing learning patterns, matching résumés to job descriptions, standardizing job roles, and targeted sourcing.

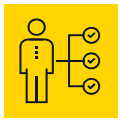
HR analytics: Deeply relevant and actionable insights with consumer grade interface dashboards enable great EX and hold relevance across every HR function. It includes adoption of intelligent and on-demand reports, dashboards, KPIs, balanced scorecards, and predictive and prescriptive analytics, alongside ETL (Extract, Transform, Load) tools, data science and big data.

Social and collaboration: As interactions within teams profoundly affect EX, organizations are using next-GenAI tools in social recruitment, learning, collaboration, internal networks, knowledge management, and immersive virtual working for hybrid and remote workers.

Gamification: This approach is being increasingly employed to enhance EX, engagement and participation. Applicability and usage examples include rewards for recognition, training, learning, recruitment, knowledge management, simulations, employee engagement, incentivization of process adherence and performance, points, badges, encouraging collaboration, leaderboards and microlearning based games.

AR/VR/XR-based immersive technologies: Immersive onboarding experience through VR and AR augmented by GenAI is used for familiarizing candidates with culture, teams, work environment and tasks. They hold benefits in job training immersions, 3D modeling, visual overlays in process steps, allowing safe learning simulations for dangerous and complex activities, recruitment in job scenarios, workplace virtual conferencing and collaboration, AR adding dynamic digital elements to conferencing, 3D avatars, spatial audio and advanced workforce engagement systems, among others.

IoT and connected enterprise: Some examples include smart workplaces, wearables, safety management, employee health, fitness trackers, automated attendance tracking, headset simulations, bias-free hiring, sentiment tracking, and productivity analysis.



Blockchain in HR: With the potential to reshape HR technology, use cases encompass résumé validation, background verification, smart contracts, learning education repositories, cross-border payments, international assignees, intellectual property, automated claims and many more.

Apart from these, there are additional examples of process use cases in HR with AI which are causing a deep impact on EX:

- **Recruitment:** AI tools can be used extensively in candidate relationship management, automated sourcing, talent branding, contextual search, strategic workforce planning, social and network

recruiting, JD creation and updates, candidate chatbots, video interviews with auto grading, candidate skill matching, résumé parsing, effective screening and predicting candidate success.

- **Learning:** Next-GenAI tools can be used to draw personalized learning paths, automate future skilling and reskilling recommendations, enhance continuous learning, microlearning, AR/VR/XR simulations, gamification, social learning, mobile learning, adaptive learning, curated content, intelligent learning needs analysis, AI learning coaches, learning retention, proficiency mapping, just in time learning, effectiveness measurement and assessment generators.
- **Talent management and marketplace:** Automated identification of skill and job gaps, skill-based resource management, career insight recommendations, succession and performance analysis, real-time continuous performance feedback, bias-free evaluations, automated career pathing.

Challenges and future

With the advent of GenAI, the EX landscape is undergoing a profound transformation. Amidst the plethora of tools available, organizations must strike a delicate balance, ensuring that the fundamental human touch inherent to HR remains central, while leveraging technology to enhance it. This necessitates a nuanced approach, wherein ethical and responsible usage of AI, potential bias and fairness, safety, data privacy, compliance, transparency, trust, consent, intellectual property and security are taken into consideration.

The HCM platforms space has become highly diverse, driven by evolving maturity, super specialization and intense digital innovation. Below is a summary of the different categories of HCM platforms. Given that organizations often deploy multiple platforms, there is an urgent need to deliver a single consumer-grade employee experience across all.

Experience layer platforms

These platforms have come to the fore since they allow all the diverse platforms to work together and give a single, seamless, consumer-grade employee experience. Some examples include ServiceNow, Applaud and Microsoft Viva.

Foundational HCM platforms

Every mature organization requires these foundational systems since these platforms hold the key masters, employee data and core HR processes apart from catering to the entire hire to retire lifecycle. Examples of Tier 1 vendors include SAP SuccessFactors, Oracle HCM, Workday and DarwinBox, among others, along with local HCM platforms.

Specialized digital and AI vendors for HR

These platforms leverage AI and digital capabilities to offer specialized HR use cases across every process but especially talent management. Learning innovative digital vendors include Eightfold.AI, Skyhive, Knewton and Saberr. Additionally, these vendors might also be GenAI vendors (OpenAI, Google AI, Anthropic), blockchain vendors (Bitwage, CareerBuilder, HireRight, Chronbank, Blockchain Helix), RPA vendors (Automation Anywhere, UIPath, BluePrism, etc.), or virtual agents (Amelia, IBM Watson, for example).

Employee engagement, listening and feedback vendors

These are specialized platforms designed to get feedback, work as listening posts and facilitate 360° employee engagement. Some of these vendors include Qualtrics, Glint, CultureAmp and Perceptyx.

Best of Breed HR platforms

These thrived through a process focus, created specialized white spaces and digital AI innovations and are now competing with core HCM platforms. The learning segment has morphed into several sub categories like LMS, learning experience platforms (Edcast, Degreed, Percipio, and other), learning content (for example, Coursera, Udacity, Skillsoft), learning gamification (Gametize, Axonify, for instance), assessment (Talview, Mettl, etc.)and microlearning (Grovo, Edustream, for example). Recruitment process has similarly created subareas like applicant tracking, candidate relationship management (Smashfly, Beamery, Talemetry, to name a few), candidate experience (Ideal, AllyO, Mya), sourcing (Arya, Entelo), assessment and screening (Hirevue, Pymetrics, Harver, for example). Similar Best of Breed vendors exist for every process of the HR value chain, including talent development, skills, compensation, payroll and onboarding.

HR Analytics Platforms

Though every HR platform has some reporting embedded in its scope, it is frequently transactional, siloed and limited. A specialized analytics platform is frequently enterprise wide and goes far beyond in aspects like data management, ETL, data warehousing, dashboarding, visualization, reporting, predictive/prescriptive analytics, collaboration, scalability, customization and flexibility. Some examples of these platforms include SAS, Business Objects, Tableau, Visier, and PowerBI.

Productivity, communication and collaboration platforms

These platforms are integrated into work to foster higher productivity. Examples include Office 365, Meta Workplace, Google Workspace, Slack, Teams, Miro and Mural.

Employee wellness, diversity and inclusion:

These specialized platforms are increasingly deployed at organizations. Vendors include HealthifyMe, Belong and Textio among others.

Summary

Progressive businesses prioritize human-centric approaches, focusing on enhancing employee experiences (EX) with digital technologies and AI. Investing in EX yields significant benefits, including higher profits, revenues, productivity, and employee retention. The HR tech space is thriving, with processes undergoing transformation on the basis of many AI-driven and other tools such as robotic process automation (RPA), conversational AI, machine learning, HR analytics, social collaboration, gamification, immersive technologies, IoT, and blockchain. These tools optimize several functions in recruitment, learning, talent management, and marketplace. However, as AI technology evolves, organizations must balance technological adoption with ethical considerations to create an engaging and enriching employee journey. Integration of digital EX across various HR platforms is essential for fostering an empowered workforce.

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