

LOW CODE, NO CODE: A MARKED MOVEMENT FOR DIGITAL PLATFORM DEVELOPMENT

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Low code, no code tools and platforms effectively accelerate the digital transformation of organizations. These platforms employ visual tools to define data, logic, flows, forms, and other application artifacts without writing codes. This enables users with little to no technical knowledge build customer and enterprise applications. Organizations achieve business agility and cost optimization through citizen development.

What can I help you with?

Traditional application development involves writing lines of code to create functionality and capabilities. This requires programmers to have indepth knowledge of computer languages, as well as development environments, deployment processes, and testing frameworks.

Low code, no code (LCNC) platforms typically feature reusable components with drag-and-drop features that a user links together to create desired applications without writing code. LCNC also increases the responsiveness of IT to meet business requirements. This boosts digital transformation, reduces time to market, and strengthens innovation by bringing ideas from the grassroots level.

Enterprises must consider the below when implementing LCNC tools:

- LCNC playbooks for guardrails and best practices to avoid improper use and scope creep.
- Governance, operations, and monitoring services for appropriate scale, adoption, and consolidation.
- Community development and collaboration for continued growth and adoption.
- Added security and privacy controls to ensure data loss prevention, regulatory compliance, controlled accessibility, and data visibility.

While the LCNC space is crowded, specialization areas mainly comprise developer productivity, user experience, citizen development for simple use cases, and high-impact enterprise applications.

Last year, organizations largely used LCNC applications to migrate and eliminate the existing shadow IT applications; short-term projects (3-12 weeks); and operational reporting and self-service applications.

This year, we see a marked movement toward enterprise-grade applications that perform complex functions. These applications have high volume workloads and need enterprise-grade security. Businesses adopt LCNC to accelerate innovation, escape legacy technology and process debt, increase IT responsiveness, and enable citizen development. The technology gained much attention in recent times and witnessed the following macrotrends:

- LCNC simplifies complex solutions: Many commercial-off-the-shelf (COTS) packages do not meet the required functionalities and goals. Here, LCNC helps create user interface (UI)/frontend layers. LCNC comprises rich UI components, multichannel support, reactive components, and integration capabilities.
- Facilitates business agility: COVID-19 forced businesses either adapt or shutter. LCNC enabled model-driven development to define new processes and experiences, helping return to work. The technology also facilitates loan processing through paycheck protection platform, supplier replanning, curb-side pickup for retail giants, and employee safety and business continuity tracker applications.
- Enhances cloud-native support: LCNC platforms enable cloud-native architecture, facilitating businesses to assemble modular niche cloud LCNC capabilities and string them together into a single use case. LCNC solutions also support one-click cloud deployment.
- Facilitates aggregation: LCNC increasingly focuses on aggregating experience and functionality across several cloud providers and multiple back-end systems. Further, the open-source ecosystem makes technology adoption more human-centric.
- Center of Excellence (CoE) model gains prominence: CoEs, with support from system integrators, smoothen LC platform adoption by setting up the right guardrails, governance strategy, and processes. CoE models also ensure successful parallel IT and applications proliferation, decentralization, and spiraling cloud costs are thwarted early in the project lifecycle.
- A bigger marketplace for LCNC: Finally, we also see app providers creating a richer marketplace of value-added components and artifacts, at once horizontal, vertical, and tool specific. PowerApps has over 1,250, and Infosys Bot Repository has over 15,000.

While these trends define the LCNC space in detail, we found that the LCNC space is divided into three broad categories: no code (NC, less than 5%), low code (LC, less than 20%), and business platform addons. These categories are dominant across five technology domains:

- **Experience design:** User experience (UX) prototyping approaches and experience as code.
- **Digital experience and application platforms:** Accelerated website/application development, sales and service accelerated approaches, digital experience platforms, LC approaches, and multiexperience horizontal application platforms.
- **Digital process automation and operations:** Business process engines, robotic process automation (RPA), and workflows.
- **Enterprise productivity:** Rapid application approaches for enterprise productivity.
- Data science and artificial intelligence (AI): Faster AI/data science development landscape and AI-powered application development.

Evolution across the three horizons (H1 to H3)

We have explored the evolution of LCNC across the three horizons (H1 to H3), spanning five technology domains: Experience design, digital experience and application platforms, digital process automation, enterprise productivity, and data science and Al.

Horizon 1 (H1) – Mainstream, legacy, or customer adoption greater than 70%

In H1, we saw the unification of unstructured data across enterprises, leading to rapid application developments, rule engine- based automation. However, LCNC at this stage was noncollaborative, as working in silos aimed at individual productivity, limiting some traditional processes.

Horizon 2 (H2) – Growing acceptance and initial successful implementation, but customer adoption less than 30%

Better collaboration, integration, and flexibility in this horizon result in team productivity. Cloudbased services provide better features, extensibility, standardization, and dependability. In this phase, we also see the usage of RPA and AI for process automation and application development.

Horizon 3 (H3) – Breakthroughs in technology begin to drive relevance, yet customer adoption less than 5%

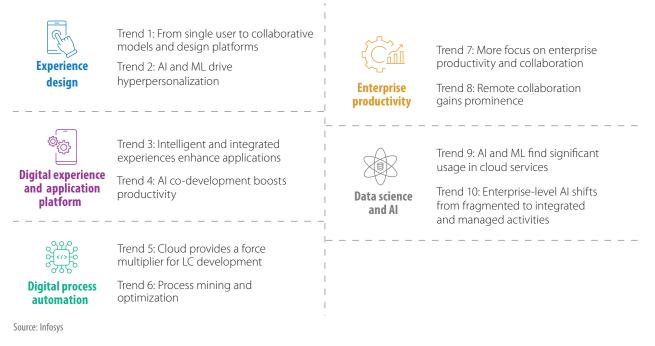
H3 is all about citizen developers building apps powered by intelligent AI capabilities that sense, analyze, respond, and evolve. These apps appear through different experience channels such as traditional web, mobile apps, voice, gesture, chat, and augmented reality (AR)/virtual reality (VR). We also see the emergence of hyperpersonalization, headless application development, pair programming, and machine-generated codes.

Figure 1: Market dynamics across the three horizons

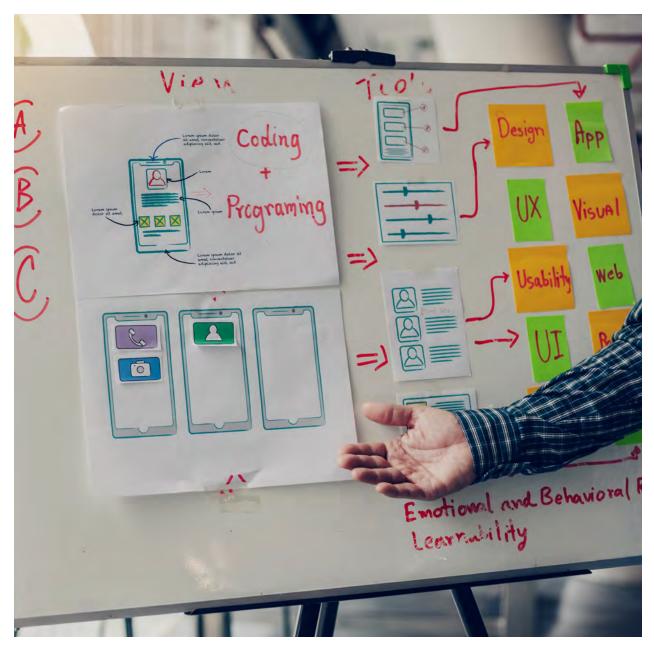
	H1	H2	НЗ
Experience design	• Traditional, individual user design	 Collaborative cloud-based design Data-based designs 	Hyperpersonalization designsOmni channel and Al augmented design
Digital experience and application platform	 Rapid application development Static HTML/CSS-based WYSIWYG editors 	 RAD with flexibility, extensibility, and standardization Enriched cloud services integrations 	 Out of box intelligence and prediction Al assisted development Headless application development
Digital process automation and operations	 Traditional business process management Rule engine-based solutions 	 Process automation augmented by RPA and AI Advanced process intelligence 	 FLUID DPA with capabilities to sense, analyze, respond, and intelligently evolve Intelligent decisioning augmenting
Enterprise productivity	 Personal productivity in silos Unification of unstructured data Apps to improve operational efficiency 	 Team productivity Integrated, collaborative, and always on Marketplace of prebuilt templates, workflows for repetitive tasks 	 Citizen development - with remote collaboration and cognitive apps Interaction-based workflow generation Drag and drop graph API
Data science and Al	 Traditional do-it-yourself (DIY) and take forward the learning Supervised, semi supervised, and unsupervised learning 	 Democratization of model training Domain agnostic and domain specific pretrained models Dynamic/Unsupervised active learning 	 Machines doing machine learning (ML) Machine generated code based on human instructions Pair programming

Source: Infosys

Figure 2. Key trends across LCNC platforms



EXPERIENCE DESIGN



As LCNC platforms move beyond exclusive enterprise usage, prototyping approaches greatly influence experience design. This enables in testing and communication of simulated products. Tools facilitating prototyping have become more reliable and easier to learn. This, in part, causes a "rise of the machines," where Al plays a dominant role in design.

Design prototyping earlier involved low fidelity, lone designers working with teams offline, which made

testing and development a manual effort. Today, reusable components and collaboration capabilities built into design artifacts help realize prototypes quickly. Data is now used to drive iterations on the design, and the experience itself has transformed into conversational interactions on the go. From this paradigm shift emerged the idea of experience as code, where intelligence automates the production of design, making it a truly LC experience design.

Trend 1: From single user to collaborative models and design platforms

As the experience shifts from the web to mobile, voice, and other forms, there is a need to integrate different strands of expertise from design, tech, and business. Today's applications demand closer collaboration between stakeholders across businesses, technologies, designs, and end users. Feedback and reviews trigger iterations on the design, which flow back into the design as part of its lifecycle. With better collaboration and reduced feedback loops, today's design tools have shifted from designer-centric to user-centric. Tools like Adobe XD, InVision, Sketch, Figma, and Axure feature team-centric sharing models for designs and prototypes, as well as a single-workspace collaborative model to provide feedback.

Another factor that brings in increased collaboration is the rise of experience as code. Here we see rule-based and AI services that automate the design-to-code flow for developers to use directly. These platforms enable designers, businesses, tech, and users collaborate impeccably. Leading examples are Sketch2Code, which creates wireframes from hand drawings; Flow. AI, which automates the generation of chatbots from design experience; Screenshot to code, which builds websites from design mock-ups; and Google AutoDraw, which recommends vectors faster from basic hand-drawn shapes.

Infosys has transformed the trucker experience with a mobile app for a US-based multinational transportation and contract logistics company that operates in 30 countries and manages supply chains for 50,000 customers.

Trend 2: AI and ML drive hyperpersonalization

LCNC platforms help create integrated, omnichannel experiences across voice, mobile, and web. These platforms automatically create UI with end-to-end API and data integrations. We can now generate screens based on images leveraging AI.

Further, design systems enable teams to manage every detail of the UI, equipping them with specifications that ensure usability and consistency. Streamlined workflows and Agile methodologies within the team reduce time to market. Resultantly, projects are completed on time and within budget.

Earlier, design discussions took longer since there was an element of visualization left to the stakeholders' imagination. How would it move, sound, and look in different environments? Today, designers can build in high fidelity with rich media and real behavior to improve sign-off and development time.

Infosys' employee platform creates a compelling workplace and a learning environment. It is an employee-centric platform with a positive impact on productivity, engagement, efficiency, and innovation. Over 350,000 Infosys' employees actively use this platform.

DIGITAL EXPERIENCE AND APPLICATION PLATFORM



LC emerged with 4GL, static what-you-see-is-whatyou-get (WYSIWYG) editors, and rapid application development (RAD) tools that built siloed, monolithic systems. H1 focused on rapid application development using point solutions.

LCNC platforms have seen rapid development with greater flexibility and standardization. They feature framework-based frontend strategies, studio development models, enriched cloud services integrations, and template-driven approaches.

As LCNC matures, LC will move quickly toward integration of out-of-the-box intelligence and prediction capability. Conversational commerce will involve AI-assisted development and cognitive capabilities like vision and speech. It will also enhance predictive intelligence by providing incident detection, action recommendation, and cluster analysis.

Multiexperience applications will integrate innovative cloud services and add more comprehensive capabilities to scale and govern citizen application development. We will see LC aggregation with integrated applications in customer experience, self-service, case management, business operations, and more. Digital experience platforms will become 100% headless with the help of progressive web apps (PWAs) and will feature user-friendly micro frontend experience layers and vertical solutions for B2C, B2B, B2B2C, and D2C applications.

Trend 3: Intelligent and integrated experiences enhance applications

Solving problems today involves a close collaboration of engagement, intelligence, and records systems. Multiexperience horizontal platforms like Outsystems, Mendix, and Microsoft PowerApps create seamless integrations between AI and intelligence in their LC application development strategies.

Mature LCNC platforms provide studios, enterprise connector pools, and continuous integration/ continuous delivery (CI/CD) deployment models. They increasingly focus on continuous testing (CT) by supporting for business-driven developmentbased test automation frameworks. They also come bundled with functional accelerators like self-service, case management, legacy modernization, business operations, and field service applications. They have experienced marketplace models that provide the flexibility to adopt solutions faster. Industry platforms for sales and service like Salesforce, SAP, Oracle, and Microsoft Dynamics have an insights-driven strategy embedded within the LC experience. For example, the Al-powered Infosys Enterprise Service Management Café is built on top of Infosys' ServiceNow platform and has over 65 industry recipe apps for clients.

The digital experience platform's LC strategies focus on omnichannel friendliness, standardized approaches, and connected experiences. Classic examples are digital commerce platforms like SAP Commerce, Magento, HCL Commerce, Salesforce Commerce Cloud, Shopify, and Infosys SKAAVA. These e-commerce providers embrace microservices-based headless approaches to provide maximum flexibility and agility with studio models and recommendation engines. Digital content management and marketing platforms (Adobe AEM and Sitecore) follow the same LC approach for rapid digitization, forms-based application development, and template-based brand portal development.

Enterprises need a well-defined playbook on the fitment of the strategy for the application lifecycle. They must establish stronger governance, operations, security, and monitoring mechanisms for scaled deployment, as well as a collaborative development model to ease community development.

An American multinational investment bank, in association with Infosys, enabled a multimedia conferencing asset management solution as a service powered by a platform model. The solution offers capabilities like real-time service management, intelligent preventive health check on resources, threat management, and JIT secured access token activation. This solution built on Infosys ServiceNow creates an experience for multiple B2C and B2E roles and integrates a wide variety of solutions.

Trend 4: Al co-development boosts productivity

Scale and agility are two core value propositions of any LCNC strategy. A rich studio environment enables to build applications faster and create a WYSIWYG experience.

Al-based co-development is a significant trend in multiexperience horizontal platforms. Examples of critical accelerations are in areas where the experience metadata and properties are auto-filled, development suggestions and recommendations are combined with integrated development environments, and alerts are created during development stages. We will soon see real-time semantic code analysis powered by Al and actionable recommendations, coding autocomplete models, Al-powered implementation review, and more. The direct benefit will be in multiapplication factory development models, where integration is needed for multiple backend systems.

Infosys delivered more than 12 reactive web and mobile apps in just four to five months for a Singaporean multinational telecommunications conglomerate. The company's time to market became five times faster and cost of development reduced by nearly three times.

A standardization-friendly approach that coexists with robotic pair programming models is essential for industry adoption. The critical patterns adopted by the platforms are:

- Industry-accepted frontend technology standards with the latest capabilities like PWA
- CI/CD support for platform-based development methodology
- Open, standards-based connectors
- Ability to integrate plugins
- Microservices-based core architecture

Extending the LCNC-generated code with open standards enables better business adaptability and builds broader acceptance and confidence among communities.

DIGITAL PROCESS AUTOMATION



Enterprises traditionally use LC process automation platforms for digitizing workflows. The model-driven environment has proven abilities of these platforms in process and case design, drag-and-drop UI, and easy integration with legacy data. Today, with a focus on building digital customer experiences, LC platforms are stepping up to deliver responsive processes and capitalize on market opportunities. Integrated support for Al-driven decisions and next-best-action help provide meaningful, relevant experiences. Intelligent automation combines robotics and cognitive AI services to reduce the burden of mundane, repetitive tasks and amplify productivity. Augmenting traditional test automation with RPA to address whitespaces in test automation coverage see wide usage, especially with multichannel applications.

Enterprises constantly respond to their shifting ecosystem and changing customer behavior. They require flexible processes to build a responsive business value chain and deliver tangible experiences. Infosys prescribes the approach and architecture of FLUID DPA, which integrates complementary capabilities from LC platforms across four dimensions – sense, analyze, respond, and evolve.

Sense – Real time awareness of the process through user and machine data

Analyze – Define the optimal processes using process mining, modeling, and document analysis

Respond – Automate processes with case design, robotics, and process workflows

Evolve – Fine-tune relevant decisions in the processes with Al-driven next-best-action decisions

Trend 5: Cloud provides a force multiplier for LC development

Cloud hyperscalers and market leaders invest heavily in pushing the boundaries of innovation in cognitive Al services such as vision, speech, language, and document interpretation. LCNC DPA platforms are in an ideal position to take advantage of the cloud as the enabler for the ease and speed of developing such functionalities. Let's say there is a requirement to create a customer-centric onboarding experience that shortens onboarding time. The LC solution will weave together the following processes:

- Vision services to scan and validate ID documents securely
- Decision services to make real-time underwriting decisions
- Automated routine data-update screens from third-party registries using cloud RPA
- Collaborative end-to-end process through a process management engine

With LCNC DPA, citizen developers build powerful, smart process applications. Infosys invested in unique solutions like FastApp and BotFactory to ease the development experience for citizen developers on DPA platforms. BotFactory is an Infosys catalog of several hundred microbot services. FastApp provides a simplified environment for users to import existing business process modeling notation processes. It offers tools like UI screen templates and interaction APIs to build configurable workflows.

Infosys built over 300 processes in only 10 months from SharePoint/IBM BPM/custom workflows to an open-source DPA platform leveraging Infosys IP and FastApp.

Trend 6: Process mining and optimization

In a complex modern landscape, any end-to-end process typically spans across multiple systems, steps, and people. This is especially true in the backdrop of multiple ERPs and diverse teams. Before optimizing the end-to-end experience or delivering business efficiency outcomes, one must first understand the issues that impact the experience. It is also critical to know where the process is broken and where to find optimization opportunities.

Process mining augments the DPA journey synergistically. Process mining platforms like Celonis allow business-oriented developers to build visualizations of the end-to-end journey along with a custom analysis. Process mining insights are connected to the right automation lever – a bot or a process workflow – to complete the Sense to Evolve cycle.

Infosys supports a Global Process Excellence CoE for an FMCG company to use process mining, modeling, and downstream automation for end-to-end process excellence.

Infosys helped the world's largest agriculture technology company in process discovery for the identification of inefficiencies and optimization opportunities in the O2C and I2P processes.

ENTERPRISE PRODUCTIVITY



Electronic devices such as mobiles, tablets, and laptops immensely support the remote working environment. This creates an increased demand for IT to develop enterprise-scale, multiform-factor apps to improve adoption and employee productivity quickly. According to Gartner, the demand for enterprise cwill grow at least five times faster than internal IT organizations' capacity to deliver. Employees have the flexibility to choose among devices, apps, and processes to complete a task.

Commercial apps have set the bar for user experience while enterprise apps lag significantly on ease of use, connectivity to backend applications, and time to market. The key reasons for this gap include an insufficient number of purpose-built applications and skilled developers, difficulty accessing business data spread across systems, a need for substantial customization, and the inability to cater to multiple user roles. As a result, productivity suffers.

LCNC platforms have transformed enterprise productivity. According to Gartner,¹ LC will form more than 65% of all app development by 2024.

Trend 7: More focus on enterprise productivity and collaboration

With hyperpersonalized experience, drag-and-drop UI build capability and ease of integration, LC platforms boost productivity by accessing data anytime, anywhere. LCNC platforms also offer LC bot build capabilities that employees can use for self-service applications.

A recent Forrester study² suggests that LCNC platforms can help enterprises save 70% of application development costs and efforts, approximately 38% in maintenance costs and thousands of worker hours.

Al and ML capabilities help employees make better and faster decisions with access to more information. LCNC apps are also expected to save compliance costs of organizations that use their inbuilt GDPR, HIPAA, and other compliance capabilities. Retailers and facilities management organizations increasingly adopt LCNC platforms with AR/VR capabilities and embedded prediction models.

A leading commercial and business banking services provider in the UK, with the help of Infosys, created a mobile regulatory compliance tool for its sales and relationship managers. Using Power Platform for over 7,000 managers across 58 countries, the company reduced administration staff costs by 50–60% and increased app adoption by 30% in less than five months.

A leading electricity distribution company in Australia, in association with Infosys, replaced its legacy enterprise procurement and sourcing platform with Power Platform. This enhanced service delivery experience for its customers, provided digital experience to its business users, and significantly reduced licensing costs. Standard Power Platform solutions fulfill more than 90% of the company's requirements.

Trend 8: Remote collaboration gains prominence

Enterprises rethink their ways of doing business post pandemic. While essential staff still work on site, almost 88% of the global workforce work remotely. Prior to the pandemic, only 20% worked remotely.

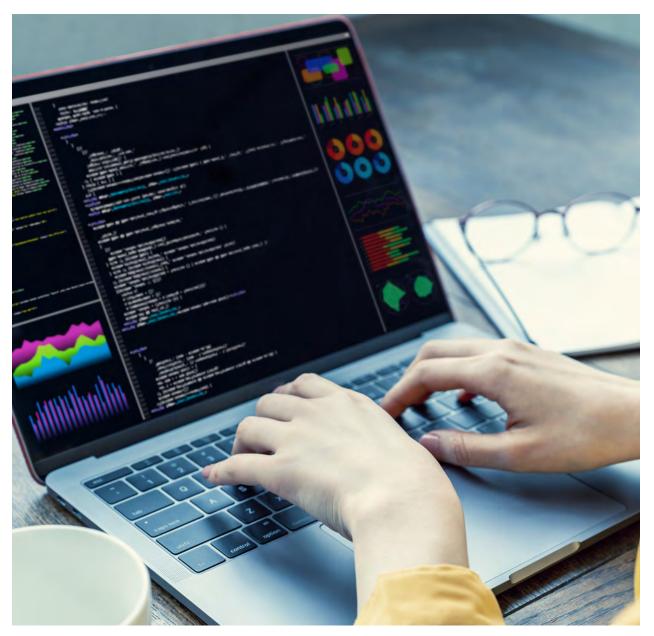
Greater visibility and orchestration have become more critical post pandemic. With remote collaboration, we see the "best in breed" of LCNC platforms coming together with their collaboration platform counterparts as a combined solution. Microsoft offers a holistic solution with Teams for communication and Power Platform for LCNC. It provides a tight-knit integration that gives employees the advantage to collaborate anytime, anywhere, and on any device. With citizen developers able to build apps, and an increasing set of connectors to these virtual platforms, productivity is at its best. As a testimonial to this, Microsoft's Teams subscriptions grew more than 70% to a total of 75 million daily active users. In the last six months, they saw a 250% increase in their Power Platform subscriptions.

Infosys helped a leading automobile manufacturer build a remote after-sales survey app for 80 dealerships. The automaker previously visited the dealerships in person to administer the questionnaires. Now it carries out the survey remotely through PowerApps and Teams. This resulted in low travel costs, more employee safety, and a 30% reduction in time previously spent reporting and digitizing the survey process.

For one of the largest grocery retailing companies in Saudi Arabia, which employs more than 25,000 employees, Infosys implemented an integrated communication platform. The platform facilitates two-way communication, where frontline employees and supervisors communicate and share information and messages seamlessly.

LCNC platforms have a tight-knit integration with collaboration platforms to serve as the digital foundation for information collection and consolidation. A manager can schedule an invite using an LCNC app, which triggers a Teams invite and shares the invite automatically with a distribution group without using corporate devices. Enterprises are now looking beyond document storage and sharing to consider all collaborative aspects of sharing, coauthoring, and virtually connect platforms.

DATA SCIENCE AND AI



Earlier, data science and AI experts performed most of the tasks in "do-it-yourself (DIY)" mode. Now in DIY mode, business users and citizen data scientists extract insights, perform exploratory data analysis, and find the best-fit model suggestions through pretrained models. Tools that perform ML ops/model ops have taken over the responsibility of model production and maintenance.

LCNC platforms are trying to bridge the gap between the increased demand for data scientists and ML

professionals and the lack of qualified candidates. Currently, these platforms help citizen data scientists address simpler use cases by applying generalized, mature algorithms and adjusting them based on the available data. LCNC platforms will widen the breadth and depth of available out-of-the-box algorithms and compute power going ahead. This will increase the democratization of the data science and Al arena, allowing more complex and niche areas for data scientists.

Trend 9: AI and ML find significant usage in cloud services

Analyzing massive amounts of unstructured data like images, transcripts, and recorded speeches is a top requirement for enterprises. It necessitates significant upfront investments in the compute and storage infrastructure to collect, cleanse, and tag the data for training and model building. Public cloud service providers (CSPs) saw an opportunity to provide pretrained models related to vision, speech, and language as platform as a service (PaaS) models. CSPs now offer fully managed cognitive services like AWS Comprehend Medical, Azure Form Recognizer, and Google Video AI. These services allow businesses to build cost-effective and faster-to-market solutions based on the latest AI/ML pretrained models.

Other cloud services like storage and information as a service (laaS) virtual machines will complement the solution build phase. But PaaS services imply a lock-in with CSPs. Proper design and use of containerization and cloud-agnostic code-building platforms create an easier exit path, if required. Developers and software service providers are building mature domain-specific solutions using CSP PaaS services and making them available in the analytics and AI marketplace.

Infosys uses the Azure Form Recognizer for automated processing of prior authorization requests received through fax or email in Infosys Healthcare Platforms.

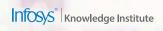
Trend 10: Enterprise-level AI shifts from fragmented to integrated and managed activities

Platforms and services that perform all the functions of a typical AI/ML implementation lifecycle help businesses move toward a more standard, managed, integrated and collaborative environment. Platforms like H2O Driverless AI, Azure ML, and Amazon SageMaker bring citizen data scientists and CSPs together. They collaborate on everything from ideas and code to implementation and best practices. The maturity in the platforms and services reduces concerns around people experience, complex use cases, and shadow IT scenarios. The auto ML feature of the platform reduces the effort in identifying the right algorithm for use cases. Users utilize the Integrated Ensemble feature to produce one optimal predictive model for a use case. IT service providers like Infosys built their own accelerators and tools like data advisory and AI workbench to aid clients' AI/ML journeys.

A leading US-based bank, in association with Infosys, built a self-service analytics tool to generate daily actionable insights of complex, multivariate data for customer segmentation, profitability, and campaign analytics to enhance its mortgage business.

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